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Barra de Tabatinga and Touros Formations: evidence for pleistocene high sea-level stillstands of the Rio Grande do Norte coast

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Abstract - The Barra de Tabatinga Formation corresponds to the previous informally named Barra de Tabatinga unit, after a homonymous beach name. These marine terrace deposits occur along the present shoreline in patches between Natal and Barra de Sagi (ca. 80km). The summit of those deposits is about 7.5 m above m.s.l. at Natal. They are composed of very friable clayey sandstones and conglomerates, exhibiting more-or-less conspicuous hydrodynamic sedimentary structures. The Touros Formation, after a homonymous town name, corresponds to the previous Tertiary Guamaré Formation, found by Petrobrás only in subsurface. These marine terrace deposits extend, frequently as steep sea-cliffs along the present shoreline, between São Bento and Zumbi (ca. 120 km). The summit of these deposits reaches to a maximum of 20 m above m.s.l., 2 km to the N of Zumbi. Deposits are made-up of medium to coarse-grained sandstones, frequently well-cemented due to partial dissolution of biotrital components. Hydrodynamic sedimentary structures, and trace fossils of *Ophiomorpha nodosa*, are very conspicuous. Both marine terraces, recently dated by TL and/or OSL methods, indicated Upper Pleistocene ages, and overlie unconformably the Neogene Barreiras Formation. Finally, as they fulfill all the requirements of the Brazilian Stratigraphic Nomenclature Code, as demonstrated in this paper, two new formations are formally proposed here.

Keywords - Pleistocene, Marine terrace deposits, Sea-level change.

INTRODUCTION

Until now, the most complete record of Pleistocene marine terraces, embracing four different past high sea-level stillstands, have been recognized only in the Rio Grande do Sul State coastal plain (Villwock *et al.*, 1986). These marine terraces are situated 20-25m, 15m, 8m and 4m above present m.s.l., from the oldest to the youngest.

They have been referred to barrier island – lagoonal systems I to IV, according to their decreasing ages, being the first three Pleistocene, and the last one Holocene in age. Tentatively, the two most ancient sea-levels, not yet dated by absolute methods, have been considered as 400ky and 325 ky old, attributable to the oxygen isotope stages 11 and 9, respectively. Meanwhile the barrier island – lagoonal system I occurs only in the Rio Grande do Sul State, barrier island – lagoonal system II is also represented along the Santa Catarina and Paraná states, and possibly in Icapara – Iguape area, São Paulo State (Martín *et al.*, 1988).

The barrier island – lagoonal system III was considered as occurring more-or-less continuously from Rio Grande do Sul to Paraíba states. Unfortu-

nately, in spite of their long extension, absolute ages of these deposits have been known only in Olivença area, southern Bahia State. Five Io/U ages obtained from coral (*Siderastrea*) samples (Bernat *et al.*, 1983), collected from the basal portion of the terrace deposits, supplied with an average age of 123, 5±5, 7ky BP. This high sea-level stillstand have been correlated with the Sangamon (North America) or Eemian (Scandinavia) transgressions, previously recognized by Bloom *et al.* (1974). Nevertheless, the Pleistocene sea-level changes along the Brazilian coast are fragmentarily known owing to the scarcity of absolute ages.

Recently, Barreto *et al.* (in press) recognized two Late Pleistocene marine terrace deposits occurring along the Rio Grande do Norte State coast (Fig. 1 and 2). The older terrace is situated along the N-S trending coast, extending for about 80km. These deposits are known informally as Barra de Tabatinga unit, which is a designation loaned from a beach name situated to the south of Natal city, where they are represented by very conspicuous outcrops. The more recent terrace deposits are located along E-W trending coast, extending for about 120km, which was correlated by

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Srivastava & Corsino (1984) with the Guamaré Formation defined by Souza (1982), and drilled by Petrobrás in the Potiguar basin.

The main objective of this paper is to formally present these two Late Pleistocene marine terrace

deposits of the Rio Grande do Norte State coast as lithostratigraphic units, named Barra de Tabatinga Formation and Touros Formation, respectively. This proposal follows the recommendations of the CBNE-GNE (1986).

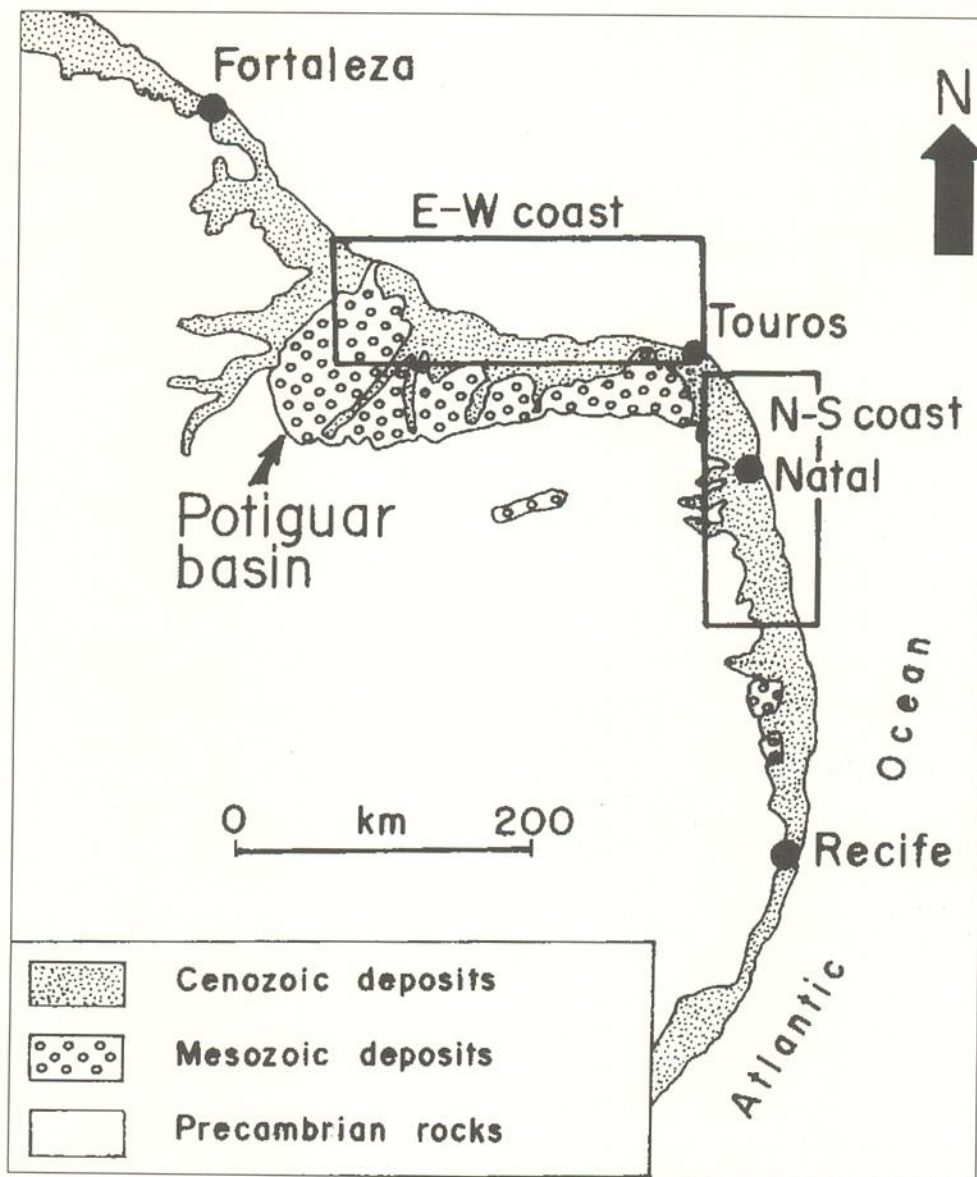


Figura 1- Schematic geologic map of the studied area, in the Rio Grande do Norte State, with indication of N-S and E-W trending coasts.

BARRA DE TABATINGA FORMATION

a) Justification

These marine terrace deposits are perfectly mapable in the scale 1:25,000, mainly due to their length (80km), in spite of their limited width (some hundred meters ?), and thickness (maximum of about 10m in the Baía Formosa area), Fig. 3.

b) Selection of name and its hierarchy

Previously, these terrace deposits have been informally named Barra de Tabatinga unit by Lucena (1995 and 1997). Then, our proposal is to maintain the name within a category of formation, that is, a fundamental unit of the formal lithostratigraphic classification.

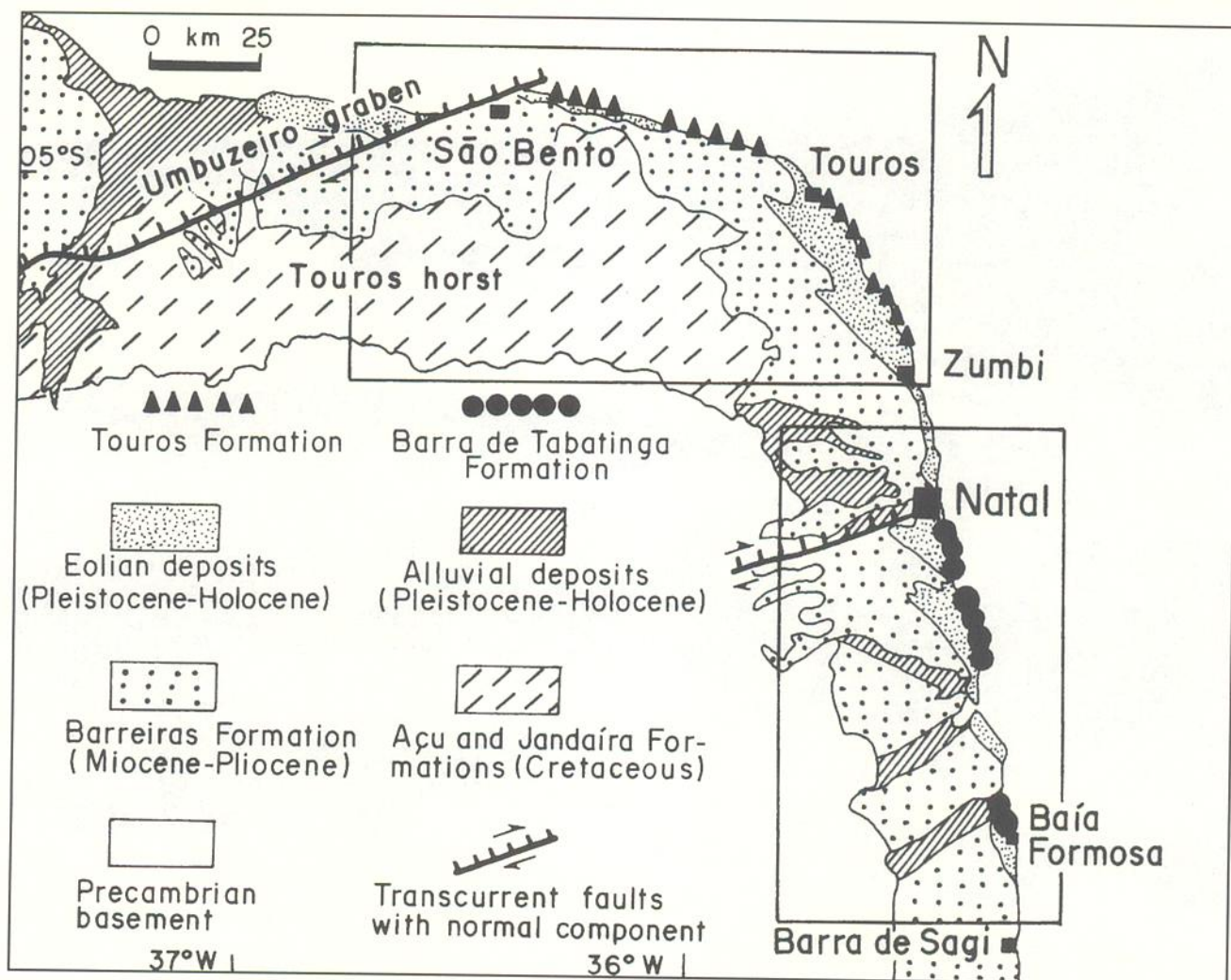


Figura 2 - Distribution of main outcrops of the Late Pleistocene terrace deposits following the current Rio Grande do Norte State coast: 220-206ky, Barra de Tabatinga Formation terrace deposits from Barra de Sagi to Natal, and 117-110ky, Touros Formation terrace deposits from Zumbi to São Bento (Barreto *et al.*, in press).

c) Type-locality, type and reference sections

As in the proposal of Lucena (op. cit.), the Barra de Tabatinga beach, to the south of Natal city could be considered as the type-locality presenting the type-section (Fig. 4). To the south of Natal city and at Baía Formosa, other two reference-sections are being proposed.

d) Lithology and geometry

According to Lucena (1997), Barra de Tabatinga Formation is composed by quartzose sandstones at its base, and clayey sandstones at the top. This author assumed that lithologically the formation can be subdivided into four parts, and usually occurs along the present shoreline. The two basal portions are constituted by pale yellowish medium-grained sandstones, including thin coarser layers, with middle-

scale low-angle crossbeddings and trough crossbeddings. Toward the top, the third portion resembles the previous ones, but there are small-scale crossbeddings with high-angle crossbeddings. The most upper portion is composed by reddish yellow lithified clayey sandstones with parallel laminations.

These terrace deposits occur overlying wave-cut terraces of Neogene Barreiras Formations, and is superimposed by inactive eolian sands.

e) Possible correlation, geologic age and origin

Mainly based on their heights above present sea-level (commonly 4-5m), Lucena (1997) considered Barra de Tabatinga Formation as correlative of Holocene marine terrace deposits identified at central, southeastern and southern coasts of Brazil by Suguio *et al.* (1985). However, three samples (5/97, 6/97 and 15/98), dated

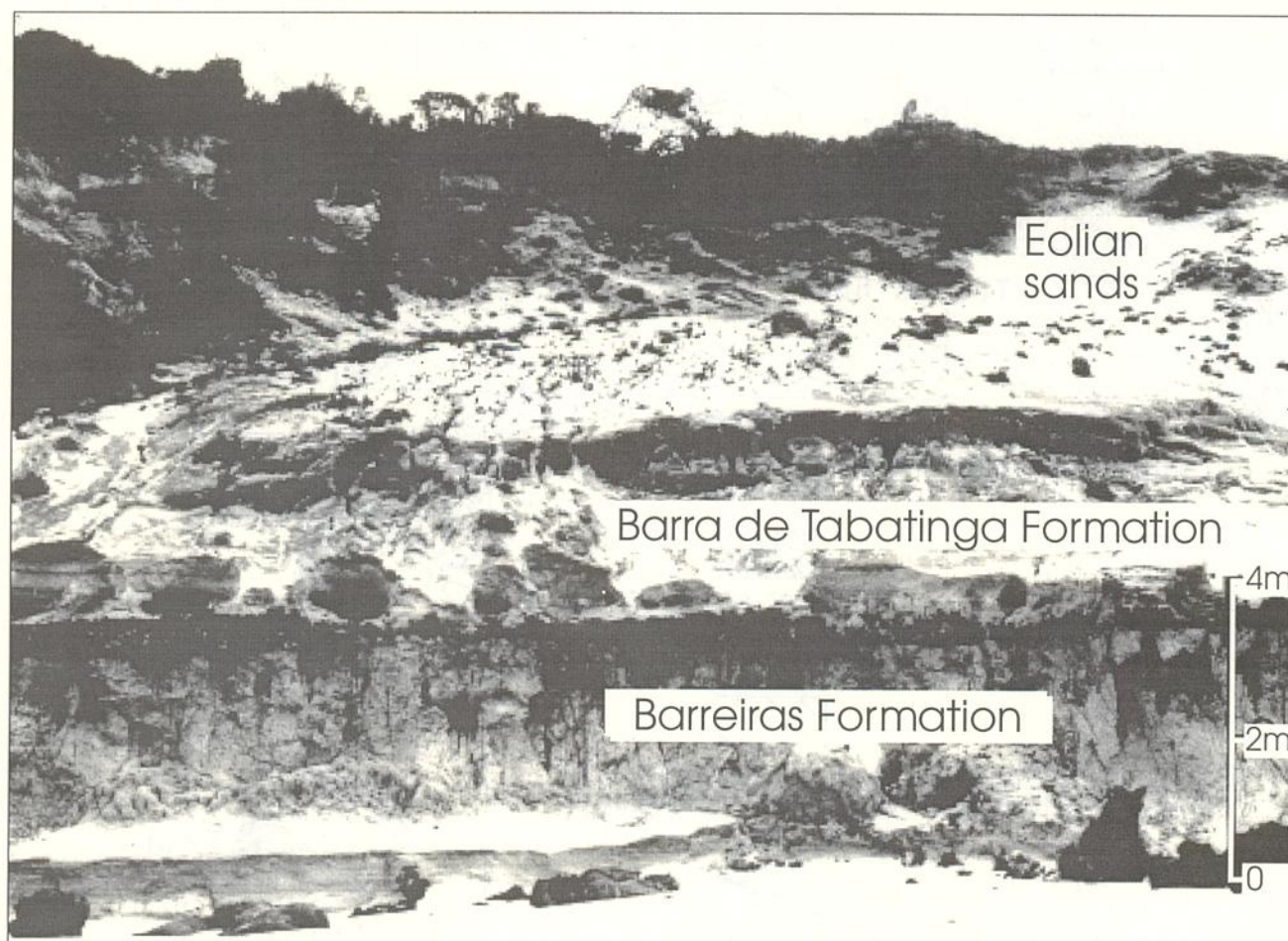


Figura 3 - The Barra de Tabatinga Formation at homonymous beach type-locality. The lower contact is clearly marked by the Barreiras Formation laterite crust, but its upper limit is covered and obliterated by eolian sands.

by TL additive dose, TL total bleach and OSL methods, allowed Barreto *et al.* (in press) to interpret Barra de Tabatinga as 220-206 ky marine terrace deposits. The inactive dune sands that overlie the 220-206 ky marine terrace deposits, with ages ranging from 189-186 ky, are also consistent with the TL and OSL ages presented by these authors for this formation.

A wave-cut terrace surface truncates the underlying Barreiras Formation, giving rise to a clearly defined erosional unconformity, which is marked by a superimposed conglomerate bed, whose megaclasts are chiefly made up of laterites. The intermediate part of the marine terrace deposits is characterized by trough and herringbone crossbeddings, composed of coarse to medium-sized and well-rounded to subangular quartzose sandstones. These features are very suggestive of deposition in an intertidal zone.

Macrofossils were not found by Lucena (1997), but he identified very poorly preserved *Globigerina* and *Quinqueloculina* specimens.

TOUROS FORMATION

a) Justification

As in the previous formation, these marine terrace deposits are also perfectly mapable in the scale 1:25,000, extending for about 120 km along the present shoreline (Fig. 5), with a limited width (some hundred meters?) and thickness (maximum of about 20 m, as at north of Zumbi).

b) Selection of name and its hierarchy

Srivastava & Corsino (1984) considered these marine terrace deposits as correlative of the Guamaré Formation (Upper Tertiary to Quaternary), drilled by Petrobrás (Souza, 1982; Araripe & Feijó, 1994). According to Srivastava & Corsino (op. cit.), these marine terrace deposits could represent the only known onshore exposures of the Guamaré Formation. Moreover, they state that, both petrographic and field

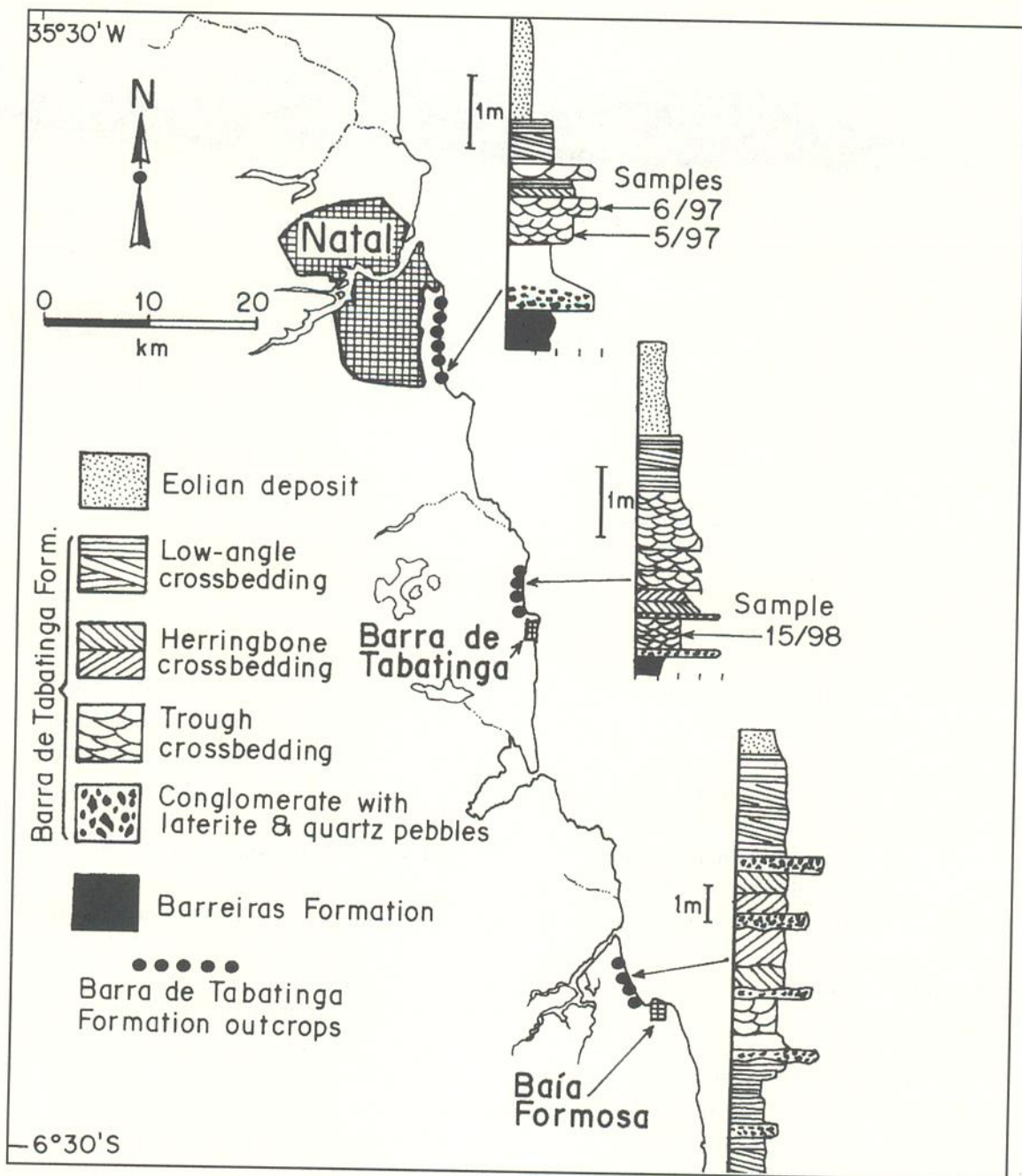


Figura 4 - The type- section of the Barra de Tabatinga Formation located at the homonymous beach, south of Natal, and two reference sections (in Natal and Baía Formosa).

observation, point to the Upper Tertiary age of these deposits. Nevertheless, these characteristics could hardly work as age indicators, as demonstrated by Testa & Bosence (1998), who obtained ^{14}C ages of 30ky, and concluded that the age of these deposits is beyond the standard radiocarbon method limit.

Our proposal is to change the name used by Srivastava & Corsino (1984), considering firstly that Guamaré Formation outcrops are completely absent in the homonymous town area. Secondly, that any

continuity between Guamaré Formation of Petrobras and these outcrops has not yet been demonstrated. Finally, TL and OSL dating methods indicated that these deposits have an age much more recent than suggested by above mentioned authors, and as the previous described formation, Touros Formation is also overlying wave-cut terrace of Neogene Barreiras Formation, being superimposed by inactive dunes. Consequently, our proposition is to replace the present name Guamaré Formation by Touros Formation.



Figura 5 - The Touros Formation at a beach of the homonymous town type- locality, where it is forming a headland with 6-7m above present m.s.l. steep sea-cliff, due to its carbonate cementation.

c) Type-locality, type and reference sections

The name Touros Formation derives from the Touros town, where their outcrops are most conspicuously observed, and the type-section is proposed for this type-locality (Fig. 6). A reference section in São Bento town area, corresponding to the western extremity of occurrence of this formation, is also proposed.

d) Lithology and geometry

Mainly in Touros town, the homonymous formation crops-up as several meters high steep sea-cliffs, composed by pale creamish biotrital carbonates (Srivastava & Corsino, 1984). Based on microfacies investigations, these authors assumed that lithologically this formation represents a beachrock, with typical sedimentary structures, as well as, cementation patterns (Shinn, 1969). As in the previously described formation, the lithosome geometry could be considered as “blanket” type sandstones.

The most frequent hydrodynamic sedimentary structures are trough, herringbone and low-angle crossbeddings, superimposed in this order. Locally, as in the Touros town outcrops, there are basal conglomerates formed mainly of Barreiras Formation lateritic megaclasts. On the other hand, at the São Bento outcrops, hummocky crossbeddings and

convolute beddings can be locally observed. Finally, *Ophimorpha nodosa* is an ubiquitous domichnia-type ichnofossil, which was recently described in some detail by Barreto *et al.* (in press).

e) Possible correlation, geologic age and origin

According to Srivastava & Corsino (1984), these marine terrace deposits could be the only known onshore exposures of the Guamaré Formation. However, the proposal of this paper is that these 117-110ky marine terrace deposits, now with two dated samples (samples-32/98 by TL additive dose and total bleach and OSL methods, and sample 39/98 by TL additive dose method) must be considered as independent from the Guamaré Formation.

The petrographic studies done by Srivastava & Corsino (1984) allowed the reconnaissance of three different microfacies: algal-foraminiferal grainstones, algal grainstones and fossiliferous calcarenites. Based on these microfacies, associated with main hydrodynamic sedimentary structures and cementation pattern, these authors assumed as beachrocks, deposited mostly in intertidal and infratidal environments.

FINAL CONSIDERATIONS

The Barra de Tabatinga Formation represents a 220-206ky marine terrace deposits, formed during

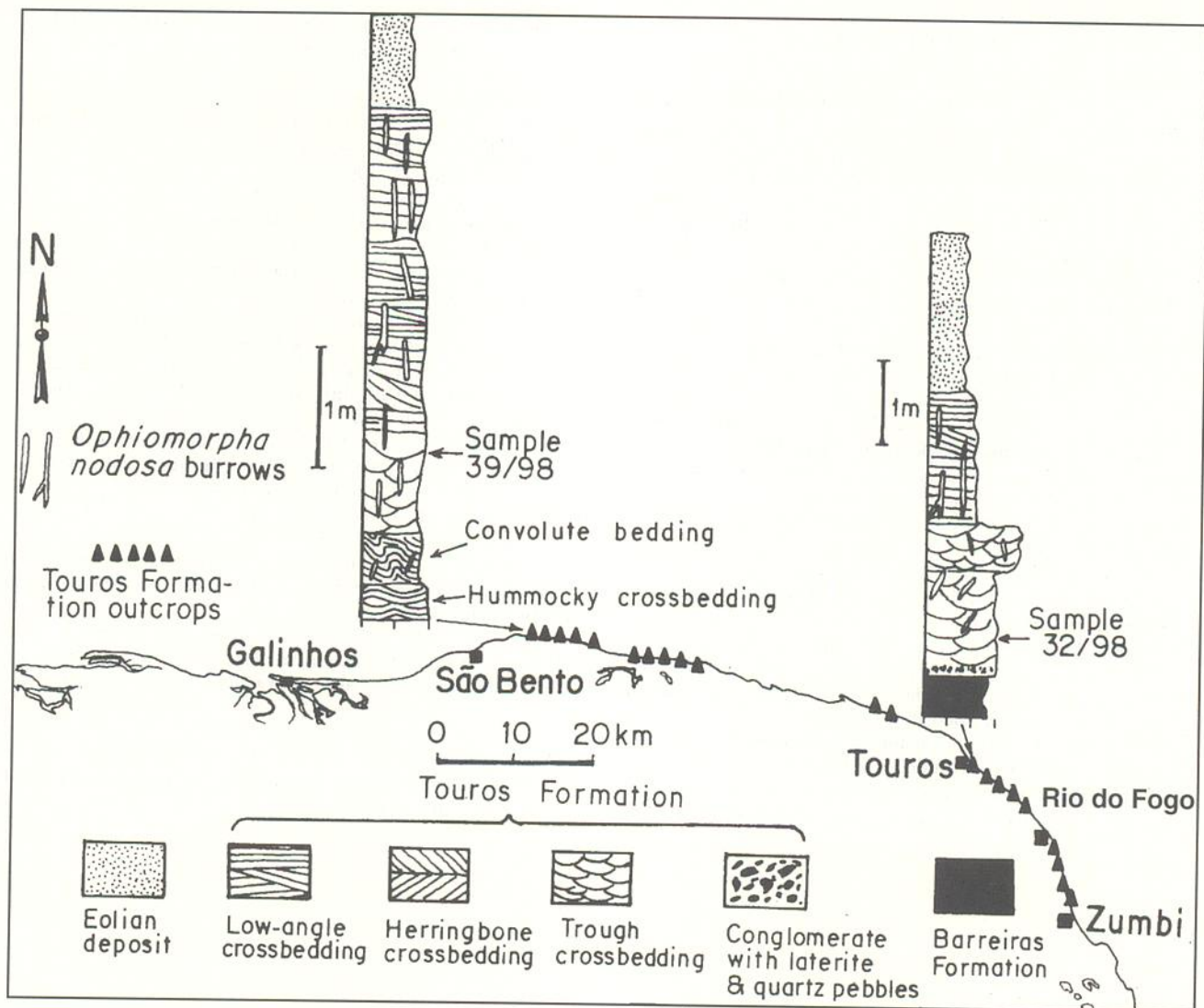


Figura 6 - The type-section of the Touros Formation located at the homonymous town, west of Natal, and one reference section at São Bento town.

the 210ky Late Pleistocene culmination stage recognized, for example, by Harmon *et al.* (1983), and Lundberg & Ford (1994) in the Bahamas area. Marine terrace deposits of this age were not previously recognized in other parts of the Brazilian coast.

The Touros Formation represents 117-110ky marine terrace deposits, formed during 120ky Late Pleistocene culmination stage recognized by Harmon *et al.* (1983), and Lundberg & Ford (1994) in the Bahamas area. Marine terrace deposits of this age were identified until now from Rio Grande do Sul to Paraíba states coasts, and now in the Rio Grande do Norte State coast.

These two formations represent two important high sealevel stillstands, during the Late Pleistocene, along the Brazilian coast. On the other hand, the

comparison of their heights above present sea-level and their geologic ages suggests that the occurrence areas of these marine terrace deposits are characterized by different tectonic behaviors during the Late Quaternary (Barreto *et al.*, in press). This means that the N-S stretch exhibits subsiding and that E-W stretch presents uplifting tendencies, at least from Late Pleistocene until today.

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REFERENCES

- Araripe, P.T. & Feijó, F.J. 1994. Bacia Potiguar. **Boletim de Geociências, Petrobras**, 8:127-141.
- Barreto, A.M.F.; Suguio, K.; Almeida, J.A.C. & Bezerra, F.H.R. (in press) A presença da icnoespécie *Ophiomorpha nodosa* Lundgren em rochas sedimentares pleistocênicas da costa norte-riograndense e suas implicações paleoambientais. **Revista Brasileira de Paleontologia**.
- Barreto, A.M.F.; Bezerra, F.H.R.; Suguio, K.; Tatumi, S.H.; Yee, M.; Paiva, R.P. & Munita, C.S. (in press) Late Pleistocene marine terrace deposits in northeastern Brazil: sea-level change and tectonic implications. **Palaeogeography, Palaeoclimatology, Palaeoecology**.
- Bernat, M.; Martin, L.; Bittencourt, A.C.S.P. & Vilas-Boas, G.S. 1983. Datation Io/U du plus haut niveau marin du dernier interglaciaire sur le côte du Brésil. Utilisation du ^{229}Th comme traceur. **Comptes Rendus de l'Académie de Sciences de Paris, Tome 296**: 197-200.
- Bloom, A.L.; Broecker, W.S.; Chappell, J.; Matthews, R.K. & Mesolella, K.J. 1974. Quaternary sea-level fluctuations on a tectonic coast: new $^{238}\text{Th}/^{234}\text{U}$ dates from the Huon Peninsula. **Quaternary Research**, 4: 185-205.
- CBNE-GNE. 1986-Código Brasileiro de Nomenclatura Estratigráfica e Guia de Nomenclatura Estratigráfica. **Revista Brasileira de Geociências**, 16: 370-415.
- Harmon, R.S.; Mitterer, R.M.; Kriausakal, N.; Land, L.S.; Schwarcz, H.P.; Garrett, P.; Larson, G.J.; Vacher, H.L. & Rowe, M.1983.U-series and amino-acid racemisation geochronology of Bermuda: implications for eustatic sea-level fluctuations over the past 250,000 years. **Palaeogeography, Palaeoclimatology, Palaeoecology**, 44: 41-70.
- Lucena, L.R.F.1995. Unidade Barra de Tabatinga: caracterização e ocorrência no pacote sedimentar quaternário sub-recente na região sul de Natal, RN. In: SIMPÓSIO SOBRE PROCESSOS SEDIMENTARES E PROBLEMAS AMBIENTAIS NA ZONA COSTEIRA NORDESTE DO BRASIL, I, Recife, 1995. **Anais...** Recife, p.136-138.
- Lucena, L.R.F. 1997. Unidade Barra de Tabatinga – novas evidências de um paleodépósito quaternário de praia no litoral potiguar. In: SIMPÓSIO DE GEOLOGIA DO NORDESTE, 17., 1997, Fortaleza. **Resumos Expandidos...** Fortaleza, SBG, Boletim 15, p. 168-171.
- Lundberg, J. & Ford, D.C. 1994. Late Pleistocene sea-level change in the Bahamas from mass spectrometric U-series dating of submerged speleothem. **Quaternary Science Reviews**, 13:1-14.
- Martin, L.; Suguio,K. & Flexor, J.M. 1988. Hauts niveaux marins pléistocènes du littoral brésilien. **Palaeogeography, Palaeoclimatology, Palaeoecology**, 68: 231-239.
- Shinn, F.A. 1969. Submarine lithification of Holocene carbonate sediments in the Persian Gulf. **Sedimentology**, 12: 109-144.
- Souza, S.M. 1982. Atualização da litoestratigrafia da Bacia Potiguar. In: CONGRESSO BRASILEIRO DE GEOLOGIA, 32., Natal. **Anais...**, Natal, SBG, 5: 2392-2406.
- Srivastava, N.K. & Corsino, A.R. 1984. Os carbonatos de Touros (RN): petrografia e estratigrafia. In: SIMPÓSIO DE GEOLOGIA DO NORDESTE, XI, 1984, Natal. **Atas...**, Natal, SBG, p. 165-176.
- Suguio, K. ; Martin, L.; Bittencourt, A.C.S.P.; Dominguez, J.M.L.; Flexor, J.M. & Azevedo, A.E.G. 1985. Flutuações do nível relativo do mar durante o Quaternário superior ao longo do litoral brasileiro e suas implicações na sedimentação costeira. **Revista Brasileira de Geociências**, 15: 273-286.
- Testa, V. & Bosence, D. 1998. Carbonate-siliciclastic sedimentation on a high-energy ocean-facing tropical ramp, NE Brazil. In: V.P. Wright & T.P. Burchette (eds.) **Carbonate ramps**: 55-71. London Geological Society Special Publication 149.
- Villwock, J.A.; Tomazelli, L.J.; Loss, E.L.; Dehnhardt, E.A.; Horn Filho, N.O.; Bachi, F.A. & Dehnhardt, B.A. 1986. Geology of the Rio Grande do Sul coastal province. **Quaternary of South America and Antarctic Peninsula**, 4: 79-97.