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PALEOGEOGRAPHIC AND PALEOCLIMATIC EVOLUTION DURING THE QUATERNARY  
IN THE NORTHERN HALF OF THE COAST OF THE STATE OF BAHIA, BRAZIL

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ABSTRACT

After the deposition of the sediments of the Barreiras Formation under a semi-arid climate, in an epoch during which the sea level was lower than today's, the climate changed to humid. It is probable that this change marked the end, in a strict sense, of the deposition of those sediments. A transgression occurred which eroded a part of the Barreiras Formation. The limit reached by the sea is marked in some places by a line of old coastal cliffs. After this transgressive event the climate became drier while sandy braided river deposits formed at the base of these cliffs. The climate became humid again during the penultimate transgression (120,000 years B.P.), while the sea eroded part or locally all of these continental deposits. In the last phase of this transgression, terraces 6 to 8 m higher than today's mean sea level were formed. From this time on, the region south of Salvador no longer suffered climatic variations of the types mentioned above, as is demonstrated by the

preservation of the crests of beach ridges built up during the terminal phase of the penultimate transgression. On the other hand, north of Salvador the climate would have been dryer (like it is today) since the sand deposits, both continental and marine, have been slightly reworked by the wind.

Between 120,000 and 7,000 years B.P., the sea level remained below today's mean level. Later it oscillated above and below it. If, in fact, the climate did not vary appreciably after 120,000 years B.P., it is probable that small oscillations occurred. For instance, the formation of the dunes north of Salvador and the deposition of sandy sediments (with the age of 13,000 years B.P.) in the small valleys imply a climate slightly drier than today's.

## INTRODUCTION

The area covered by this paper extends from the locality called Conde south to Ilheus, including approximately the region between the 12° and 15° parallels of south latitude along the coast of Bahia (Fig. 1).

From the climatic point of view, it is possible to characterize this part of the coast in terms of the values of temperature and humidity necessary for the existence of the cocoa culture existing there. So, according to the data of the Secretary of Planning, Science and Technology of the State of Bahia (BAHIA. SEPLANTEC, 1977), there is a climatic frontier situated south of Todos os Santos Bay, separating at the coast two regions: the southern region with a water deficit below 50 mm, favourable to the cocoa culture, and the northern region with a water deficit above to 50 mm unfavourable to the cocoa culture (Fig. 2). At the present time, with the exception of some small littoral dunes active today, all this northern coast is covered by a vegetation sufficiently well developed to avoid a transportation by the wind of the numerous sand deposits existing there. The present re-transportation of the sands of some deposits is not the consequence of a climatic variation, but it is a result of the anthropic action resulting from destruction of vegetation. As will be shown later in this work, climatic differences between these two zones have also

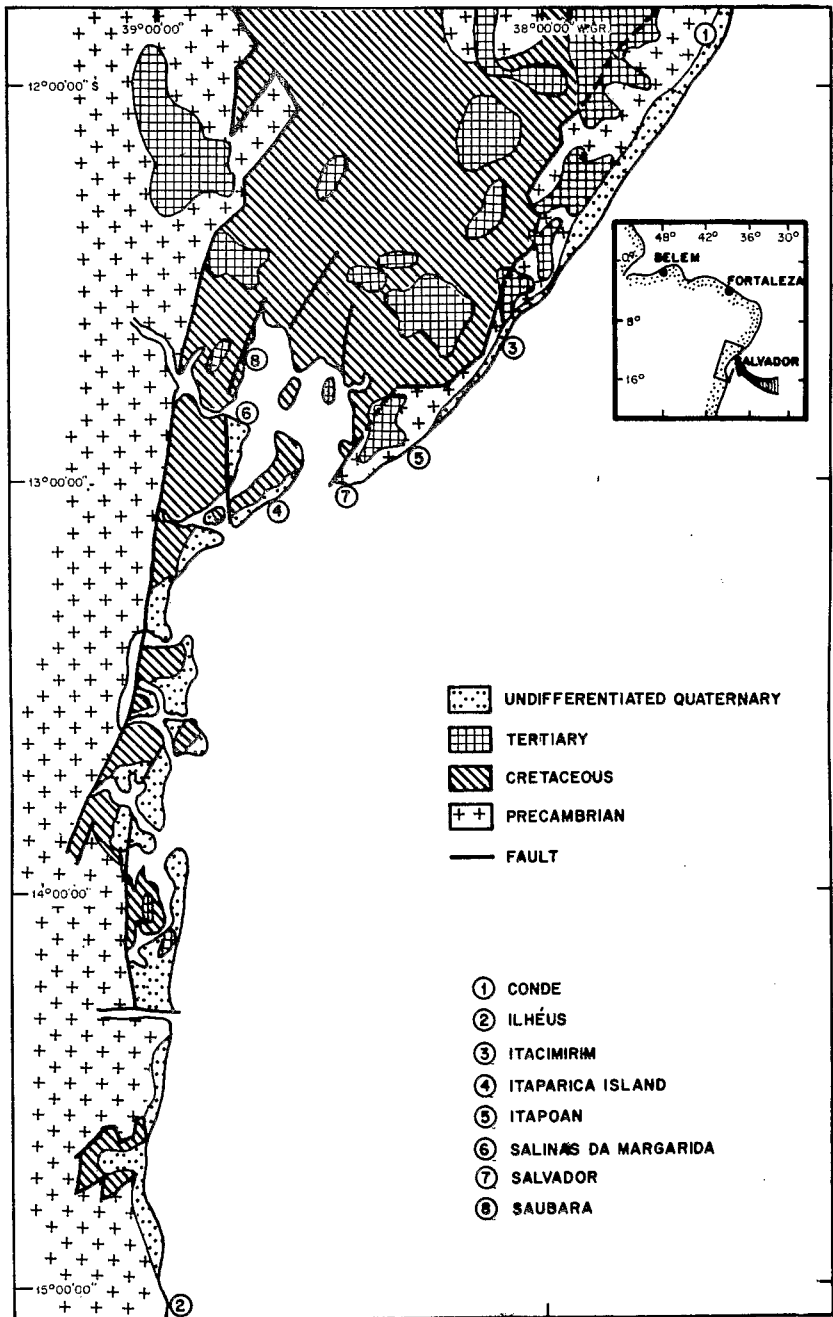


Figure 1 - Geological map of the coast of the State of Bahia between Conde and Ilhéus



occurred in other periods of the Quaternary history.

The Quaternary was a geological period marked by great variations of climate and ocean level. These phenomena found expression in the formation of sedimentary deposits which occur along the coast of the State of Bahia (TRICART & CARDOSO DA SILVA, 1968; MARTIN *et al.*, 1978a; BITTENCOURT *et al.*, 1978). The objective of this paper is to endeavour to reconstruct the history of the Quaternary events in the northern half of the Bahian coast from the point of view of its paleogeographic and paleoclimatic evolution, starting from the characteristics of the aforementioned deposits.

#### EVIDENCE LEFT BY THE GREAT TRANSGRESSIVE EVENTS

Along the coast of the State of Bahia, the most ancient transgressive episode, at the maximum of which the relative level of the sea was superior to the present mean level, eroded during its course the external frontal part of the Tertiary sediments of the Barreiras Formation. The limit achieved by the sea at its maximum height is represented by coastal cliffs carved in the Barreiras detritic sediments. After this event, a second transgression with maximum level superior to the present mean sea level, here denominated as the penultimate transgression, left sand terraces, the tops of which are situated from 6 to 8 m above the present mean sea level (MARTIN *et al.*, 1978a).  $^{14}\text{C}$  datings of wooden remnants found in clay intercalations in these deposits show that the transgressive episode is older than 35,000 years B.P. It is probable that it might have occurred around 120,000 years B.P.

From Itaparica Island south, the surface of the sand terraces left by the penultimate transgression is marked by the presence of well defined beach ridges. This fact indicates that the region to the south of Itaparica Island (Fig. 1) did not suffer radical climatic variations that might have caused the disappearance or at least an important decrease in the vegetation. In effect, such a variation would have stimulated a reworking of the upper part of the sand terraces by the wind with the consequent disappearance of the beach ridges. On the contrary, in the region to the north of Salvador such ridges

are not found, dunes existing instead of them. This demonstrates that north of Salvador, after the penultimate transgression, the climate was drier than to the south. At the present time the dunes are fixed by the vegetation, indicating that at the moment of their formation the climate was drier than it is at present. This climatic variation north of Salvador occasioned a considerably important decrease in the vegetation to the point which permitted sand mobilization by the wind, resulting in the disappearance of the beach ridges.

Finally, the most recent evidence is related to the last great transgressive episode, in the Holocene, represented by marine sand terraces and lagoon deposits, coral reefs, algal and *Vermetidae* incrustation. The latter part of this transgression is well known from numerous  $^{14}\text{C}$  datings (MARTIN *et al.*, 1978b). The present zero level was cut for the first time around 7,000 years B.P. Afterwards, the relative sea level passed through maxima not exceeding 5.0 m above the present mean sea level around 5,200, 3,500 and 2,400 years B.P. and through minima around 3,800 and 2,700 years B.P.

#### CONTINENTAL DEPOSITS

Northeast from Salvador, in the Itacimirim region (Fig. 1), at the foot of the coastal cliffs carved in the Barreiras sediments, sand deposits containing gravel are found, the tops of which are situated between 15 and 20 m above sea level. The continental sands were in part eroded during the penultimate transgression, the marine terraces formed at that time being supported directly against their external frontal part. These continental deposits appeared between the penultimate and antepenultimate transgressions. On the borders of the Todos os Santos Bay, in the region of Salinas da Margarida and Saubara (Fig. 1), there are important sand deposits containing gravels and having continental characteristics, these deposits being situated at the base of the eroded Cretaceous sediments. Information is not available for the dating of these deposits; however, it is probable that they are contemporary with those northeast of Salvador. Taking into account their extent, characteristics and position at the base of sedimentary formations

rich in sand, MARTIN *et al.*, 1978a, consider that these materials probably were deposited in the form of braided river deposits, which implies for their formation climatic conditions totally different from the present ones: climate of the semi-arid type with rare and violent rainfalls.

In the coastal region of Salvador there are other types of continental sediments which, unlike the previous ones, were deposited after the penultimate transgression. There are fluvial deposits of small extent which are found in the small valleys carved in the Precambrian basement rocks. There are sands of varied grain size, the grains being very angular, indicating depositional conditions different from the present ones. In effect, the present small water courses transport only fine particles, and do not have sufficient competency to transport sand. This variation in energy should correspond to a period of lower base level and to a climate slightly drier than the present one. Meanwhile, this period of drier climate did not achieve the intensity of the previous, above-mentioned one, since the major part of the alteration mantle that existed above the crystalline rocks remained in situ. In a small valley next to Itapoan (Fig. 1), situated slightly above the crystalline basement and covered by 2 to 3 m of sand, stems of trees were found which dated from 13,400  $\pm$  125 years B.P. (Bah. 535). In that epoch the sea level was effectively below the present level, the climate being drier.

#### GENERAL ASPECTS OF PALEO GEOGRAPHIC AND PALEOCLIMATIC EVOLUTION AFTER THE TERTIARY

Before the deposition of the Barreiras Formation, the climate must have been hot and humid during a long period, permitting the formation of a very thick alteration mantle. Subsequently, the climate became drier (semi-arid type with rare and violent rainfalls), reducing the vegetal cover and giving place to the erosion of the alteration mantle. The products of this erosion were deposited at the foot of the slopes in the form of braided river deposits of great extension (KING, 1956; BIGARELLA & AB'SABER, 1964; MABESOONE *et al.*, 1972). During this period the sea level must have been lower than the

present one, the sediments of the Barreiras Formation having covered a part of the continental shelf (BIGARELLA & ANDRADE, 1964).

The end of the Barreiras deposition was marked by the return to a hot and humid climate when a transgressive episode was initiated which eroded the external frontal part of that formation. The maximum limit reached by the sea during this episode is registered in some localities by a line of coastal cliffs. After this transgression the climate again became semi-arid which gave rise to the formation of new continental braided river deposits at the base of the slopes in conditions quite similar to those existing during the deposition of the Barreiras Formation. However, as these deposits are much less developed than those of Barreiras, it is possible that the dry period during which they were deposited might have been much shorter. During their deposition the sea level must have been lower than the present one, which appears to be confirmed by the existence of a facies of relict sediments with continental characteristics at the bottom of the Todos os Santos Bay between Itaparica Island and the continent (BITTENCOURT *et al.*, 1976).

During the epoch of the maximum of the penultimate transgression the climate must have been quite similar to the present climate. After, that, there were no more extreme climatic variations such as those mentioned earlier. In effect, south from Salvador, the beach ridges left by the penultimate transgression were preserved by vegetal cover. However, if the climate after 120,000 years B.P. did not suffer great variations, it is possible that north from Salvador there might have occurred small oscillations as indicated by the existence of dunes and coarse sediments in the valleys where today there are water courses which transport only fine particles. From 120,000 to 7,000 years B.P., the relative mean sea level remained lower than the present mean level. Around 15,000 years B.P., it must have been approximately 110 m below the present mean level (MILLIMAN & EMERY, 1968; MARTIN, 1972). From 7,000 years B.P. on, the relative mean sea level oscillated around the present one.



## CONCLUSION

After the deposition of the Barreiras Formation sediments under a semi-arid climate in an epoch of low sea level, the climate became humid. This return to a humid climate marked the end of the deposition of the Barreiras sediments. Following this epoch, evidence was left of three transgressive episodes, the last two of which are well defined. Between the two oldest transgressions the climate changed to semi-arid, resulting in the formation of braided river deposits. During the maximum of the penultimate transgression the climate became humid. Between the two last transgressions the climate did not suffer radical variations in this part of the Brazilian Coast, but only small oscillations.

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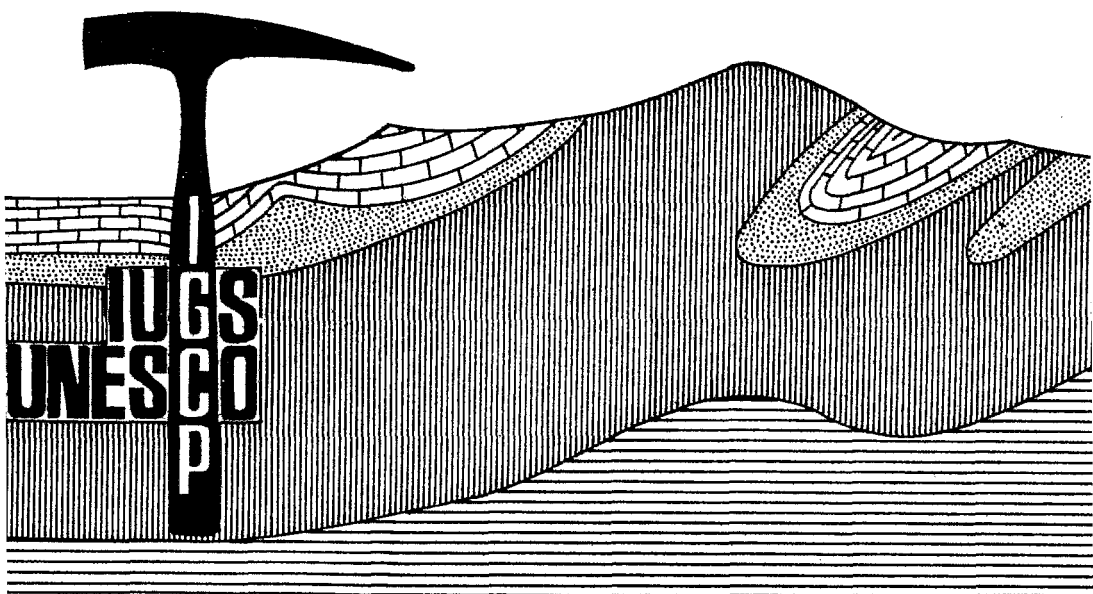
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19