PALEOCLIMATIC EVIDENCE DERIVED FROM THE ANCIENT BEACH RIDGES: EXAMPLES FROM BRAZIL AND POSSIBLE APPLICATIONS IN AFRICA.

MARTIN, Louis
ORSTOM/ON-CNPq-Rua General Bruce,586
Rio de Janeiro - Brazil

SUGUIO, Kenitiro
Instituto de Geociências/USP - C.P.20899
São Paulo - Brazil

FLEXOR, Jean-Marie
ON/CNPq-Rua General Bruce, 586
Rio de Janeiro - Brazil

Along sandy coastlines in emergence the relative sea level drop promotes an important transfer of sands from the inner shelf toward the beach. The lateral transport of beach sands, in this case, is provoked by longshore currents related to obliquely oriented wave fronts. The direction of transport is a function of the quadrant from which the wave fronts come. Thus, it is evident that knowledge of the direction of longshore transport during a given period will be able to furnish the quadrant of wave fronts reaching the coastline during this time. Longshore transport of sands will continue until their blockage by an obstacle, which generally gives rise to the accumulation of a series of beach ridges. A detailed study of the geometry of these ridges allows us to discern the direction of transport and, consequently, the quadrant from which the wave fronts have come during the last few thousand years. An inversion of littoral transport in the past may be related to an inversion of the dominant wave-front direction, which is frequently due to changes in atmospheric circulation. By dating such evidence, it will be possible to establish the chronology of these inversions with great precision.

Sometimes, an influx of important rivers into the sea will form a hydraulic obstacle which will block longshore transport of sands. In fact, during periods of high energy, river flow will function like artificial groynes. In this case, beach sands, furnished by the inner shelf due to relative sea level drop, will be transported until they are blocked by the river flow, thus accumulating only on the updrift side of the river mouth, while river sands will accumulate on the downdrift side. These two types of sands are easily distinguished by their very distinctive degrees of roundness. During dry periods, this hydraulic jetty is diminished as is the blockage effect

as well. Moreover, during this period, dominantly fine-grained sediments will be transported by the river, and the sands supplied by relative sea level drop will be deposited on both sides of the river mouth. A detailed study of sand-grain roundness from beach ridges on the downdrift side of the river mouth has allowed us to identify alternating periods of strong and weak energies of past fluvial current. Furthermore, the absolute chronologies of these events and eventually the corresponding climatic fluctuations may be established by ^{14}C datings.

Along the central portion of the Brazilian coast, the two most important directions of wave incidence are the S-SE and the NE. The former direction is related to the penetration of Antarctic polar air masses across the South American continent. Is in especially frequent during winter and autumn and its influence is effective southward of 10°S latitude. The NE direction is related to trade-winds, whose effects extend further southwards. However, the S-SE waves, are much stronger than the NE ones, and thus play the dominant role in the longshore sediment transport, where both directions interact. During the last 5,000 years, littoral sediments have consistently moved from S to N in the Paraíba do Sul river mouth area (22°S latitude) and from N to S in the São Francisco river mouth area (10°S latitude). On the other hand, in the Doce river mouth area (19°S latitude), these directions have been alternately dominant. For example, between 5,100 and 3,900 years B.P., sediments moved mostly from N to S. From 3,600 years B.P. to the present, the sediment transport had been dominantly from S to N. Recently, two inversions seem to have been produced but they are not still well known.

The normal conditions of circulation during the autumn and winter in South America are characterized by the passage of successive "meridian" waves through the middle and upper troposphere and, at the earth's surface by corresponding frontal systems. At the ocean surfaces, these systems produce S-SE waves. Along the Brazilian coast some of these frontal systems reach the 10°S latitude. They are very important for rain production in the greatest part of the Brazilian Northeast. During the strongest activity of the "El Niño" phenomenon, the passage of the "meridian" waves through middle and upper troposphere is blocked by the presence of a strong, permanent subtropical current. This extends from the Pacific coast to Southern Brazil, passing through Northern Chile and Argentina. During the periods of blockage, the frontal zones was for a long time in S and SE Brazil. Thus, Southern Brazil was characterized by a very rainy period, while the Northern Brazil was very dry. Somewhere, the S-SE waves did not advance to N,

allowing the NE waves to advance southward. It is possible to imagine that this phenomenon presently periodical could have been more permanent in the past.Obviously the presence of warm water along the Peruvian coast, due to mechanisms independent of the "El Niño" phenomenon, could have the same effect.

A study of roundness in sand grains of the coastal plains around the Paraíba do Sul river mouth has shown that the downdrift beach ridges are constituted by sand exhibiting fluvial characteristics alternating with sands with inner shelf characteristics. Paraíba do Sul river sands are supplied to down-drift-side during river floods, when river discharge acts like a hydraulic jetty, blocking littoral transport. At other times, inner shelf sands are supplied to the downdrift-side, and sand spits tend to close the river mouth. Obviously, the high energy phase is related to periods of high pluviosity, which could correspond to periods of blockage of "meridian" atmospheric circulation in the northern portion of the State of Rio de Janeiro, as in 1983. This blockage has been characterized by a very high pluviosity in the southern half of Brazil, mostly within the Paraíba do Sul river basin. Very detailed sampling of each beach ridge north of the river mouth could allow us to establish the chronology of similar events during the last 5,000 years based on previously obtained ^{14}C dates. It is possible that analogous phenomena could have been recorded within beach ridges of sandy coastlines in emergence of the African continent.

REFERENCES

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 . Cah.ORSTOM,sér.Géol.;vol.XIII,nº 1:59-81.

MARTIN(L.),FLEXOR(J-M.),KOUSKY(V.),CAVALCANTI(I.F.A.),1984, 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,nº1:25-27.

MARTIN(L.),FLEXOR(J-M.)et SUGUIO(K.),1984,Enregistrement des périodes de faibles énergie à l'embouchure d'un fleuve. Le cas du Rio Paraíba do Sul.C.R.Ac.Sc.Paris, t.299,Série II,nº 10:661-664.