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THE SEARCH FOR THE (NEOPROTEROZOIC) LOST OCEANS OF WESTERNMOST GONDWANA

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1. INTRODUCTION

This paper is a by-product of the work of IGCP 440 (Rodinia reconstitution) in South America. As far as the descendants of Rodinia were being identified, the immediate work was to try to clarify the nature of those geologic spaces among these descendants. Among them, rift systems, aulacogens and (small, intermediate and some large) ocean basins could be identified based on lithological assemblages and tectonic features.

In the last decade, the majority of papers focusing on this kind of subject have made options for computer programs, while the geological data contribution for this continent were then relegated. The oversimplification in terms like “Brazilide” and “Adamastor” oceans are no longer acceptable.

Actually, the problem is complex due to the character of branching systems of orogens of the Brasiliano Structural Province (mosaic-like schemes), the incomplete lithological records and the final events of escape tectonics (Neoproterozoic to Early Ordovician) that have promoted important longitudinal displacements (major shear zones) which are significant obstacles to gather better paleogeographic reconstitutions.

Having in mind the shape and size of the lithospheric fragments produced by the (long-lived and diachronous) fission of Rodinia, the nature of these descendants and of their borders (passive and active margins and their lithological and tectonic features) and other geological records positioned among them (ophiolitic remnants, deep sea sediments, magmatism), it was possible to achieve a likely scheme for the lost oceans during the (long-lived, diachronous) fusion of Western Gondwana.

Two groups of oceanic realms can hereafter be proposed: the linear (and almost continuous) belts and the scattered segments (along the easternmost Brasiliano Provinces).

2. CONTINUOUS BELTS

2.1 TOCANTINS/PAMPEAN STRUCTURAL PROVINCES - TRANS-SOUTH AMERICA REALM

The most continuous and expressive records for oceanic domains is one which crosses the South America continent, from the north up to the south of Cordoba, in Argentina and follows the external edge of the Amazonian block, and to the south it is positioned between the Pâmpia and Rio de la Plata blocks. This linear domain is assembling geological and tectonic data from the Rokelide belt, Araguaia Belt (with more than 400 km of dismembered ophiolitic sequences), Mara Rosa (volcanic arc and ophiolitic remnants), Paraguay Belt (passive continental margin) and the Eastern Pampean belt (Cordoba arc and ophiolitic remnants), and so it is accomplishing an almost continuous and linear oceanic environment over 4, 000 km long.

Additionally, an extension from this Neoproterozoic oceanic realm is present to the west, between Arequipa-Antofalla and Pampia blocks. Some other kind of connections should be expected to the east (Pharusian-Coreaú , Peri – São Francisco) and so on, but this demands further studies.

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2.2 PERI-SÃO FRANCISCO REALM

The northern margin of the São Francisco Craton (Sergipano + Riacho do Pontal + Rio Preto belts \approx 1,000 km long) comprises characteristics/geological records of the evolution of a passive continental margin (up to oceanic environments) that was completely transformed into a collisional orogenic system. This can be extended to the west, in Africa, to the Oubanguides belt (Bangui area). Some true ophiolitic remnants have been scarcely described in this north sector.

This same general geological and tectonic situation may be ascribed to the western margin of the craton (along the whole Brasília belt \approx 1 400 km long). Moreover, the Brasília belt is the natural continuation of that northern sector (the link is covered by Mesozoic sediments). But, for this western margin, the evolution of an important oceanic realm is by far better recorded (most of the Stein Mann trinity is there present), of many ways, in many different circumstances. These oceanic rock units are now exposed as sheet-like bodies among the nappes of the Brasília belt, with vergence towards the S. Francisco Craton. The magnitude of these geological records have been responsible for the coined term “Goianides Ocean”, since long time ago. Once again, it is necessary to talk about the real possibilities of the existence of paleo-connections Peri-São Francisco with the Trans South- America. Between these domains there are only some minor Rodinia descendants. Other kind of connections with the oceanic realms of the Borborema (Pharusian-Dahomeyan) and Mantiqueira Province were possible. Particularly, for this last case, a connection with the “Ribeirão da Folha” ophiolitic segment of Araçuaí belt would make this realm like a cocontinuous belt, absolutely peripheral to the whole São Francisco craton/peninsula.

3. SCATTERED OCEANIC OCCURRENCES

3.1 BORBOREMA PROVINCE

The Borborema Province- Northeast of South America – displays three different domains, north, central (Transversal Zone) and the southern. Only in the southern zone/domain is there a fraction of a continuous belt of oceanic rock units, that is the particular case of easternmost part of the Peri-São Francisco realm, already discussed.

In the northernmost part, there is a continuation of the Pharussian-Dahomeyan belt of Africa, which contains some oceanic rock units (retro-eclogites, deep sea sediments), a juvenile magmatic arc (Santa Quitéria) as well as part of a passive continental margin (Médio Coreau sediments). The continuation to the south of these rock assemblages and structures is frankly intercepted for a series of important shear zones (Patos and Pernambuco). There area possibly links between Pharussian domain and the Peri-São Francisco (“Goianides Ocean”), but there have not been reliable constraints up to now.

In the central domain (between two shear zones) there are scant records of oceanic rock units, local and disputable occurrences, and all needing additional studies. Following the most complete Neoproterozoic orogenic belt (Piancó-Alto Brígida) there are records of important arc plutonism (630 –580 Ma), but without other evidences for the remnants of the subducting oceanic basin.

3.2 MANTIQUEIRA PROVINCE

As in the case of Borborema, it is necessary to analyze the Mantiqueira Province (southeast of South America) according to three different segments, each one with particular characteristic in terms of oceanic remnants.

a) In the northern segment (between 16° and 20° S) in the interior of the Araçuaí-West Congo orogenic belt there is a narrow strip (\approx 20 km) of oceanic rocks (meta-basalts, metacherts, BIF, plagiogranites, ultramafic rocks) about 450 km long (N-NS) contained in deep sea clastic sediments. This strip of ophiolitic nature – “Ribeirão da Folha - occurs side by side with a large and important magmatic arc (Governador Valadares-Teófoli Otoni or Mucuri, 630-570 Ma in age).

Although very important, this evidence for oceanic rocks is completely isolated, even from those to the south of the Mantiqueira province itself, as the result of the Late-Brasiliano deformational processes. A previous

correlation of this strip of oceanic rock units with those of the Peri-São Francisco realm is possible (and wishful), and this is somehow supported by the regional geology and general tectonics features that are indicating to the São Francisco segment a role of peninsula (bounded by passive margins), during the Cryogenian. A previous connection of Ribeirão da Folha strip (gulf? small ocean basin?) with the Adamastor Ocean (of South Africa) has been proposed, but this it is very difficult to be supported in the present state of knowledge.

Still in the northern segment of Mantiqueira Province (between parallels 20°S and 23° S) there are indirect indications for oceanic realms, based on general geologic features, such as the juvenile magmatic arc of Rio Negro (coastal area of Rio de Janeiro and São Paulo), deep sea sediments (Andrelandia-Itapira) and back arc assemblages (Búzios –Palmital). Even these data being product of serious geological investigation (they are thrustfull), real oceanic rock units have not been pointed out yet. Once again, as mentioned above, connections of these probable oceanic domains will continue as open questions (Peri-São Francisco?? Adamastor?).

b) For the central part of Mantiqueira Province (São Roque-Apiaí belts, between Paranapanema and Luis Alves-Curitiba blocks, 24°S to 26°S) the problem is similar, with some very well developed and mature magmatic arcs (Cunhaporanga, Três Corregos, Agudos Grandes) but with some scarce and sparse indications (meta-basalts, some pillow basalts) of oceanic domains. If these oceanic basins have existed and their probable connections are open questions.

c) The southern segment of Mantiqueira Province (Don Feliciano belt, from Paraná to Uruguay, south of parallel 26°) displays less problems of the northern and central segments. The geological records are better, including good evidences for passive (south Luis Alves block) and active continental margins (Piên, Pelotas, Cambaí) as well as better records of oceanic rock units. Evidences of oceanic rock units are present in Piên (SC) and along the Vacacaí metasediments of Rio Grande do Sul as well as in the African side (Gariép). Moreover, correlations with the African side faced much more progress, with data for subduction (eastward) around 620-610 Ma and collision (Rio de La Plata versus Kalahari) since 600 Ma, along a belt over 1,100 km long. As the correlation with Damara and Kaoko belts (African side) have experimented a good stage of progress, for this case, it is possible to figure out a correlation with the Brazilian oceanic domains (small, scant) and include them in those of the Adamastor Ocean. If only the South American side is considered, it would be necessary to include their oceanic occurrences in the item of “scattered”.