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The Quaternary coastal deposits of the State of Alagoas: Influence of the relative sea-level changes

ABSTRACT

The Quaternary Coastal Deposits of the State of Alagoas are correlative, from both geomorphic and sedimentologic viewpoints, with coastal deposits occurring along the coast of the States of Bahia and Sergipe.

Three important transgressive episodes affected the coast of the State of Alagoas during the Quaternary. These episodes left readily interpretable records represented by lagoonal deposits and two levels of marine terraces.

The Quaternary paleogeographic evolution of the studied area comprises 6 stages: 1) Pleistocene: the Most Ancient Transgression carved a line of coastal cliffs into the unconsolidated sediments of the Barreiras Group; 2) Pleistocene deposition of coalescing alluvial fans at the foot of the coastal cliffs formed during the previous stage; 3) 120,000 years BP: the Penultimate Transgression partially eroded the alluvial fans deposited during stage II; 4) Pleistocene: the lowering in sea level that followed the maximum of the Penultimate Transgression favoured the development of coastal plains which were probably very similar to those existing today; 5) - 5,100 years BP: the Last Transgression partially eroded the Pleistocene strandplains. It also caused the drowning of the lower river courses giving rise to estuaries; 6) Holocene: the lowering in sea level that followed the maximum of the last Transgression favoured the construction of the Holocene portion of the Quaternary strandplains.

RESUMO

Os depósitos quaternários costeiros do Estado de Alagoas apresentam uma notável correlação, do ponto de vista de suas características geomórficas e sedimentológicas, com os depósitos quaternários das regiões costeiras dos Estados de Sergipe

e Bahia. Três grandes episódios transgressivos afetaram a costa do Estado de Alagoas durante o Quaternário, deixando como mais importantes testemunhos dois níveis de terraços marinhos e depósitos lagunares.

Foram identificados seis estágios na evolução paleográfica quaternária desta área, a saber: 1) Pleistoceno: recuo da linha de falésias esculpidas no Grupo Barreiras pela Transgressão Mais Antiga; 2) Pleistoceno: deposição de uma série de leques aluviais coalescentes no sopé das falésias formadas no evento anterior; 3) 120.000 anos AP - a Penúltima Transgressão, durante o seu curso, erodiu parcialmente os leques aluviais pleistocênicos; 4) Pleistoceno: descida do nível do mar, posterior a Penúltima Transgressão, formando uma planície costeira semelhante a atual; 5) 5.100 anos AP: Última Transgressão erodindo parcialmente a planície pleistocênica, ocasionando ainda afogamento dos cursos fluviais, constituindo assim, estuários; e 6) Holoceno: descida do nível do mar e construção da planície costeira atual.

INTRODUCTION

Systematic studies based on detailed mapping and on the C^{14} datations were carried out on the eastern coast of Brazil in order to understand the genetic and evolutionary aspects of the Quaternary sedimentation. The interpretation of data earlier published by workers has helped to define a model of paleogeographic evolution in which the role of the oscillations of the sea level has been a determining factor in the construction of the Quaternary plain (Suguio & Martin, 1978; Bittencourt et al., 1979, 1982, 1983a and b; Vilas Boas et al., 1979 and in press; Martin et al., 1980a and b; Barbosa et al., 1986).

The above mentioned paleogeographic evolutionary model comprehends two big transgressive episodes called the Cananéia and Santos transgressions (Suguio & Martin, 1978) in the State of São Paulo, corresponding to the Penultimate and Last transgressions (Bittencourt et al., 1979), in the State of Bahia. On the coastal plains of the States of Bahia, Sergipe and in the extreme south of Alagoas, Bittencourt et al., (1982, 1983a and b) also identified a third transgressive episode having denominated it the Most Ancient Transgression. The above mentioned authors consider the paleo-sea cliffs sculptured in the Barreiras Group sediments as evidence of this event. Pleistocene and Holocene Marine terraces mark, respectively, the effects of the Penultimate and Last transgressions on the Quaternary coastal plain (Suguio & Martin, 1978; Martin et al., 1980a and b).

During the Penultimate Transgression the sea level reached a maximum of 8 to 10 m above the present mean sea level around 120,000 years BP (Martin et al., 1982). The final part of this

event and the subsequent regression were characterized by littoral sand terraces. This interpretation is supported by the presence of sea shells and *Callichirus* fossil burrows, an arthropod of the foreshore intertidal zone, with marked alignments on surface.

The Holocene marine terraces commenced formation in the final stage of the Last Transgression, maximum sea level occurred 5,100 BP, reaching approximately from 3 to 4 m above the present mean sea level (Martin et al., 1979). They are characterized by the presence of beach ridges on the surface, perfectly aligned and considerably more closely spaced than Pleistocene examples, by the existence of distinct beach sedimentary structures and by the presence of sea shells and *Callichirus* fossil burrows.

Along the Bahian coast, the positions of paleo-sea levels were defined in space and time, permitting the construction of a mean sea level curve during the Holocene, for the Salvador region (Martin et al., 1979 and 1980b). The curve obtained for the last 7,000 years presents three maxima above the present sea level, at approximately 5,100 years BP (4,7 m), 3,600 years BP (3,0 m) and 2,500 years BP (2,5 m) and, two minima, approximately 3,900 and 2,700 years BP, slightly under the present level.

The sedimentary deposits identified along the above mentioned coastal Quaternary plains show correlative sedimentologic and geomorphic characteristics (Bittencourt et al., 1979, 1983b; Martin et al., 1980b). The authors specify these features as follows: marine terraces, alluvial fans deposits, fluvio-lagoonal deposits, swamp deposits, mangrove deposits, dunes, coral and coralligenous algal reefs and sandstone reefs.

The objectives of this paper are to present maps and define the litho- and chronostratigraphy of the Coastal Quaternary deposits of the State of Alagoas, as well as to check the validity of the above mentioned paleogeographic evolutionary model.

The Quaternary coastal plain of the State of Alagoas has its northern limit traced by the Persinunga river, at the frontier with the State of Pernambuco, and the southern limit by the São Francisco River, along the frontier with the State of Sergipe. It comprehends a narrow elongated NE-SW strip, with an extension of approximately 220 km, between the 8°53'S and 10°30'S and 35°09'W and 40°24'W (Figure 1).

QUATERNARY DEPOSITS OF THE COASTAL PLAIN OF THE STATE OF ALAGOAS

1 MARINE TERRACES

It is possible to distinguish two levels of marine terraces (Qt_1 and Qt_2) clearly visible on air photographs and

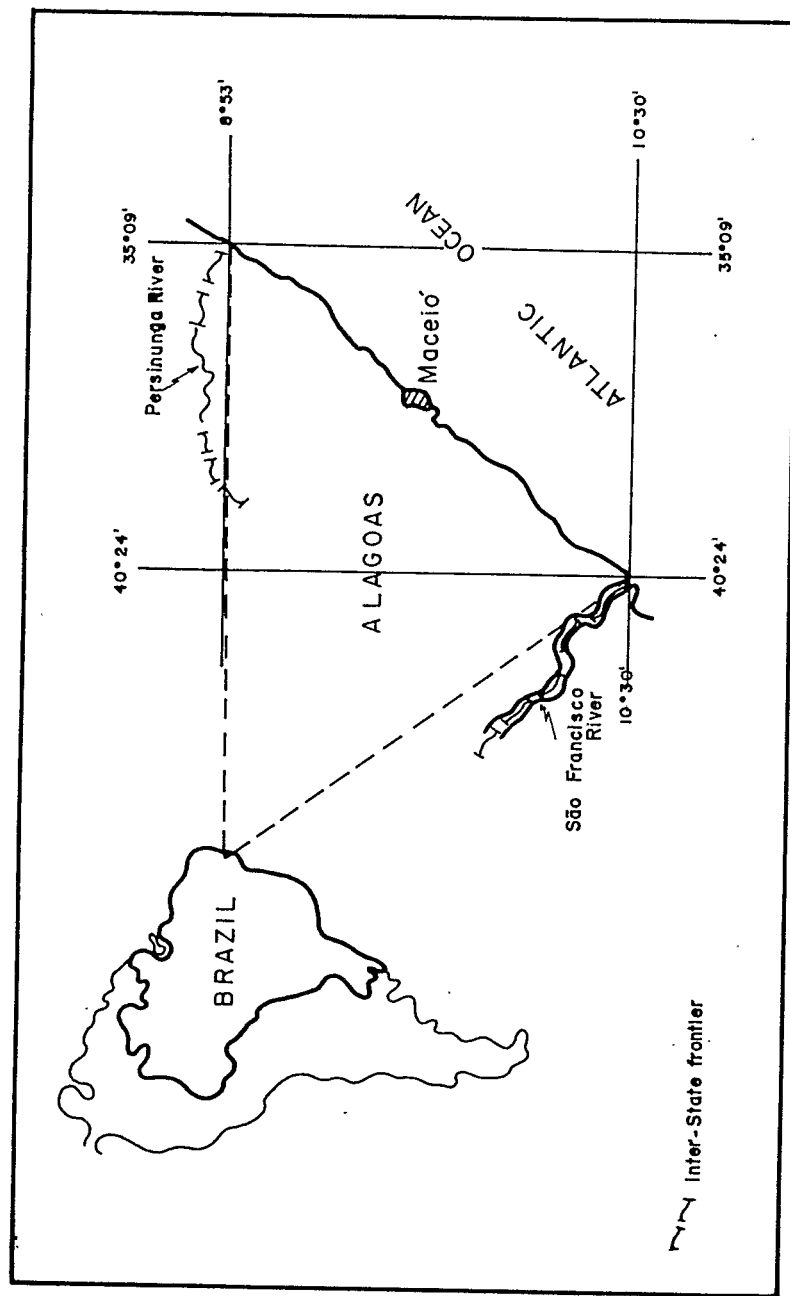


Figure 1. Location of the studied area.

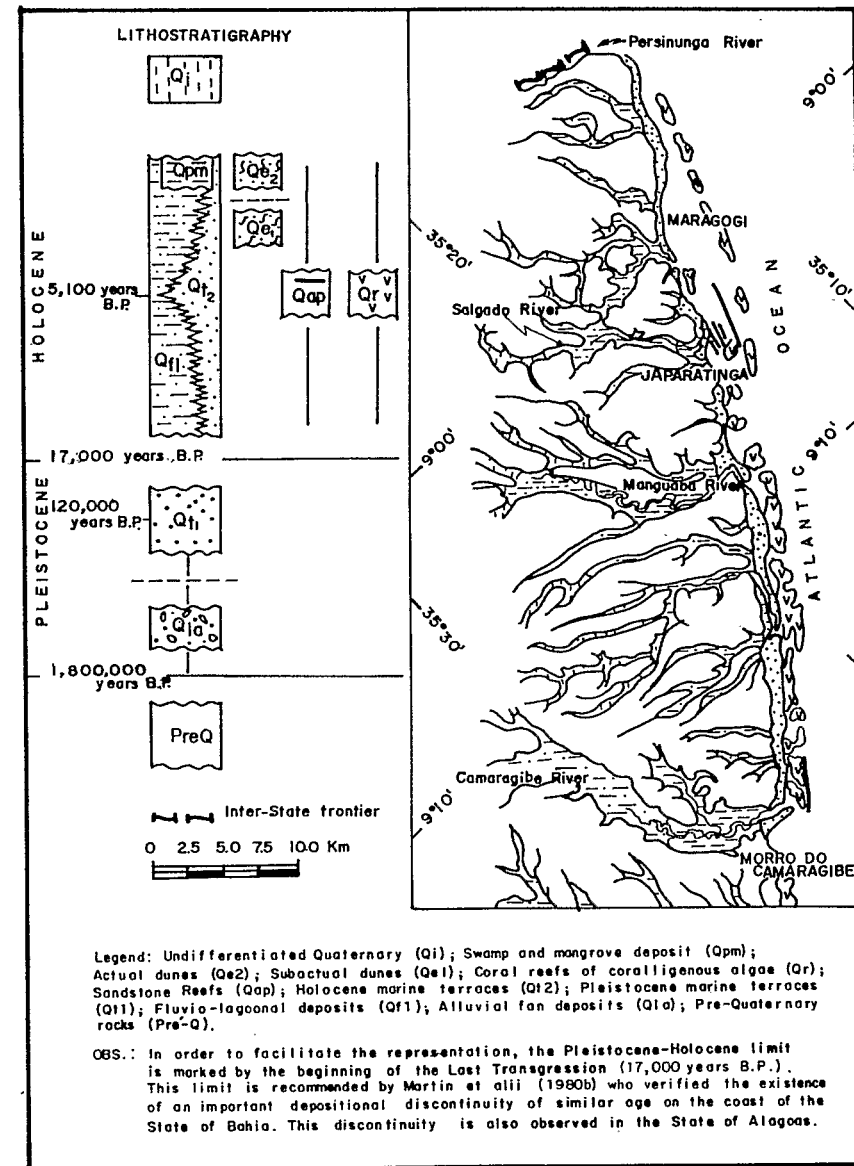


Figure 2. Geological map of the Quaternary coastal deposits of the State of Alagoas: Persinunga River-Camaragiba River section.

observable in the field. These terraces are recognized along the coast of Alagoas, Bahia and Sergipe (Bittencourt et al., 1983a), and interpreted as evidence of two great transgressive episodes (Penultimate and Last Transgressions) which affected the Brazilian eastern coast during the Quaternary. These deposits have geomorphological and sedimentological characteristics identical to those encountered by Martin et al., (1980b) and Bittencourt et al., (1983a and b), respectively, in the States of Bahia and Sergipe and present perfect spatial continuity from Bahia to Alagoas, locally interrupted by water courses.

The marine origin of these terraces is evidenced here by the sea shells and by the beach ridges preserved on the surface of the deposits.

1.1 Pleistocene marine terraces (Qt₁) (Figures 3 and 4)

The Pleistocene marine terraces show a plained top and some alignments of ancient beach ridges and frequently cut by swampy zones.

The sediments are sandy, greyish light brown, of medium to coarse granulation with sub-angular grains. At the terrace base weakly cemented and brownish sands, resulting from the concentration of humic acids and ferric oxide, sometimes occur. Occasionally, friable sea shells moulds are present, as on the Santa Rita Island (Figure 3). In the progradation zone of the São Francisco River, Bittencourt et al., (1982) observed localized gravel levels intercalated throughout the whole vertical sequence of these terraces.

On the right margin of the São Miguel River, a terrace section shows an arched convex topographic form, suggesting a large beach ridge. This feature is probably associated with the formation of a barrier-island, which, due to its elevation (9.0 m above the present sea level) was not levelled off by the Last Transgression.

Between the Manguaba Lagoon and the São Miguel River, terraces were identified at the base of a fossil sea cliff in the Barreiras Group (Figure 3). Costa (1981) considered two possibilities of terrace formation: a) fluvio-marine-lagoonal or b) fluvio-lagoonal. These terraces show the following features: a) altitudes of 8 to 10 m above the present mean sea level, b) traces of ancient beach ridge alignments, suggested by the low swampy zones and c) medium granulation sand. This does not support the hypothesis of their lagoonal or fluvial origin; on the contrary, they are probably of Pleistocene marine origin considering their elevation.

1.2 Holocene marine terraces (Qt₂) (Figures 2, 3 and 4)

The Holocene marine terraces form an elongated plain commonly with noticeable beach ridges alignments.

They do not constitute a continuous body, being sporadically interrupted by sea cliffs and water courses.

The deposits are constituted of light brownish well sorted sand of fine to medium granulation, sub-angular and sub-rounded grains, forming accumulations, the tops of which do not exceed 5 m above the present mean sea level. They are characterized by the presence of sea shells, the sands of the northern region of Maceió are richer in biotic components (*Halimeda* algae fragments, echinoderma, foraminifera, corals and molluscs) than those of the southern region.

Locally, Holocene terraces can be developed as cusate morphological features starting from the continent and situated behind the barriers formed by the coral reefs and coralligenous algae (Figures 2, 3 and 4).

In the zone of the São Francisco River progradation, these terraces represent the most expressive portion of the whole coastal plain (Figure 4). They are described by Bittencourt et al., (1982) as fine to medium sand deposits, chestnut colour, presenting a parallel planar stratification and dipping slightly seaward. Five examples of *Anomalocardia brasiliensis* shells collected in shell-bearing levels encountered within and immediately under the terraces furnished ages between 2,570[±]170 (Bah 1168) and 3,690[±]180 years BP (Bah 1145) which proves the Holocene age of these deposits (Table 1).

2 FLUVIO-LAGOONAL DEPOSITS (Qf₁) (Figures 2, 3 and 4)

Deposits of predominantly greyish silty-argillaceous deposits, containing organic material, shells and, locally, wood remnants. Marine environments organisms like sea shells of *Anomalocardia brasiliensis*, *Lucina pectinata*, *Classostrea rhizophorae*, *Tagelus plebeius* and *Trachycardium muricatum* were identified.

The sediments are normally bedded in the river valleys dissecting the barren plateaux or even in low swampy zones incised into the Pleistocene and Holocene marine terraces that developed into swamps.

Dating carried out on *Anomalocardia brasiliensis*, *Classostrea rhizophorae* shells and on wood remnants, in a total of 13 samples, furnished ages between 770[±]160 years (Bah 1164) and 6,540[±]230 years BP (Bah 1164) (Table 1). These ages date the drowning of the valleys during the Holocene.

Gigantic oyster shells (*Classostrea rhizophorae*) from the Coruripe River valley were dated at 3,750[±]180 years BP (Bah 1144). This age also indicates that the lower part of the river valley was submerged during the Holocene.

Typically fluvial sediments are encountered in the

Figure 3. Geological map of the Quaternary coastal deposits of the State of Alagoas: Santo Antonio River-São Miguel River section.

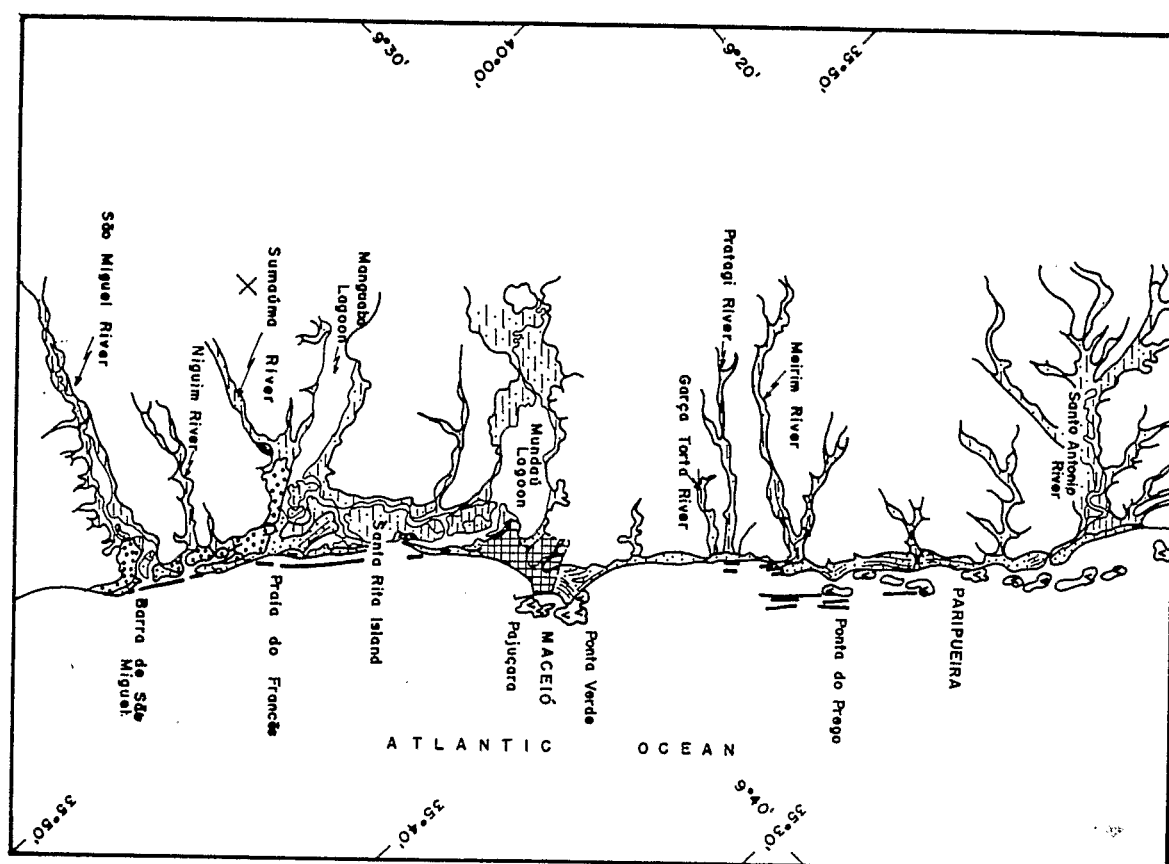


Table I - Samples dated by the carbon 14 method

Station (See Appendix)	Sample Reference	Nature	Sedimentary Deposit	Ages (years BP)	Laboratory Reference	Position of the ancient sea level in relation with the present level (m)
E 130	AL 148	Shells	Sandstone	7,470 \pm 280	Bah 1166	> 0.1
E 135	AL 03	Shells	Fluvio-lagoonal	6,540 \pm 230	Bah 1012	
E 129	AL 146	Shells	Sandstone	6,450 \pm 220	Bah 1155	> 0.9
E 101	AL 101c	Shells	Fluvio-lagoonal	6,320 \pm 250	Bah 1141	
E 135	AL 153	Shells	Fluvio-lagoonal terrace	6,160 \pm 230	Bah 1145	
E 130	AL 17	Shells	Sandstone	5,920 \pm 200	Bah 1026	> 1.0
E 139	SF 07	Wood	Fluvio-lagoonal	5,730 \pm 200	Bah 985	
E 110	AL 116	Coral	Reef	5,700 \pm 230	Bah 1149	> 1.4
E 111	AL 118	Shells	Sandstone	5,600 \pm 230	Bah 1151	> 0.9
E 101	AL 101a	Shells	Fluvio-lagoonal	5,520 \pm 250	Bah 1140	
E 120	AL 16	Shells	Fluvio-lagoonal	5,500 \pm 200	Bah 1025	
E 110	AL 115	Coral	Reef	5,420 \pm 230	Bah 1148	> 1.5
E 113	AL 122	Shells	Fluvio-lagoonal	5,390 \pm 220	Bah 1157	
E 125	AL 142	Shells	Fluvio-lagoonal	5,270 \pm 220	Bah 1165	
E 117	AL 131	Shells	Fluvio-lagoonal	5,240 \pm 220	Bah 1161	
E 109	AL 114	Algae	Reef	4,880 \pm 190	Bah 1147	> 1.7
E 101	AL 101b	Wood	Fluvio-lagoonal	4,870 \pm 190	Bah 1177	
E 136	AL 06	Coral	Reef	4,740 \pm 200	Bah 1015	> 1.9
E 136	AL 05	Shells	Sandstone	4,570 \pm 200	Bah 1014	> 0.8
E 136	AL 07	Coral	Reef	4,520 \pm 150	Bah 1016	> 1.9
E 136	AL 08	Shells	Sandstone	4,360 \pm 150	Bah 1017	> 1.3

Table I - Cont.

Station (See Appendix)	Sample Reference	Nature	Sedimentary Deposit	Ages (years BP)	Laboratory Reference	Position of the ancient sea level in relation with the present level (m)
E 140	SF 09	Algae	Reef	4,310 \pm 180	Bah 992	
E 121	AL 138	Shells	Fluvio-lagoonal Terrace	4,250 \pm 190	Bah 1176	> 1.7
E 137	AL 13	Coral	Reef	4,210 \pm 190	Bah 1022	> 1.3
E 116	AL 129	Shells	Sandstone	4,060 \pm 180	Bah 1160	> 0.4
E 116	AL 128	Coral	Sandstone	3,900 \pm 190	Bah 1175	> 1.0
			Incrustations			
E 132	AL 151	Shells	Fluvio-lagoonal	3,750 \pm 180	Bah 1144	
E 138	AL 11	Shells	Sandstone	3,720 \pm 180	Bah 1020	> 0.4
E 107	AL 112	Shells	Marine terrace	3,690 \pm 180	Bah 1146	
E 106	AL 111	Shells	Marine terrace	3,510 \pm 180	Bah 1172	> 0
E 108	AL 113	Shells	Mangrove	3,440 \pm 170	Bah 1173	
E 111	AL 119	Verme- tidae	Sandstone incrustations	3,350 \pm 180	Bah 1152	+0.7 (\pm 0.5m)
E 136	AL 04	Shells	Marine terrace	2,570 \pm 170	Bah 1013	
E 102	AL 102	Shells	Marine terrace	2,570 \pm 150	Bah 1168	
E 112	AL 121	Verme- tidae	Incrustations in the Barreiras Group blocks	2,100 \pm 160	Bah 1154	+2.0 (\pm 0.5m)
E 119	AL 135	Coral	Reef	1,900 \pm 150	Bah 1162	> 2.9 (?)
E 115	AL 127	Verme- tidae	Cretaceous rocks incrustations	1,670 \pm 160	Bah 1159	+1.0 (\pm 0.5m)

Table I - Cont.

Station (See Appendix)	Sample Reference	Nature	Sedimentary Deposit	Ages (years BP)	Laboratory Reference	Position of the ancient sea level in relation with the present level (m)
E 116	AL 15	Verme- tidae	Sandstone incrustations	1,590 \pm 160	Bah 1024	+1.4 (\pm 0.5m)
E 134	AL 152	Algae	Incrustations in the Barreiras Group blocks	1,530 \pm 140	Bah 1167	> 1.8
E 104	AL 106	Verme- tidae	Incrustations in blocks of Cretaceous rocks	930 \pm 160	Bah 1142	+1.8 (\pm 0.5m) (?)
E 102	AL 103	Verme- tidae	Sandstone incrustations	920 \pm 150	Bah 1169	+0.7 (\pm 0.5m)
E 118	AL 133	Shells	Fluvio-lagoonal	770 \pm 160	Bah 1164	
E 115	AL 126	Verme- tidae	Cretaceous rocks incrustations	670 \pm 140	Bah 1158	+1.0 (\pm 0.5m)
E 136	AL 09	Wood	Mangrove	480 \pm 150	Bah 1018	> 0.4
E 104	AL 107	Coral	Incrustations in blocks of Cretaceous rocks	260 \pm 150	Bah 1171	> 2.4 (?)

progradation zone at the mouth of the São Francisco River (Bittencourt et al., 1982) and in the upper parts of the valleys incised in the barren tablelands.

Some of sand terraces developed on the lagoonal margins are constituted of chesnut coloured fine sands, with sub-angular to sub-rounded grains, containing also *Anomalocardia brasiliensis* shells that furnished ages between 770 ± 160 (Bah 1164) and $6,160 \pm 230$ years BP (Bah 1145).

3 COALESCENT ALLUVIAL FAN DEPOSITS (Q_{1a}) (Figures 3 and 4)

They consist of non-consolidated sediments, predominantly sand but poorly-sorted with clay and pebbles. The sedimentological characteristics, elevation and spatial distribution, differentiate these from the Pleistocene terraces. The sands of the alluvial fans are little re-worked, very angular, with absence of rounded grains and low sphericity and encountered from 10 to 20 m above the present mean sea level.

They are identified on the right margin of the Sumaúma River (Figure 3) and in the internal part of the progradation zone of the São Francisco River.

In the southern part of the São Francisco progradation zone, as shown by Dominguez et al., (1981) and Bittencourt et al., (1982 and 1983a and b), evidence of alluvial fans are encountered in linear sections of paleoclipfs sculptured in the Barreiras Group during the maximum level of the Most Ancient Transgression.

Similar deposits encountered along the coast of the State of Bahia were considered to be associated with a climatic condition considerably different from the present one, that of semi-arid type with rare and violent rainfalls (Vilas Boas et al. - in press).

4 SWAMP AND MANGROVE DEPOSITS (Q_{pm})

On the attached map, the swamp and mangrove deposits appear mapped together as Q_{pm}.

4.1 Swamp deposits (Figures 2, 3 and 4)

Clayey-sand sediments with a lot of organic material are encountered in some ancient lagoons.

The formation of the Holocene marine terraces favoured the damming of the ancient valleys incised in the plateaux and impeded the communication of the lagoons with the sea, causing their evolution into swamps.

The isolation of the swamp sediments promoted the development of peats, as verified on the Niquim River margins. The peats

constitute a black sediment rich in partially decomposed organic material.

4.2 Mangrove swamp deposits (Figure 2, 3 and 4)

Along the whole Alagoan coast, in the protected zones, still under the influence of the tides, mangroves are developing. The deposits are predominantly clayey-silty materials rich in organic material.

At some points of this coastal region the mangroves are being eroded. In Paripueira (Figure 3), erosion of the littoral plain occurs, and an ancient mangrove is recovered by Holocene terraces, with shells dated at 720 ± 160 years BP (Bah 1019). Wood remnants collected from this mangrove furnished ages of 480 ± 150 years BP (Bah 1018).

5 DUNES (Q_{e1}, Q_{e2}) (Figures 3 and 4)

Two generations of littoral dunes are recognized; they are constituted of fine and well sorted sands; fixed dunes (sub-actual) and mobile dunes (actual). The subactual dunes (Q_{e1}) are more internal with respect to the Holocene terraces, whereas the actual dunes (Q_{e2}) border the littoral strip.

The dune areas become more expressive from the city of Maceió toward the south, being largest on the littoral plain of the São Francisco River mouth (Figure 4).

To the south of the Santa Rita Island, there is evidence of the aeolic reworking of the Pleistocene terraces; however, the dune areas noted by Costa (1981) were not observed.

Sand samples of dunes developed on Holocene terraces are sub-rounded grains, whereas the samples of sediments re-worked by wind and accumulated on the Pleistocene terraces are sub-angular.

6 CORAL REEFS AND CORALLIGENOUS ALGAE (Q_r) (Figures 2, 3 and 4)

The largest frequency of coral reefs and coralligenous algae in the area is observed to the north of Maceió. From Maceió to the south they are observed only at Pontal do Peba.

A certain linearity of the reefs was observed and Laborel (1969) and Ottman (1960) relate this to the substrate on which they are sitting that are thought to be sandstone reefs.

The reefs are disposed parallel to the coast, in river mouths (barrier type reef) or on the beach (fringe type reefs). As fringe reefs, they geomorphically constitute promontories. The reefs appear as tabular bodies, the top is eroded and covered by an algal crust and, rarely, when emerged, living corals were observed.

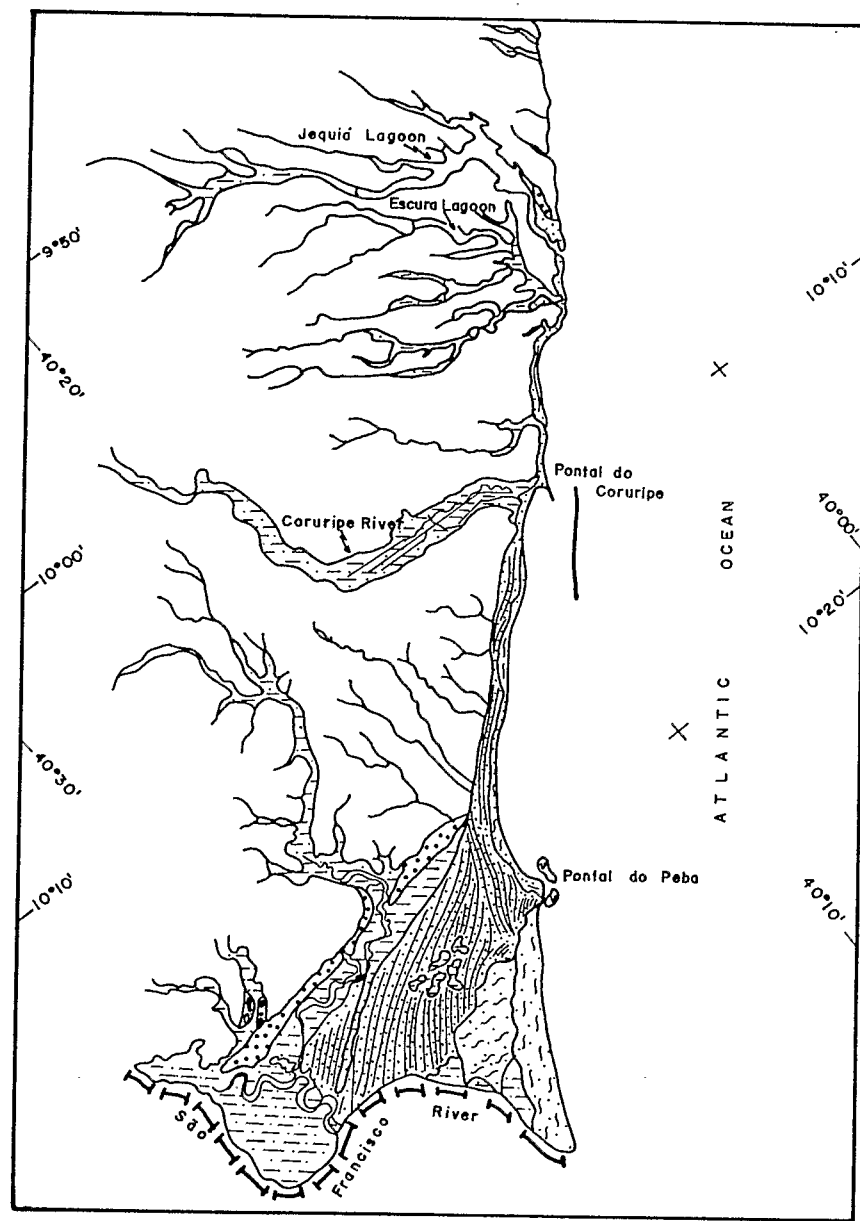


Figure 4. Geological map of the Quaternary coastal deposits of the State of Alagoas: Jequiá Lagoon-São Francisco River section.

When the reefs are aligned, e.g. south of the Salgado River (Figure 2), channels occur between the reef bodies. The bottom sediment of these channels is rich in carbonatic material (mollusc shells, Echinoderma fragments, some foraminifera and mostly fragments of *Halimeda* algae).

The corals identified by Laborel (1969) comprehend, from the top to the base, a biological zonation of: *Milepora alcicornis*, *Mussismilia harttii* and *Montastrea cavernosa*. *Favia gravida* and *Siderastrea stellata* are encountered in the landward part of the reef, meanwhile on the frontal part there is an algal crust covered by *Plythoa* plates. The majority of these constructions are considered to be a barrier type.

The fringe type reefs, occurring around Maceió (Figure 3), remain exposed during low tide and are frequently interrupted by natural pools where Laborel (1969) documented a rich population of organisms (*Mussismilia harttii* and *Siderastrea stellata* are the most frequent species).

Coral and coralligenous algae samples furnished ages between 5,700 \pm 230 (Bah 1149) and 260 \pm 150 years BP (Bah 1171) (Table 1). These corals indicate elevated Holocene marine levels probably up to 1.9 m above the present mean sea level (Table 1).

Corals and incrustated algae are also encountered in the sand reef deposits, on blocks of cemented sediments of the Barreiras Group and Mesozoic outcrops on the beach.

7 VERMETIDAE INCRUSTATIONS

There are vermetidae incrustations on sand reefs, Cretaceous rocks and ferruginous parts of the Barreiras Group outcrop along the coast. These incrustations are localized above the present living Vermetidae zone, situated at the upper limit of the infralittoral zone, which gave ages between 670 \pm 140 and 3,350 \pm 180 years BP and indicate Holocene marine levels probably up to 2.0 m (\pm 0.5 m) above the present mean sea level (Table 1).

8 SANDSTONE REEFS (Qap) (Figures 2, 3 and 4)

The sandstone reef bodies are tabular, stratified (trough and planar cross-stratifications) with bedding dipping seaward, composed of medium to coarse sand with marine shell fragments.

Sedimentary structures and grain size suggest that the depositional environments of these sands were probably of two types: a) shoreface zone - deposits with trough cross bedding and smooth inclination to the sea and b) beach face zone - deposits presenting trough cross bedding and more accentuated seaward inclination.

Northward from Maceió, such deposits are rich in organic fragments (*Halimeda* algae, mollusc fragments, *Echinoderma*,

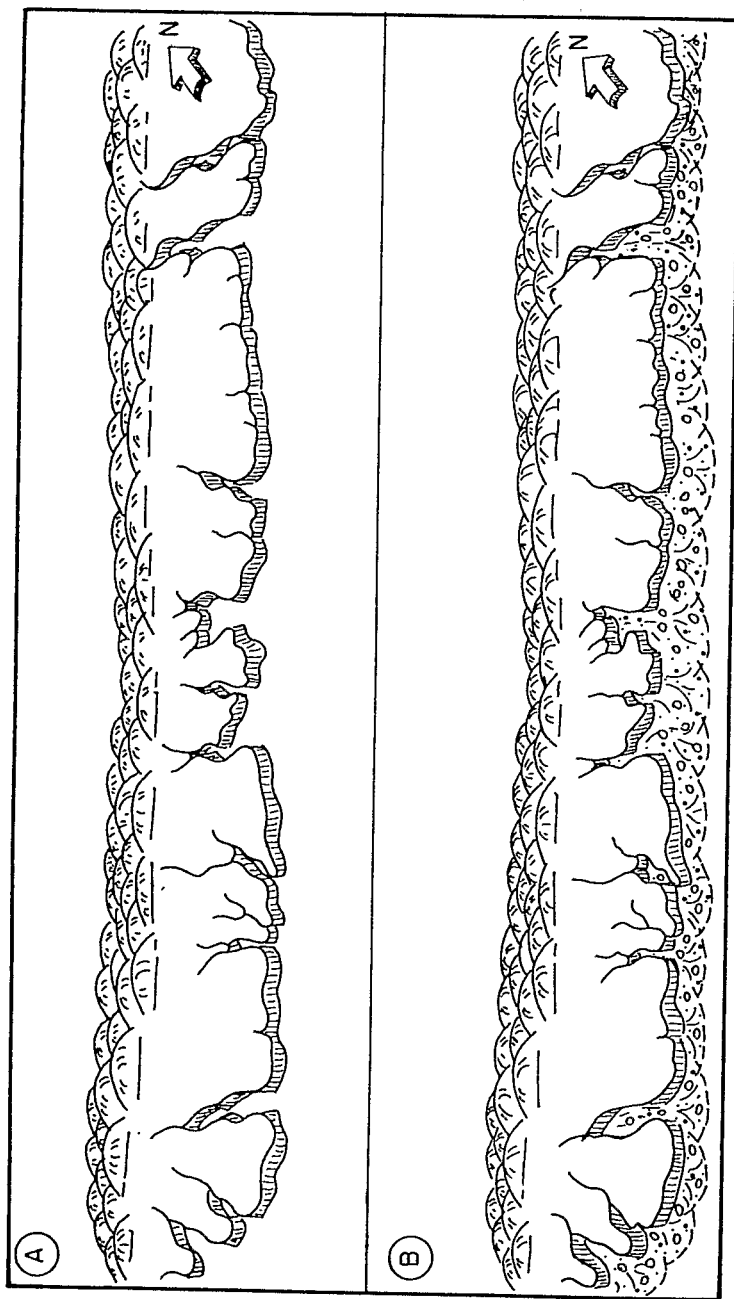


Figure 5. Scheme of the Quaternary paleogeographic coastal evolution of the State of Alagoas:
A) Pleistocene retreat of the sea cliffs (the Most Ancient Transgression); B) Pleistocene marine regression, with deposition of coalescent alluvial fans.

sponge spicules), constituting a poorly sorted sandstone, with an irregular indented surface. Southward from Maceió the deposits are predominantly quartzose with a well worn planar surface.

Datations of 14 samples of *Anomalocardia brasiliensis* shells furnished ages between 7,470±200 (Bah 1166) and 3,720±180 years BP (Bah 1020), indicating elevated Holocene marine levels of up to 1.4 m above the present mean sea level (Table 1).

Along the coast it is possible to identify certain sections as in the Ponta do Prego regions (Figure 3) and Salgado River (Figure 2) where successive parallel lines of sandstone reefs exist, marking ancient coastal positions during the Holocene. The marine erosive action, occasionally, exposes bodies of sandstone reefs already buried by Holocene terraces as at Barra de São Miguel (Figure 4) and Praia do Frances Beach (Figure 3).

9 UNDIFFERENTIATED QUATERNARY (Q_i)

All the sand and argillaceous sediments encountered in valley bottoms above the level reached by the Penultimate Transgression, are considered as Quaternary without further refinement.

CONCLUSION

As mentioned above, there is a noticeable correlation of the geomorphic and sedimentological characteristics between the Quaternary deposits identified on the Alagoas coast and in the coastal regions of the States of Bahia and Sergipe. Paleocliffs cut in the sediments of the Barreiras Group are recognized, resulting from marine transgression. Lower regions were drowned (fluvial valleys, low zones between coastal beach ridges) during three great Quaternary transgressive episodes which invaded the coastal plain. Two levels of marine terraces and coalescent alluvial fan deposits indicate a marine regression after the referred Quaternary events.

The Holocene deposits show clearer indications of the marine invasion, being better preserved, suitable of being dated and, sometimes, positioned in the space with relation to the sea level, indicating its preterite positions.

The principal characteristics of the six stages in which the Quaternary paleogeographic evolution of the Alagoas State coast is divided are the following:

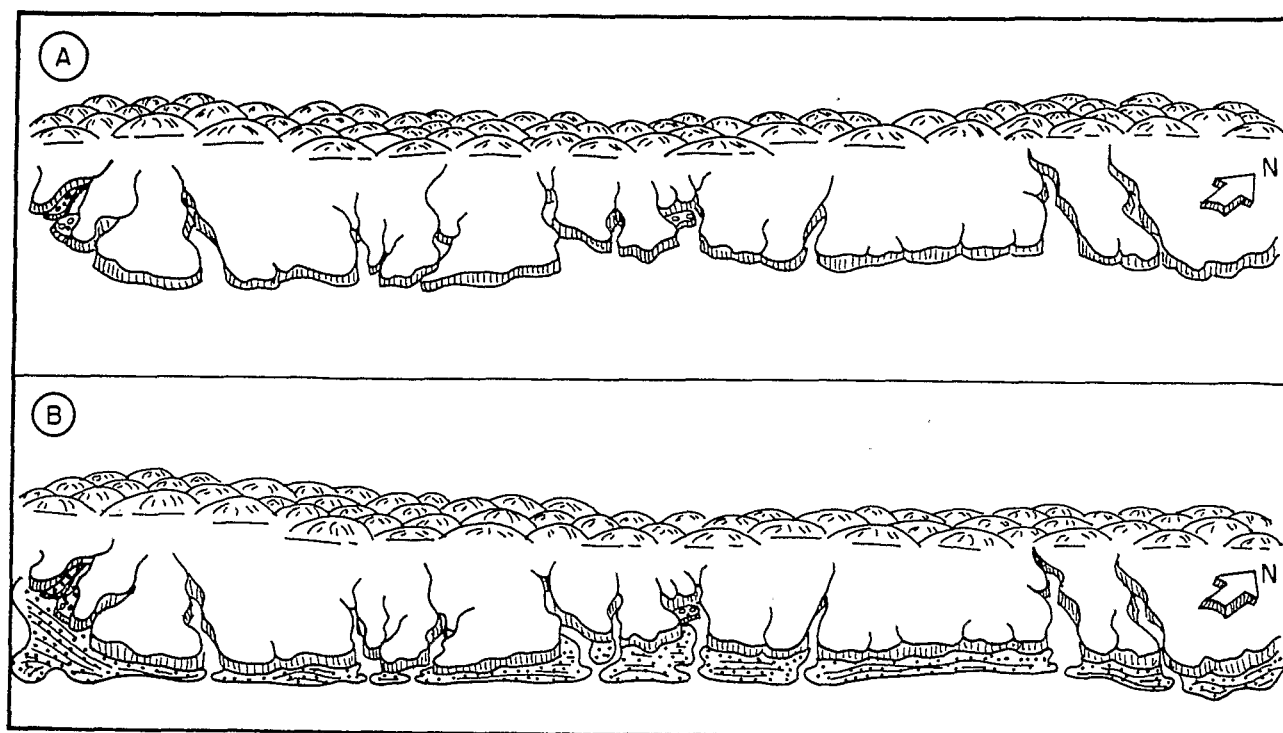


Figure 6. Scheme of the Quaternary paleogeographic coastal evolution of the State of Alagoas: A) Pleistocene-marine erosion of the alluvial fans, drowning of the rivers and re-working of the sea cliffs (Penultimate Transgression), B) Pleistocene-regression, marine terraces deposition and return of the fluvial courses.

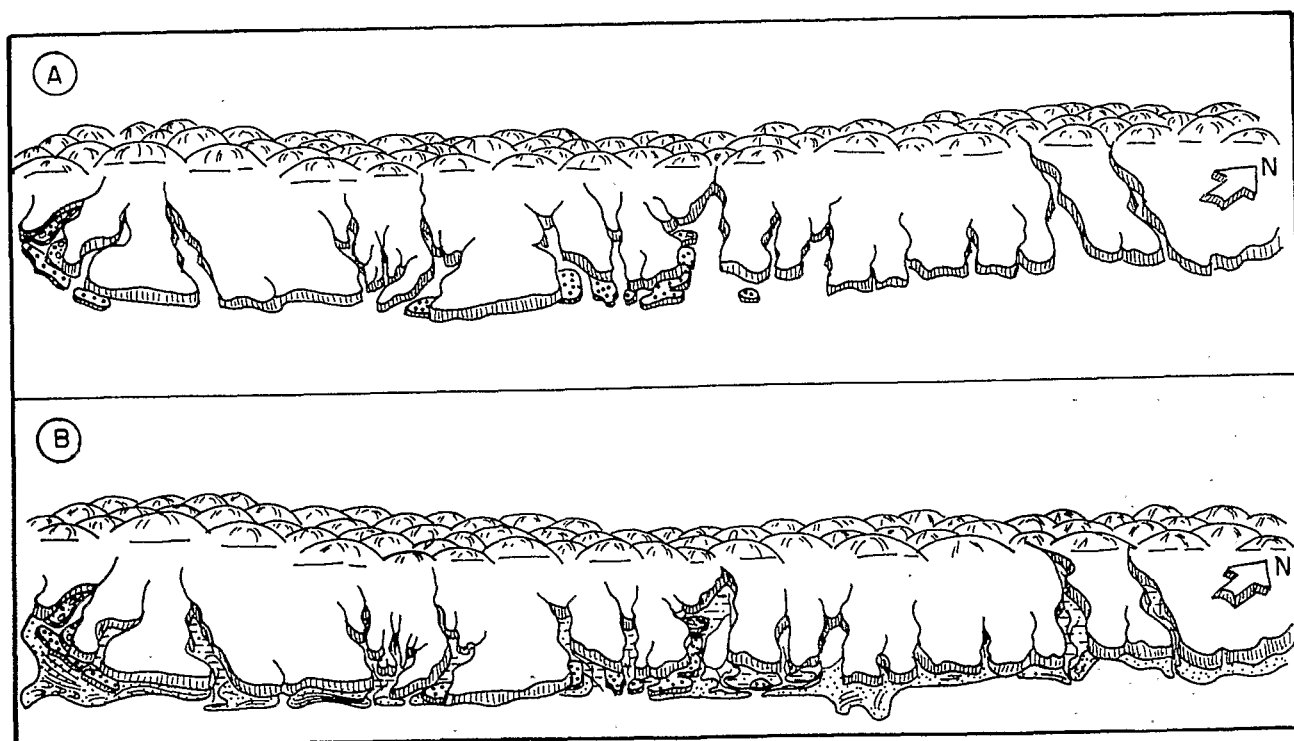


Figure 7. Scheme of the Quaternary paleogeographic coastal evolution of the State of Alagoas: A) Holocene-Last Transgression-drowning of the Pleistocene coastal plain; B) Holocene-construction of the present Holocene plain, after regression.

Stage I (Figure 5a): During the Pleistocene marine incursion over the continent, sea cliffs formed in the Barreiras Group and drowning of the coastline (Most Ancient Transgression). The remnants of this episode are rectilinear sea cliffs in the southern half of the São Francisco River progradation zone.

Stage II (Figure 5b): Following the Most Ancient Transgression there was a regression which caused deposition of coarse, poorly sorted, coalescent alluvial fans, deposited during a semi-arid period with sparse but torrential rainfall at the foot of the sea cliffs and in the interior of the valleys.

Stage III (Figure 6a): The next marine transgression (Penultimate Transgression - 120,000 years BP) caused drowning of the river estuaries and lagoons. Reworking of the cliffs and of the coalescent alluvial fans also occurred.

Stage IV (Figure 6b): Lowering of sea-level produced a coastal plain with deposition of marine sand terraces at the foot of the slopes and in the widened portions of the valleys, normally close to river mouths.

Stage V (Figure 7a): Once more the ascending sea level covered the coastal plain during the Last Transgression. The transgressive event covered the Pleistocene plain with destruction of features formed in the previous events. The climax of the transgression occurred approximately 5,100 years BP. Nowadays, the sand marine terraces are almost completely worn away, and the alignments of the ancient Pleistocene beach ridges are now difficult to see. Most of the cliffs were again attacked by the sea. The lower parts of the valleys as well as the depressions between the Pleistocene ridges were drowned by the sea, forming occasional lagoons. The coral and coralligenous algal reefs, as well as sandstone reefs are also associated with this phase.

Stage VI (Figure 7b): The regression subsequent to the Last Transgression promoted the formation of the present coastal plain. During this phase, construction of the Holocene marine terraces, the return of the water courses and the ever increasing damming of the river discharges promoted the establishment of lagoons. Channels and swampy zones between beach ridges were abandoned, the sediments deposited there having developed into marshes, sometimes even forming peats. The two generations of dunes were formed at this stage. The proliferation of the mangroves was favoured by the formation of mouth bars, originated by the coastal dynamics. In this stage the São Francisco River constructed its present progradation zone.

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