GEOCHEMISTRY AND GEOCHRONOLOGY OF CALC-ALKALINE AND THOLEIITIC DYKE SWARMS FROM THE TANDILIA SYSTEM, ARGENTINA.

J.P.P. Pinese[1], W. Teixeira[2], V.A.V. Girardi[2], H. Echeveste[3], A. Ribot[3], R. Fernandez[3], M. Iacumin[4], E.M. Piccirillo[4] and P.R Renne[5].

[1] University of Londrina, Department of Geoscience. PO Box 6001 (86051-990) Londrina (PR), Brazil. pinese@npd.uel.br
[2] University of São Paulo, Institute of Geoscience. PO Box 11348 (05422-970) São Paulo (SP), Brazil. wteixeir@usp.br; girardi@usp.br
[3] University of La Plata, INREMI and LEMIT. Calle 52, PO Box 128. 1900 La Plata, Argentina. rfernand@isis.unlp.edu.ar; aribot@isis.unlp.edu.ar
[4] University of Trieste, Dipartimento di Scienze della Terra. Via Weiss, 8 (34127) Trieste, Italy. jacumin@univ.trieste.it; picciril@univ.trieste.it
[5] Berkeley Geochronology Center . 2455 Ridge Road, Berkeley, CA 94709, USA.

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The Precambrian crust of Sierras Septentrionales known as Tandilia System, Buenos Aires Province (Argentina), crops out in the southernmost part of Rio de La Plata Craton (Terruggi *et al.*, 1988). This system comprises metamorphic and granitic basement, which predominantly belongs to the Transamazonian Cycle (*e.g.* Varela *et al.*, 1988: Dalla Salda *et al.*, 1992), intruded by two distinct dyke swarms: one basic (**B**), and other intermediate (**I**) and acid (**A**) in composition. These dykes have mean widths from 1 to 80 meters and until 5 kilometers long.

The basic dykes (**B**) are characterized by ophitic to subophitic, sometimes intergranular textures. Common minerals are plagioclase [labradorite (An 52-53)], olivine and pyroxene. The latter is more commonly augite, subordinately pigeonite and/or orthopyroxene. Intermediate dykes (**I**) exhibit porphyrytic texture, composed of andesine plagioclase and Ti-augite. Acid dykes (**A**) show porphyrytic fabric and are constitued by plagioclase, alcali-feldspar and hornblende.

According to geochemical classification of De La Roche *et al.* (1980), modified by Bellieni et al. (1981), the **B** dykes are predominantly tholeiitic basalts and subordinately andesi-basalts. The **I** dykes plot in the andesite and andesi-basalts fields. The **A** dykes are classified as rhyolites. In the AFM diagram, **B** dykes plot in the tholeiitic field whereas both **I** and **A** dykes plot in the calc-alkaline field. The available geochemical data and field relations suggest that **I** and **A** dykes together, are related to single evolution trend (Echeveste *et al.*, 1997; Iacumin *et al.*, this volume).

Geochemically, averages of major, minor and trace elements, including REE, reveal significant variation among the tholeiitic and calc-alkaline groups. In general, the two groups of dykes present differences in terms of MgO contents (wt%), but within the tholeiitic group (**B** dykes), internal variations have been observed for similar MgO contents. The tholeiitic dykes with TiO_2 higher than 1.7 (wt%) are more enriched in P_2O_5, FeOt, K_2O, Ba, Sr, La, Ce, Nd, Zr, Y and Nb relative to those with TiO_2 less than 1.7. The calc-alkaline group (**I** and **A** dykes) have major and trace elements characteristics distinctive from the tholeiitic group. Moreover **I** and **A** dykes show higher mean values of SiO_2 (56 to 76 wt%), K_2O (1.0 to 4.8 wt%), Na_2O, Ba and Rb than those of the tholeiitic types, that otherwise have higher mean contents of TiO_2, FeOt, CaO, Ni and Cr. The calc-alkaline dykes are also characterized by REE patterns with [La/Lu]n ratios of 9.0 to 40.0, whereas the tholeiitic dykes have [La/Lu]n values of 1.3 to 2.8. The geochemical data therefore demonstrate that **B** dykes are genetically different from the **I** and **A** dykes.

Rb-Sr geochronology was carried out, by isotope dilution technique, on eighteen whole rocks from the tholeiitic dykes and ten whole rocks from the calc-alkaline dykes (five samples of each **I** and **A** dykes). The latter yield an errorchron of 2,112 ± 169 Ma (1σ), Ro = 0.70290 ± 0.05843, whereas the tholeiites yield an errorchron of 1,363 ± 167 Ma (1σ),

Ro = 0.70820 ± 0.05883. The extremely high errors showed in both linear arrays are due to the large data scatter, interpreted to be related from heterogeneous isotopic disturbance of the Rb-Sr whole rock systematic. However, we consider the unprecise Rb-Sr "ages" obtained to be indicative of minimum emplacement age of both dyke groups.

Interpretation of three $^{40}Ar/^{39}Ar$ and two K-Ar dates on plagioclase, biotite and whole rocks from the calc-alkaline and tholeiitic dykes of the Tandilia System, provides additional constraints on the dyke emplacement ages and the regional tectonothermal history. The emplacement age of the calc-alkaline dykes are estimated from two $^{40}Ar/^{39}Ar$ dates of outgassed biotites from baked country rocks that were sampled in sharp contact with the dykes. Both biotite samples yield step-heating plateau ages of 2,020 ± 24 and 2,007 ± 24 Ma (2σ) [Iacumin *et al.*, unpublished]. K-Ar dates on whole rocks samples of the tholeiitic dykes in the region, range from 803 ± 14 to 1,193 ± 18 Ma [Pinese *et al.*, unpublished], and $^{40}Ar/^{39}Ar$ data on plagioclase yield an age of 811 ± 36 Ma (2σ) [Iacumin et al., unpublished], but could be related to argon loss in accordance with the geological setting of the Tandilia System which rocks were partly deformed and metamorphosed during the Neoproterozoic (Dalla Salda *et al.*, 1992). On the other hand, it is noteworthy that the Uruguayan dyke swarm, Rio de La Plata Craton emplaced at 1,727 ± 10 Ma ago, as supported by detailed $^{40}Ar/^{39}Ar$ and Rb-Sr geochronology (e.g. Teixeira *et al.*, 1999). This age supports the idea that the Rb-Sr linear array herein obtained for the Tandil tholeiitic dykes (see above) is a minimum emplacement age.

Ten Sm-Nd whole rock determinations were carried out in calc-alkaline dykes (five samples) and tholeiitic dykes (five samples), by isotope dilution technique. The Sm-Nd (T_{DM}) model ages of the calc-alkaline dykes (2.53 to 2.63 Ga), provides a restrict time period for the rock protholiths. The $\varepsilon_{Nd\ (2.0Ga)}$ parameters yield slightly negative values between −4.83 to −3.19, supporting that the calc-alkaline rocks derived by means of partial melting of a probably metasomatic (lithospheric) mantle source. However, the tholeiitic dykes provided highly variable Sm-Nd (T_{DM}) model ages between 660 to 2,513 Ma, as we expected because their isotopic composition compared to the mantle array. We have tentatively modelled the ε_{Nd} for t_0=1.73 Ga (-5.82 to +12.93) and t_0=0.81 Ga (-15.63 to +7.54). The values suggest that the tholeiitic dykes are derived from an enriched and depleted mantle sources comparing to the Bulk Earth. In addition, this indicates a heterogeneity of the lithospheric mantle sources independently of the adopted age.

To summarize, available dates indicate that the calc-alkaline dykes clearly emplaced at 2,000 Ma ago, as supported by $^{40}Ar/^{39}Ar$ and Rb-Sr determinations. Tectonically they emplaced during a transextensional phase of the Transamazonic Orogeny, as already suggested by Echeveste *et al.* (1997). The tholeiitic dykes either late Paleoproterozoic (1.73 Ga ?) or younger (0.8 Ga ?), as suggested from Rb-Sr and $^{40}Ar/^{39}Ar$ determinations and regional correlations, but additional data are needed for testing these ideas. In anycase the unprecise emplacement ages suggest that large scale extensional tectonics occurred prior to the Brasiliano Orogenic Cycle, as suggested in Western Uruguay (Teixeira *et al.*, 1999; Bossi *et al.*, 1993) and in the Nico Perez terrane, Eastern Uruguay (Rivalenti *et al.*, 1995; Girardi *et al.*, 1996) .

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