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# Significance of Quaternary sea-level fluctuations for delta construction along the Brazilian Coast

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## ABSTRACT

Many important areas of Quaternary deltaic sedimentation along the Brazilian coast are practically unknown in the geologic literature, especially outside Brazil. Our studies show that these areas, previously considered as highly destructive wave-dominated deltas of Holocene age, were affected by a wave-dominated phase during the Pleistocene, succeeded by highly constructive, intralagoonal stage in the Holocene, in turn followed by wave-dominated deltaic sedimentation that continues until today. The geologic evolution of these coastal plains is exemplified here by the Doce River mouth area, State of Espírito Santo, where relative sea-level fluctuations during the Quaternary played an important role in the construction of the deltaic complex.

## INTRODUCTION

There are several Quaternary deltaic complexes at the mouth of the most important rivers flowing into the Atlantic Ocean (Fig. 1), but only a few are mentioned in the international literature [1]. Moreover, few of them are well known from a geological viewpoint.

Detailed geological mapping carried out on the Quaternary of the States of São Paulo [2,3] and Bahia [3-5] accompanied by several hundred absolute dates allowed us to reconstruct, in space and time, some of the different positions occupied by the relative sea levels during the last few thousand years.

For want of absolute ages, previous works on the coastal plains of the Doce River, State of Espírito Santo [6,7], and Paraíba do Sul River, State of Rio de Janeiro [8], did not consider the 4 to 5 m lowering of the sea level that occurred in the last 5,000 years. Moreover, these plains are partially of Pleistocene age, contrary to the previously held idea [6-9] that these deltaic complexes were essentially Holocene having formed only after the last transgression.

## COMMON CHARACTERISTICS OF THE BRAZILIAN DELTAIC COMPLEXES

**Physiography.** Subaerial portion—For most of the Quaternary deltaic complexes of the Brazilian coastline three geomorphologic provinces can be distinguished: a) mountain ridges, b) flat-topped plains and c) coastal plains.

The mountain ridges are forested higher terrains, made up of Precambrian rocks, drained by a dendritic hydrographic net.

Installed on Tertiary deposits of the Barreiras Formation, the flat-topped plains are characterized by a smooth surface tilting seaward about 1.2 m per km. The drainage net established on this surface has an angular subparallel pattern.

The coastal plains are formed of sandy littoral sediments

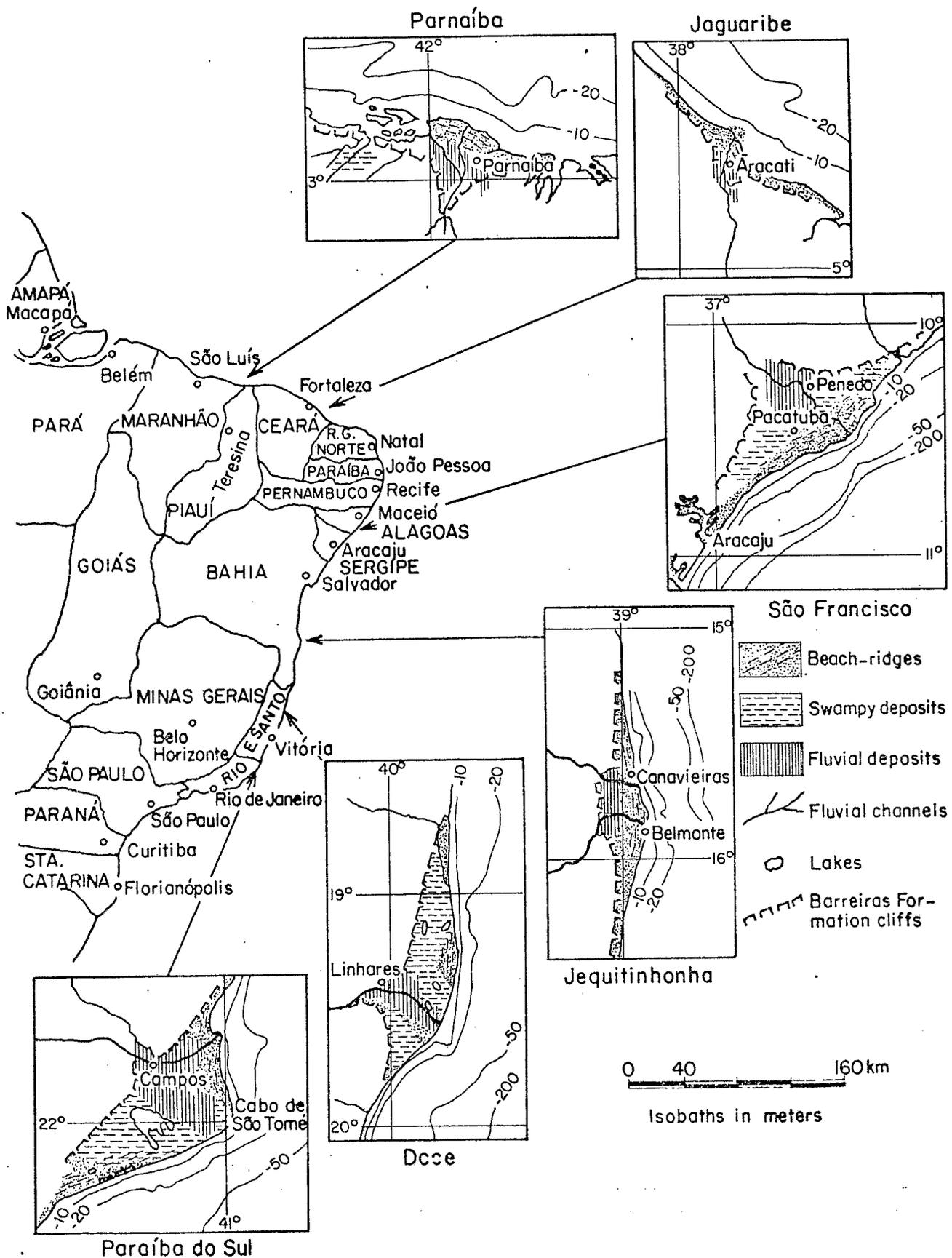


Figure 1. Quaternary deltaic complexes of the Brazilian coastline (modified from Bacoccoli, 1971).

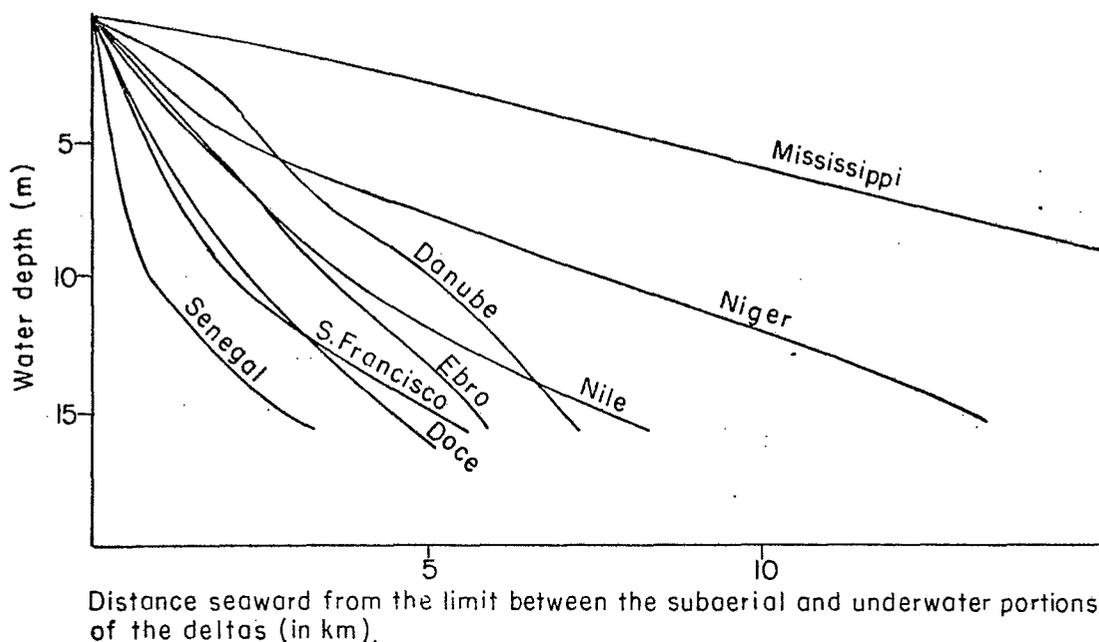


Figure 2. Average slopes of underwater surfaces of selected Quaternary deltas including two of the most important Brazilian deltas (modified from Coleman, 1976).

and fluvial sandy-clayey deposits with surficially peaty low lying zones. This province frequently exhibits lakes and a diffuse drainage pattern.

**Underwater portion**—Strong wave energy (more than  $20 \times 10^7$  ergs/second) causes great textural and compositional changes in fluvial sediments, resulting in the deposition of clean sand bodies with very high-angle concave underwater surfaces in delta front areas (Fig. 2).

**Tectonic behavior.** The sedimentary sequences underlying the Doce River and Paraíba do Sul River deltaic sedimentary piles are characterized by faults which influenced Cretaceous in the former case, and Cretaceous and Tertiary deposits in the latter. According to Schaller [10], the superficial drainage is strikingly controlled by subsurface structural alignments.

In spite of suggested vertical displacements originating tilted blocks, in the Paraíba do Sul River mouth area, attributed by some authors [11] to penecontemporaneous subsidence and isostatic compensations, the time interval during the construction of the deltaic complexes here discussed would have been characterized by negligible tectonic activity.

**Geologic evolution.** Some developmental stages are more or less evident or even absent, in the studied deltaic complexes but we believe that the Quaternary sedimentation sequence proposed by Suguio and others [12] for the Doce River coastal plain (Figs. 3–5) represents the most complete history of the geological events. The six stages of geologic evolution are discernible from the following geologic evidence: a) sandy deposits forming terraces attributable to Cananéia transgression maximum [2] that occurred about 120,000 years B.P. [13]; b) sedimentary pile composed, from bottom to top, of deposits attributable to estuarine, lagoonal, lacus-

trine and swampy environments, which together form an intralagoonal constructive delta, dominated by fluvial processes active between about 6,500 and 4,000 years B.P., and c) an external sandy area composed of regressive beach ridges built up during the last 5,100 years and comprising a wave-dominated destructive delta, which is the present pattern of deltaic sedimentation in the area.

#### DISTINCTIVE CHARACTERISTICS OF THE DELTAIC COMPLEXES

The differences between deltaic complexes are relatively few and much less important.

They are situated between latitude  $3^\circ$  S (Parnaíba Delta) to  $22^\circ$  S (Paraíba do Sul Delta), thus resulting in appreciable climatic differences. Moreover, differences in fluvial regimes and coastal processes are also evident. Such differences must be responsible for the observed variations in configuration of the subaerial portions, the volume and area of the deltaic sedimentary deposits, etc. Nevertheless, the mentioned discrepancies are negligible and they are not enough to change notably the singular pattern of evolutionary history of the Brazilian deltaic complexes, which follows a model discussed very little in international geologic literature on deltaic sedimentation.

#### CONCLUSIONS

Geologic research on Brazilian Quaternary deltaic complexes has demonstrated that:

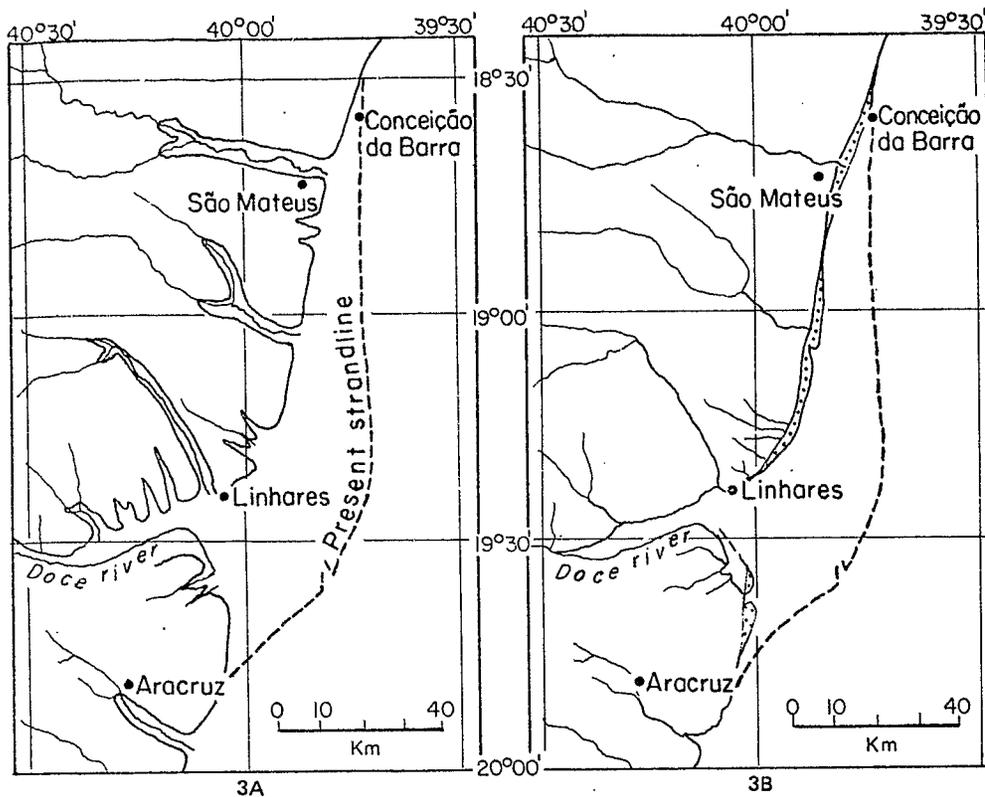


Figure 3. Sequence of geologic evolution during the Quaternary on the Doce River mouth area (from Suguio and others, 1981). 3A = situation about 120,000 years B.P., and 3B = situation about 6,500 years B.P. with partially eroded Pleistocene terraces.

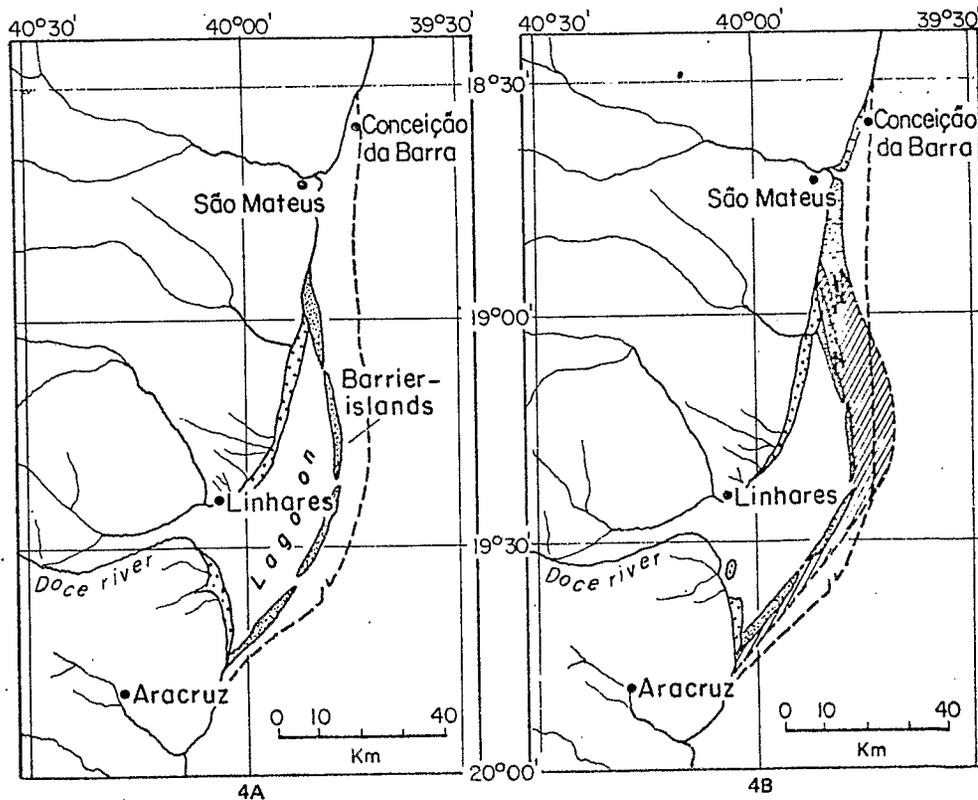


Figure 4. Sequence of geologic evolution during the Quaternary on the Doce River mouth area (from Suguio and others, 1981). 4A = first lagoonal phase (6,500 to 5,100 years B.P.), and 4B = first generation beach ridges (5,100 to 3,900 years B.P.).

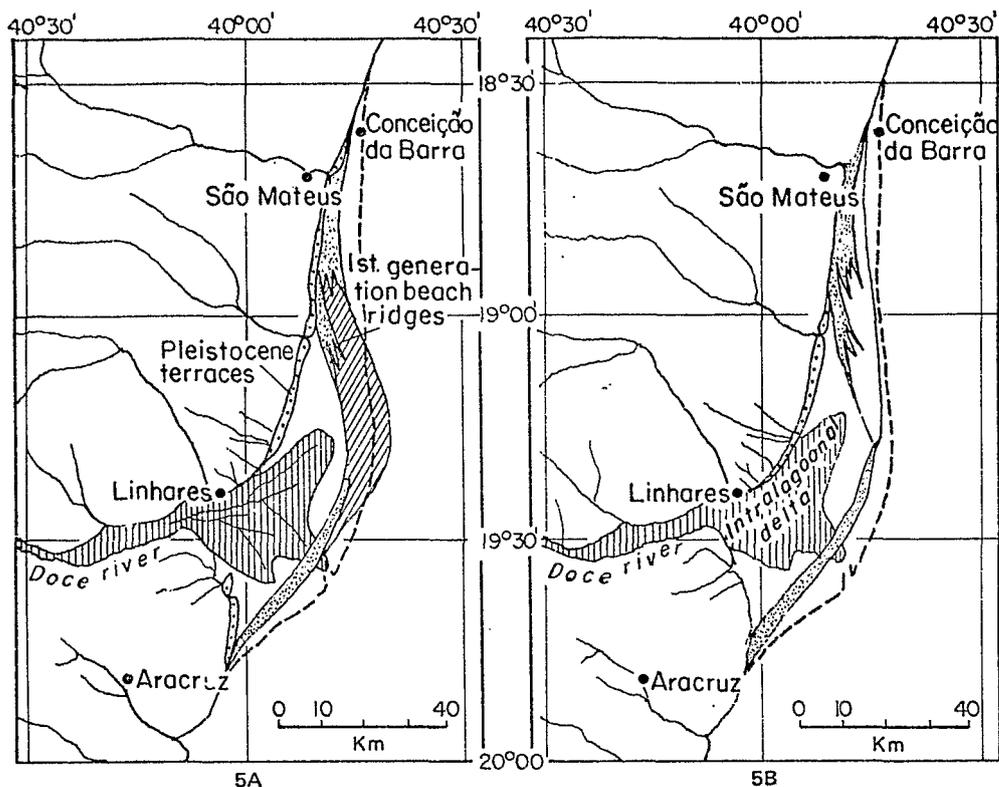


Figure 5. Sequence of geologic evolution during the Quaternary on the Doce River mouth area (from Suguio and others, 1981). 5A = construction of an intralagoonal delta (from 6,500 years B.P.); situation about 4,100 years B.P., and 5B = second lagoonal phase.

1. The relative sea-level fluctuations which occurred about 120,000 years B.P. and, later, in the last 7,000 years were decisive in the construction of these deltaic complexes.

2. The deltaic complexes were submitted to two phases of Holocene "deltation": an older phase related to a fluvial-dominated, constructive, intralagoonal delta and a newer one related to a wave-dominated, destructive delta that is still active today.

3. Despite a few differences, the sedimentary models which characterize the geologic evolution of all these Brazilian Quaternary deltaic complexes have been almost the same.

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