

# Quaternary Emergent and Submergent Coasts: Comparison of the Holocene Sedimentation in Brazil and Southeastern United States\*

(Quaternary sea level changes\Holocene coastal sedimentation\Quaternary oceanic deltas)

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(With 3 text-figures)

## INTRODUCTION

Relative sea level fluctuations during the past 7,000 years and coastal sedimentation processes active over more than 2,000 km of the central Brazilian coastline (Fig. 1) are now well known through research carried out during the last few years (Bittencourt *et al.*, 1979 and 1982, Dominguez *et al.*, 1981 and 1982; Martin and Suguio, 1975 and 1978; Martin *et al.*, 1979a, 1979/1980 and 1980; Suguio and Martin, 1976, 1978, 1981 and 1982; Suguio *et al.*, 1982). Sea level fluctuation curves have been delineated for many homogeneous sectors of the coastlines of the States of São Paulo, Rio de Janeiro and Bahia (Martin *et al.*, 1979b and Suguio *et al.*, 1980). Comparison of these curves shows great similarity in their configuration, although some small differences in amplitude are observed. The present zero level was crossed between 6,500 and 7,000 years B.P. and the Holocene maximum, about 4-5 m above present sea level, occurred 5,100 years B.P. After this date relative sea level returned more-or-less gradually and regularly toward the present level, with the exception of two short periods of sea levels higher than today's between 3,800-3,600 and 2,700-2,500 years B.P.

A great number of ancient sea level reconstruction curves for the past 7,000 years have been made for the coast of the southeastern United States. Newman *et al.* (1980) present a table with curves for 14 different sectors of this coastline. Discounting second order variations, a constant feature of these curves is that not one shows a sea level higher than the present one. Similarly, curves representing several coastal sectors of the Gulf of Mexico (Curry, 1960; Coleman and Smith, 1964; Shepard and Curry, 1967; Scholl *et al.*, 1969 and Nelson and Bray, 1970) also

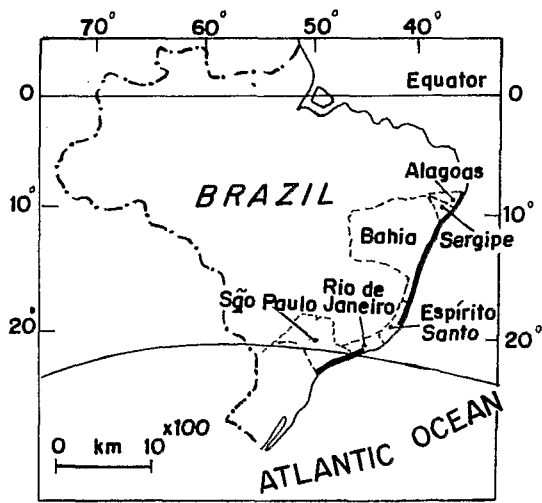


Fig. 1 - Index map of the central Brazilian coastline showing the sectors where the main relative sea level fluctuation curves have been obtained.

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exhibit a sea level lower than present during the past 7,000 years.

#### COMPARISON OF BRAZILIAN AND SOUTHEASTERN UNITED STATES AVERAGE SEA LEVEL CURVES

In spite of minor local differences between sea level curves for these areas, an astonishing resemblance exists between them. It is possible to construct schematic average curves by eliminating second order variations and representing only the most important variations (Fig. 2). Along the Brazilian coast the relative sea level rose until about 5,100 years B.P., when sea level was 4 to 5m above the present level. After that, relative sea level dropped more-or-less regularly until reaching its present level. In order to simplify the Brazilian curves, two short periods of higher sea levels between 3,800-3,600 and 2,700-2,500 years B.P. have been neglected because of the general tendency for emergence since 5,100 years B.P. until the present. It is evident, however, that these short submergent periods have played an important role in coastal sedimentation (Suguio *et al.*, 1982). The schematic average curve for the coastline of the southeastern United States shows that the Quaternary sea level has risen continuously toward its present position and has never been above its present level.

It is obvious that both the present coastal morphology and depositional patterns in Brazil and southeastern United States have been

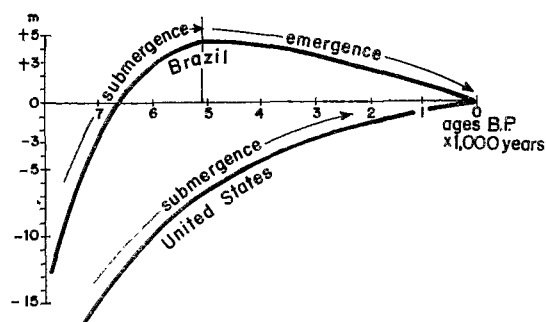


Fig. 2 - Schematic average curves of relative sea level fluctuations along the central Brazilian and southeastern United States coastlines during the past 7,000 years.

influenced by distinctive relative sea level fluctuations. Prior to 5,100 years B.P. the Brazilian coast was probably quite similar to that of the present southeastern United States.

#### GENERAL FEATURES OF THE CENTRAL BRAZILIAN AND SOUTHEASTERN UNITED STATES

The Gulf coast of the United States is characterized by barrier islands and lagoons that have spread over extensive pre-Holocene lowlands.

On the other hand, the central Brazilian coastline is characterized by extensive Quaternary sedimentary plains partly made up of Pleistocene and Holocene marine terraces. Holocene terraces may be widespread and their surfaces, which slope gently oceanward, are characterized by numerous aligned beach ridges. In the swampy lowlands that comprise the contact zone between Pleistocene and Holocene terraces there are many paleolagoons filled by organic-rich muddy sediments containing abundant mollusk shells.

#### COMPARISON BETWEEN THE CAPE HATTERAS AREA (UNITED STATES) AND THE DOCE RIVER COASTAL PLAIN (BRAZIL)

The Cape Hatteras region is characterized by an extensive lagoon (Palmico Sound) separated from the open ocean by a series of barrier islands. The Doce River mouth coastal plain, comparable in size to the Cape Hatteras region, forms an extensive oceanwardly convex crescent 38 km wide and about 150 km long in a N-S direction. Detailed geological mapping, augmented by several hundred radiometric dates (Suguio and Martin, 1981 and Suguio *et al.*, 1982), has allowed us to delineate the following sequence of events:

- a) Pleistocene marine terrace sedimentation;
- b) Formation of the first generation of Holocene beach ridges;
- c) Formation of the main paleolagoon, partially filled by the intralagoonal Doce River

delta, located between the residual Pleistocene terraces and the first generation Holocene beach ridges;

d) Deposition of the second generation of Holocene beach ridges;

e) Formation of a new paleolagoon, situated between the two generations of Holocene beach ridges.

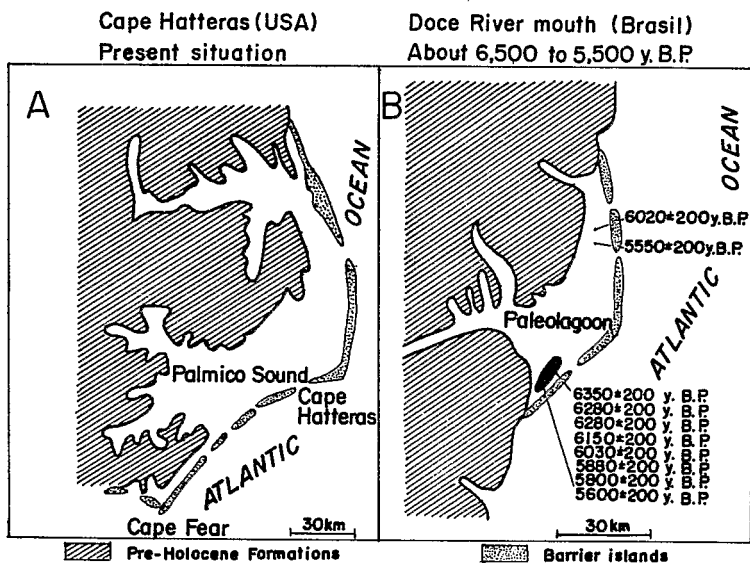
Submergent episodes are recorded by a barrier island/lagoonal system, whereas emergent episodes promoted the desiccation of the lagoon and the development of a new generation of beach ridges seaward of the barrier islands. Radiocarbon dates on mollusk shells from the main paleolagoonal deposits indicate that the lagoon was formed 5,100 years B.P. (Fig. 3). Almost certainly this paleolagoon was protected from the open ocean by a series of aligned barrier islands, which are presently incorporated within the first generation of Holocene beach ridges. Before about 5,100 years B.P., the Doce River mouth area was very similar to the present day Cape Hatteras area (Fig. 3). From the viewpoint of relative sea level evolution, before 5,100 years B.P. the Doce River mouth area was in submergence, just as the Cape Hatteras area is today. It

is simple to imagine what will happen with a drop in relative sea level in the Cape Hatteras area. The Palmico Sound will dry up and a new generation of sand ridges will be added to the outer margin of the barrier island system giving rise to a coastal plain analogous to that of the Doce River mouth. Probably the only difference would be the absence of an intralagoonal delta since there are no important rivers flowing into Palmico Sound.

CONCLUSIONS

Very distinctive relative sea level fluctuations along the southeastern Atlantic and Gulf coasts of the United States and along the central Brazilian coast have occurred over the last 7,000 years. The southeastern coast of the United States has been subjected to continuous submergence during this period while the Brazilian coast was submerged prior to about 5,100 years ago and emergent since then.

Paleogeographic reconstruction of the Doce River mouth area provides a picture of the morphological features of this area before 5,100 years ago, which is very similar to the



Comparison between present-day Cape Hatteras (USA) and the Doce River mouth (Brazil) coastal plains during the interval 6,500-5,500 years BP. (Radiocarbon ages obtained on samples from the paleolagoon within the Doce River mouth area).

present-day Cape Hatteras area. Obviously, depositional histories of these two areas have been different during the past 7,000 years. The same depositional models can not be applied to these areas for the period from 5,100 years B.P. to the present. Unfortunately, the drop of 4-5 m in relative sea level during the past 5,100 years along the Brazilian coast has rarely been considered by previous Brazilian authors. Moreover, the concept of wave-dominated deltas must be revised in the light of recent knowledge about Brazilian river mouth areas, in whose construction a quickly prograding shoreline along an emergent coast was a major factor (Suguio and Martin, 1981). Along the Brazilian coastline, the relative sea level drop, together with longshore currents, played an essential role in coastal sedimentation. In most cases, rivers flowing into the ocean act above all like an obstacle, much as a jetty does, to the free longshore drift of the sediments.

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#### SUMMARY

Very distinctive relative sea level fluctuations during the past 7,000 years occurred along the coasts of Brazil and the southeastern United States. The Brazilian coast was subjected to submergence until about 5,100 years B.P., followed by emergence. The Atlantic and Gulf coasts of the United States, on the other hand, have been in submergence continuously. Consequently, great differences are evident in the respective patterns of coastal deposition during the Holocene. Before 5,100 years B.P. the Brazilian coast was probably quite similar to that of the present southeastern United States.

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