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PRECAMBRIAN DYKE SWARMS FROM SIERRAS SEPTENTRIONALES (BUENOS AIRES PROVINCE, ARGENTINA): PETROLOGY, GEOCHEMISTRY, ISOTOPES AND THEIR PETROGENETIC SIGNIFICANCE.

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The southernmost Archean-Proterozoic cratonic area of South America are exposed in the Azul and Tandil region (Buenos Aires province, Argentina). This area represents the southern part of the Rio de la Plata Craton and is believed related to the continental collision between the Rio de la Plata and "Tandilia" plates (Teruggi *et al.*, 1988). Rio de la Plata Craton is intruded by two types of granites, the older (2.2-1.9 Ga) with relatively low Sr_i ratios (0.706-0.702, Varela *et al.*, 1988), the younger (1.8-1.6 Ga) with relatively high Sr_i ratios (0.718-0.730, Varela et al., 1988; Dalla Salda et al., 1992).

Basic, intermediate and acidic dykes intruded the metamorphic and granitic basement (Fernández and Echeveste, 1995). $^{40}Ar/^{39}Ar$ and K-Ar dating allow to distinguish the Early Proterozoic (2.0 Ga) andesi-basaltic, andesitic, and rhyolitic dykes, from Middle-Late Proterozoic (1.2-0.8 Ga) basaltic ones. The older dykes (D3 and D4 groups) trend E-W, have calc-alkaline chemical characteristics (Fig. 1), while the younger dykes, instead, have trend N30°W and correspond to tholeiites with low (0.9 to 1.7 wt.%) and high (1.7 to 3.7 wt.%) TiO2 content (D1 and D2, respectively; Fig.1).

The Early Proterozoic D3 - D4 dykes display incompatible trace element patterns with Nb and Ti negative spikes, enrichment in Rb, Ba, K (LILE) and La, Ce, Nd (LREE) with respect to E- and N-MORB (Fig. 2). MELTS modelling (Ghiorso and Sack, 1995) suggests that crystal fractionation occurred at low pressure (1 Kb), relatively high fO2 (QFM+2 $\log_{10}$ units) with max. H2O 0.5 wt.%. Mass balance indicates that source mantle of D3 mafic dykes would be enriched in LILE and LREE with respect to primitive mantle (PM). Isotopically, D3 and D4 (acidic) dykes have $^{87}Sr/^{86}Sr_{i(2.0\ Ga)}$ ratios ranging from 0.7029 to 0.7050 (εSr 12 to 41) as the old granites, and initial $^{143}Nd/^{144}Nd$ spanning from 0.5098 to 0.5099 (εNd -3 to -4). Nd-model ages of D3-D4 dykes suggest that the isotopic mantle enrichment would be occurred between 2.5-2.6 (TDM) and 2.3-2.4 Ga (TCHUR).

The low-Ti D1 dykes display incompatible element patterns similar to E-MORB excepting some incompatible trace elements enriched samples (D1a; Fig. 2). MELTS fractional crystallization modelling suggests low pressure (1Kb), low fO2 (QFM -2 $\log_{10}$ units) and low H2O (0.3 wt.%),. In general, mass balance indicates that D1 dyke source mantle was depleted in incompatible trace elements with respect to PM and with positive Nb spike with respect to La and K. Isotopically, D1 Middle-Late Proterozoic dykes have high $^{87}Sr/^{86}Sr_{i(0.8\ Ga)}$ (0.7057-0.7353) that only partly can be explained by crustal contamination

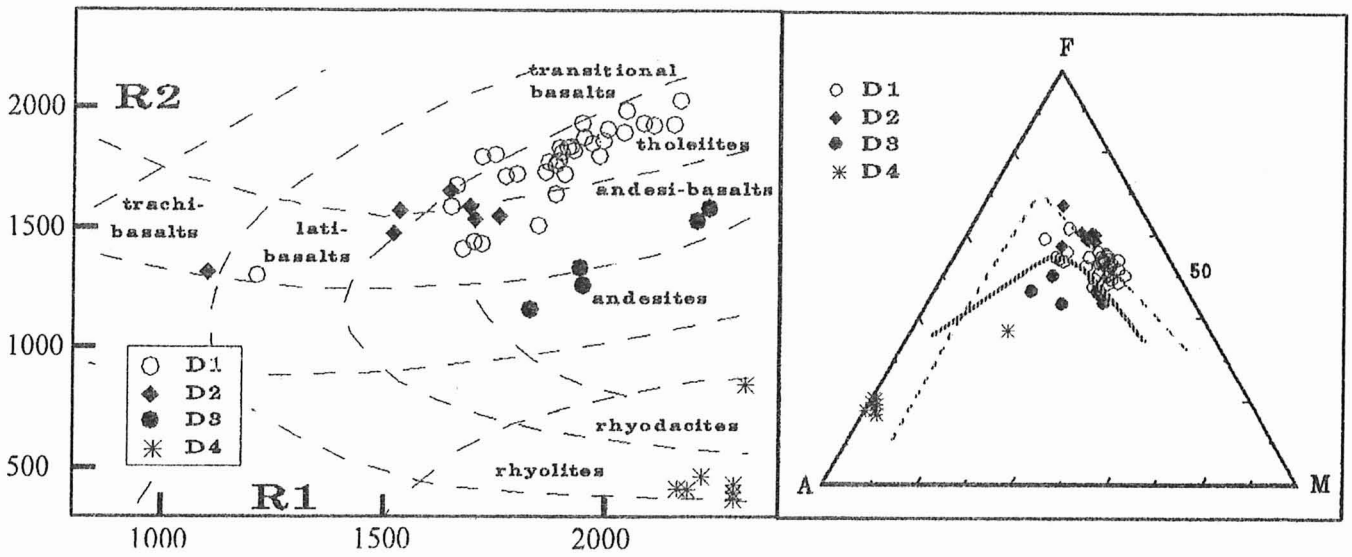

Figure 1: R1-R2 and AFM diagrams for the dykes.

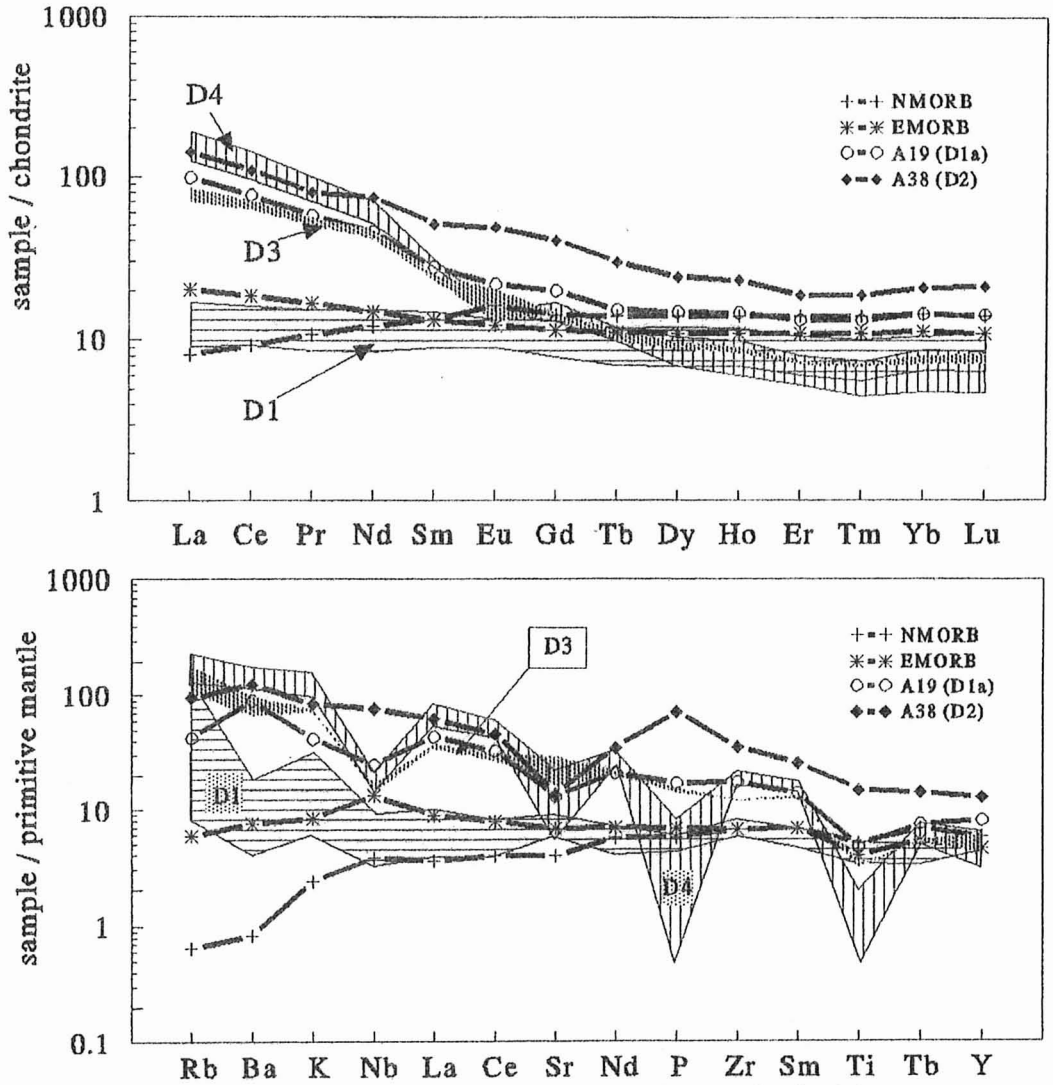

Figure 2: Diagrams of REE and incompatible trace elements for the dykes

(e.g. AFC). Nd isotopes reflect a time integrated source (εNd 5 to 7) for the dykes with the lowest $^{87}Sr/^{86}Sr_i$ (0.7057-0.7103). Initial $^{143}Nd/^{144}Nd$ difference between D1 and D3-D4 dykes demonstrate that the Nd isotopic depleted signature of D1 dykes could be related to the melting of residual mantle after the genesis of D3-D4 dykes at 2.0 Ga.

The high-Ti dykes (D2) have patterns of incompatible trace elements enriched with respect to E- and N-MORB. They show positive and negative spikes for P and Sr respectively (Fig. 2). MELTS modelling indicates that crystal fractionation would be occurred at virtually anhydrous conditions (H2O = 0.1 wt.%), low pressure (1 Kb) and low fO2 (QFM -2 $\log_{10}$ units). Notably, D2 dykes cannot be related to D1 dykes by crystal fractionation. Mass balance revealed that mantle source of D2 dykes was enriched in incompatible trace elements with respect to PM. Initial (0.8 Ga) $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ ratios suggest an isotopically enriched source mantle (εSr 34 to 153, εNd -8 to -16).

Chemical and isotopic differences between the Proterozoic dykes from Tandil and Azul areas reflect heterogeneity of their source mantle. The evolution of this heterogeneous, likely lithospheric, mantle could be resumed in following three stages model (Fig. 3):

a) Between 2.6 and 2.3 Ga, mantle metasomatic processes produced chemical (*e.g.* Rb and Nd) and the isotopic enrichment (with respect to PM and Bulk Earth respectively) and gave a calc-alkaline imprinting to the mantle derived melts.
b) At 2.2-1.6 Ga, during the Transamazonic Orogenic Cycle in a transextensional phase, occurred the intrusion of the granites and the D3-D4 dykes. The genesis of the D3-D4 dykes (2.0 Ga), as well as the old granites (2.2-1.9 Ga) believed derived from mantle melts, caused variable basalt-component extraction from the mantle. At the end of this stage (1.8-1.6 Ga), melting of lower crust portions may have been generated the young granites.
c) During Middle-Late Proterozoic, in an extensional tectonic phase, melting of previously depleted mantle would be the source of the low-Ti (D1) dykes. On contrast, the high-Ti (D2) dykes would be related to undepleted mantle portions.

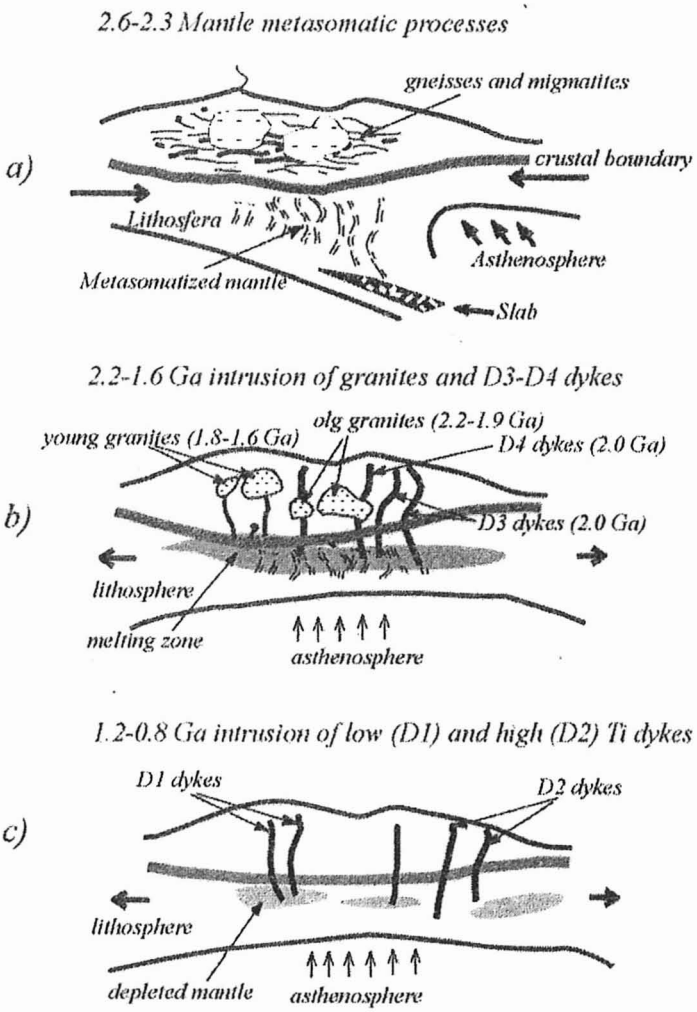

Fig. 3: Schematic model for the evolution of Tandil and Azul subcontinental mantle.

Middle Proterozoic (1.2-1.0 Ga) low- and high-Ti dykes similar to D1 and D2 dykes, are recognized in the Sao Francisco Craton (Salvador and Olivença-Ilheus-Itabuna-Camacà areas, NE Brazil; Bellieni *et al.*, 1991, 1998). D1-D2 and Middle Proterozoic Brazilian dykes emplacement suggests that large scale extensional tectonics occurred prior to the Brasiliano Orogenic Cycle.

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