

## PRECAMBRIAN TERRANES OF AFRICAN AFFINITIES IN THE SOUTHEASTERN PART OF BRAZIL AND URUGUAY

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The interest in correlating terranes at opposite margins of the South Atlantic Ocean reflects a natural curiosity of both researchers who work in the eastern South America and who study southwestern Africa. On a large scale scenario the geology of this region is characterized by a central portion composed of Neoproterozoic-Cambrian belts (Dom Feliciano, Kaoko, Damara, Gariep, Saldania) having on each side old gneissic-migmatitic terrains on both continents (Luis Alves, Rio de La Plata, Kalahari and Congo).

In South America the Neoproterozoic Dom Feliciano Belt (DFB) predominates in the eastern part of the region and is internally organized according to three different crustal segments characterized, from southeast to northwest, by a *Granite belt* (deformed I-type medium to high calc-alkaline granites and alkaline granitoid rocks; a *Schist belt* (volcano-sedimentary rocks metamorphosed from greenschist to amphibolite facies and

intrusive granitoids), and a *Foreland basin* (anchimetamorphic sedimentary and volcanic rocks), the latter situated between the Schist belt and the Archean-Paleoproterozoic foreland. Despite discontinuously covered by younger sediments, the NS continuity of these three crustal segments is suggested by similar lithotypes, structural characteristics, ages and isotopic signature, as well as by the gravimetric data.

The Major Gercino, Cordilheira, and Sierra Ballena shear zones are part of the major NE-SW lineaments that affect all southern Brazilian and Uruguayan Precambrian terrains. They separate the Dom Feliciano Schist Belt (supracrustal rocks of the Brusque-Porongos and Lavallega groups), to the West, from the granitoids of the Granite belt, to the East. The shear zones are characterized by a regional NE trend and a resultant oblique direction of movement where ductile-brittle structures predominate.

It is here postulated, as discussed later on, that this lineament separates terranes that are geologically, geochronologically and isotopically distinct, representing the main suture that separates the terranes of African and South-American affinities.

As observed in figure 1, it is considered in this article that the region of African affinity is constituted by the terrains located east of the Major Gercino-Sierra Ballena suture zone, being represented by two major units: the Granite Belt - outcropping along the whole eastern portion of the Brazilian southern region, and the Punta del Este terrain (PET) south-easternmost of Uruguay.

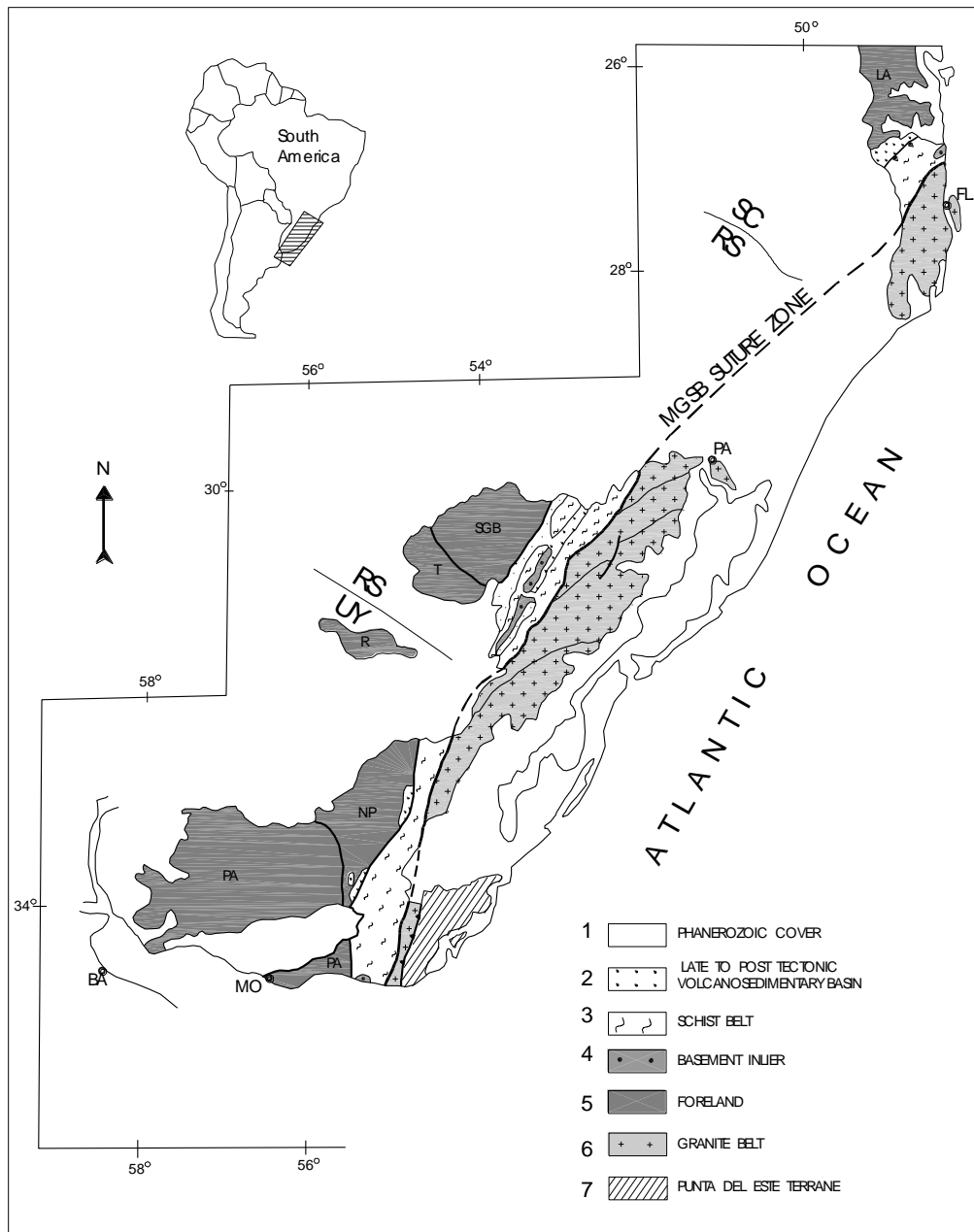
The Punta del Este Terrane (PET) is composed of a series of gneisses and migmatites formed in the 1000-900 Ma interval, according to Preciozzi et al. (1999; Basei et al 2000), intensely reworked during the Rio Doce orogeny (600-500 Ma). These authors proposed that the terranes situated east of the Alféres-Cordilheira Shear Zone should not integrate the Granite Belt, suggesting that this crustal segment represent in South America terranes related to the Namaqua Belt recognized in the southwestern portion of the African continent. Similar terranes have not been recognized in Brazil and Argentina. In PET, three major tectonic units can be characterized: a

gneissic-migmatitic basement, a low-grade metasedimentary cover (Rocha Group) and a post-tectonic series that includes alkaline granitoids and acid volcanic rocks. Considering that the PET basement correlates with the Namaqua Complex gneisses, the Rocha Group was tentatively correlated with the Gariep Group supracrustal units.

The Granite Belt magmatic development (between 620 and 590 Ma) would be associated with the generation of a mature magmatic arc with important crustal participation, generated from eastward subduction, evolving in a distinct geographic position and in a dissociated manner from the terranes located west. The probable back-arc basin for this belt would be situated on the African side (part of the Coastal Damara/Kaoko/Gariep belts).

The main argument to suggest that the plunge of the oceanic crust must have been east- and not westward, is the Granite Belt Sm-Nd signature, totally different from the pattern observed in the other South-American eastern tectonic domains. It is here suggested that this should also be the explanation for the isotopic similarities between the Granite Belt and the SW African magmatism. Model ages ( $T_{DM}$ ) for the Granite Belt are systematically younger

(between 1.2-1.7 Ga, clustering in the 1.4-1.6 Ga interval) than those for the Schist Belt units (granitic and metasedimentary rocks with values around 1.9 Ga) and much younger than those found in the Luis Alves- or even Rio de La Plata-type basement units (clustering around 2.5Ga).



**Figure 1- Fig 1 - Geological Map of Southeastern Brazil and Uruguay:** 1) Phanerozoic cover; 2) Foreland basins: Itajaí (SC), Camaquã (RS), El-Soldado-Piriapolis (UY); 3) Schist Belts and Intrusive granitoids: Brusque Metamorphic Complex (SC), Porongos Metamorphic

Complex (RS), Lavalleya Metamorphic Complex (UY); 4) Paleoproterozoic Basement inliers: Morro do Boi (SC), Encantadas (RS) and Punta Rasa (UY); 5) Foreland –Luis Alves Microplate (LA), Piedra Alta Terrane (PA), São Gabriel Block (SGB), Taquarembó (T), Rivera (R) and Nico Perez (NP), – 6) Granite Belt: Florianópolis (SC), Pelotas (RS) and Aiguá (UY) batholiths; 7) Punta del Este Terrane (PET)

### **Tectonic interpretation of the Nd model age data**

The Sm-Nd results are considered as good indicators of the source-area of the material involved in the generation of the analyzed rock and the occurrence of regionally uniform isotopic patterns may reflect common geologic histories. Model ages available for the Precambrian to Eo-Paleozoic terranes on both sides of the South Atlantic were used to construct the histogram in figure 2. This set of data broadly represents a W - E section.

An analysis of the histogram shows that there is a considerable decrease of the model ages eastwards, with african rocks presenting the youngest ages. This trend is even more evident when some discrepant ages due to problematic analyses (anomalous Sm-Nd ratios, etc) or by influence of the basement in the lower units of the metasedimentary pile (as the case of the Etusis Fm. of the Damara Belt) are eliminated. There is a concentration of

values around 1.9 Ga for the DFB Schist Belt, whereas for the Granite Belt the average age lies close to 1.6 Ga. In the context of the Damara belt younger values slightly exceed 1.1 Ga (mainly for the granitoids) but the average also falls close to 1.6Ga.

This similarity can represent a possible affinity between the source-areas of the materials of the Granite Belt and of the African side. It can be explained by the participation of similar sources (above the subducting plate) in the generation of these materials. Therefore, isotopic differences between the Granite Belt and those located west, even considering those of similar ages, corroborate to the suggestion that the lithosphere on both sides of the Major Gercino-Sierra Ballena suture zone should have different isotopic characteristics.

Therefore, if on the South-American side model Nd ages between 1.2 and 1.6 Ga are characteristics of the Granite Belt, values in the same interval are common in several

regions of the South-African portion. Mesoproterozoic ages predominate for the rocks of the Damara western portion (region between the Walvis Bay/Karibib/Huab River) with the Palmental-type calc-alkaline granitoids and intra-plate syenites to granites presenting model ages between 1.1-1.5 Ga (McDermott 1986; McDermott and Hawkesworth, 1990). A very similar pattern was also found for metaluminous A-type granitoids of the Damara central region (Jung *et al.* 1998).

Values in the same interval are equally common in the Neoproterozoic Mozambique Belt in Tanzania, where several metapelites and charnockites located in the eastern portion of the belt present Nd model ages between 1.1 and 1.5 Ga (Möller *et al.* 1998). On the other hand, Archean (Limpopo Belt, xenoliths in Kaapvaal and some of the basement nuclei within the Damara metasediments) or Paleoproterozoic (Namaqua and xenoliths within the deformed granitoids of the Namaqua belt) ages are characteristics of the rocks associated with the basement of the Neoproterozoic covers (Harris *et al.* 1987, Möller *et al.* 1998).

Part of the metasediments of the Damara (notably Rossing and Kuiseb) and Nama (mainly Kuibis and Schwarzrand) show Nd model ages similar to those obtained for the

Granite Belt, suggesting that this must have been an important source for these metasediments, reinforcing the model of an evolution in a back-arc basin environment for the Kaoko and Gariiep.

### **Final Remarks**

The geometric distribution and great part of the structural features presently observed in the tectonic units that compose the southern Brazil and Uruguay would have been generated in the Proterozoic-Cambrian transition, related to the collisional events that juxtaposed the different parts of Gondwana.

Considering the difference between the isotopic signatures of the Granite Belt and of the terrains situated west and their similarity with the Neoproterozoic-Cambrian magmatism on the African side, it is here emphasized that the major paleosuture that separated the domains of African affinities from the South-American would be represented by the Major Gercino - Sierra Ballena suture zone, that is, by the tectonic contact between the Granite Belt and Don Feliciano Schist Belt.

The Granite Belt and Punta del Este Terrane were linked to the African supracrustal belts being accreted to the South American side only during the

formation of Gondwana. Its separation from Africa occurred only in the Cretaceous due to opening of Atlantic Ocean.

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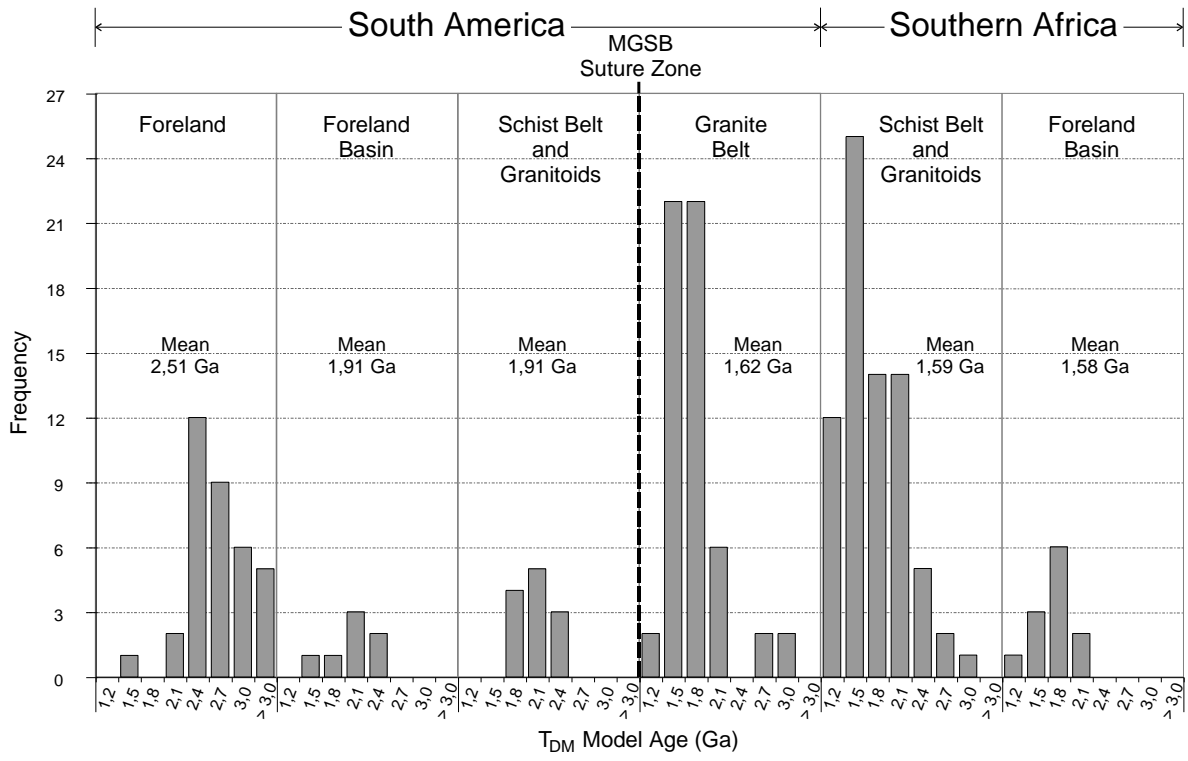


Figure 2- Nd model ages (TDM) histogram for South America and Southern Africa