Quaternary Sea-level History and Variation in Dynamics along the Central Brazilian Coast: Consequences on Coastal Plain Construction

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ABSTRACT

The central part of the Brazilian coast experienced considerable relative sea-level fluctuations during the Quaternary. It has been possible to identify three high marine levels. The last two, during which the sea-level was at a maximum 8 ± 2m (123,000 yr BP) and 4,8 ± 0.5m (5,100 yr BP) above the current level, have left substantial records, whose identification was possible due to numerous absolute datings. This sea-level history had a profound effect on the evolution of sedimentary plains.

Wave energy, tidal range and river loads, for example, have been considered as the most important factors in the classical models of coastal sedimentation. However, the role played by relative sea-level changes has been not much considered. Probably, this is due to the fact that the models have been proposed by authors from the northern hemisphere countries, where most commonly the present sea-level is the highest during the Holocene time. This is not the case of Brazil, where most part of the coast was submerged until 5,100 yr BP followed by emergence up today, abstracting two quick oscillations. Obviously, the coastal dynamics could not be the same during relative sea-level rise or sea-level drop. The equilibrium profile of a sandy coast will be destroyed with sea-level changes and its restoration will be accompanied by transfer of sands, from backshore and adjacent land areas to foreshore during sea-level rise and from foreshore to backshore during sea-level drop. During submergence periods (relative sea-level rise), barrier-island/lagoonal systems are dominant and the rivers could reach protected areas, as lagoons and estuaries, to build deltas. In contrast, a sea-level fall creates highly unfavourable conditions for the genesis and maintenance of barrier island/lagoonal systems. Lagoons and bays become emergent and beach-ridge plains rapidly prograde, resulting in regressive sand sheet. When fossil beach-ridges are present, their geometry reflects the past directions of longshore transport. This makes it possible to determine the provenance of past efficient swells and to establish the past wind patterns.

Paleogeographic reconstructions supported by numerous radiocarbon datings allowed us to recognize the essential role played by relative sea-level changes, associated with longshore transport of sediments and paleoclimatic fluctuations, in the formation of the coastal plains in Brazil.

Key words: Quaternary sea-level changes, central brazilian coast, coastal dynamics.

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1. INTRODUCTION

Relative sea-level fluctuations are the result of real variations of the sea-level (eustasy) and of changes in the level of continents (tectonics and isostasy) (Martin *et al.*, 1986b).

Changes in the level of continents are controlled by:

a – Tectonic movements, whether horizontal or vertical, which affect the earth's crust by mechanisms with a time scale ranging anywhere from the long-term to the instantaneous (seismic movements);

b – Isostatic movements related to load variations connected with: the formation and disappearance of ice caps; the erosion of continents and accumulation of sediments in sedimentary basins; transgressions and regressions on continental platforms (hydro-isostasy);

c – Deformations of the continental geoid (our current reference).

Changes in the level of the ocean surface are also controlled by a number of factors:

a – Fluctuations of the total volume of oceanic basins, as a consequence of plate tectonics (tectono-eustasy);

b – Fluctuations of the volume of water in the oceans, connected with glaciation and deglaciation (glacio-eustasy);

c – Deformation of the ocean surface (geoido-eustasy).

Thus, the ocean level, at a given point on the coast, is the instantaneous product of complex interactions between the surface of the ocean and the continent. Fluctuations of the volume of the ocean basins and variations of volume of ocean exert their effects on a global scale. On the other hand, geoid surface area changes and continental level changes exert their influence on a local or regional scale. Therefore, it is logical that inconsistencies exist among reconstruction of the sea-level position in the same age but at different points of the globe.

To reconstruct an old relative sea-level position, it is necessary to define a marker for it in space and time. In order to define the position of this marker in space, it is necessary to know its present altitude with respect to its formation or deposition. In order to define the marker in time, it is necessary to know the age of its formation or deposition (isotopic, archeological or other dating methods). A marker thus defined gives a relative position of the sea-level at a certain age. If we manage to establish a sufficiently large number of old relative sea-level positions, satisfactorily covering a certain period of time, we can then plot a variation curve for this period. It is quite obvious that only information originated from one coastal sector, where the local phenomena are always the same, can be utilized. Hence we are often confronted with the following dilemma: a) to construct a curve based on a large number of reconstructions covering the time period in question, but this often involves using data from a relatively large coastal sector, with the risk that local factors may not be the same throughout the sector; b) to consider only a restricted sector of the coast, but, in this case, the number of reconstructions may be insufficient to yield a precise complete curve.

2. EVIDENCE OF QUATERNARY HIGH SEA-LEVELS ALONG THE CENTRAL BRAZILIAN COAST

Evidence has been cited by several authors, such as Hartt (1870), Branner (1902, 1904), Freitas (1951) and Bigarella (1965). However, they were studied initially from a geomorphological viewpoint and were assumed to be Tertiary in age; presently they are considered as Quaternary. Until the 1960's research on past sea-levels was scarse in Brazil (Suguio, 1977). One of the first studies, which was somewhat systematical and which included radiocarbon ages, was conducted by Laborel (Van Andel and Laborel, 1964; Delibrias and Laborel, 1971). After 1974, studies carried out along the central part of Brazilian coast (Fig. 1) greatly improved our knowledge of Quaternary sea-level history for this region, mostly during the last 7,000 years.

2.1 – SEDIMENTOLOGICAL EVIDENCE

Quaternary marine deposits situated above the present sea-level are unquestionable evidence of

Fig. 1 — Orientation map of the studied area.

ancient sea-level higher than today. Systematic geological mapping and isotopic datings have allowed us to distinguish several generations of sandy terraces constructed after the maximum sea-levels related to different transgressive episodes of the Quaternary (Martin *et al.*, 1987d, 1988). A detailed study of the sedimentary structures and grain size of these sandy terraces can indicate the place where the sands were deposited, and thus define with a precision of more than ± 50cm, the position of mean sea-level at the time of deposition.

2.2 – Biological Evidence

Along almost the entire Brazilian coastline, biologic evidence represented by Vermetidae (gastropods) oyster and coral incrustations, as well as by sea-urchin holes, situated above the present life-zone of these animals, are encountered (Laborel, 1979). Moreover, many Pleistocene and Holocene marine terraces exhibit frequent *Callichirus* burrows situated above the present life-zone of this animal (Suguio & Martin, 1976; Suguio *et al.*, 1984b; Rodrigues *et al.*, 1985).

2.3 – Prehistoric Evidence

A great number of shell-middens (sambaquis) constructed by ancient indians, are found in the Brazilian sedimentary coastal plains. The geographical position of some of these shell-middens, situated in the interior of the continent (for example, more than 30 km from the present shoreline), can be explained only by lagoonal extent clearly larger than it is today and, consequently, by a sea-level higher than the present (Martin *et al.*, 1984e, 1986b, 1987b; Suguio *et al.*, 1992).

3. ANCIENT SEA-LEVELS HIGHER THAN THE PRESENT ALONG THE CENTRAL BRAZILIAN COAST

3.1 – High Sea-Levels Prior to 123,000 Years B.P.

Scattered across the coastal plain in the states of Santa Catarina, Paraná and southern part of São Paulo State, there are some sandy or gravelly terraces (more than 13m-high) of probable marine origin (Fig. 2) (Martin *et al.*, 1988) which could be correlated with the Barrier II of the Rio Grande do Sul (Fig. 3) (Villwock *et al.*, 1986). In the states of Bahia and Sergipe, there are not outcrops which can be attributed to this transgressive episode. The only known evidences are constituted by cliffs carved in Pliocene continental deposits of the Barreiras Formation. This high sea-level which could be correlated with the Barrier II of the Rio Grande do Sul, is known as *Ancient Transgression* (Bittencourt *et al.*, 1979 a,b; Martin *et al.*, 1983).

3.2 – High Sea-Levels of 123,000 Years B.P.

The above mentioned *Ancient Transgression* has been followed by a new transgressive event, when the relative sea-level was 8 ± 2m above the present level. This high sea-level episode is known as the *Cananéia Transgression* in the coastal plain of São Paulo State (Suguio & Martin, 1978), and as the *Penultimate Transgression* in the coastal

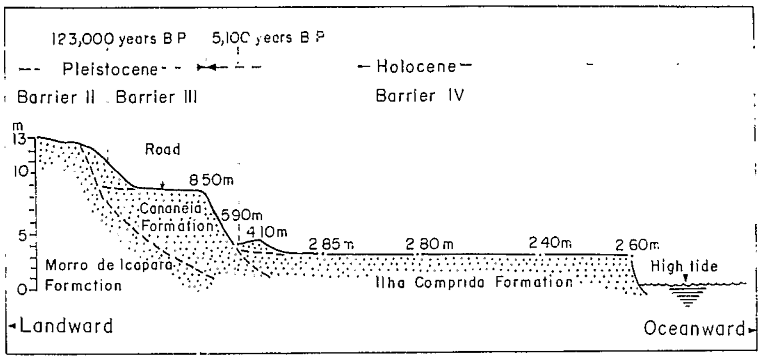

Fig. 2 — Sandy deposits of Icapara, near Iguape (SP), whose terrace summits are 13m, 8m and 3m above present high tide level (modified from Martin *et al.*, 1988).

plain of the states of Bahia, Sergipe, Alagoas and Pernambuco (Bittencourt *et al.*, 1979 a,b; 1983; Dominguez *et al.*, 1990). The records of this high sea-level are constituted essentially by sandy terraces which occur, at least, from the State of Paraíba to the State of Rio Grande do Sul. The tops of these terraces reach 6 to 10m above the present high tide level. They are normally located in a landward position on the sedimentary plains. They are frequently composed of leached sands which grade downward into a "coffee rock" cemented by humic acids and iron oxides leached from upper horizons. Sedimentary structures in most cases have been destroyed by pedogenic processes. Nevertheless, *Callichirus* burrows, associated with tabular and trough cross-bedding are sometimes found at the base of these terraces, allowing to reconstruct the relative sea-level in space. Surfaces of these terraces are characterized by remnants of beach-ridges somewhat subdued by slope and weathering processes. Although well preserved in certain areas, the outcrops of this formation in the southern and southeastern coasts of Brazil did not yield any material which could be dated to obtain absolute ages. However, carbonized tree trunks collected from basal clay beds of these outcrops indicate ages higher than 35,000 yr B.P. (limit of the ^{14}C method). Nevertheless, the age of this transgression has been established through five datings obtained from coral (*Siderastrea*) samples (see Annex), collected from the basal portion of marine terraces in the coastal plain of the State of Bahia,

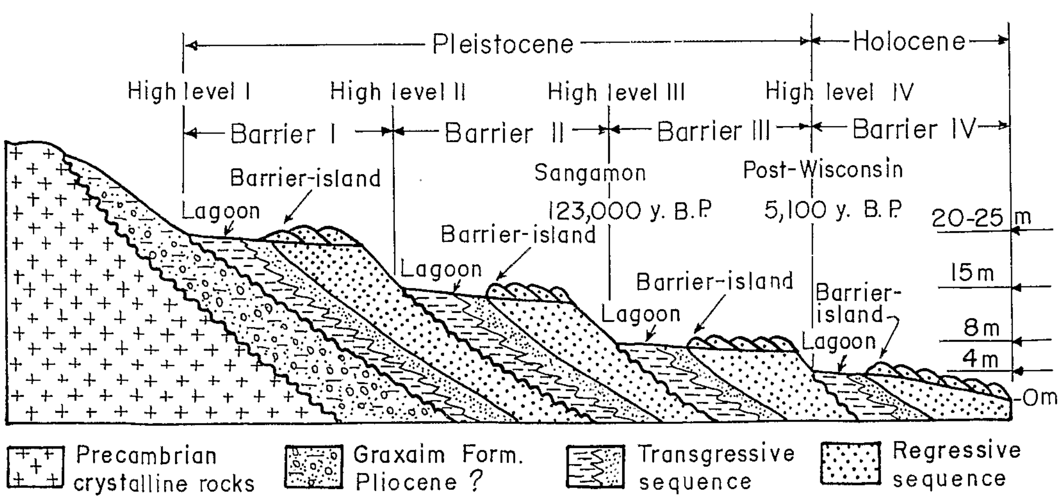

Fig. 3 — Barriers I, II, III and IV formed during four stages of high sea-level during the Quaternary in the State of Rio Grande do Sul coastal plain (modified from Villwock *et al.*, 1986).

using the Io/U method (Martin *et al.*, 1982; Bernat *et al.*, 1983). Their average age was 123,500 ± 5,700 years B.P., being correlative to a well known worldwide upper Pleistocene high sea-level still-stand (Bloom *et al.*, 1974; Chappell, 1983).

3.3 – Holocene High Sea-levels

The last transgressive phase, known as the *Santos Transgression* in São Paulo (Suguio & Martin, 1978), is represented in Rio Grande do Sul by Barrier IV deposits (Fig. 3). The last 7,000 yr of this transgression are very well known, due to numerous sedimentological, biological and prehistorical data gathered along the central part of the Brazilian coast and defined by more than 700 radiocarbon ages (see annex) (Martin *et al.*, 1986b, 1987d; Suguio *et al.*, 1985a). Beach-ridge terraces, located seaward of those of Pleistocene age are the most abundant deposits. They are normally separated from the latter by a low area filled with lagoonal muds, now capped by freshwater swamps. The height of the Holocene terraces varies from 4 to 5m (most landward) to a few centimeters (most seaward) above present high tide. The surface of the Holocene terraces slopes gently seaward; this suggest that their construction took place in a period of dropping sea-level. Sedimentary structures are perfectly preserved and are represented by beach face stratifications. At the surface, the Holocene terraces are characterized by very well preserved beach-ridges in contrast to the eroded Pleistocene beach-ridges (Martin *et al.*, 1980 a,b). All radiocarbon dates from the Holocene terraces gave ages younger than 5,000 yr BP. The lagoonal deposit consists of organic-rich muds with abundant wood debris and shells, most of them are found in life position. Radiocarbon dates gave ages younger than 7,500 yr BP.

3.3.1 – *Relative sea-levels for the last 7,000 years*

On the basis of all these data, it has been possible to delineate complete or partial relative sea-level fluctuation curves during the last 7,000 yr for several sectors of the central part of the Brazilian coast (Fig. 4) (Martin *et al.*, 1987 b,c,d). In order to have relatively homogeneous curves, only very short segments of the coastline (60 to 80 km), with the same geologic framework and sufficiently numerous data, were considered. Abstracting the variations of second order, which appear in the curves, we can observe that, in all the studied sectors, the relative sea-level was above it is today:

— the present mean sea-level was surpassed for the first time between 7,000 and 6,500 yr BP;

— by about 5,100 yr BP, sea-level had risen between 3 and 5m above today's mean sea-level;

— at about 3,900 yr BP, sea-level experienced a lowstand and was positioned slightly below today's mean sea-level;

— at 3,600 yr BP sea-level rose between 3.5 and 2.0m above today's mean sea-level;

— at 2,800 yr BP sea-level again experienced a lowstand, dropping slightly below present mean sea-level;

— by about 2,500 yr BP, a third highstand was reached. At this time, sea-level was 2.5 to 1.5m above today's mean sea-level, and since then it has been progressively dropping (the precision of ^{14}C ages do not allow us to know the present day trend).

3.3.2 – *Comments on the curves*

All these curves have the same general shape, although some are shifted vertically. In some well-delineated coastal sector it has been possible to demonstrate Holocene shoreline shifts as a consequence of vertical neotectonic movements. For example, in the Todos os Santos Bay (BA), located within the Recôncavo graben, vertical movements have resulted in pronounced shifts of Holocene shoreline (Martin *et al.*, 1984 a, 1986a). Some part of the coast, for example in the states of São Paulo and Rio de Janeiro, have been affected by regional flexures (Martin & Suguio, 1975), although this phenomenon apparently did not have a very great influence during the Holocene time. In all of the sectors where sea-level curves have been constructed (Fig. 1 and Fig. 4), with the exception of Angra dos Reis, there are records of marine terraces of the 123,000 yr BP high sea-level. Nowhere do the innermost parts of these terraces, of

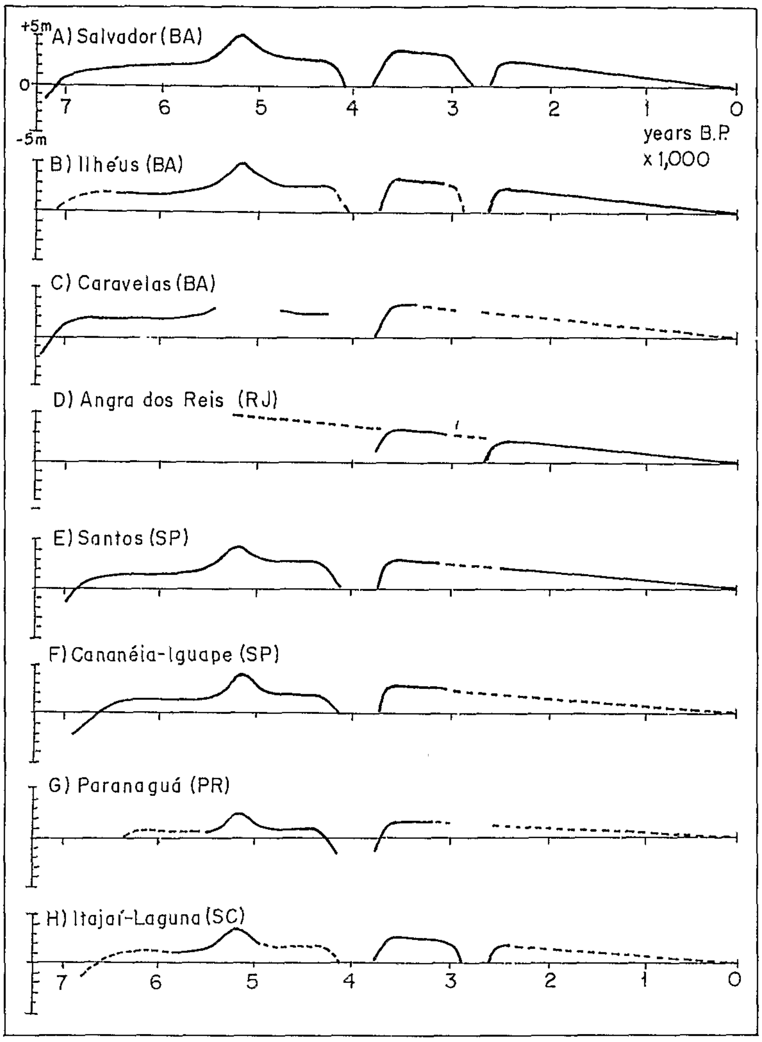

Fig. 4 — Relative sea-level variation curves for the last 7,000 years along several sectors of the central Brazilian coast (from Martin *et al.*, 1987).

roughly the same age, exhibit significant differences in elevation. If the shift in maximum height at 5,100 yr BP was tectonic in origin, the records of the high marine level of 123,000 yr B.P. would be shifted very greatly (almost 60m), which is not at all the case. Thus, the shifts observed between certain curves can be interpreted as the result of deformation of the geoid (Martin *et al.*, 1985a).

4. CONSEQUENCE OF RELATIVE SEA-LEVEL FLUCTUATIONS ON COASTAL SEDIMENTATION

In summary, regardless of origin, the central part of the Brazilian coast was in submersion until about 5,100 yr BP, and, disregarding two rapid oscillations, in emersion since then. This is not a common global situation during this time interval.

For example, along the Atlantic coast of the United States (Shepard & Curray, 1967), relative sea-level never intercepted the present level during the Holocene (Fig. 5). Evidently, coastal evolution during this time interval cannot be the same in these areas. Submerged coasts, such as those of the United States, are characterized by barrier-island/lagoonal systems, while emergent coasts, such as those of Brazil, are characterized by extensive beach-ridge plains (Dominguez *et al.*, 1987). A situation equivalent to that presently occurring in the United States could have existed in Brazil about 5,100 yr BP (Suguio *et al.*, 1984a).

A sandy low coastal zone has an equilibrium profile that is a function of dynamics and granulometry. The dynamics vary incessantly (tides, surge, etc.), so the profile is constantly being destroyed. However, if one considers a sufficiently long period of time, one can presume the existence of mean equilibrium profile. It is quite obvious that a relative sea-level fall or rise destroys this equilibrium. According to Bruun (1962), once the equilibrium profile is established, a later sea-level rise will disturb this equilibrium, which will be re-established by its landward migration. In consequence, the beach prism will be eroded and the resulting material will be transported and deposited in foreshore areas. This process will induce an elevation of foreshore bottom in equal magnitude to sea-level rise, thus keeping water depth constant. Field and laboratory experiments performed by several authors (Schwartz, 1965, 1967 and Dubois, 1976, 1977) have ratified the Bruun hypothesis (*op. cit.*). Although this rule has been developed only for the inverse situation, the equilibrium destroyed during the sea-level fall must also be restored (Dominguez, 1982, 1987). In consequence, waves will move the unconsolidated foreshore sediments landwards, depositing them in the beach prism and then propitiating coastal progradation. This transfer from the outer beach towards the beach prism ends when the previously existing water depth is re-established. Comparatively, this process is analogous to that in which the storm beach profile is restored by sediment transfer from foreshore to beach prism in a swell profile, as is widely recorded in the literature (Davies, 1972; King, 1972; Komar, 1973, 1976; Swift, 1976). Analogously, this mechanism can be observed perfectly during a monthly tide cycle. During syzigyal tides, corresponding to a "mini-transgression", backshore erosion and foreshore deposition will occur and, on the contrary, during quadrature tides, corresponding to a "mini-regression", backshore deposition and foreshore erosion will occur.

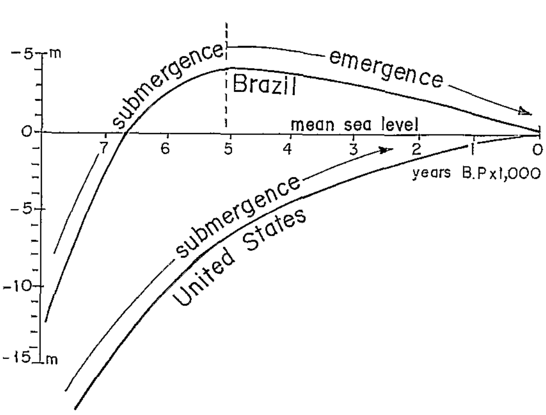

Fig. 5 — Average schematic curves of relative sea-level variations along the central Brazilian coast, and along the Atlantic and Gulf coast of the United States, over the last 8,000 years (from Martin *et al.*, 1987).

Thus, it is obvious that, on gentle sandy coasts, a relative sea-level fall will induce intensive transportation of sand from the inner continental shelf onto the beach. These sands are incorporated into the wave-generated longshore drift system and finally come to rest at sediment traps located along the coast, such as river mouths or any other features that decrease the sediment transport ability of the longshore drift system.

5. ROLE OF LONGSHORE SAND TRANSPORT ON COASTAL SEDIMENTATION

Near to the beaches, the waves do not find sufficient depth for their advancement, and are broken. This phenomenon is accompanied by liberation of large amounts of energy which will be partially used to put sands in suspension and, in part, to generate longshore current. Obviously, longshore current is active only when the wave fronts approach shoreline obliquely and the direction of this current will depend upon the angle of incidence of wave fronts which reach the shoreline.

The velocity of this current is very slow but its influence is very effective where sand was put into suspension by wave-break and, therefore, a very significant volume of sand will be transported in this way. This transportation continues until the sands are blocked by a trap or an obstacle. This explains the great difference that can be found between two regions having been subjected to an equivalent relative sea-level fall. Sandy deposits are small or even absent in transit region, and very large in regions where a trap or an obstacle causes sand accumulation. If the coast is submitted to diverse swell patterns, the efficient swells are defined as those that determine the resulting longshore transport directions. Such swells are not necessarily the most common ones.

5.1 – Blocking of Littoral Sand Transport by a River Flow

In favourable conditions, the flow of water from a river-mouth can block the sand transport, in the manner of an artificial groyne built on a beach. These structures are built so as to extend beyond the wave breaking zone, interrupting the littoral sand transport. As a consequence, the updrift shoreline will be subjected to a rapid progradation and the downdrift shoreline will be eroded causing a rapid retrogradation. The active mechanism at a river mouth can be explained as follows (Dominguez, 1982; Martin *et al.*, 1984d, 1985b; Suguio *et al.*, 1985b):

— In a period of high river discharge, the river flow acts as a hydraulic groyne tending to block the sand transport. These results in sand accumulation in the updrift portion and erosion or deposition of fluvial sediments in the downdrift area (Fig. 6b).

— In a period of low discharge, the obstacle formed by the river flow tends to disappear. The longshore current causes partial erosion of the previous deposits and builds a sand spit which tends to obstruct the river mouth (Fig. 6c).

— If the low-energy period lasts long enough, the sand spit will be enlarged to resist the following high-energy period. In some cases, only the distal end of the sand spit will be destroyed, and the blocking effect of the river flow will be displaced in the direction of the longshore drift and a new accumulation will occur (Fig. 6d).

As a consequence of "groyne effect" the coastal plain on either side of the river mouth will thus be asymmetric with the updrift portion formed by a series of sand ridges, and the downdrift portion consisting of alternating sandy ridges and clayey-sandy wetlands. Displacements controlled by the river mouth will be recorded as unconformities in the alignments of sandy ridges. These mechanisms are obvious in the Rio Paraíba do Sul mouth (Fig. 6).

5.2 – Patterns of Swell Systems Along the Central Brazilian Coast

The patterns of swell systems along this stretch of coast are not well known, but there are sufficient data to identify two swell regimes, corresponding to two wind systems active in the area: one from E-NE and the other from S-SSE (Fig. 7). The winds from the E-NE are related to the recurrent trade winds active during the entire year particularly from October to March, whereas those from the S-SSE are related to "cold fronts" which periodically reach the central part of this coast, mostly from April to September. Over the sea, the "cold fronts" are followed by swells from the southern sector. These swells, in spite of their low frequency, are much more powerful than those from the northern sector and, in consequence, the predominant longshore transportation of sediments occurs from south to north.

However, this model can be disturbed by strong El Niño events. When this phenomenon is active, as in 1983, the subtropical jet is enhanced and the polar frontal systems are blocked (Fig. 8) (Kousky *et al.*, 1984). During the blockage period, the frontal systems remain for a long time in southern and southeastern Brazil. Consequently, the swells from the southern sector, that are generated by the frontal systems, do not reach the central part of the Brazilian coast. In such cases, the northern sector swells become effective, provoking a longshore drift from north to south (Martin *et al.*, 1984 b,c, 1993a).

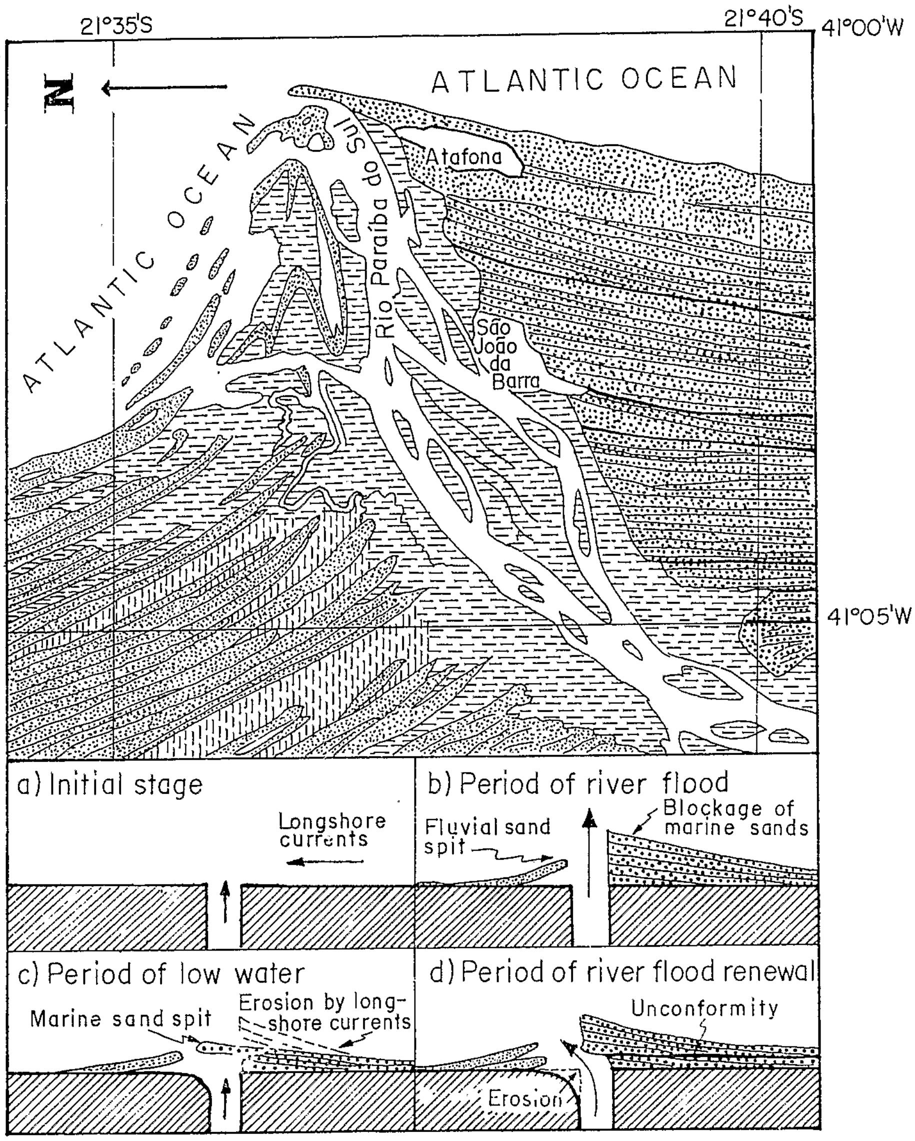

Fig. 6 — Schematic diagram of littoral sand transport blocking by a river flow, illustrated by the Rio Paraíba do Sul mouth (modified from Martin *et al.*, 1984).

6. MAIN STAGES OF CONSTRUCTION OF COASTAL PLAINS OF THE CENTRAL BRAZILIAN COAST

6.1 – General Model

Relative sea-level fluctuations and longshore sand transport, associated with climatic changes, controlled this construction. The most complete evolutionary model has been established for the coast of the State of Bahia (Martin *et al.*, 1980c; Dominguez *et al.*, 1981). This model remains valid for the entire coast between Macaé (RJ) and Recife (PE), characterized by the presence of Barreiras Formation continental sediments (Martin *et al.*, 1987d). On the other hand, in the southern half of the coast of São Paulo State, and along the coastline of Santa Catarina and Paraná, this model is only partially applicable for local reasons (Martin *et al.*, 1987b).

In the coast of the State of Bahia, the following stages have been identified:

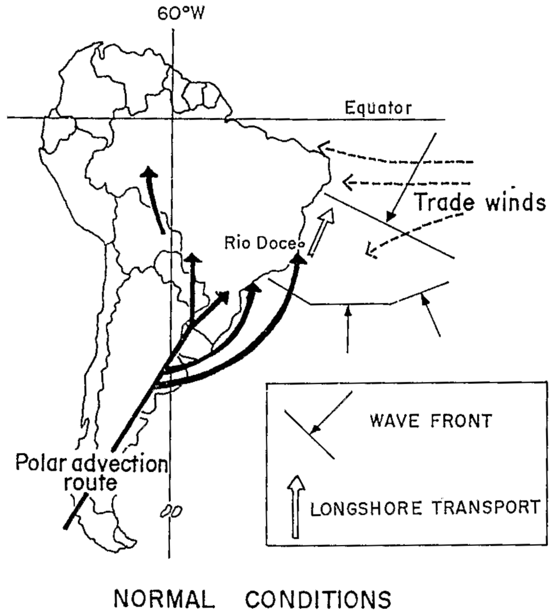

Fig. 7 — Wind pattern along the central Brazilian coast and direction of incidence of wavefronts in normal conditions, resulting in a littoral sand transport from south to north (modified from Martin & Suguio, 1992).

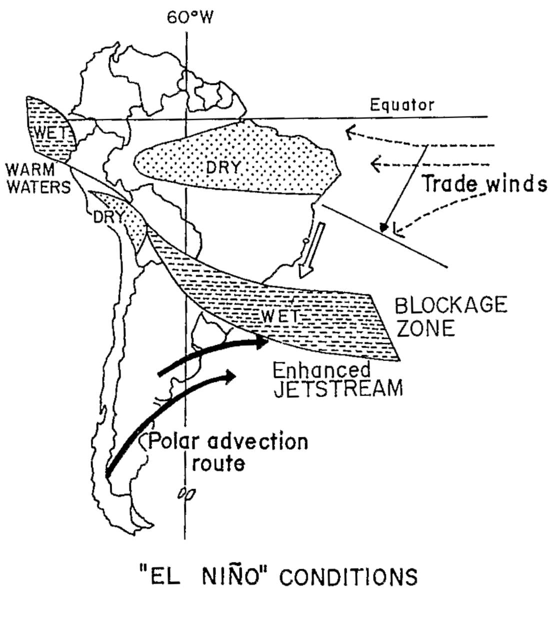

Fig. 8 — Wind pattern along the central Brazilian coast and direction of incidence of wavefronts in El Niño conditions, resulting in a littoral sand transport from north to south (modified from Martin & Suguio, 1992).

— Stage 1: Deposition of Barreiras Formation continental sediments – After a long period of hot and humid climate which resulted in the formation of a very thick weathering mantle, the climate became drier (typically semi-arid with infrequent but torrential rains), the vegetation cover tended to disappear, and the alteration mantle was exposed to erosion (end of Tertiary). The products of the erosion were deposited at the foot of cliffs in the form of coalescent alluvial fans (Fig. 9A). During this period, relative sea-level was much lower than it is today, since these continental deposits covered part of the continental shelf (Bigarella & Andrade, 1964).

— Stage 2: Maximum of the Ancient Transgression – The limit reached by the maximum of this transgression is indicated by a line of dead cliffs cut through the Barreiras Formation sediments (Fig. 9B). The climate was wetter than during the stage 1.

— Stage 3: Deposition of post-Barreiras continental sediments – After the maximum of the transgression, and during the following regression, the paleoclimate re-acquired semi-arid characteristics. This turn-back to semiaridity propitiated sedimentation of new continental deposits as coalescing alluvial fans, which were laid down at the foot of the cliffs carved into the Barreiras Formation during the Stage 2 (Fig. 9C). These deposits, recorded only in the states of Bahia and Alagoas, are known as the *Post-Barreiras Continental Formation* (Vilas-Boas *et al.*, 1985). In some regions, the surface of these deposits has been reshaped by wind, leading to the formation of large dune fields, whose vestiges have been found to the north of Salvador (Martin *et al.*, 1980c) and on the coast of the State of Sergipe (Bittencourt *et al.*, 1982). We know that the *Post-Barreiras Continental Formation*, and the dunes that sometimes cover it, are older than 123,000 yr BP, since they were partially eroded during the maximum of the Penultimate Transgression.

— Stage 4: Maximum of the Penultimate Transgression – At about 123,000 yr BP, the relative sea-level was 8 ± 2m above the present level. During this transgression, the continental deposits formed during the previous stage were partially or

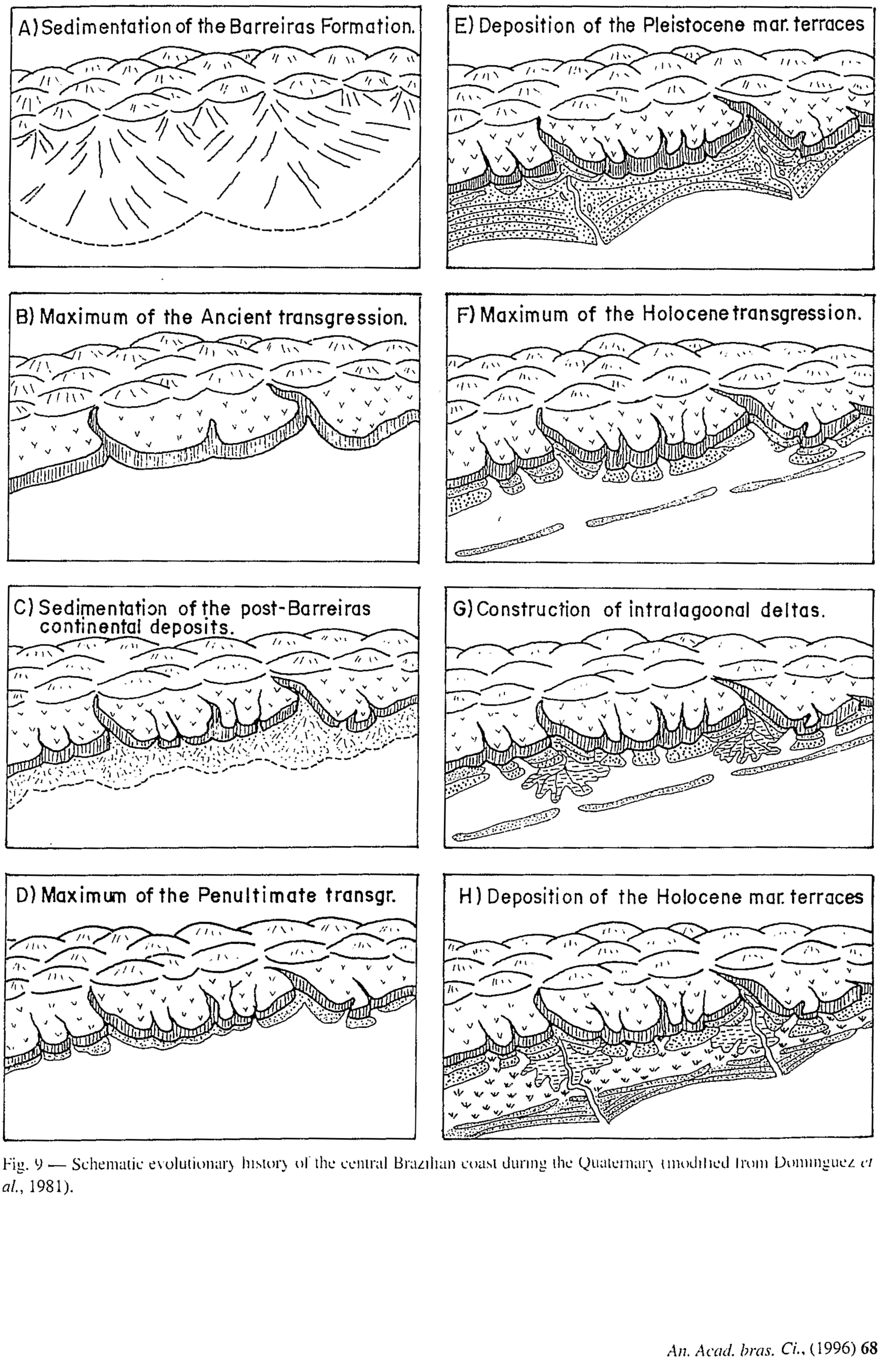

Fig. 9 — Schematic evolutionary history of the central Brazilian coast during the Quaternary (modified from Dominguez *et al.*, 1981).

totally eroded. The downstream courses of the rivers were drowned and transformed into estuaries and lagoons (Fig. 9D).

— Stage 5: Construction of Pleistocene marine terraces – A new regression started and sandy terraces covered with beach-ridges were formed, giving rise to extensive coastal plains (Fig. 9E). During this low sea-level period a hydrographic network was established on the emerged part of the continental shelf, and in particular on the sandy terraces. Consequently, some rather wide and deep valleys were found. Nevertheless, the original surface was often preserved in inter-fluvial zones, where beach-ridges are still more or less visible.

— Stage 6: Maximum of the Last Transgression – At about 7,000 yr BP, the relative sea-level reached the present level, and then passed through a maximum of 4 to 5m above the present level at about 5,100 yr BP. During this transgression the Pleistocene marine terraces were partially or totally eroded. The most common manifestation of this submersion was the formation of barrier island/lagoonal systems (Fig. 9F). Depending on the region, this system was of varying significance or even absent.

— Stage 7: Construction of intralagoonal deltas – When a river opened up into one of these lagoons, an intralagoonal delta was formed, with dimensions varying as a function of the lagoon and river sizes (Fig. 9G).

— Stage 8: Construction of Holocene marine terraces – After 5,100 yr BP, the relative sea-level gradually fell to its present position, although two rapid oscillations did occur, between 4,100 and 3,600 yr BP, and between 3,000 and 2,500 yr BP. During the emersion stages, sandy terraces covered of beach-ridges clung to the outer part of the barrier islands (Fig. 9H). It was possible, in some cases, to distinguish among three generations of Holocene terraces in relation to the three emersion stages occurring after 5,100 yr BP, as in Rio Jequitinhonha coastal plain (Dominguez, 1982). Besides the construction of marine terraces, the sea-level drop causes gradual transformation of lagoons into lakes, followed by marshes and swamps and the river opening into them began to flow directly to the ocean.

6.2 – Special Cases of Coastal Plains Located at the Mouths of Large Rivers

In association with mouths of the most important Brazilian rivers (Paraíba do Sul, Doce, Jequitinhonha and São Francisco) (Fig. 1), there are prograding zones which were classified by Bacoccoli (1971) as "*wave-dominated highly destructive deltas*". This author considered all of these deltas to be Holocene in age and proposed an evolutionary scheme in which they were formed after the maximum of the *Flandrian Transgression* (Last Transgression), passing in some cases through an intermediate estuarine stage, finally to constitute typical deltas whose implied construction is a generalized shoreline progradation. However, along the Brazilian coast, there are also extensive progradation zones without any relationship with present or past river mouths. The most typical of these zones is that of Caravelas (BA) (Martin *et al.*, 1987d), where, with the exception of fluvial sediments, there are all the other types of sedimentary deposits which are present in the "*Quaternary Brazilian Deltas*" described by Bacoccoli (*op. cit.*). The fact that zones in progradation could be formed without the presence of a river is very striking. Obviously, in such case, the source of sandy material is not the river. Most of the existing coastal sedimentation model have not properly incorporated the fundamental role of Holocene sea-level history in the development of modern coastal regions. For example, the classic work by Coleman and Wright (1975), although analysing the influence of as many as 400 parameters on the geometry of deltaic sand bodies, did not address the effects of Holocene sea-level oscillations. Coastal sedimentation models have focused on tidal range, wave energy, and fluvial discharge as the primary controls in determining the general framework of coastal sedimentary environments (Fisher, 1969; Coleman & Wright, 1972 a,b; Galloway, 1975; Hayes, 1979). But, in fact these factors are important only in controlling aspects of the local coastal morphology. It is the sea-level history which determines the general framework within which these factors act.

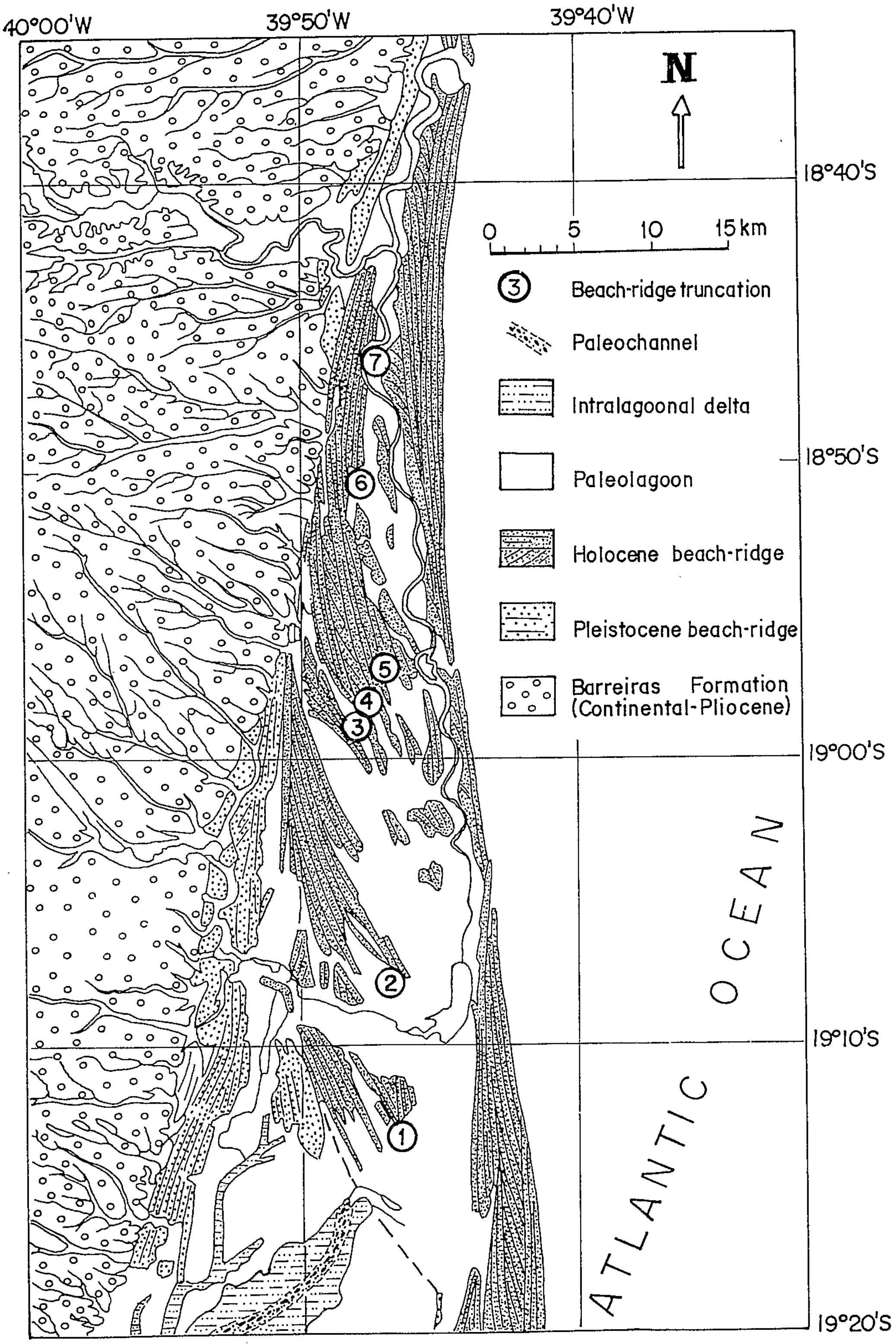

Fig. 10 — Schematic geologic map of the northern Rio Doce coastal plain, showing seven unconformities in beach ridge alignments (from Martin & Suguio, 1992).

New detailed studies (Dominguez *et al.*. 1981, 1983. 1987; Dominguez, 1990; Martin *et al.*, 1993b) carried out on coastal plains of the Rio Paraíba do Sul (21°S) (Martin *et al.*, 1984f, 1987a), Rio Doce (19°S) (Suguio *et al.*, 1982; Dominguez, 1989; Dominguez & Wanless, 1991; Martin & Suguio, 1992), Rio Jequitinhonha (Dominguez, 1982; Dominguez *et al.*, 1982, 1987), Rio São Francisco (Bittencourt *et al.*, 1982, 1983; Barbosa *et al.*, 1987; Dominguez & Barbosa, 1994) showed that their Holocene history had been strongly controlled by relative sea-level changes and longshore transport. Finally, considering the *sensu strictu* definition of delta, these prograding coastal zones could not be assumed as true deltas, because their sediments were only partially supplied by the rivers.

The Rio Doce coastal plain, stretching in a nearly N-S direction, has a maximum width of about 38 km and length of about 130 km (Figs. 10 and 11). The build up of its Holocene part began about 7,000 yr BP with the formation of a barrier island/lagoonal system (Fig. 12). After the paleo-lagoon was created, it became a trap for the sediments supplied by the river. There are no data to follow the steps in the development of the intralagoonal delta, but it is important to determine the moment when the Rio Doce began to flow directly into the ocean, thus contributing to the formation of sandy terraces. There are two possibilities: (a) the intralagoonal delta filled the lagoon rapidly and a few distributaries could attain the ocean very early (Dominguez, 1989) or (b) the abrupt fall in sea-level, between 4,200-3,900 yr BP, provoked an almost simultaneous oceanward exit of several still active distributaries of the intralagoonal delta (Martin & Suguio, 1992). In the Fig. 11, is possible to recognize the location of five positions occupied by paleo-river mouths in the central part of the Rio Doce coastal plain in front of the intralagoonal delta (A, B, C, D and E). It is clear that these paleo-river mouths were active during the same period of time and that, consequently, they reached the ocean more or less simultaneously (Fig. 13). Only a global mechanism as the abrupt sea-level fall after 4,200 yr BP could explain the contemporaneous exit of these five distributaries.

At the maximum of the transgression, the configuration of the barrier island system showed a pronounced recess in the northern part of the coastal plain (Fig. 12), which served as a trap for sand transported by longshore current. Before the Rio Doce entered the ocean, this recess has been filled and the coastline has been almost straightened out. Therefore, it can be stated that between 5,100 and 4,200 yr BP, a first generation of sandy terrace covered by aligned beach-ridges was formed. It was created by mean hydrodynamic conditions related to effective waves from the southeast. However, detailed mapping of beach-ridge alignments shows the existence of well-established unconformities (Fig. 10). They are related to a sequence of alternating erosional and depositional periods, which indicate changes in coastal hydrodynamics.

As a consequence of the Rio Doce flowing directly into the ocean, the dynamics of sandy sedimentation changed completely. The first generation sandy depositional zone, was abandoned and sandy sedimentation started in a new area, situated in the south of the coastal plain (Fig. 13). The absence of truncations in beach-ridge alignments formed during this period suggests that no striking changes in hydrodynamic conditions were produced.

After this depositional phase, the coast was subjected to a general erosion in relation with the sea-level rise between 3,900 and 3,600 yr BP (Fig. 14). At the same time, parts of the ancient lagoon of the barrier island/lagoonal system were reoccupied, as well as the elongated lagoons formed during the formation of the first sandy terrace. As a consequence of this relative sea-level rise, the five mouths became unstable and were abandoned, to be replaced by a single mouth independent of the previous one. The rapid formation of an island in the center of river mouth created an eastern (H) and a southern (G) exits (Fig. 15).

The period of sea-level fall between 3,600 and 2,700 yr BP was characterized by an intense progradation in part nourished by sands supplied by the new river mouths (Fig. 15). The absence of any unconformity in the preserved beach-ridge alignments suggests that no changes occurred in the hy-

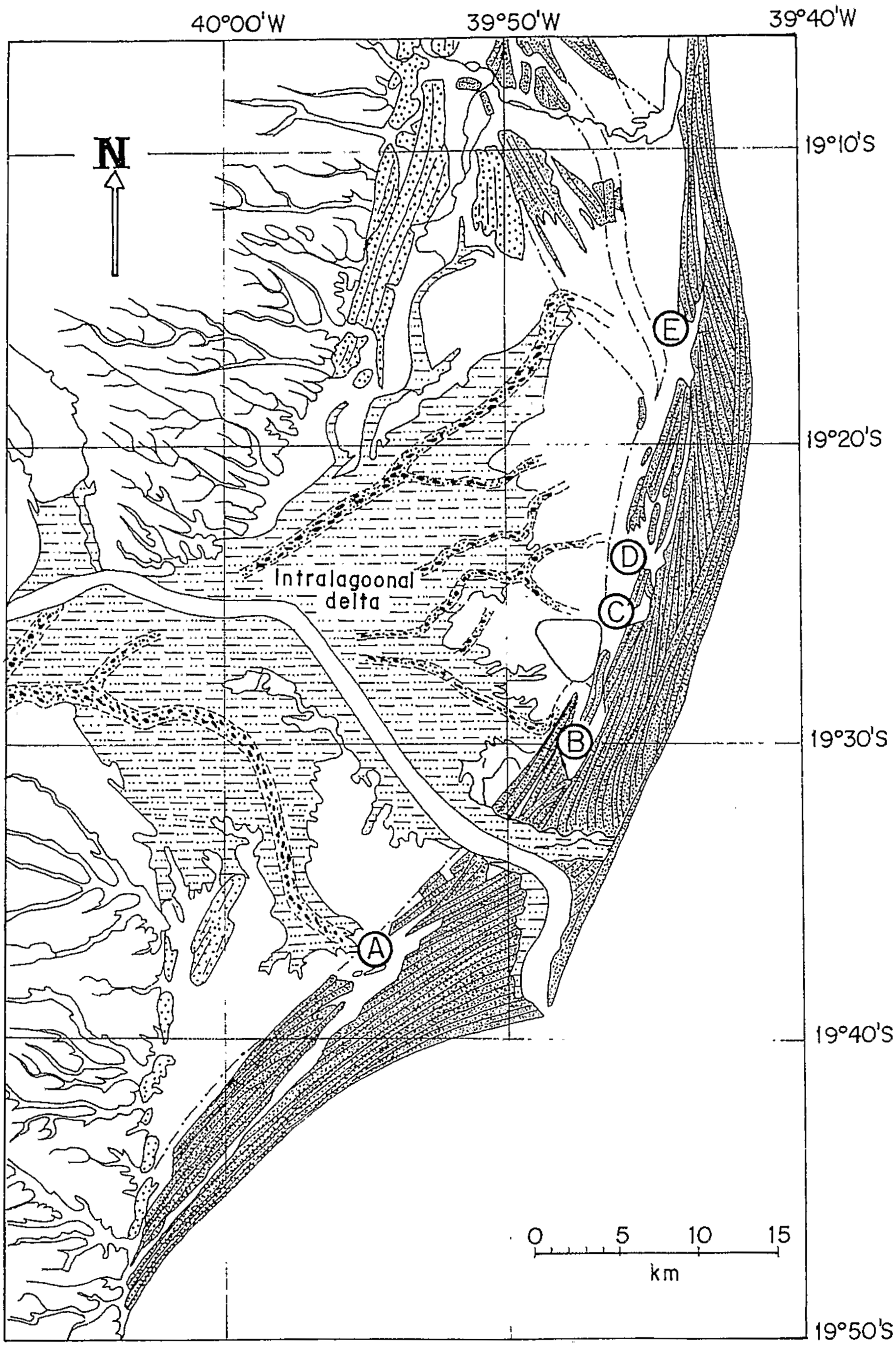

Fig. 11 — Schematic geologic map of the southern Rio Doce coastal plain, showing the intralagoonal delta and the second generation of beach ridges. Note the locations of the ancient mouths (A), (B), (C), (D) and (E) (from Martin & Suguio, 1992).

drodynamic conditions; that is, no reversal of effective waves took place.

The existence of unconformities in beach-ridge alignments, along the entire shoreline demonstrates a period of general erosion due to sea-level rise between 2,700 and 2,500 yr BP (Fig. 16). After 2,500 yr BP, the progradation started again. A close inspection of Figure 11 shows the existence

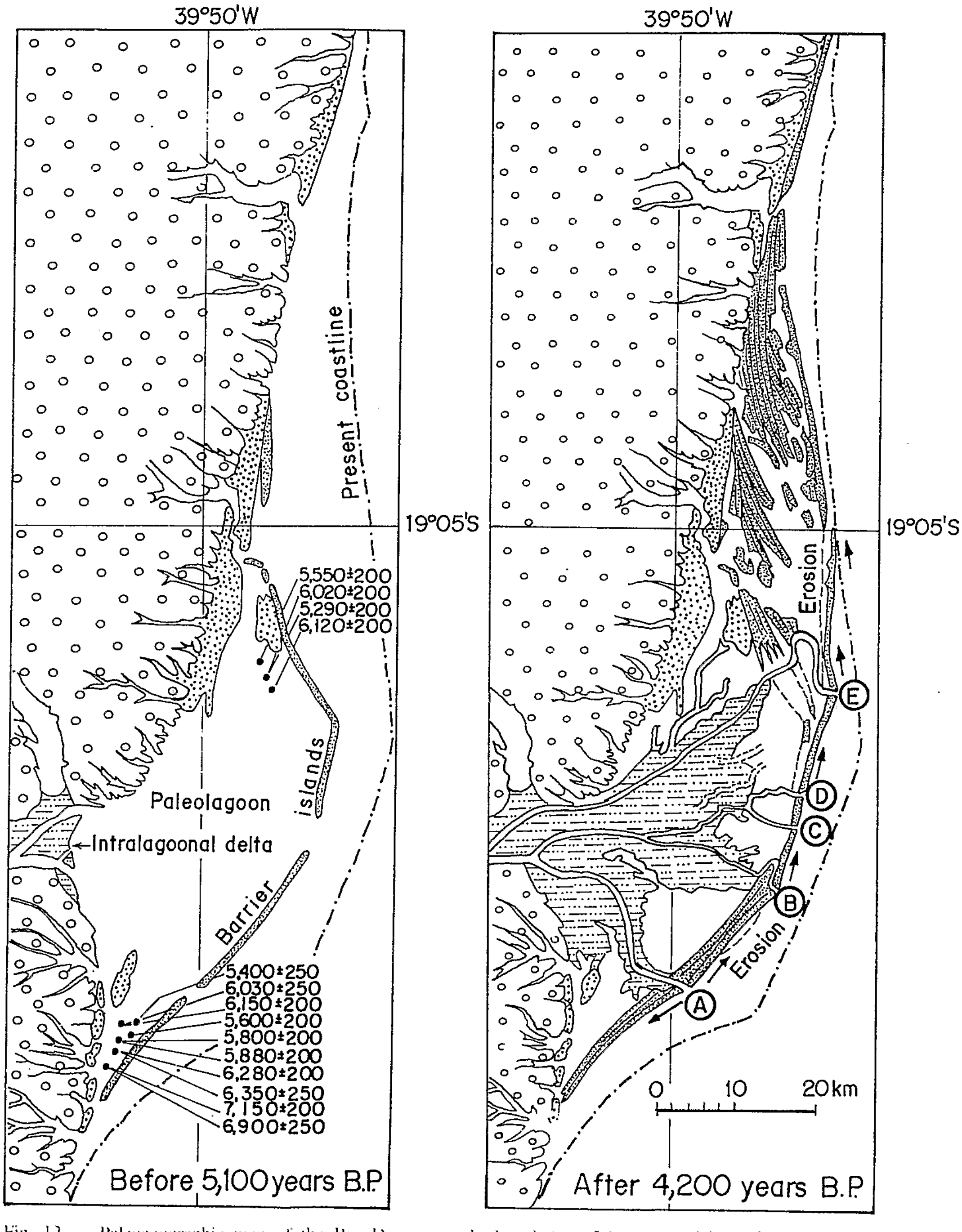

Fig. 12 — Paleogeographic map of the Rio Doce coastal plain before 5,100 years BP, with formation of a barrier island/lagoonal system (modified from Martin & Suguio, 1992). Fig. 13 — Paleogeographic map of the Rio Doce coastal plain after 4,200 years B.P., showing a direct exit into the ocean of five distributary channels of the intralagoonal delta (modified from Martin & Suguio, 1992).

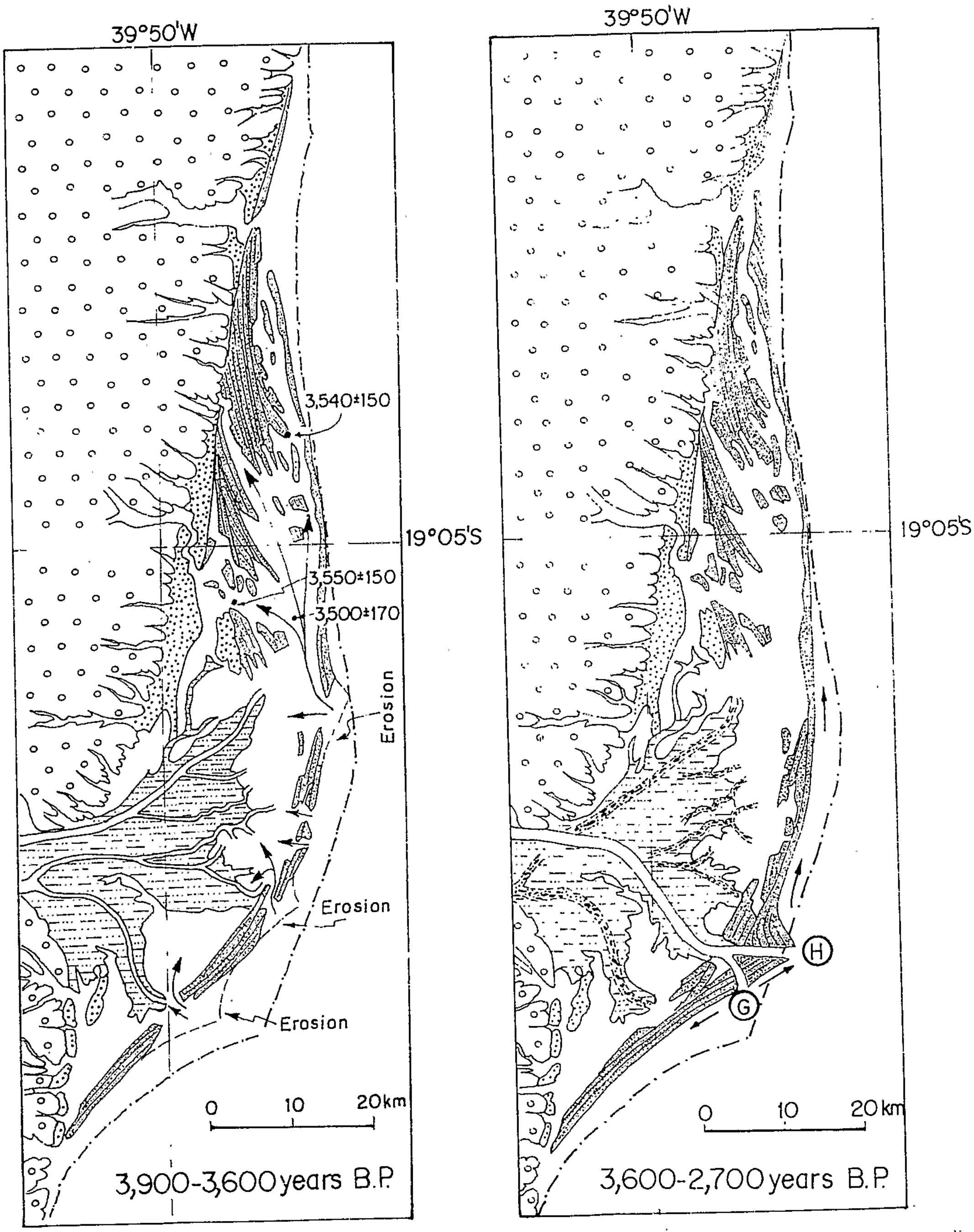

Fig. 14 — Paleogeographic map of the Rio Doce coastal plain between 3,900 and 3,600 years BP, showing a generalized erosion and reoccupation of the ancient lagoons following a relative sea-level rise (modified from Martin & Suguio, 1992).
Fig. 15 — Paleogeographic map of the Rio Doce coastal plain between 3,600 and 2,700 years BP, characterized by a new progradation period (modified from Martin & Suguio, 1992).

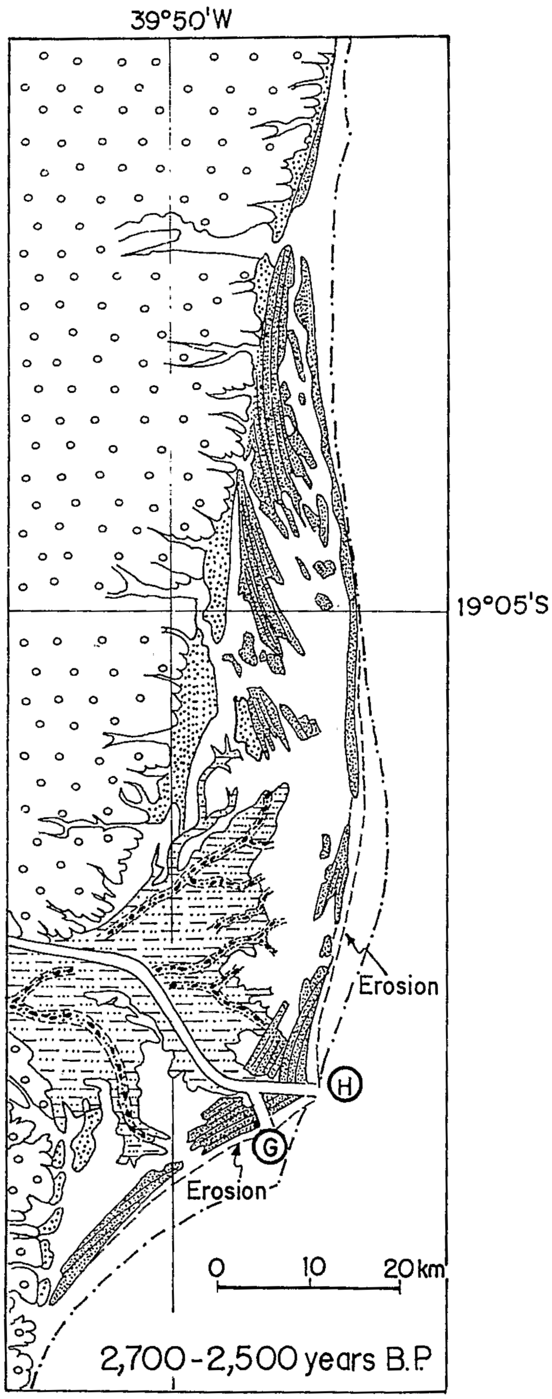

Fig. 16 — Paleogeographic map of the Rio Doce coastal plain between 2,700 and 2,500 years BP, showing a general erosion following a relative sea-level rise (modified from Martin & Suguio, 1992).

of clear local unconformities in beach-ridge alignments. This fact demonstrates the existence of several depositional and erosional phases, caused by different hydrodynamic conditions.

These reversals can be explained only by changes in the direction of the effective waves and of the wind pattern, such as that occurred in 1983 on a Salvador (BA) beach (Farias *et al.*, 1985). This disturbance occurred as a result of blockage of polar advections and waves from the southeast by reinforcement of the subtropical jet, as a consequence of a strong El Niño event. As this phenomenon is capable of producing, on a monthly time scale, disturbances in the coastal transport of sediments in the central part of the Brazilian coast, the periods of sand transport reversals, well recorded in the Rio Doce coastal plain can, therefore, be correlated with periods of "El Niño-like" conditions of long duration (Martin *et al.*, 1984 b,c, 1993a).

The sand terraces, situated at the mouth of the Paraíba do Sul and Jequitinhonha rivers, indicate changes in local hydrodynamics similar to those observed in the Rio Doce coastal plain. The abrupt relative sea-level rises between 3,900 and 3,600 yr BP and between 2,700 and 2,500 yr BP are reflected by major unconformities. On the other hand, secondary unconformities show the existence of periodic reversals in the direction of longshore drift. In contrast, the morphological records show that, in the Rio São Francisco mouth, the longshore current flowed permanently from north to south, as a consequence of effective waves from east-northeast. This corroborates the fact that, in a normal situation, the waves from the southeast rarely reach this region today. The blockage of these waves by "El Niño-like" conditions does not change the coastal dynamics of the River São Francisco mouth which is permanently controlled by waves from east and northeast.

7. CONCLUSIONS

The existence of large Quaternary coastal plains is one of the characteristics of the central part of the Brazilian coast. It has been possible to distinguish in them two principal generations of sandy terraces recording two periods of high Quaternary sea-levels. Some plains are situated at the mouth of a large river, but others have no connection with either a present or a previous river mouth.

A second feature of this coast is that it was, as opposed to other regions of the world, submerged until 5,100 yr BP, and, on the average, in emersion since then. The submersion period, before 5,100 yr BP, often resulted in the formation of barrier islands, which isolated lagoons of varying size. When these lagoons were sufficiently large, the rivers opening into them would build up intralagoonal or intraestuarine deltas. The emersion period occurring after 5,100 yr BP, was reflected in a tendency for the lagoons to dry up. It was only from that time when the rivers opening into the lagoons could flow directly into the sea. Coastal plains situated at the mouths of large rivers, such as the Rio Paraíba do Sul, Rio Doce, Rio Jequitinhonha and Rio São Francisco, were classified in the category of "*highly destructive deltas dominated by waves*". It is clear that application of the term delta to these plains is an exaggeration. In fact, we have seen that coastal plains with very similar characteristics bore no relationship to present or previous rivers. Moreover, throughout the entire lagoonal stage, sediments transported by the river were trapped in the lagoon, and hence could not have contributed to the edification of the sandy terraces that were formed on the outside of the barrier island. During the intralagoonal stage, the sandy terraces were build up for a large part from coarse sediments supplied by lowering of the relative sea-level. It was only once the river flowed directly into the sea that it started to play an important role in the construction of the coastal plain.

A third characteristic of these coastal plains is that they are situated in a high-energy environment, where the longshore current plays an essential role. The shape of the coastal plains changes with the direction and intensity of the longshore transport. When sandy terraces are covered by fossil beach-ridges, their geometry reflects the past directions of longshore sand transport. This makes it possible to determine the provenance of past effective swells and to establish the past wind patterns. A detailed study of beach-ridge geometry of the Rio Doce coastal plain showed a sequence of reversals of the longshore current during the last 5,100 years, with duration ranging from 10 to 100 yr. These reversals represent changes in the direction of effective swells, which determine the longshore transport of sediments, and, consequently, indicate changes in wind pattern. The period of reversal of littoral transport, very well recorded in the Rio Doce coastal plain can, therefore, be correlated with periods of "El Niño-like" conditions of same duration. "El Niño-like" conditions are past mean climate situations that generate the same perturbations as the strong El Niño events. They are likely to correspond to the long-duration low phase of the Southern Oscillation. In contrast, the morphological records show that, at the Rio São Francisco mouth, the longshore current flowed permanently from north to south as a consequence of effective swells from the east and northeast.

REFERENCES

BACOCCOLI, G., (1971), Os deltas marinhos holocênicos brasileiros. Uma tentativa de classificação. *Bol. Téc. Petrobrás,* **14:** 5-38.

BARBOSA, L. M.; BITTENCOURT, A. C. S. P.; DOMINGUEZ, J. M. L. & MARTIN, L., (1987), The Quaternary coastal deposits of the State of Alagoas: influence of the relative sea-level changes. *Quaternary of South America and Antarctic Peninsula*, Balkema Publishers, vol. **4:** 269-290.

BERNAT, M.; MARTIN, L.; BITTENCOURT, A. C. S. P. & VILAS-BOAS, G. DA S., (1983), Datation Io/U du plus haut niveau marin du dernier interglaciaire sur la côte du Brésil. Utilisation du ^{229}Th comme traceur. *C.R.Ac.Sc. Paris*, T. **296:** 197-200.

BIGARELLA, J. J., (1965), Subsídios para o estudo das variações do nível oceânico no Quaternário Brasileiro. *Anais Ac. Bras. de Ciências* (Suplemento), **47:** 365-393.

BIGARELLA, J. J. & ANDRADE, G. O., (1964), Considerações sobre a estratigrafia dos sedimentos cenozóicos em Pernambuco (Grupo Barreiras). *Arquivos do Instituto das Ciências da Terra,* **2:** 2-14.

BITTENCOURT, A. C. S. P.; MARTIN, L.; VILAS-BOAS, G. DA S. & FLEXOR, J.-M., (1979a), The marine formations of the coast of the State of Bahia (Brazil). *Proceedings of the 1978 Int. Symp. on Coastal Evolution in the Quaternary*. K. SUGUIO, T. R. FAIRCHILD, L. MARTIN & J. -M. FLEXOR, eds.: 232-253, São Paulo.

BITTENCOURT, A. C. S. P.; VILAS-BOAS, G. DA S.; FLEXOR, J-M. & MARTIN, L., (1979b), Geologia dos depósitos quaternários do litoral do estado da Bahia. In: *Geologia e Recursos minerais do Estado da Bahia. Textos Básicos*, vol. **1:** 1-21, Governo do Estado da Bahia, Secretaria das Minas e Energia, Salvador.

BITTENCOURT, A. C. S. P.; DOMINGUEZ, J. M. L.; MARTIN, L. & FERREIRA, Y. DE A., (1982), Evolução do "delta" do Rio São Francisco (SE/AL) durante o Quaternário: influência das variações do nível do mar. *Atas do IV Simpósio do Quaternário no Brasil*: 46-68, Rio de Janeiro.

BITTENCOURT, A. C. S. P.; MARTIN, L.; DOMINGUEZ, J. M. L. & FERREIRA, Y. DE A., (1983), Evolução paleogeográfica quaternária da costa do estado de Sergipe e do sul da costa do estado de Alagoas. *Rev. Bras. de Geociências,* **13** (2): 93-97.

BLOOM, A. L.; BROECKER, W. S.; CHAPPELL, J.; MATHEWS, R. K. & MESOLELLA, K. J., (1974), Quaternary sea-level fluctuations on a tectonic coast: new $^{238}Th/^{234}U$ dates from the Huon peninsula, New Guinea. *Quaternary Research,* **4:** 185-205.

BRANNER, J. C., (1902), Geology of northeast coast of Brazil. *Bull. Geol. Soc. Amer.,* **13:** 41-98.

BRANNER, J. C., (1904), The stone reefs of Brazil, their geological and geographical relations. *Bull. of the Museum of Comparative Zoology. Geological series,* **44** (7): 207-275.

BRUUN, P., (1962), Sea level rise as a cause of shore erosion. *Amer. Soc. Civil Engrs. Proceedings, Journal Waterways and Harbors Division,* **88:** 117-130.

CHAPPELL, J., (1983), A revised sea-level record for the last 300,000 years from Papua New Guinea. *Search,* **14:** 99-104.

COLEMAN, J. M. & WRIGHT, L. D., (1972a), Analysis of major river systems and their deltas: procedure and rationale, with two examples. *Louisiana State Univ., Coastal Studies Inst., Technical Report,* **95:** 1-125.

COLEMAN, J. M. & WRIGHT, L. D., (1972b), *Delta morpholog in relation to the discharge, wave power anc climate*. Anais XXVI Cong. Bras. de Geologia, 2: 145-155, Belém.

COLEMAN, J. M. & WRIGHT, L. D., (1975), Modern rivei deltas: variability of process and sand bodies. In *Deltas-models for exploration*, M. L., Broussard ed., *Houston Geological Society.*

DAVIES, J. E., (1972), Geographical variation in coastal development. In: Geomorphology Text 4, K. M. Clayton ed., Longman Group Ltd, New York, 204p.

DELIBRIAS, G. & LABOREL, J., (1971), Recent variations of sea-level along the Brazilian coast. *Quaternaria,* **10:** 45-49.

DOMINGUEZ, J. M. L., (1982), Evolução quaternária da planície costeira associada à foz do rio Jequitinhonha (BA): influência das variações do nível do mar e da deriva litorânea de sedimentos. *Dissertação de Mestrado, Univ. Fed. da Bahia* 79p.

DOMINGUEZ, J. M. L., (1987), Quaternary sea level changes and the depositional architecture of beach-ridge strandplains along the coast of Brazil. *PhD Thesis, Univ. of Miami, USA*, 288p.

DOMINGUEZ, J. M. L., (1989), Ontogeny of a strandplain. Evolving concepts on the evolution of the Doce river beach-ridge plain (east coast of Brazil). *Int. Symp. on Global Changes in South America during the Quaternary, Spec. Publ.*, Vol. **1:** 235-240, São Paulo.

DOMINGUEZ, J. M. L., (1990), Deltas dominados por ondas: críticas às idéias atuais com referência particular ao modelo de Coleman & Wright. *Rev. Bras. de Geociências,* **20:** 352-361.

DOMINGUEZ, J. M. L. & BARBOSA, L. M., (1994), Controls on Quaternary evolution of the São Francisco strandplain: role of sea-level history, trade winds and climate. *14th Int. Sedimentological Congress, field trip guide*, 39p.

DOMINGUEZ, J. M. L. & WANLESS, H. R., (1991), Facies architecture of a falling sea level strandplain, Doce river coast, Brazil. In: *Shelf Sandstone Bodies*, D. J. P. SWIFT & G. F. OERTEL eds., *Spec. Publ. Int. Assoc. of Sedimentologists*, **14:** 259-289.

DOMINGUEZ, J. M. L.; BITTENCOURT, A. C. S. P. & MARTIN, L., (1981), Esquema evolutivo da sedimentação quaternária nas feições deltaicas dos rios São Francisco (SE-AL), Jequitinhonha (BA), Doce (ES) e Paraíba do Sul (RJ). *Rev. Bras. de Geociências,* **11** (4): 225-237.

DOMINGUEZ, J. M. L.; MARTIN, L. & BITTENCOURT, A. C. S. P., (1982), Evolução paleogeográfica do "delta" do Rio Jequitinhonha (BA) durante o Quaternário: influência das variações do nível do mar. *Atas do IV Simp. do Quaternário no Brasil*: 62-92, Rio de Janeiro.

DOMINGUEZ, J. M. L.; BITTENCOURT, A. C. S. P. & MARTIN, L., (1983), O papel da deriva litorânea de sedimentos arenosos na construção das planícies costeiras associadas às desembocaduras dos rios São Francisco, Doce, Jequitinhonha e Paraíba do Sul. *Rev. Bras. de Geociências,* **13** (2): 98-105.

DOMINGUEZ, J. M. L.; MARTIN, L. & BITTENCOURT, A. C. S. P., (1987), Sea-level history and Quaternary evolution of river mouth associated beach-ridge plains along the eastern/southeastern Brazilian coast: a summary. *In: Sea-level Changes and Coastal Depositional Systems Architecture*, D. NUMMEDAL, O. H. PILKEY & I. D. HOWARD eds., *Society of Economic Paleontologists and Mineralogists*: 115-127.

DOMINGUEZ, J. M. L.; BITTENCOURT, A. C. S. P.; LEÃO, Z. M. A. N. & AZEVEDO, A. E. G. DE, (1990), Geologia do Quaternário costeiro do estado de Pernambuco. *Rev. Bras. de Geociências,* **20**(1-4)**:** 208-215.

DUBOIS, R. N., (1976), Nearshore evidence in support of the Brunn rule on shore erosion. *Journal of Geology,* **84** (4): 485-491.

DUBOIS, R. N., (1977), Predicting beach-erosion as a function of rising water level. *Journal of Geology,* **85** (4): 470-476.

FARIAS, F. F.; BITTENCOURT, A. C. S. P.; ZANINI, A. & DOMINGUEZ, J. M. L., (1985), Variações temporais e espaciais na dinâmica de sedimentação da praia de Armação, Salvador (BA). *Rev. Bras. de Geociências,* **15**(1)**:** 48-54.

FISHER, W. L., (1969), Facies characterization of Gulf coast basin delta system, with Holocene analogous. *Transaction Gulf Coast Ass. of Geol. Soc.,* **19:** 239-261.

FREITAS, R. O., (1951), Ensaio sobre a tectônica moderna do Brasil. *Bol. da Fac. de Filosofia, Ciências e Letras do USP,* **130:** 1-120.

GALLOWAY, W. E., (1975), Process framework for describing the morphologic and stratigraphic evolution of deltaic depositional systems. In: *Deltas-models for exploration*, M. L. BROUSSARD ed., Houston Geological Society: 87-89.

HARTT, G. F., (1870), Geology and Physical Geography of Brazil. *Boston, Fields, Osgoods and Co*, 620p.

HAYES, M. O., (1979), Barrier island morphology as a function of tidal and wave regime. In: *Barrier Islands from Gulf of St Lawrence to the Gulf of Mexico*, S.P. Leatherman, ed. Academic Press, New York: 1-27.

KING, C. A. M., (1972), Beaches and Coasts. E. Arnold, London, 570p.

KOMAR, P. D., (1973), Computer models of delta growth due to sediments input from rivers and longshore transport. *Bull. Geol. Soc. of America,* **84** (7): 2217-2226.

KOMAR, P. D., (1976), Beach processes and sedimentation. *Prentice Hall Inc., New Jersey*, 429p.

KOUSKY, V. E.; KAGANO, M. T. & CAVALCANTI, I. F. A., (1984), A review of Southern Oscillation: oceanic-atmospheric circulation changes and related rainfall anomalies. *Tellus,* **36A:** 490-504.

LABOREL, J., (1979), Fixed marine organisms as biological indicators for the study of recent sea level and climatic variations along the Brazilian tropical coast. *Proceedings of 1978 Int. Symp. on Coastal Evolution in the Quaternary.* K. SUGUIO, T. R. FAIRCHILD, L. MARTIN & J. M. FLEXOR, eds.: 193-211, São Paulo.

MARTIN, L. & SUGUIO, K., (1975), The State of São Paulo coastal marine Quaternary geology. The ancient shorelines. *An. Ac. Bras. de Ciências*, nº **47** (Suplemento): 249-263.

MARTIN, L. & SUGUIO, K., (1992), Variation of coastal dynamics during the last 7,000 years recorded in beach-ridge plains associated with river mouths: example from the central Brazilian coast. *Palaeogeography Palaeoclimatology Palaeoecology,* **99:** 119-140.

MARTIN, L.; BITTENCOURT, A. C. S. P. & VILAS-BOAS, G. DA S., (1980a), Différenciation sur photographies aériennes des terrasses sableuses marines pléistocènes et holocènes du littoral de l'état de Bahia (Brésil). *Photo Interprétation*, nº **3**, fasc. 4-5.

MARTIN, L.; SUGUIO, K.; FLEXOR, J.-M.; BITTENCOURT, A. C. S. P. & VILAS-BOAS, G. DA S., (1980b), Le Quaternaire marin brésilien (littoral pauliste, sud-fluminense et bahianais). *Cahiers ORSTOM,* série Géol., vol. XI, **1:** 96-125.

Martin, L.; Vilas-Boas, G. da S.; Bittencourt, A. C. S. P. & Flexor, J.-M., (1980c), Origine et âges des dunes situées au nord de salvador (Brésil). Importance paléoclimatique. *Cahiers ORSTOM*, série Géol., vol. XI, **1:** 125-132.

Martin, L.; Bittencourt, A. C. S. P. & Vilas-Boas, G. da S., (1982), Primeira ocorrência de corais pleistocênicos da costa brasileira: datação do máximo da penúltima transgressão. *Ciência da Terra,* **1:** 16-17.

Martin, L.; Dominguez, J. M. L.; Suguio, K.; Bittencourt, A. C. S. P. & Flexor, J-M., (1983), Schéma de la sédimentation quaternaire sur la partie centrale du littoral brésilien. *Cahiers ORSTOM, série Géol.*, Vol. XIII, **1:** 59-81.

Martin, L.; Bittencourt, A. C. S. P.; Flexor, J-M. & Vilas-Boas, G. da S., (1984a), Evidência de um tectonismo quaternário nas costas do estado da Bahia. *Anais do XXXIII Cong. Bras. de Geologia*, vol. **1:** 19-35, Rio de Janeiro.

Martin, L.; Flexor, J-M.; Bittencourt, A. C. S. P. & Dominguez, J. M. L., (1984b), Registro do bloqueio da circulação atmosférica meridiana na geometria dos cordões litorâneos da costa brasileira. *Anais do XXXIII Cong. Bras. de Geologia*, vol. **1:** 133-144.

Martin, L.; Flexor, J-M.; Kousky, V. & Cavalcanti, I. F. A., (1984c), Inversion du sens du transport littoral enregistrées dans les cordons littoraux de la plaine côtière du Rio Doce (Brésil). Possible liaison avec des modifications de la circulation atmosphérique. *C.R.Ac.Sc. Paris*, T. 298, série **II:** 25-27.

Martin, L.; Flexor, J-M. & Suguio, K., (1984d), Enrégistrement des périodes de fortes et faibles énérgie à l'embouchure d'un fleuve. Le cas du Paraíba do Sul (Brésil). Implications paléoclimatiques. *C.R.Ac.Sc. Paris*, T. 299, série **II:** 661-664.

Martin, L.; Suguio, K. & Flexor, J-M., (1984e), Informações adicionais fornecidas pelos sambaquis na reconstrução de paleolinhas de praias quaternárias: exemplos da costa do Brasil. *Revista de Pré-história, Univ. de São Paulo*, vol. **VI:** 128-147.

Martin, L.; Suguio, K.; Flexor, J-M.; Dominguez, J. M. L. & Azevedo, A. E. G. de, (1984f), Evolução da planície costeira do Rio Paraíba do Sul (RJ) durante o Quaternário: influência das flutuações do nível do mar. *Anais do XXXIII Cong. Bras. de Geologia,* **1:** 84-97.

Martin, L.; Flexor, J-M.; Blitzkow, D. & Suguio, K., (1985a) Geoid change indications along the Brazilian coas during the last 7,000 years. *Proceedings of the V*[th] Int. Coral Reef Cong., Vol. **3:** 85-90.

Martin, L.; Suguio, K.; Flexor, J-M.; Tessler, M. G. & Eichler, B. B., (1985b), Roundness in Holocen sands of the Paraíba do Sul coastal plain, Rio d Janeiro, Brazil. *Journal of Coastal Research,* **1** (1): 343-351.

Martin, L.; Bittencourt, A. C. S. P. & Dominguez, J. M. L., (1986a), Neotectonic movements on a passive continental margin: Salvador region, Brazil. *Neotectonics: an International Journal of Crustal Dynamics,* **1** (1): 87-103.

Martin, L.; Suguio, K. & Flexor, J-M., (1986b), Shell-middens as a source for additional information in Holocene shoreline and sea-level reconstructions: examples from the coast of Brazil. In: *Sea-level research: a manual for collection and evaluation of data.* O. Van de Plassche ed., Published by *Geo Books*, Norwich: 503-521.

Martin, L.; Dominguez, J. M. L. & Suguio, K., (1987a), Consequences of relative sea-level changes during the Quaternary on sandy coastal sedimentation: examples of Brazil. *Quaternary of South America and Antarctic Peninsula*, Balkema Publishers, vol. **4:** 119-135.

Martin, L.; Suguio, K. & Flexor, J-M., (1987b), Relative sea-level reconstruction during the last 7,000 years along the states of Paraná and Santa Catarina coastal plains: additional informations derived from shell-middens. *Quaternary of South America and Antarctic Peninsula*, Balkema Publishers, vol. **4:** 219-236.

Martin, L.; Suguio, K. & Flexor, J-M., (1987c), Flutuações do nível relativo do mar no Quaternário e seu papel na sedimentação costeira: exemplos brasileiros. *Anais do Simpósio sobre Ecossistemas da Costa Sul e Sudeste Brasileira. Publicação Ac. Ci. Estado de São Paulo*, vol. **1:** 40-61.

Martin, L.; Suguio, K.; Flexor, J-M.; Dominguez, J. M. L. & Bittencourt, A. C. S. P., (1987d), Quaternary evolution of the central part of the Brazilian coast. The role of relative sea-level variation and of shoreline drift. *UNESCO Reports in Marine Science*: Quaternary Coastal Geology of West Africa and South America, n° **43:** 97-145.

MARTIN, L.; SUGUIO, K. & FLEXOR, J-M., (1988), Hauts niveaux marins pléistocènes du littoral brésilien. *Palaeogeography Palaoeclimatology Palaeoecology,* **68** (2/4): 231-238.

MARTIN, L.; ABSY, M. L.; FLEXOR, J-M.; FOURNIER, M.; MOURGUIART, PH.; SIFEDDINE, A. & TURCQ, B., (1993a), Southern oscillation signal in South America paleoclimatic data of the last 7,000 years. *Quaternary Research,* **39:** 338-346.

MARTIN, L.; SUGUIO, K. & FLEXOR, J-M., (1993b), As flutuações do nível do mar durante o Quaternário superior e a evolução geológica de "deltas" brasileiros. *Bol. IGUSP, Publ. Esp.* nº **15:** 186p.

RODRIGUES, S. A.; SUGUIO, K. & SHIMIZU, G. Y., (1985), Ecologia e paleoecologia de *Callichirus major* Say, 1918 – Crustacea, Decapoda, Thalassinidae. *Anais do Seminário Regional de Ecologia*: 499-519, São Carlos.

SCHWARTZ, M. L., (1965), Laboratory study of sea-level rise as a cause of shore erosion. *Journal of Geology,* **73:** 528-534.

SCHWARTZ, M. L., (1967), The Brunn theory of sea-level rise as a cause of shore erosion. *Journal of Geology,* **75:** 76-92.

SHEPARD, F. P. & CURRAY, J. R., (1967), Carbon 14 determination of sea level changes in stable areas. *Progress in Oceanography,* **4:** 283-291.

SUGUIO, K., (1977), Annotated bibliography (1960-1977) on Quaternary shorelines and sea-level changes in Brazil. *Contribution IGCP Project 61 (IUGS/ UNESCO)*, 35p.

SUGUIO, K. & MARTIN, L., (1976), Presença de tubos fósseis de *Callianassa* nas formações quaternárias do litoral paulista e sua utilização na reconstrução paleoambiental. *Bol. IGUSP*, vol. **7:** 17-26.

SUGUIO, K. & MARTIN, L., (1978), Quaternary formations of the states of São Paulo and Southern Rio de Janeiro. *Special Publ. nº 1 of the 1978 Int. Symp. on Coastal Evolution in the Quaternary*: 92p.

SUGUIO, K.; MARTIN, L. & DOMINGUEZ, J. M. L., (1982), Evolução do "delta" do Rio Doce (ES) durante o Quaternário: influência das variações do nível do mar. *Atas do IV Simp. do Quaternário no Brasil*: 93-116, Rio de Janeiro.

SUGUIO, K.; MARTIN, L.; DOMINGUEZ, J. M. L.; BITTENCOURT, A. C. S. P. & FLEXOR, J-M., (1984a), Quaternary emergent and submergent coasts: comparison of the Holocene sedimentation in Brazil and Southeastern United States. *An. Ac. Bras. de Ciências,* **56** (2): 163-167.

SUGUIO, K.; RODRIGUES, S. A.; TESSLER, M. G. & LAMBOOY, E. E., (1984b), Tubos de *ophiomorphas* e outras feições de bioturbação na Formação Cananéia. Pleistoceno da planície costeira Cananéia-Iguape, SP. In L. D. LACERDA *et al.* (org.) *Restingas: origem, estrutura, processos*: 111-122, Niterói.

SUGUIO, K.; MARTIN, L.; BITTENCOURT, A. C. S. P.; DOMINGUEZ, J. M. L. & FLEXOR, J-M., (1985a), Flutuações do nível relativo do mar durante o Quaternário superior ao longo do litoral brasileiro e suas implicações na sedimentação costeira. *Rev. Bras. de Geociências,* **15** (4): 273-286.

SUGUIO, K.; MARTIN, L.; FLEXOR, J-M.; TESSLER, M. G. & EICHLER, B. B., (1985b), Depositional mechanisms active during the late Quaternary at the Paraíba do Sul river mouth area, State of Rio de Janeiro, Brazil. *Quaternary of South America and Antarctic Peninsula*, Balkema Publishers, vol. **3:** 175-185.

SUGUIO, K.; MARTIN, L. & FLEXOR, J-M., (1992), Paleoshorelines and the sambaquis of Brazil. In *Paleoshorelines and Prehistory*, L. L. JOHNSON & M. STRIGHT, ed., *CRC Press*, Boca Raton, An Arbor, London, 83-99.

SWIFT, D. J. P., (1976), Coastal sedimentation. In: *Marine sediments transport and environmental management.* D. J. STANLEY & D. J. P. SWIFT eds., John Wiley: 255-310.

VAN ANDEL, T. H. & LABOREL, J., (1964), Recent high sea-level stand near Recife, Brazil. *Science,* **145** (3632): 580-581.

VILAS-BOAS, G. DA S.; BITTENCOURT, A. C. S. P. & MARTIN, L., (1985), Leques aluviais pleistocênicos da região costeira da Bahia: implicações paleoclimáticas. *Rev. Bras. de Geociências,* **15** (3): 255-258.

VILLWOCK, J. A.; TOMAZELLI, J. L.; 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*, Balkema Publishers, vol. **4:** 79-97.

ANNEX
Ionium/Uranium Ages
Pleistocene corals from the coast of the State of Bahia (14°58.7′S and 39°00.1′W)

Sample N°	$^{234}U/^{238}U$	U mg/g	^{234}U (dpm/g)	Io (dpm/g)	Ages yr BP
CP.01	1.076	2.59	2.08	1.43	122,000±6,100
CP.02	1.08	2.70	2.17	1.42	116,000±6,900
CP.06	1.11	3.09	2.57	1.85	132,000±9,000
CP.08	1.08	2.86	2.30	1.60	124,000±8,700
CP.07	1.11	2.58	2.14	1.61	142,000±9,700

Note: CP.01, CP.02, CP.06 and CP.08 have comparable ages (average age: 123,500±5,700 years) but CP.07 is significantly older.

Radiocarbon ages
Radiocarbon ages of mollusk shells and wood fragments sampled from coastal deposits of the State of Santa Catarina.

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
SC.03	26°10.6′S 48°37.1′W	Shells	6,080±250	Bah.1280	> 0.0 m
SC.18	27°14.0′S 48°43.0′W	Wood	5,870±240	Bah.1359	> 0.0 m
SC.41	28°43.5′S 49°10.7′W	Shells	5,710±200	Bah.1382	> 0.0 m
SC.14	26°51.9′S 48°41.3′W	Shells	5,580±240	Bah.1290	+1±0.5 m
SC.44	28°12.7′S 48°43.74′W	Shells	4,490±200	Bah.1395	> 0.0 m
SC.33	28°22.1′S 48°17.7′W	Shells	4,240±200	Bah.1374	+1.5±0.5 m
SC.28	28°02.8′S 48°46.5′W	Shells	4,080±200	Bah.1369	> 0.0 m
SC.27	27°46.1′S 48°30.5′W	Shells	4,070±200	Bah.1368	> 0.0 m
SC.29	28°07.0′S 48°42.0′W	Shells	3,960±200	Bah.1370	> 0.0 m
SC.09	26°17.4′S 48°34.9′W	Shells	3,920±190	Bah.1286	> 0.0 m
SC.40	28°35.6′S 48°58.1′W	Shells	3,830±180	Bah.1381	> 0.0 m
P.d.A.*	28°35.8′S 48°27.5′W	Shells	3,620±100	Io.2627	+2.6±0.5 m
SC.12	26°35.5′S 48°42.2′W	Wood	3,520±180	Bah.1289	+1.5±0.5 m
SC.31	28°17.5′S 48°43.2′W	Shells	3,460±200	Bah.1372	> 1.0 m

Carniça 1**	28°33.9'S 48°48.5'W	Shells	3,400±150	L.1164 b	+2.5±0.5 m
Carniça 2**	28°33.2'S 48°48.5'W	Shells	3,350±150	Io.2620	+2.5±0.5 m
Carniça 3**	28°33.2'S 48°48.5'W	Shells	3,300±150	L.1164	+2.5±0.5 m
SC.39	28°33.3'S 48°48.3'W	Shells	2,500±170	Bah.1380	+2.0±0.5 m
SC.36	28°21.6'S 48°53.4'W	Shells	2,450±170	Bah.1377	> 1.0 m
SC.19	27°20.7'S 48°37.8'W	Shells	2,420±160	Bah.1360	> 0.0 m
SC.21	27°26.6'S 48°27.4'W	Shells	2,220±160	Bah.1362	> 1.0 m
SC.24	27°31.4'S 48°26.4'W	Wood	1,860±160	Bah.1365	> 1.0 m
SC.17	27°12.9'S 48°37.5'W	Shells	1,700±160	Bah.1358	> 0.0 m

*: from Piazza (1966); **: from Hurt (1974).

Radiocarbon ages of lagoonal and marine mollusk shells sampled from shell-middens of the coast of the state of Santa Catarina

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
SC.04	26°04.4'S 48°48.8'W	Shells (base)	5,420±230	Bah.1282	High (max.)
SC.16	26°53.4'S 48°51.6'W	Shells (surface)	5,340±210	Bah.1357	High (max.)
Gaspar 1**	26°51.1'S 48°55.5'W	Shells	5,270±300	Si.362-c	High (max.)
Gaspar 2**	26°51.1'S 48°55.5'W	Shells	5,230±350	Si.1280	High (max.)
SC.01	25°58.9'S 48°38.54'W	Shells (base)	5,040±210	Bah.1280	High
Ponta das Almas*	27°53.8'S 48°27.5'W	Shells (base)	4,280±400	Si.222	Indifferent
Ratones	27°30.0'S 48°27.0'W	Shells	4,260±210	Bah.1329	> 0.0 m
SC.37	28°40.0'S 48°58.7'W	Shells (surface)	4,240±190	Bah.1378	> 0.0 m
SC.43	28°12.7'S 48°43.7'W	Shells (surface)	3,990±200	Bah.1394	< +1.0 m
SC.10	26°22.1'S 48°34.5'W	Shells (surface)	3,850±200	Bah.1287	
SC.35	28°19.3'S 48°52.9'W	Shells (base)	3,690±190	Bah.1376	Indifferent
SC.11	26°17.3'S 48°32.8'W	Shells (base)	3,600±180	Bah.1288	> 0.0 m

SC.30	28°10.7′S 48°35.5′W	Shells (base)	3,520±180	Bah.1371	High
SC.38	28°37.5′S 48°53.9′W	Shells	3,450±170	Bah.1370	Indifferent
Carniça**	28°32.9′S 48°48.5′W	Shells (base)	3,310±150	A.912	> +2.5 m
SC.7	26°27.9′S 48°38.8′W	Shells	2,760±180	Bah.1284	> 0.0 m
Carniça** (2nd phase)	28°32.9′S 48°48.5′W	Shells (base)	2,550±100	A.914	> +2.0±0.5 m
Ponta das Almas**	27°35.8′S 49°27.5′W	Shells (base)	2,400±250	Si.111	> +2.0±0.5 m
SC.26	27°39.7′S 48°39.7′W	Shells (base)	2,170±170	Bah.1367	> 0.0 m

*: from Piazza (1966); **: from Hurt (1974).

Radiocarbon ages of mollusk shells and wood fragments sampled from coastal deposits of the State of Paraná.

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
PR.16	25°58.0′S 48°38.5′W	Shells	5,820±220	Bah.1279	> 0.0 m
PR.07	25°35.0′S 48°29.6′W	Shells	5,040±230	Bah.1271	> +1.5 m
PR.14	25°56.9′S 48°36.2′W	Shells	3,[illegible]0±170	Bah.1277	> +1.0 m
PR.15	25°57.0′S 48°36.8′W	Shells	2,970±150	Bah.1278	> +1.0 m
PR.06	25°33.2′S 48°27.9′W	Shells	2,680±240	Bah.1270	+1.0±0.5 m
PR.04	25°32.5′S 48°31.5′W	Shells	2,650±170	Bah.1269	+1.0±0.5 m
PR.17	25°22.4′S 48°18.9′W	Wood	1,100±150	Bah.1388	> 0.0 m

Radiocarbon ages of lagoonal and marine mollusk shells sampled from shell-middens of the coastal plain of the State of Paraná

PR.21	25°19.6′S 48°45.3′W	Shells	5,050±220	Bah.1392	High (max.)
PR.22	25°27.3′S 48°45.3′W	Shells	4,890±210	Bah.1393	> 0.0 m
Gomes*	25°31.0′S 48°41.5′W	Shells (base)	4,890±70	P.543	> 0.0 m
Godo	25°25.0′S 48°44.6′W	Shells (base)	4,740±90	Si.1029	> 0.0 m
PR.12	25°54.0′S 48°42.2′W	Shells (base)	4,500±190	Bah.1275	> 0.0 m

Gòmes*	25°31.0′S 48°41.5′W	Shells (surface)	4,490±140	P.540	> 0.0 m
Saquarema*	25°30.9′S 48°41.2′W	Shells (base)	4,370±70	P.588	+1.0 m
PR.09	25°55.2′S 48°25.7′W	Shells (base)	3,920±190	Bah.1272	0.0 m
PR.19	25°21.9′S 48°25.2′W	Shells (surface)	3,830±190	Bah.1390	< +1.0 m
PR.20	25°19.9′S 48°25.1′W	Shells (base)	3,800±190	Bah.1391	< +1.5 m
PR.01	25°33.0′S 48°37.3′W	Shells (base)	3,670±180	Bah.1265	< +1.6 m
PR.10	25°55.4′S 48°38.3′W	Shells	3,290±190	Bah.1273	< +1.3 m
PR.13	25°50.7′S 48°43.5′W	Shells (base)	2,420±170	Bah.1276	> 0.0 m
PR.18	25°22.4′S 48°18.9′W	Shells	1,250±150	Bah.1389	< +0.5 m

*: from Rauth (1962, 1968).

Radiocarbon ages of mollusk shells and wood fragments sampled from deposits of the Cananéia-Iguape coastal plain of the State of São Paulo

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
A.73	25°00.0′S 48°00.0′W	Wood	≥ 32,000	Bah.227	± 0.0 m
A.334	24°52.5′S 47°55.0′W	Wood	≥ 32,000	Bah.627	> 0.0 m
A.86	25°00.0′S 47°54.0′W	Wood	6,650±120	Bah.228	+ 0.3±0.4 m
A.335	25°00.0′S 47°54.0′W	Wood	6,520±150	Bah.628	0.0±0.4 m
A.93	24°59.7′S 47°53.7′W	Wood	6,450±170	Bah.230	–0.4±0.4 m
A.138	24°39.7′S 47°43.0′W	Wood	6,190±175	Bah.231	>0.0 m
A.55	25°12.7′S 48°01.7′W	Wood	6,000±160	Bah.226	+1.2±0.4 m
A.89	25°00.0′S 47°53.8′W	Shells	5,410±120	Gif.3444	+1.5±0.4 m
A.90	25°00.0′S 47°53.8′W	Wood	5,290±110	Bah.229	+1.5±0.4 m
A.28	25°09.2′S 47°02.1′W	Shells	4,400±110	Gif.3439	+1.5±0.4 m
A.337	24°51.9′S 47°47.8′W	Wood	3,780±110	Bah.630	+2±0.4 m
A.131	24°51.2′S 47°28.5′W	Wood	3,710±140	Bah.445	+0.5±0.4 m

A.23	25°01.9′S 47°55.0′W	Wood	690±90	Gif.3438	0.0±0.4 m

Radiocarbon ages of lagoonal and marine mollusk shells sampled from shell-middens of the Cananéia-Iguape coastal plain of the State of São Paulo

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
Itapoã III	24°53.0′S 47°53.0′W	Shells	5,245±125	Bah.365	> 0.0 m
Jataituba	24°38.0′S 47°42.8′W	Shells	5,240±150	Bah.346	High (max.)
Guaxixi	24°53.0′S 47°52.0′W	Shells	5,110±100	Bah.370	> 0.0 m
Pariqüera-Açu	24°37.6′S 47°43.5′W	Shells	5,035±140	Bah.295	High (max.)
Juruvaúva I	24°56.0′S 47°50.0′W	Shells	5,010±115	Bah.359	> 0.0 m
Juruvaúva III	24°56.0′S 47°50.0′W	Shells	4,970±110	Bah.361	>0.0 m
Batatal	25°02.7′S 47°58.2′W	Shells	4,920±100	Io.9186	> 0.0 m
Rio das Pedras III	24°28.0′S 47°58.2′W	Shells	4,860±100	Bah.343	High
Momuna	24°41.5′S 47°35.7′W	Shells	4,790±115	Bah.308	> 0.0 m
Rio das Pedras I	24°30.0′S 47°28.0′W	Shells	4,750±110 4,710±145	Gif.3641 Bah.300	> 0.0 m
Vapumaúva II	24°53.0′S 47°53.6′W	Shells	4,680±110	Bah.362	< +3.0 m
Rio Comprido	24°27.8′S 47°13.4′W	Shells	4,560±110	Gif.3646	> 0.0 m
Rio Nóbrega	25°00.0′S 47°55.5′W	Shells	4,380±160	SPC.21	< +3.0 m
Cananéia	25°01.5′S 48°03.5′W	Shells	4,340±110 4,300±140	Gif.3435 Bah.302	> 0.0 m
Juruvaúva III	24°56.0′S 47°50.0′W	Shells	4,305±140	Bah.360	> 0.0 m
Itapoã II	24°52.0′S 47°53.0′W	Shells	4,215±140	Bah.364	Indifferent
Ararapira II	25°01.5′S 48°03.5′W	Shells	4,175±100	Bah.290	< +1.5 m
Boguaçu II	24°59.0′S 48°03.5′W	Shells	4,160±95 4,120±110	Bah.303 Gif.3436	< +1.5 m < +1.5 m
Tapera	25°02.0′S 47°59.0′W	Shells	4,010±110	Bah.291	< +1.5 m
Ubatuba	24°51.5′S 47°45.5′W	Shells	3,870±100	Bah.294	< +2.0 m

Ararapira I	25°08.2′S 48°02.1′W	Shells	3,790±110	Gif.3437	≥ 0.0 m
Fosfasa	25°01.5′S 48°03.5′W	Shells	3,350±135	Bah.340	> 0.0 m
Pereirinha	25°05.0′S 48°01.0′W	Shells	3,300±125	Bah.286	After max.
Boguaçu III	24°58.4′S 47°51.7′W	Shells	3,220±90 3,090±110	Bah.307 Gif.3645	After max.
Pindu	24°39.0′S 47°29.0′W	Shells	3,090±120	Bah.348	> 0.0 m
Boguaçu I	24°58.6′S 47°53.4′W	Shells	3,080±55	Bah.285	< +2.5 m
Guarapari	25°03.0′S 48°01.0′W	Shells	2,285±45	Bah.368	< +1.0 m
Rio das Minas	25°01.5′S 48°02.0′W	Shells	1,850±100	Gif.3643	< +0.5 m
S. Bernardo	24°47.0′S 47°40.0′W	Shells	1,840±150	Bah.347	< +4.0 m
Sambaquinho	25°04.0′S 48°02.2′W	Shells	1,500±120	Bah.292	< +0.5 m
Itapitangui	25°00.7′S 48°00.0′W	Shells	1,490±120	Bah.293	< +1.5 m

Radiocarbon ages of mollusk shells and wood fragments sampled from deposits of the Itanhaém coastal plain of the State of São Paulo

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
A.205	24°12.0′S 46°48.6′W	Vermetidae	6,280±135	Bah.350	+1.3±0.4 m
A.186	24°12.5′S 46°26.2′W	Wood	5,275±125	Bah.349	> 0.0 m
A.203	24°12.0′S 46°48.6′W	Vermetidae	1,105±115	Bah.325	+1.6 m

Radiocarbon ages of lagoonal and marine mollusk shells sampled from shell-middens of the Itanhaém coastal plain of the State of São Paulo

Rio Branco	24°04.3′S 46°48.0′W	Shells	5,970±140	Bah.297	> 0.0 m
Rio Preto	24°08.0′S 46°54.0′W	Shells	4,635±100	Bah.331	> 0.0 m
Ararañ	24°08.3′S 46°55.8′W	Shells	4,630±130	Bah.296	> 0.0 m
Mundo Novo	24°08.1′S 46°57.1′W	Shells	4,575±110	Bah.446	> 0.0 m

Radiocarbon ages of mollusk shells and wood fragments sampled from deposits of the Santos coastal plain of the State of São Paulo

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
A.225	23°58.0′S 46°25.0′W	Wood	> 35,000	Gif.3844	> 0.0 m
A.988	23°52.7′S 46°26.1′W	Wood	7,550±170	Bah.233	–11±1 m
A.272	24°00.8′S 46°23.3′W	Wood	6,565±115	Bah.449	+1.0±0.4 m
A.234	24°00.8′S 46°23.8′W	Wood	6,480±115	Bah.237	< +2.0 m
A.242	24°00.5′S 46°30.9′W	Wood	6,380±75	Bah.354	+1.5±0.4 m
A.238	23°57.2′S 46°26.3′W	Wood	6,280±130	Bah.3646	+0.8±0.4 m
A.237	24°00.8′S 46°23.3′W	Shells	6,200±165	Bah.392	+1.3±0.4 m
A.273	24°00.8′S 46°23.8′W	Wood	5,795±125	Bah.450	+1.7±0.4 m
A.232	24°00.8′S 46°23.3′W	Wood	5,455±170	Bah.326	+2.4±0.4 m
A.254	23°52.3′S 46°50.8′W	Vermetidae	5,010±120	Bah.354	+3.8±0.4 m
Lab. 1*	23°55.0′S 46°14.0′W	Vermetidae	4,480±180	Gif.2147	+3.0±0.4 m
A.247	23°57.2′S 46°26.4′W	Shells	4,210±145	Bah.353	+2.5±0.4 m
A.244	24°00.9′S 46°17.7′W	Vermetidae	3,625±100	Bah.352	+2.6±0.4 m
A.249	23°58.4′S 46°11.8′W	Vermetidae	790±90	Gif.3848	+1.4±0.4 m
A.270	24°00.8′S 46°23.3′W	Wood	390±80	Bah.447	+0.4±0.4 m

*: from Delibrias & Laborel (1971).

Radiocarbon ages of lagoonal and marine mollusk shells sampled from shell-middens of the Santos coastal plain of the state of São Paulo

Piaçagüera*	23°51.8′S 46°22.1′W	Shells	4,930±110	Io.4491	> 0.0 m
A.229	24°00.1′S 46°26.2′W	Shells	4,520±150	Bah.328	< +3.5 m
Mar** Casado	23°57.9′S 46°11.5′W	Shells	4,400±130	Gif.1194	< +3.0 m
Casqueirinho***	23°53.0′S 46°23.2′W	Shells	4,300±180	SPC.15	Indifferent
Maratuá****	23°57.0′S 46°15.0′W	Shells	3,925±145	Bah.382	< 0.0 m

Maratuá****	23°57.0′S 46°15.0′W	Shells	3,825±95	Io.9185	< 0.0 m
A.219	23°55.8′S 46°24.8′W	Shells	545±90	Bah.330	< 1.0 m

*: sampled by C. del Rio Garcia and D. Pinto Uchoa; **: sampled by P. Duarte;
: sampled by J. A. de Moraes Passos; *: sampled by J. Emperaire.

Radiocarbon ages of mollusk shells and wood fragments sampled from deposits of the Bertioga coastal plain of the State of São Paulo

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
A.256	23°50.5′S 46°08.6′W	Wood	6,020±130	Gif.3850	+1.0±0.5 m
A.262	23°49.1′S 46°02.2′W	Shells	5,470±100	Bah.609	+1.9±0.5 m
A.274	23°49.8′S 46°08.1′W	Wood	3,520±130	Bah.498	+2.5±0.5 m
A.266	23°47.8′S 45°59.7′W	Vermetidae	2,240±90	Bah.357	+1.6±0.4 m
A.267	23°45.9′S 45°48.1′W	Vermetidae	1,985±120	Bah.358	+1.5±0.4 m
A.264	23°49.2′S 46°02.2′W	Vermetidae	1,270±130	Bah.356	+1.0±0.4 m

Radiocarbon ages of mollusk shells and wood fragments sampled from deposits of the coast between São Sebastião (SP) and Serra do Parati (RJ)

SPO 5.2	23°39.3′S 45°29.0′W	Wood	8,030±150	Gif.3434	–16.5±1.0 m, Rising
SPO 5.1	23°29.3′S 45°29.0′W	Wood	7,950±220	Gif.3433	–12.5±1.0 m, Rising
A.300	23°40.6′S 45°28.64′W	Shells	6,950±185	Bah.455	+1.0±1.0 m
A.302	23°41.3′S 45°28.6′W	Shells	6,890±175	Bah.456	+1.0±1.0 m
A.282	23°44.9′S 45°28.8′W	Shells	4,605±150	Bah.462	> +1.6 m
A.281	23°44.9′S 45°20.8′W	Vermetidae	4,455±145	Bah.461	+1.9±0.5 m
A.293	23°38.8′S 45°27.2′W	Shells	4,405±110	Bah.454	> 0.0 m
A.290	23°38.5′S 45°26.1′W	Shells	2,750±130	Bah.452	> 0.0 m Rising S-L.
A.280	23°44.9′S 45°20.8′W	Vermetidae	2,665±130	Bah.460	+0.8±0.4 m
A.295	23°39.9′S 45°26.6′W	Shells	2,565±130	Bah.476	> 0.0 m Falling SL.
A.309	23°29.6′S 45°05.9′W	Vermetidae	2,530±130	Bah.469	+1.8±0.4 m

A.307	23°34.4′S 47°17.5′W	Shells	2,085±140	Bah.457	+1.5±0.4 m
A.308	23°30.0′S 45°08.5′W	Vermetidae	1,840±140	Bah.468	+1.2±0.4 m
A.296	23°39.8′S 45°26.1′W	Shells	1,325±140	Bah.477	> 0.0 m Falling L.
A.311	23°19.9′S 45°54.8′W	Vermetidae	1,265±140	Bah.481	+0.7±0.4 m
A.288	23°39.6′S 45°25.8′W	Shells	1,225±85	Bah.475	> 0.0 m
A.291	23°38.5′S 45°26.1′W	Shells	885±115	Bah.453	> 0.0 m
A.305	23°37.9′S 45°23.4′W	Vermetidae	865±90	Bah.463	+1.0±0.4 m
A.312	23°22.6′S 45°50.4′W	Vermetidae	620±120	Bah.487	+0.3±0.4 m
A.304	23°37.9′S 45°23.4′W	Vermetidae	325±100	Bah.480	+0.4±0.4 m

Radiocarbon ages of mollusk shells sampled from deposits of the coast between Parati and Guaratiba of the State of Rio de Janeiro

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
Curray	22°57.0′S 44°25.6′W	Oyster crust	5,200±200	Lj.1364	+4.8±0.5 m
A.333	23°01.0′S 43°36.0′W	Shells	4,900±120	Bah.493	> 0.0 m
A.340	22°58.7′S 44°27.0′W	Shells	4,395±140	Bah.631	> +1.8 m
A.332	22°59.8′S 43°39.0′W	Shells	3,550±105	Bah.492	> +2.5 m
Lab.II**	23°00′S 45°00′W	Vermetidae	3,420±110	Gif.1059	+3.0±0.4 m
A.327	22°57.8′S 44°02.7′W	Vermetidae	3,255±100	Bah.472	+1.7±0.4 m
A.330	22°55.7′S 43°50.5′W	Oyster crust	3,055±140	Bah.471	> +1.6 m
A.321	22°58.7′S 44°26.3′W	Vermetidae	2,695±130	Bah.465	+1.5±0.4 m
A.329	22°55.7′S 43°50.6′W	Vermetidae	2,595±130	Bah.473	+1.6±0.4 m
A.322	22°58.7′S 44°26.3′W	Oyster crust	2,510±125	Bah.466	> +1.5 m
A.178	23°08.2′S 44°42.0′W	Shells	2,390±100	Gif.3647	> +1.5 m
A.316	23°09.2′S 43°41.8′W	Vermetidae	2,300±95	Bah.470	+1.4±0.4 m

A.315	23°14.0′S 44°42.0′W	Oyster crust	2,300±95	Bah.464	> +1.7 m
A.320	23°09.2′S 43°41.8′W	Vermetidae	1,840±90	Bah.471	+1.5±0.4 m
Lab.III**	23°00′S 45°00′W	Vermetidae	1,670±100	Gif.1060	+1.5±0.4 m
A.328	22°58.2′S 44°02.8′W	Vermetidae	1,630±65	Bah.499	+0.8±0.4 m
A.325	23°14.8′S 44°37.6′W	Vermetidae	1,490±80	Bah.482	+1.0±0.4 m
A.318	23°02.9′S 44°36.7′W	Vermetidae	975±80	Bah.478	+0.7±0.4 m
A.314	23°14.4′S 44°37.9′W	Oyster crust	960±110	Bah.467	> +0.9 m
A.317	23°09.2′S 43°41.8′W	Vermetidae	500±80	Bah.489	+0.5±0.4 m
A.313	23°21.2′S 44°43.3′W	Vermetidae	390±100	Bah.488	+0.4±0.4 m
Lab.IV**	23°00′S 45°00′W	Vermetidae	380±90	Gif.1061	+0.5±0.4 m
A.326	23°01.0′S 44°13.3′W	Vermetidae	230±60	Bah.483	+0.5±0.4 m

*: J. Curray (personal communication); **: from Delibrias & Laborel (1971).

Radiocarbon ages of mollusk shells and organic matter sampled from deposits of the Jacarepaguá coastal plain of the State of Rio de Janeiro

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
JA.01	23°01.2′S 43°27.3′W	Shells	5,970±230	Bah.1207	> 0.0 m
1673-9*	22°59.2′S 43°27.4′W	Shells	5,740±150	Bah.649	> 0.0 m
		Shells	5,710±150	Bah.645	
		Shells	5,700±160	Bah.648	
		Shells	5,610±150	Bah.390	
		Shells	5,570±160	Bah.647	
1699-13*	22°58.0′S 42°23.0′W	Shells	5,350±150	Bah.698	> 0.0 m
		Shells	5,220±230	Bah.699	
JA.04	23°00.0′S 43°29.5′W	Shells	5,280±230	Bah.1210	> 0.0 m
1699-12*	22°58.1′S 43°23.6′W	Shells	5,220±150	Bah.394	> 0.0 m
1527-18*	23°00.3′S 43°30.7′W	Shells	5,060±120	Bah.671	> 0.0 m
JA.05	23°00.3′S 43°29.5′W	Shells	4,980±210	Bah.1211	> 0.0 m

1677-2-1*	22°59.8′S 43°22.0′W	Shells	4,890±100	Bah.692	> 0.0 m
		Shells	4,740±150	Bah.697	
		Shells	4,570±150	Bah.690	
JA.08	22°59.8′S 43°22.0′W	Shells	4,620±140	Bah.1214	> 0.0 m
JA.03	23°01.6′S 43°29.4′W	Shells	4,450±180	Bah.1209	> 0.0 m
JA.06	23°00.3′S 43°20.7′W	Shells	4,320±150	Bah.1112	> 0.0 m
1699-14*	22°57.8′S 43°23.0′W	Shells	4,240±140	Bah.652	> 0.0 m
		Shells	4,130±110	Bah.653	
		Shells	4,110±120	Bah.441	
		Shells	4,090±110	Bah.655	
JA.02	23°01.4′S 43°29.5′W	Shells	3,780±200	Bah.1208	> 0.0 m
MY-03*	23°01.5′S 43°28.3′W	Org. matter	3,670±90	Bah.642	
MY-02*	23°00.4′S 43°25.0′W	Org. matter	3,650±130	Bah.641	
MY-01	23°00.0′S 43°20.0′W	Org. matter	3,130±130	Bah.640	

*: from Roncarati & Neves (1976).

Radiocarbon ages of mollusk shells and wood fragments sampled from deposits of the coast between Niterói and Armação dos Búzios of the State of Rio de Janeiro

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
RJ.01	22°56.6′S 42°02.7′W	Wood	> 30,000	Bah.1135	> 0.0 m
RJ.19	22°49.0′S 41°58.4′W	Wood	6,800±280	Bah.1307	> 0.0 m
RJ.11	22°57.6′S 42°02.3′W	Shells	6,610±260	Bah.1299	> 0.0 m
RJ.02	22°45.2′S 41°57.3′W	Shells	6,070±230	Bah.1137	> 0.0 m
RJ.15	22°45.7′S 41°57.6′W	Shells	5,660±240	Bah.1303	> 0.0 m
RJ.14	22°45.4′S 41°57.6′W	Shells	5,600±240	Bah.1302	> 0.0 m
RJ.13	22°53.3′S 42°03.3′W	Shells	4,690±200	Bah.1301	> 0.0 m
RJ.12	22°53.3′S 42°03.3′W	Shells	4,640±200	Bah.1300	> 0.0 m
RJ.03**	22°57.9′S 43°02.9′W	Shells	4,460±200	Bah.1291	> 0.0 m
RJ.05	22°55.7′S 42°28.3′W	Shells	4,030±210	Bah.1293	> 0.0 m

RJ.30	22°56.2'S 42°14.8'W	Shells	3,690± 90	Bah.1399	> 0.0 m
RJ.16	22°44.3'S 41°51.3'W	Vermetidae	3,420±190	Bah.1304	+ 2.1±0.4 m
RJ.07	22°55.7'S 42°21.7'W	Shells	3,370±190	Bah.1295	> 0.0 m
RJ.18	22°46.2'S 41°53.0'W	Vermetidae	3,360±180	Bah.1306	+1.8±0.4 m
RJ.29	22°55.4'S 42°04.9'W	Shells	3,110±180	Bah.1398	> 0.0 m
RJ.10	22°56.7'S 42°01.0'W	Vermetidae	2,680±180	Bah.1298	+1.8±0.4 m
RJ.09	22°56.3'S 42°01.5'W	Shells	2,640±190	Bah.1296	> 0.0 m
Lab.*	22°57.0'S 42°01.3'W	Vermetidae	2,400±100	Gif.1935	+2.0±0.4 m
RJ.08	22°55.0'S 42°12.5'W	Shells	2,210±170	Bah.1296	> 0.0 m
RJ.17	22°44.3'S 41°51.3'W	Vermetidae	2,010±160	Bah.1305	+1.6±0.4 m
RJ.04	22°57.5'S 42°41.8'W	Wood	1,880±150	Bah.1291	> 0.0 m
RJ.06	22°54.5'S 42°22.8'W	Shells	1,330±170	Bah.1294	> 0.0 m

*: from Delibrias & Laborel (1971);
**: Shells from the base of the Sambaqui of Camboinhas (Itaipu).

Age determinations made on drilling material.

Sample N°	Depth	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
a) Core 1/33 from the Itaipu Lagoon (22° 57.5'S and 42°02.1'W) (Ireland, 1987)					
	35-45 cm	Peat	370±55	KI-2261/1	
	196-205 cm	Peat	7,110±110	KI-2226/2	
	219-227 cm	Peat	7,810±75	KI-2226/3	
	398-404 cm	Peat	> 35,000	KI-2226/4	
	455-461 cm	Peat	> 35,000	KI-2226/5	
	482-487 cm	Peat	> 42,500	KI-2226/6	
	586-604 cm	Peat	> 38,000	KI-2226/7	
b) Core 2/12 from the Itaipuaçu Lagoon (22° 57.0'S and 42°59.7'W) (Ireland, 1987)					
	80-87 cm	Peat	2,460±55	KI-2225/1	
	90-97 cm	Peat	2,700±60	KI-2225/2	
c) Core LP 2/12 from the Do Padre Lagoon (22° 56.5'S and 42°46.9'W) (Ireland, 1987)					
	136-144 cm	Peat	2,270±55	KI-2223/1	
	180-189 cm	Peat	2,590±65	KI-2223/2	

246-252 cm	Plant	4,850±80	KI-2373/1
282-306 cm	Plant	5,230±90	KI-2373/2

d) Core LP 1/32 from the Do Padre Lagoon (22° 57.0′S and 42°45.3′W) (Ireland, 1987)

275-284 cm	Peat	6,800±110	KI-2222/1
297-306 cm	Peat	7,150±120	KI-2222/2

e) Core SA 1 from the Saquarema Lagoon (22° 55.0′S and 42°32.3′W)

191-195 cm	Shells	3,580±210	OBDY.859
417-421 cm	Shells	5,910±50	OBDY.844

f) Core LV-4 from the Vermelha Lagoon (22° 55.8′S and 42°21.5′W)

114 cm	Wood	2.330±90	Beta-45729
156-162 cm	Org. matter	4,320±100	Beta-45730
180-185 cm	Org. matter	4,470±50	OBDY.885
216-218 cm	Shells	5,180±70	Beta-45731
		5,250± 50	OBDY.425
288-292 cm	Org. matter	6,150±50	OBDY.891
317-322 cm	Org. matter	6,530±100	Beta-45732

g) Core LV.89/16 from the Vermelha Lagoon (22° 55.6′S and 42°21.6′W)

00-02 cm	Shells	Present	OBDY.1013
36-38 cm	Shells	4,050±50	OBDY.1016
38-40 cm	Shells	4,210±50	OBDY.1012

h) Core LV.89/19 from the Vermelha Lagoon (22° 55.8′S and 42°02.5′W)

30-35 cm	Shells	760±80	Beta-45734
110-115 cm	Org. matter	3,700±80	Beta-45735

i) Core LBE 82/2 from the Brejo do Espinho Lagoon (22°56.0′S and 42°14.5′W)

89-95 cm	Shells	2,400±50	Beta-45722
150-155 cm	Org. matter	3,620±70	Beta-45723
205-210 cm	Shells	4,430±90	Beta-45724
265-275 cm	Org. matter	5,790±90	Beta-45725
320-324 cm	Shells	6,660±70	Beta-45726
335-340 cm	Shells	7,170±110	Beta-45727

j) Core B2 from the Araruama Lagoon (22° 54.0′S and 42°22.6′W)

137-140 cm	Shells	2,560±50	OBDY.861
151-154 cm	Shells	3,430±50	OBDY.855
209-217 cm	Shells	4,960±50	OBDY.843
336-346 cm	Org. matter	7,260±70	Beta-45714

k) Core B3 from the Araruama Lagoon (22° 54.5′S and 42°22.3′W)

229-234 cm	Shells	3,405±50	OBDY.846
277-280 cm	Shells	5,550±50	OBDY.844

280-285 cm	Peat	7,400±50	OBDY.935
320-323 cm	Peat	8,200±50	OBDY.947

l) Core LA89/4 from the Araruama Lagoon (22° 53.1′S and 42°20.0′W)

08-11 cm	Shells	530±40	OBDY
36-38 cm	Shells	2,390±40	OBDY
43-45 cm	Shells	2,710±50	OBDY
73-78 cm	Shells	7,500±60	OBDY

Radiocarbon ages of mollusk shells sampled from deposits of the coast between Armação dos Búzios and Macaé of the State of Rio de Janeiro.

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
RJ.27	22°21.3′S 41°49.5′W	Shells	6,370±250	Bah.1396	> 0.0 m
RJ.25	22°20.8′S 41°46.0′W	Shells	5,900±230	Bah.1313	> 0.0 m
RJ.26	22°18.4′S 41°46.1′W	Shells	5,820±230	Bah.1314	> 0.0 m
RJ.24	22°29.9′S 41°55.8′W	Shells	5,280±230	Bah.1312	> 0.0 m
RJ.22	22°41.4′S 42°03.0′W	Shells	5,080±220	Bah.1310	> 0.0 m
RJ.23	22°34.8′S 42°01.0′W	Shells	4,850±220	Bah.1311	> 0.0 m
RJ.21	22°38.8′S 42°02.8′W	Shells (surface of a midden)	3,200±190	Bah.1309	> 0.0 m

Radiocarbon ages of mollusk shells and wood fragments sampled from deposits of the Rio Paraíba do Sul Coastal Plain of the State of Rio de Janeiro.

PS.05	22°04.4′S 41°08.3′W	Shells	7,390±270	Bah.1119	Lagoon
PS.06	22°04′S 41°09′W	Shells	7,060±260	Bah.1120	Lagoon
SD.10A	21°55.2′S 41°27.3′W	Shells	7,010±250	Bah.1005	Lagoon
PS.52	22°06.7′S 41°20.7′W	Shells	6,920±280	Bah.1257	Lagoon
SD.03	22°04.4′S 41°09.5′W	Shells	6,860±200	Bah.995	Lagoon
SD.11	21°56.0′S 41°25.3′W	Shells	6,830±200	Bah.1007	Lagoon
PS.07	22°04.4′S 41°09.5′W	Shells	6,730±260	Bah.1121	Lagoon
PS.14	22°12.5′S 41°28.7′W	Shells	6,620±230	Bah.1107	Lagoon

PS.12	22°06.8'S 41°01.3'W	Wood	6,590±250	Bah.1105	Lagoon
SD.09-B	21°57.8'S 41°12.0'W	Wood	6,590±200	Bah.1004	Lagoon
PS.26	21°52.5'S 41°23.1'W	Wood	6,570±260	Bah.1133	Lagoon
PS.22	21°57.0'S 41°27.5'W	Wood	6,570±260	Bah.1135	Lagoon
PS.09	22°03.8'S 41°10.5'W	Wood	6,470±240	Bah.1123	> 0.0 m
PS.04	22°03.9'S 41°08.3'W	Shells	6,160±240	Bah.1118	Lagoon
PS.43	21°32.5'S 41°08.5'W	Shells	6,100±200	Bah.1095	Lagoon
PS.08	22°03.0'S 41°12.2'W	Shells	6,060±240	Bah.1122	Lagoon
PS.41	22°12.5'S 41°28.7'W	Shells	6,000±230	Bah.1108	Lagoon
SD.09-A	21°57.2'S 41°12.2'W	Shells	6,000±200	Bah.1003	Lagoon
SD.10-B	21°55.2'S 41°27.3'W	Wood	6,000±200	Bah.1006	Lagoon
PS.110	21°55.2'S 41°27.3'W	Shells	5,970±200	Bah.1263	Lagoon
A.22-2	22°05.4'S 41°08.8'W	Shells	5,940±240	Bah.1565	Rising S-L
PS.13	22°06.8'S 41°10.3'W	Shells	5,930±240	Bah.1106	Lagoon
A.22-3	22°05.4'S 41°08.8'W	Shells	5,790±230	Bah.1566	Rising S-L
PS.03	22°04.0'S 41°06.3'W	Shells	5,560±230	Bah.1117	Lagoon
A.20-1	22°04.0'S 41°06.3'W	Shells	5,560±220	Bah.1562	Lagoon
PS.25	21°57.2'S 41°18.7'W	Wood	5,460±280	Bah.1132	Lagoon
PS.135	21°09.7'S 40°58.3'W	Shells	5,460±220	Bah.1265	Lagoon
A.15-1	22°09.7'S 42°18.0'W	Shells	5,430±220	Bah.1520	Lagoon
PS.19	21°58.6'S 41°01.3'W	Shells	5,410±230	Bah.1109	Lagoon
A.18-1	22°03.8'S 41°25.1'W	Wood	5,340±230	Bah.1561	Lagoon
A.125	21°35.5'S 41°11.6'W	Wood	5,270±220	Bah.1264	Lagoon
SD.04-A	22°02.4'S 41°06.0'W	Shells	5,140±200	Bah.996	Lagoon

A.22-1	22°05.4′S 41°08.8′W	Shells	4,970±220	Bah.1564	Lagoon
SD.02	22°06.8′S 41°28.7′W	Shells	4,970±200	Bah.994	Lagoon
A.21-1	22°04.4′S 41°08.3′W	Shells	4,960±220	Bah.1563	Lagoon
PS.42	21°33.1′S 41°08.8′W	Shells	4,390±200	Bah.1094	Beach, Falling S-L.
PS.41	21°33.1′S 41°09.2′W	Shells	4,380±200	Bah.1093	Beach, Falling S-L.
PR.40	21°33.1′S 41°28.7′W	Shells	4,160±210	Bah.1096	Beach, Falling S-L.
PS.35	21°28.4′S 41°04.1′W	Shells	3,850±200	Bah.1102	Beach, Rising S-L.
PS.87	21°55.8′S 41°03.5′W	Shells	3,780±170	Bah.1280	Lagoon
PS.89-2	21°31.7′S 41°07.3′W	Wood	3,720±180	Bah.1316	Beach, Rising S-L.
SD.12	21°21.6′S 39°57.6′W	Vermetidae	3,620±150	Bah.1008	+3.0±0.4 m
PS.29	21°31.7′S 41°06.9′W	Shells	3,520±200	Bah.1096	Beach, Rising S-L.
SD.04-C	22°02.3′S 41°06.0′W	Shells	3,380±140	Bah.998	> 0.0 m
PS.15-B	21°56.1′S 41°00.2′W	Shells	3,180±180	Bah.1112	Falling S-L.
PS.15-A	21°56.1′S 41°00.2′W	Shells	3,120±180	Bah.1111	Falling S-L.
SD.08	21°55.0′S 41°00.3′W	Shells	3,060±150	Bah.1002	Falling S-L.
PS.39	21°23.6′S 39°59.0′W	Vermetidae	3,060±150	Bah.1120	> 0.0 m
SD.06	21°56.7′S 41°00.2′W	Shells	3,000±150	Bah.1001	Lagoon, Falling S-L.
SD.07	21°57.1′S 41°00.6′W	Shells	3,000±150	Bah.1000	Lagoon, Falling S-L.
PS.10	22°02.0′S 41°03.2′W	Shells	3,000±170	Bah.1124	Lagoon, Falling S-L.
PS.16	21°55.0′S 41°00.3′W	Shells	2,930±150	Bah.1114	Lagoon, Falling S-L.
SD.05	21°56.1′S 41°00.2′W	Shells	2,920±150	Bah.999	Lagoon, Falling S-L.
PS.11	22°02.0′S 41°03.2′W	Shells	2,660±170	Bah.1125	Lagoon
PS.31	21°31.6′S 41°06.6′W	Shells	2,530±170	Bah.1098	> 0.0 m
PS.89-1	21°31.7′S 41°07.3′W	Shells	2,490±170	Bah.1261	> 0.0 m

PS.30	21°31.7'S 41°07.3'W	Shells	2,360±200	Bah.1097	> 0.0 m
PS.15-C	21°56.1'S 41°00.2'W	Stromatolite	2,130±180	Bah.1113	Lagoon, Falling S-L.
PS.33	21°28.8'S 41°04.4'W	Shells	2,110±200	Bah.1100	Beach, Falling S-L.
PS.32	21°30.0'S 41°05.6'W	Shells	1,980±190	Bah.1099	Beach, Falling S-L.
PS.34	21°29.0'S 41°03.8'W	Shells	1,070±160	Bah.1101	Beach, Falling S-L.

Radiocarbon ages of mollusk shells and wood fragments sampled from deposits of the coast between Itabapoama and Barra do Riacho of the State of Espírito Santo

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
ES.42	20°12.2'S 40°22.0'W	Shells	7,080±280	Bah.1727	Lagoon, Rising S-L.
ES.47	20°02.2'S 40°09.7'W	Vermetidae	5,690±220	Bah.1586	+1.5±0.5 m
ES.44	20°19.6'S 40°16.1'W	Vermetidae	5,410±210	Bah.1585	+3.3±0.5 m
ES.10	20°52.1'S 40°48.0'W	Shells	5,400±210	Bah.1731	> 0.0 m
ES.01	21°14'S 41°00'W	Shells	5,220±220	Bah.1315	> 0.0 m
ES.17	20°38.2'S 40°26.1'W	Vermetidae	5,080±200	Bah.1580	+3.0±0.5 m
ES.07	20°44.4'S 40°16.1'W	Vermetidae	4,880±210	Bah.1548	+3.4±0.5 m
ES.43	20°19.6'S 40°16.1'W	Vermetidae	4,410±190	Bah.1585	≥ +1.4 m
ES.18	20°31.1'S 40°21.2'W	Vermetidae	4,380±190	Bah.1581	≥ +2.0 m
ES.03	20°56.8'S 40°49.3'W	Wood	4,140±200	Bah.1725	≥ 0.0 m
ES.11	20°50.6'S 40°46.6'W	Oyster crust	4,130±190	Bah.1732	Falling S-L.
ES.38	20°14.2'S 40°12.9'W	Coral	4,150±180	Bah.1588	≥ +2.6 m
ES.16	20°39.4'S 40°28.5'W	Vermetidae	4,050±180	Bah.1579	+2.2±0.5 m
ES.12	20°50.2'S 40°46.7'W	Shells	3,880±190	Bah.1723	> 0.0 m
ES.09	20°50.8'S 40°46.9'W	Shells	3,870±180	Bah.1730	> 0.0 m
ES.14	20°44.1'S 40°39.7'W	Shells	3,560±140	Bah.1735	> 0.0 m

ES.20	20°26.7′S 40°19.8′W	Calc. algae	3,440±190	Bah.1728	≥ +0.3 m
ES.19	20°31.1′S 40°21.2′W	Vermetidae	3,240±170	Bah.1582	≥ +2.3 m
ES.22	20°25.6′S 40°19.2′W	Vermetidae	3,220±170	Bah.1583	+2.0 m
ES.05	20°54.3′S 40°46.6′W	Oyster crust	3,030±170	Bah.1590	≥ +1.5 m
ES.39	20°12.3′S 40°19.2′W	Shells	2,930±200	Bah.1722	> 0.0 m
ES.34	20°11.5′S 40°11.4′W	Coral	2,870±180	Bah.1587	≥ +1.3 m
ES.45	20°06.4′S 40°10.3′W	Coral	2,660±170	Bah.1589	≥ +1.7 m
ES.06	20°54.3′S 40°46.6′W	Oyster crust	2,380±170	Bah.1591	≥ +1.0 m
ES.35	20°11.5′S 40°11.4′W	Calc. algae	2,380±170	Bah.1729	≥ +1.3 m
ES.36	20°11.5′S 40°11.4′W	Shells	2,020±170	Bah.1721	+1.2±0.5 m
ES.04	20°56.9′S 40°48.8′W	Wood	1,410±150	Bah.1726	> 0.0 m

Radiocarbon ages of mollusk shells and wood fragments sampled from deposits of the Rio Doce Coastal Plain of the State of Espírito Santo

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
RD.29	19°44′S 40°02.2′W	Shells	7,150±200	Bah.953	Lagoon
RD.33	19°41.0′S 40°01.7′W	Wood	6,900±250	Bah.973	Lagoon
PP.009-1	19°41.8′S 40°02.0′W	Shells	6,350±200	SPC.006	Lagoon
RD.30	19°43.2′S 40°01.8′W	Shells	6,280±200	Bah.954	Lagoon
RD.31	19°42.5′S 40°01.8′W	Shells	6,280±200	Bah.955	Lagoon
PB.0152	19°41.2′S 40°00.9′W	Shells	6,150±250	SPC.010	Lagoon
RD.20	19°14′S 39°49′W	Wood	6,120±200	Bah.975	Lagoon
PP009-2	19°41.8′S 40°02.0′W	Shells	6,030±250	SPC.014	Lagoon
RD.21	19°14′S 39°14′W	Shells	6,020±200	Bah.950	Lagoon
PP009-3	19°41.8′S 40°02.0′W	Shells	5,880±230	SPC.005	Lagoon

RD.34	19°40.7'S 40°00.5'W	Shells	5,800±200	Bah.957	Lagoon
RD.05	18°57.0'S 39°46.5'W	Wood	5,740±200	Bah.969	Rising S-L.
PP009-8	19°41.8'S 40°02.0'W	Shells	5,670±250	SPC.013	Lagoon
RD.32	19°41.0'S 40°07.0'W	Shells	5,600±200	Bah.956	Lagoon
RD.24	19°12'S 39°49'W	Shells	5,550±200	Bah.952	Lagoon
PP029-1	19°42.8'S 40°02.1'W	Shells	5,400±250	SPC.039	Lagoon
RD.22	19°14'S 39°49'W	Wood	5,290±200	Bah.971	Lagoon
RD.13	19°28.5'S 39°49.9'W	Wood	4,670±200	Bah.966	Lagoon
RD.19	19°08.2'S 39°43.6'W	Shells (B.R.)	4,630±200	Bah.949	Beach
RD.12	19°28.3'S 39°49.8'W	Wood	4,620±200	Bah.965	Lagoon
RD.14	19°31'S 39°49'W	Wood	4,600±200	Bah.967	Lagoon
PP.358	19°12.8'S 39°48.8'W	Shells	4,400±200	SPC.027	Lagoon
RD.16	19°17'S 39°49'W	Wood	4,250±200	Bah.960	Paleochannel, Fal. S-L.
PMX	18°52.0'S 39°48.2'W	Shells (shell-midden)	4,240±150	SPC.034	Lagoon
RD.06	18°57'S 39°46'W	Shells	4,000±150	Bah.943	Beach, Falling S-L.
RD.09	18°58'S 39°48'W	Shells	3,950±150	Bah.945	Lagoon
RD.11	19°32.2'S 39°48.3'W	Wood	3,940±150	Bah.964	Beach, Falling S-L.
RD.23	19°09.0'S 39°50.3'W	Shells (shell-midden)	3,550±200	Bah.951	Lagoon
RD.01	18°57.0'S 39°46.3'W	Shells	3,540±150	Bah.942	Lagoon, Rising S-L.
RD.18	19°08.2'S 39°43.6'W	Shells (B.R.)	3,520±150	Bah.948	Beach
RD.28	19°37'S 39°55'W	Wood	3,430±150	Bah.962	Lagoon
RD.10	19°02.5'S 39°47.0'W	Shells	3,300±200	Bah.946	Lagoon
RD.17	19°08.2'S 49°43.6'W	Shells (B.R.)	3,140±150	Bah.947	Beach
RD.04	18°56.5'S 39°44.5'W	Shells (B.R.)	3,070±150	Bah.958	Beach

RD.07	18°57.5′S 39°47.0′W	Shells	3,060±150	Bah.944	Lagoon
PP.347	18°52.0′S 39°48.0′W	Shells (shell-midden)	2,970±180	SPC.035	Lagoon
RD.08	18°57.5′S 39°47.7′W	Wood	2,840±150	Bah.970	Lagoon

B.R. = Beach-rock

Radiocarbon ages of mollusk shells and wood fragments sampled from deposits of the Caravelas Coastal Plain (State of Bahia)

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
B.246	17°41.4′S 39°14.8′W	Shells	> 32,000	Bah.765	> 0.0 m
B.255	17°41.0′S 39°18.2′W	Shells	7,010±120	Bah.768	+1.0±0.5 m, Ris. S-L.
B.254	17°41.0′S 39°18.2′W	Shells	6,650±120	Bah.767	+1.5±0.5 m, Ris. S-L.
B.263	17°50.5′S 39°19.2′W	Shells	5,890±110	Bah.773	+1.8±0.5 m, Ris. S-L.
B.262	17°50.5′S 39°19.2′W	Shells	5,760±160	Bah.772	+1.5±0.5 m, Ris. S-L.
B.242	17°45.0′S 39°15.8′W	Shells	5,710±110	Bah.762	+2.2±0.5 m, Ris. S-L.
B.258	17°49.5′S 39°20.2′W	Shells	5,700±100	Bah.769	+2.1±0.5 m, Ris. S-L.
B.241-A	17°45.0′S 39°15.8′W	Wood	5,400±120	Bah.761	> 0.0, Rising S-L.
B.242-B	17°45.0′S 39°15.8′W	Wood	5,300±100	Bah.760	> 0.0, Rising S-L.
B.261	17°50.5′S 39°19.2′W	Shells	4,910±110	Bah.771	> +2.6 m
B.307	17°50.5′S 39°12.4′W	Coral	4,600±100	Bah.802	≥ +1.3 m
B.260	17°50.5′S 39°19.2′W	Shells	4,520±120	Bah.770	+2.6±0.5 m
B.316	17°54.6′S 39°20.4′W	Shells	3,670±100	Bah.808	+1.5±0.5 m
B.265	17°51.7′S 39°21.2′W	Wood	3,640±110	Bah.775	+1.3±0.5 m
B.317	17°53.5′S 39°20.3′W	Shells	3,310±110	Bah.809	> 0.0, Falling S-L.

Radiocarbon ages of mollusk shells and corals sampled from deposits of the Porto Seguro region (State of Bahia)

B.224	16°16.2′S 39°01.2′W	Shells (B.R.)	5,950±130	Bah.710	+1.8±0.5 m

B.227	16°19.0′S 39°00.0′W	Coral	5,400±160	Bah.726	> +0.8 m
B.225	16°16.2′S 39°01.3′W	Vermetidae	4,740±110	Bah.711	+1.7±0.5 m
B.228	16°26.7′S 39°03.4′W	Coral	4,275±70	Bah.727	> +0.8 m

Radiocarbon ages of mollusk shells and fragments sampled from deposits of the Rio Jequitinhonha Coastal Plain (State of Bahia)

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
B.335	15°50.5′S 38°58.5′W	Wood	6,180±140	Bah.814	Lagoon
B.438	15°50.3′S 38°57.5′W	Wood	5,850±150	Bah.910	Lagoon
B.447	15°41.5′S 39°01.0′W	Wood	5,570±150	Bah.915	Lagoon
B.366	15°39.9′S 39°03.1′W	Wood	5,300±140	Bah.822	Lagoon
B.370	15°36.2′S 39°09.8′W	Wood	2,730±120	Bah.823	Lagoon
B.432	15°52.5′S 38°54.5′W	Wood	2,570±100	Bah.907	Lagoon
B.443	15°48.5′S 39°00.0′W	Wood	2,290±150	Bah.913	River
B.325	15°52.2′S 38°54.5′W	Wood	2,240±100	Bah.811	Beach, Falling S-L.
B.330	15°50.3′S 38°57.5′W	Wood	2,020±120	Bah.813	River
B.351	15°43.5′S 38°55.7′W	Wood	1,970±120	Bah.819	Beach, Falling S-L.
B.345	15°49.0′S 38°53.7′W	Wood	1,800±100	Bah.817	Beach, Falling S-L.
B.353	15°42.3′S 38°56.0′W	Wood	1,770±100	Bah.820	Beach, Falling S-L.
B.327	15°50.7′S 38°54.5′W	Wood	1,700±100	Bah.812	River
B.441	15°50.0′S 38°58.8′W	Wood	1,420±100	Bah.911	River
B.436	15°50.3′S 38°57.5′W	Wood	1,400±100	Bah.909	River
B.339	15°47.3′S 38°59.7′W	Wood	1,350±100	Bah.816	River
B.359	15°41.4′S 38°58.5′W	Wood	1,350±100	Bah.821	River
B.433	15°50.7′S 38°55.5′W	Wood	1,070±100	Bah.908	River

B.442	15°48.5′S 38°59.0′W	Wood	1,040±100	Bah.912	River
B.445	15°48.5′S 39°04.5′W	Wood	790±100	Bah.916	River
B.429	15°52.2′S 38°54.5′W	Wood	610±100	Bah.905	River
B.431	15°52.2′S 38°54.5′W	Wood	530±100	Bah.906	River
B.336	15°50.5′S 38°58.5′W	Wood	520±100	Bah.815	River
B.444	15°48.5′S 39°00.0′W	Wood	400±50	Bah.914	River
B.428	15°52.2′S 38°54.5′W	Wood	190±50	Bah.904	River
B.350	15°43.5′S 38°55.0′W	Wood	130±100	Bah.818	River

Age determinations made on drilling material.

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
a) W.15 (15°33.9′S and 38°57.9′W)					
	–5.0±1.0 m	Shells	6,870±200	Bah.908	
	–7.0±1.0 m	Shells	7,750±200	Bah.897	
	–9.0±1.0 m	Shells	7,650±200	Bah.898	
	–11.0±1.0 m	Shells	7,870±200	Bah.899	
b) W.14 (15°34.5′S and 38°58.4′W)					
	–2.0±1.0 m	Shells	6,560±160	Bah.900	
	–4.0±1.0 m	Shells	7,000±200	Bah.901	
	–6.0±1.0 m	Shells	7,320±200	Bah.902	
	–8.0±1.0 m	Shells	7,810±200	Bah.903	
c) W.08 (15°36.5′S and 38°59.0′W)					
	–4.0±1.0 m	Shells	7,200±200	Bah.893	
	–6.0±1.0 m	Shells	7,500±200	Bah.894	
d) W.03 (15°35.7′S and 38°58.7′W)					
	–2.0±1.0 m	Shells	7,330±200	Bah.879	

Radiocarbon ages of mollusk shells, corals and calcareous algae sampled from deposits of the coast between Barra do Comandatuba and Itacaré (State of Bahia).

B.207	14°58.7′S 39°00.1′W	Coral	> 32,000	Bah.709	> 0.0 m
B.209	15°17.7′S 39°00.7′W	Shells (B.R.)	6,035±160	Bah.708	+1.5±0.5 m

B.191	14°28.6′S 39°01.7′W	Calc. algae	5,770±170	Bah.714	> +1.8 m
B.107	14°47.0′S 39°03.1′W	Shells (B.R.)	5,710±150	Bah.565	+1.3±0.5 m
B.106	14°47.4′S 39°02.2′W	Calc. algae	5,460±155	Bah.564	≥ +2.6 m
B.190	14°28.6′S 39°01.6′W	Vermetidae	5,250±150	Bah.714	+ 4.0±0.5 m
B.192	14°28.6′S 39°01.7′W	Calc. algae	4,730±140	Bah.716	≥ +2.8 m
B.194	14°40.6′S 39°04.2′W	Coral	4,670±110	Bah.717	> 0.0 m
B.235	14°17′S 38°59′W	Vermetidae	4,510±130	Bah.754	< +3.3 m
B.201	14°55.8′S 39°00.9′W	Calc. algae	3,815±110	Bah.720	> +0.5 m
B.234	14°17′S 38°59′W	Vermetidae	2,580±115	Bah.753	< +3.0 m
B.238	14°17′S 38°59′W	Vermetidae	2,400±90	Bah.757	< +3.4 m
B.204	14°56.4′S 39°00.7′W	Vermetidae	2,335±115	Bah.722	+2.1±0.5 m
B.232	14°17′S 38°59′W	Vermetidae	2,250±90	Bah.751	+2.4±0.5 m
B.233	14°17′S 38°59′W	Vermetidae	2,120±90	Bah.752	< +3.0 m
B.239	14°17′S 38°59′W	Vermetidae	1,475±120	Bah.758	< +2.5 m
B.203	14°55.8′S 39°00.9′W	Vermetidae	1,370±130	Bah.721	+1.4±0.5 m
B.236	14°17′S 38°59′W	Vermetidae	1,115±80	Bah.755	< +1.4 m
B.189	14°28.6′S 39°01.7′W	Vermetidae	760±115	Bah.713	+0.7±0.5 m
B.188	14°28.6′S 39°01.7′W	Vermetidae	680±90	Bah.712	+0.6±0.5 m
B.199	14°52.4′S 39°01.4′W	Vermetidae	575±80	Bah.719	+0.8±0.5 m
B.198	14°52.4′S 39°01.4′W	Vermetidae	550±80	Bah.718	< +1.2 m

Radiocarbon ages of mollusk shells, corals and wood fragments sampled from deposits of the coast between Itararé and Itaparica Island (State of Bahia)

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
B.91	13°44.5′S 39°03.6′W	Wood	> 32,000	Bah.562	> 0.0 m
B.102	14°06.6′S 39°03.6′W	Wood	> 32,000	Bah.563	> 0.0 m

B.175	13°01.2′S 38°38.8′W	Coral	5,890±150	Bah.632	> +1.5 m
B.36	13°12.3′S 38°56.3′W	Shells	5,745±140	Bah.516	+2.3±0.5 m
B.42	13°01.2′S 38°39.2′W	Coral	5,410±150	Bah.521	> +2.0 m
B.33	13°21.4′S 38°02.4′W	Shells	4,765±100	Bah.514	> 0.0 m
B.32	13°21.8′S 38°02.4′W	Wood	4,700±160	Bah.513	+2.7±0.5 m
B.35	13°28.4′S 38°55.0′W	Coral	3,180±60	Bah.515	> +1.0 m
B.41	13°01.2′S 38°39.0′W	Shells	2,830±90	Bah.522	+2.3±0.5 m
Lab.*	12°54.0′S 38°37.0′W	Vermetidae	2,450±95	Gif.1933	+2.3±0.5 m
B.87	13°49.3′S 39°03.1′W	Wood	2,405±100	Bah.561	+2.3±0.6 m

*: from Delibrias & Laborel (1971).

Radiocarbon ages of mollusk shells sampled from deposits along the coast of the Bay of Todos os Santos (State of Bahia)

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
B.29	12°49.9′S 38°28.8′W	Shells	6,600±180	Bah.517	–1.0±0.5 m
B.31	12°50.2′S 38°27.2′W	Shells	5,120±115	Bah.538	+1.5±0.5 m
B.30	12°49.9′S 38°28.8′W	Shells	4,840±120	Bah.534	±0.0 m
B.43	13°54.2′S 38°38.0′W	Shells	4,545±120	Bah.523	+2.8±0.5 m
B.15	12°48.8′S 38°29.0′W	Shells	4,405±115	Bah.674	±0.0 m
B.49-A	12°44.3′S 38°35.8′W	Vermetidae	4,245±95	Bah.519	+2.5±0.5 m
B.28	12°49.9′S 38°28.9′W	Shells	4,210±115	Bah.673	+0.5±0.5 m
B.178	12°36.0′S 38°38.6′W	Shells	3,595±120	Bah.704	+3.5±0.5 m
M.D.1	12°44.3′S 38°35.8′W	Shells	3,550±130	Bah.269-1	+3.3±0.5 m
M.D.2	12°44.3′S 38°35.8′W	Shells	3,450±120	Bah.270	+3.3±0.5 m
B.13	12°54.7′S 38°30.0′W	Shells	3,265±145	Bah.415	≥ +1.5 m
B.50	12°51.5′S 38°28.8′W	Shells	3,260±100	Bah.539	+3.0±0.5 m

B.176	12°46.4′S 38°31.8′W	Shells	3,110±105	Bah.701	+2.3±0.5 m
B.51	12°51.5′S 38°28.8′W	Shells	3,100±120	Bah.540	+3.0±0.5 m
B.53	12°51.5′S 38°28.8′W	Vermetidae	3,030±120	Bah.542	+3.0±0.5 m
B.52	12°51.5′S 38°28.8′W	Shells	2,990±120	Bah.541	+3.0±0.5 m
Pedra Oca-1	12°51.5′S 38°28.8′W	Shells (base of shell-midden)	2,830±130	Si.470	< +0.5 m
Pedra Oca-2	12°51.5′S 38°28.5′W	Shells (base of shell-midden)	2,630±110	Gif.878	< +0.5 m
B.38	12°44.3′S 38°35.8′W	Shells	2,495±125	Bah.676	+2.3±0.5 m
B.10	12°48.7′S 38°29.5′W	Shells	2,105±70	Bah.413	0.0±0.5 m
B.07	12°49.9′S 38°28.8′W	Shells	2,060±100	Bah.410	0.0±0.5 m
B.174	12°45.0′S 38°30.1′W	Vermetidae	1,685±85	Bah.700	+0.8±0.5 m

Radiocarbon ages of mollusk shells, corals and calcareous algae sampled from deposits of the coast between Porto da Barra and Itapoã (State of Bahia)

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
B.112	13°00.4′S 38°32.1′W	Shells (B.R.)	7,095±125	Bah.571	0.0±0.5 m
B.118	13°00.6′S 38°30.3′W	Shells (B.R.)	6,880±185	Bah.578	+0.6±0.5 m
B.120	13°00.9′S 38°29.1′W	Shells (B.R.)	6,880±120	Bah.586	+0.8±0.5 m
R.V.	13°00.6′S 38°30.0′W	Shells (B.R.)	6,645±130	Bah.235	+1.7±0.5 m
B.64	12°56.7′S 38°24.3′W	Shells	6,630±175	Bah.558	> 0.0 m Rising S.-L.
B.25	13°00.6′S 38°30.0′W	Shells (B.R.)	6,610±180	Bah.510	+1.7±0.5 m
B.19	12°57′S 38°23′W	Shells	6,500±175	Bah.687	+1.8±0.5 m
B.63	12°56.5′S 38°23.6′W	Shells	6,440±170	Bah.557	> 0.0 m Rising S.-L.
B.116	13°00.5′S 38°31.0′W	Shells	6,300±170	Bah.576	> 0.0 m
B.20	12°57′S 38°23′W	Shells	6,240±155	Bah.505	+1.8±0.5 m
B.59	12°56.5′S 38°23.5′W	Shells	6,110±115	Bah.553	> 0.0 m, Rising S.-L.

B.65	12°56.8'S 38°25.7'W	Shells	5,970±170	Bah.559	> 0.0 m, Rising S-L.
B.18	12°57'S 38°23'W	Shells	5,675±145	Bah.504	+2.8±0.5 m
B.17	12°57'S 38°23'W	Shells	5,265±150	Bah.675	+3.0±0.5 m
B.107	13°00.1'S 38°32.1'W	Vermetidae	5,195±110	Bah.567	+4.7±0.5 m
B.267	13°00.3'S 38°32.1'W	Coral	4,960±90	Bah.776	> +2.2 m
B.123	13°00.7'S 38°29.5'W	Shells (B.R.)	4,175±85	Bah.589	0.0±0.5 m
B.108	13°00.1'S 38°32.1'W	Vermetidae	2,990±135	Bah.568	+3.0±0.5 m
B.23	13°00.6'S 38°30.0'W	Vermetidae	2,310±115	Bah.508	+2.8±0.5 m
B.1	12°58.5'S 38°25.3'W	Calc. algae	2,295±85	Bah.494	> +2.1 m
B.115	13°00.5'S 38°30.8'W	Calc. algae	2,250±80	Bah.575	> +0.5 m
B.21	13°00.6'S 38°30.0'W	Vermetidae	1,975±80	Bah.506	+2.0±0.5 m
B.268	13°00.3'S 39°32.1'W	Vermetidae	1,705±120	Bah.777	+1.5±0.5 m
B.174	12°45.0'S 38°30.1'W	Calc. algae	1,565±120	Bah.626	> +0.8 m
B.113	13°00.6'S 38°31.5'W	Vermetidae	1,560±80	Bah.573	< +2.0 m
B.126	13°00.9'S 28°28.4'W	Vermetidae	1,495±140	Bah.597	+1.2±0.5 m
B.122	13°00.7'S 38°29.5'W	Vermetidae	1,360±120	Bah.588	+1.3±0.5 m
B.110	13°00.1'S 38°29.5'W	Vermetidae	950±125	Bah.569	+1.0±0.5 m
B.117	13°00.6'S 38°30.6'W	Coral	905±75	Bah.577	≥ +0.7 m
B.114	13°00.6'S 38°31.5'W	Vermetidae	830±90	Bah.574	+0.8±0.5 m
B.111	13°00.1'S 38°32.1'W	Vermetidae	770±125	Bah.570	+1.0±0.5 m
B.24	13°00.6'S 38°30.0'W	Vermetidae	700±110	Bah.509	+0.7±0.5 m
B.125	13°00.9'S 38°28.9'W	Calc. algae	675±125	Bah.596	> +0.5 m
B.124	13°00.9'S 38°28.4'W	Vermetidae	660±80	Bah.595	+0.7±0.5 m
B.172	12°57.3'S 38°21.3'W	Vermetidae	610±80	Bah.624	+0.5±0.5 m

B.173	12°57.3′S 38°21.3′W	Vermetidae	570±100	Bah.625	+0.5±0.5 m
B.171	12°57.3′S 38°22.8′W	Vermetidae	400±80	Bah.623	+0.5±0.5 m
B.22	13°00.6′S 38°30.0′W	Vermetidae	365±115	Bah.507	± 0.3±0.5 m

Radiocarbon ages of mollusk shells, corals, calcareous algae and wood fragments sampled from deposits of the northern part of the State of Bahia

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
B.145	11°00.7′S 37°38.2′W	Wood	7,205±200	Bah.614	−1.4±0.5 m
B.156	11°58.2′S 37°36.3′W	Shells (B.R.)	7,025±195	Bah.619	+1.0±0.5 m
B.131	12°47.7′S 38°11.3′W	Shells (B.R.)	6,515±601	Bah.601	+2.2±0.5 m
B.54	12°47.7′S 38°11.3′W	Shells (B.R.)	5,940±155	Bah.543	+2.0±0.5 m
B.44	12°22′S 37°53′W	Shells (B.R.)	5,470±160	Bah.524	+2.0±0.5 m
B.04	12°48.1′S 38°12.0′W	Shells (B.R.)	3,880±130	Bah.497	0+0.5 m
T.C.	12°47.7′S 38°11.3′W	Shells (B.R.)	3,780±130	Gif.2150	0±0.5 m
B.167	12°34.8′S 38°00.1′W	Coral	3,545±105	Bah.621	> +1.5 m
B.27	12°40.0′S 38°05.0′W	Coral	3,290±55	Bah.512	> +1.6 m
B.152	11°45.8′S 38°32.7′W	Shells (B.R.)	2,815±100	Bah.617	0±0.5 m
B.46	12°14′S 37°58′W	Shells (B.R.)	2,805±90	Bah.525	+0.8±0.5 m
B.03	12°48.1′S 38°12.0′W	Shells (B.R.)	2,605±140	Bah.496	0±0.5 m
B.02	12°48.1′S 38°12.0′W	Calc. algae	1,785±80	Bah.495	> 0.0 m
B.170	12°38.0′S 38°03.0′W	Vermetidae	760±80	Bah.622	+0.7±0.5 m

Radiocarbon ages of mollusk shells and wood fragments sampled from deposits of the coast of the State of Sergipe

B.145		Wood	7,205±200	Bah.614	−1.5±0.5 m
B.144		Shells	6,155±100	Bah.613	> 0.0 m Rising S.-L.
B.146		Wood	4,825±100	Bah.615	

Radiocarbon ages of corals and wood fragments sampled from deposits of the coastal plain of the Rio São Francisco (Sergipe/ Alagoas)

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
SF.07	10°20.3'S 36°28.3'W	Wood	5,730±200	Bah.985	Lagoon
SF.19	10°25.0'S 36°34.0'W	Wood	5,420±200	Bah.987	Lagoon
SF.23	10°25.8'S 36°31.0'W	Wood	4,680±210	Bah.989	Mangrove, Falling S-L.
SF.09	10°21.0'S 36°17.8'W	Coral	4,310±150	Bah.992	> 0.0 m
SF.21	10°25.8'S 36°31.0'W	Wood	3,380±150	Bah.988	River
SF.24	10°25.9'S 36°31.9'W	Wood	290±150	Bah.990	River

Radiocarbon ages of mollusk shells, corals and wood fragments sampled from deposits of the coast of the State of Alagoas

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
AL.148		Shells (B.R.)	7,470±280	Bah.1166	±0.0±0.5 m
AL.03		Shells	6,540±230	Bah.1012	> 0.0 m
AL.146		Shells (B.R.)	6,450±220	Bah.1155	+1.5±0.5 m
AL.101 c		Shells	6,320±250	Bah.1141	> 0.0 m, Rising S-L.
AL.153		Shells	6,160±230	Bah.1145	> 0.0 m, Rising S-L.
AL.17		Shells	5,920±200	Bah.1026	+1.5±0.5 m
AL.116		Coral	5,700±230	Bah.1149	≥ +1.5 m
AL.118		Shells (B.R.)	5,600±230	Bah.1151	> 0.9 m
AL.101 a		Shells	5,520±250	Bah.1140	> 0.0 m, Rising S-L.
AL.16		Shells	5,500±200	Bah.1025	> 0.0 m, Rising S-L.
AL.115		Coral	5,420±230	Bah.1148	≥ +1.5 m
AL.122		Shells	5,390±220	Bah.1157	> 0.0m, Rising S-L.
AL.142		Shells	5,270±220	Bah.1165	> 0.0 m, Rising S-L.
AL.131		Shells	5,240±220	Bah.1161	> 0.0 m, Rising S-L.
AL.114		Calc. algae	4,880±190	Bah.1147	≥ +1.6 m
AL.101 b		Wood	4,870±190	Bah.1177	> 0.0
AL.06		Coral	4,740±200	Bah.1015	≥ 1.1 m
AL.05		Shells (B.R.)	4,570±200	Bah.1014	> +0.8 m
AL.07		Coral	4,520±150	Bah.1016	≥ +1.1 m
AL.08		Shells	4,360±150	Bah.1017	> +1.3 m
AL.138		Shells	4,250±190	Bah.1176	> +1.5 m
AL.13		Coral	4,210±190	Bah.1022	≥ +1.3 m
AL.129		Shells (B.R.)	4,060±180	Bah.1160	+0.7±0.5 m
AL.128		Coral	3,900±190	Bah.1175	≥ +0.7 m
AL.151		Shells	3,750±180	Bah.1144	> 0.0 m
AL.11		Shells (B.R.)	3,720±180	Bah.1020	+1.3±0.5 m

AL.112		Shells	3,690±180	Bah.1146	> 0.0 m
AL.111		Shells	3,510±180	Bah.1172	> 0.0 m
AL.113		Shells	3,440±180	Bah.1173	> 0.0 m
AL.119		Vermetidae	3,350±180	Bah.1152	+0.7±0.5 m
AL.04		Shells	2,570±170	Bah.1154	> 0.0 m
AL.102		Shells	2,570±150	Bah.1168	> 0.0 m
AL.121		Vermetidae	2,100±160	Bah.1154	+2.1±0.5 m
AL.127		Vermetidae	1,670±160	Bah.1159	+1.0±0.5 m
AL.15		Vermetidae	1,590±160	Bah.1024	+1.4±0.5 m
AL.152		Calc. algae	1,530±160	Bah.1167	≥ +1.3 m
AL.103		Vermetidae	920±150	Bah.1169	+0.7±0.5 m
AL.133		Shells	770±160	Bah.1164	> 0.0 m
AL.126		Vermetidae	670±140	Bah.1158	+1.0±0.5 m
AL.09		Wood	480±150	Bah.1018	> +0.4 m

Radiocarbon ages of mollusk shells, corals and calcareous algae sampled from deposits of the coast of the State of Pernambuco

Sample N°	Coordinates	Nature	Ages yr BP	Labo. Ref.	Sea-level positions or environments
PE.17		Shells (B.R.)	6,200±250	Bah.1231	> +0.5 m
PE.20		Shells	6,030±200	Bah.1217	> +2.5 m
Lab.**		Shells (B.R.)	5,900±300	LJ.1367	+1.0±0.1 m
PE.15-B		Shells	5,830±230	Bah.1216	> +2.5 m
PE.29-B		Coral	5,170±230	Bah.1219	> +0.2 m
PE.15-A		Shells	5,140±230	Bah.1215	> +2.5 m
PE.19		Shells (B.R.)	4,830±210	Bah.1232	> 0.6 m
PE.29-A		Calc. algae	4,750±200	Bah.1218	> +2.0 m
PE.14		Vermetidae	3,870±170	Bah.1221	+4.3±0.5 m
Lab.II*		Vermetidae	3,660±170	Shell-A.22	+2.6±0.5 m
PE.30		Calc. algae	3,620±180	Bah.1238	> +0.0 m
Lab.III**		Coral	3,100±120	Gif.1062	≥ +2.0 m
A.16		Vermetidae	2,760±150	Shell-A.16	+2.0±0.5 m
PE.12		Vermetidae	2,670±170	Bah.1222	+1.6±0.5 m
PE.13		Vermetidae	2,570±160	Bah.1237	+2.6±0.5 m
PE.9		Vermetidae	2,010±160	Bah.1236	+4.8±0.5 m
Lab.IV*		Vermetidae	1,750±170	Shell-A.21	+1.4±0.5 m
PE.27		Shells (B.R.)	1,560±160	Bah.1234	> 0.0 m
Lab.V*		Shells (B.R.)	1,190±130	Shell-A.17	+1.6±0.5 m
PE.26		Vermetidae	980±160	Bah.1223	+1.3±0.5 m
PE.34		Vermetidae	650±150	Bah.1230	+1.3±0.5 m
PE.07		Vermetidae	570±160	Bah.1225	+1.9±0.5 m
PE.08		Calc. algae	360±160	Bah.1226	≥ 0.5 m
PE.01		Vermetidae	200±160	Bah.1228	+1.3±0.5 m

*: from Van Andel & Laborel (1964); **: from Delibrias & Laborel (1971); B.R. = Beach Rock.