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The Beach: Where Is the "River of Sand"?

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ABSTRACT

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The "river of sand" concept is basically a model of sediment transport; sand is carried lengthwise along a beach from "input" end to "output" end, like a slurry in a pipe. Such transport can be seen locally, in nature, but the primary sand path is at right angles to the river of sand line. Thousands of beach ridges have tips terminating in marshland or swamp, with no attachment to any possible source of sand, commonly both ends. The termination is generally by tapering, not truncation. Others are attached at both ends, but in a pattern such that neither end was the source. Wide inlets on both sides of many beach ridge plains show that the only source of sand was offshore. Grain size studies do not indicate shore-parallel motion, but show sine-like variations in size parameters: patches of coarser sand must have been derived from offshore, here and there. The dq/dx model (shore-parallel movement) fails over long distances: it may hold for short segments. The dq/dy model (shore-normal) is more successful. Parallelism of ridges also requires an offshore source. The "river of sand" idea is a gross oversimplification. In the areas studied it is generally wrong.

ADDITIONAL INDEX WORDS: *Beach, beach ridge, beach ridge plain, dq/dx model, offshore sand, parallel beach ridges, ridge tips, "river of sand," shore-parallel transport, wide inlet.*

INTRODUCTION

The "river of sand" model for sand transport on beaches is, in its simplest form, a scheme in which sand is placed at one end of a long beach and transported to the other end, where it vanishes (as far as the model is concerned). This is shore parallel transport. The concept is simple, elegant and easy to understand. Furthermore, it has been promoted in an attractive color movie (ENCYCLOPAEDIA BRITTANICA EDUCATIONAL FILMS, 1965). The basic idea has been used widely, but commonly not explicitly identified as the "river of sand." However, there is much evidence that many beaches, if not most, were built in some other way, and the river of sand is local, temporary or minor. The present note summarizes some of this evidence.

Beach ridge plains on which this study is based are located in various parts of Canada, the USA, Mexico, Colombia, Venezuela and Brazil. Specific areas, selected from more than 60 such plains, are identified in the text. Other beaches, not on beach ridge plains, have been investigated also.

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GEOMETRY

Beach Ridge Tips

Beach ridges can be built in several different ways (TANNER, in press). A common variety is the swash-built ridge, having only minor amounts of eolian or overwash deposits in it. This type may occur in sets of five to 200 or more individual ridges, parallel, or nearly so, with their neighbors. A popular idea is that each ridge is attached, at one end or the other, and that the point of attachment permits us to identify the source of sand. Transport, in this model, was from the point of attachment to the other end of the ridge.

St. Vincent Island, Florida Panhandle, has been studied intensively for two decades (TANNER, 1974; DEMIRPOLAT *et al*, 1986). It consists of some 180-200 individual beach ridges (Figure 1), a few marked by eolian decoration. Most of the ridges are

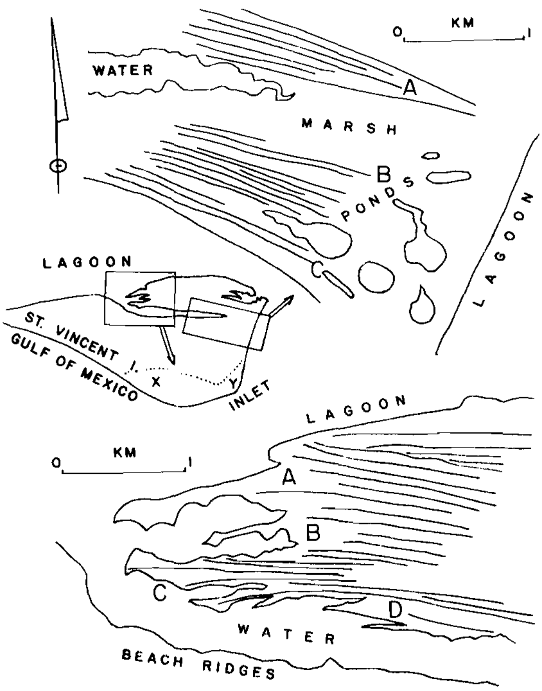

Figure 1. St. Vincent Island (small figure, left center) and beach ridges on two parts of the island (approximately to scale: for location in Florida see Figure 6). Representative beach ridges are shown. The upper figure maps part of the eastern third of the island; ridges terminate at A, B, and C, and points between. This termination is not by truncation, but by lack of deposition. Seven ponds are shown; around them is a marsh. The lower figure shows the western ends of selected ridges: note points A, B, C, D and between. The area to the left of points A-D is marsh, mud flat or very shallow water, with no ridges. In these 180 or so ridges, none indicate significant shore-parallel transport. The southern part of the island (*X* and *Y*, small map) contains beach ridges built of sand derived from the east, later in its history; they belong to a different system.

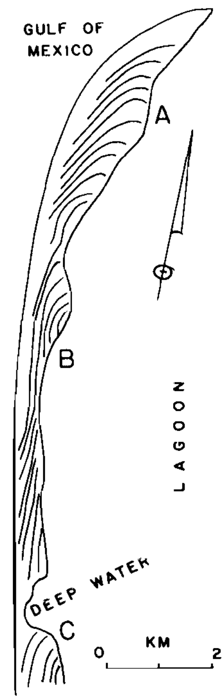

Figure 2. The northern half of St. Joseph peninsula, showing representative beach ridges. (For location, *cf.* Figure 6.) Deep water, near *C*, was at one time the inlet between two of the three original islands. The northern island started with a nucleus near *B*, where the ridges grew in both directions, until the system became integrated. The middle island started north of the old inlet. The southern island started with a nucleus below the southern edge of the map; curvature of ridge ending at *C* shows that the inlet was active.

faintly concave seaward. To the east is an active inlet. To the west is the bay head. In the "river of sand" model, transport was from east to west, across the inlet.

However, no single ridge on the island is attached to anything except some other part of the same island. Ridge sets A to G have eastern tips that end in the marshland, many of them one km or more from the beach to the east. The seven sets cover almost the entire history of the island.

Various hypotheses have been voiced to me, by persons who feel that there has to be an attachment, so that there can be an up drift source of sand. One is that a later inlet has destroyed the point of attachment. Another is that the eastern edge of the island is fault-controlled, and that the point of attachment is now below lagoon waters. Neither of these can be defended. The inlet east of the island is a kilometer or more away from the ridge tips, and has not been migrating, and the ridges taper, eastward, to points, rather than showing signs of truncation. The fault suggestion likewise fails at these points.

The oldest beach ridge on St. Vincent Island was built without any attachments. It formed in open water, probably on a long narrow shoal. The terminations show that there was no significant eastward or westward transport. The younger ridges in the seven sets listed above show the same pattern. The explanation is that the sand in these ridges was derived from offshore. The only objection to this suggestion is the "river of sand" model itself.

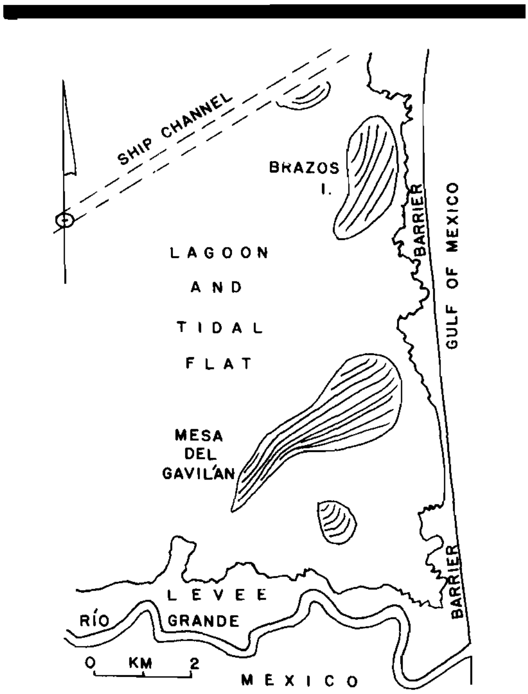

Figure 3. Southern end of Laguna Madre, Texas (near Brownsville), the Rio Grande, and the natural levee on its southern side. Four beach ridge plains with representative ridges are shown; the largest is Mesa del Gavilan, studied in detail in 1986. The ridges formed inside the lagoon, and post-date the barrier island to the east. The sequence is: oldest to the southeast, youngest to the northwest. Each beach ridge on each island has tapered ends in both directions; there was no shore-parallel transport of sand, but rather, sediment was derived from the adjacent lagoon floor.

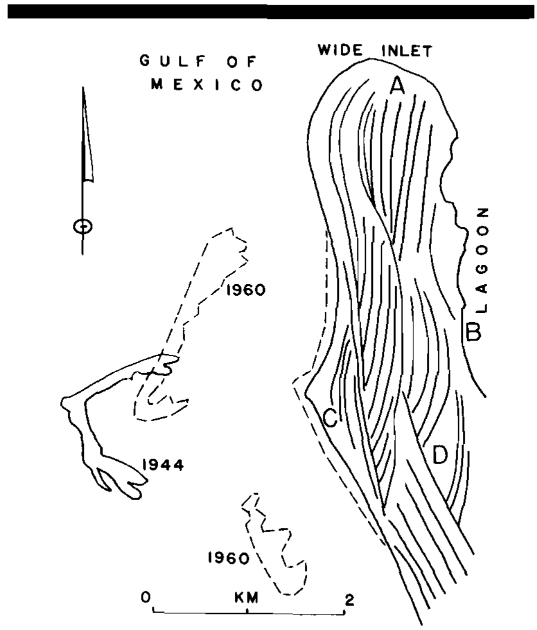

Figure 4. Part of the Cayo Costa Island (west coast of Florida: see Figure 6); and Johnson Shoal, in the Gulf of Mexico, to the west. Two positions of the shoal are shown in 1944 and 1960. Between these dates the rate of migration was 50-100 m/yr. The original shoal, or island, was not a dredge spoil pile, but a natural feature; it may have been a dune complex. At point *A* are the tapering tips of beach ridges which extend northward, but which did not bridge the inlet. At *B* is a representative early ridge, terminating in both directions, and not due to shore-parallel transport. At *C* younger ridges likewise terminate in both directions. Divergence at *D* suggests a shift in location of the offshore source of sand.

Little St. George Island, across the inlet to the east from St. Vincent, is much younger, but consists of some two dozen ridges. Some of these have been truncated by wave erosion, but many of them taper off to the southeast and to the west. The oldest was formed in open water, without attachment of any kind. Therefore this younger island cannot have been the updrift source for St. Vincent.

Gap Island, some kilometers farther east, is made of a few beach ridges, some of them showing evidence of later erosion. However, ends in both directions show taper and termination. Dog Island (SPICOLA, 1984) is made of several beach ridge sets. Except for the modern beach, which is eroding and in places truncating older ridges, depositional terminations are easy to locate. They were at no time attached to any other island, spit, point, cape, or land mass.

St. Joseph Peninsula (STAPOR, 1973) consists of at least two older islands, which were connected later by plugging the inlet between them (Figure 2). Clear beach ridge patterns show that, during the history of accretion, each island started as a nucleus in open water, and grew in three directions: toward both ends, and seaward. The beach ridge tips were unattached. With the closing of the inlet, growth of ridges into the inlet ceased, but the tips are still visible.

Mesa del Gavilan, and similar beach ridge plain islands in the Laguna Madre, east of Brownsville, Texas (Figure 3), are made of beach ridges each of which has its ends preserved and visible (TANNER and DEMIRPOLAT, in preparation). There is no attachment to any other sand body; the material in the ridges was derived from the adjacent shallow lagoon, as is shown by bedding, shape and granulometry.

Johnson Shoal, in the Gulf of Mexico west of the lower west coast of Florida (Sarasota County), has

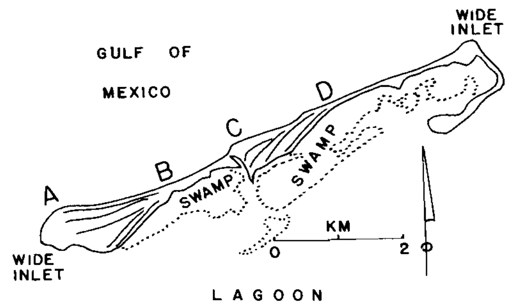

Figure 5. Isla del Carmen, Campeche, Mexico, with representative beach ridges. There are wide inlets on both sides. Beach ridges occur in two groups: one between *A* and *B*, the other between *C* and *D*. Each ridge is made of shells and shell debris, derived from offshore; beach ridge patterns reflect this. The oldest ridges are immediately adjacent to the back-swamp; growth was northerly. At *A* (Playa Norte) the ridge system continues to grow, with only shell input, even though there is erosion at *B* and to the east. New shells at *A* are fresh, and cannot have come from erosion of older ridges. Seaward growth (over about 30 years up to 1986) is 10-15 m per year.

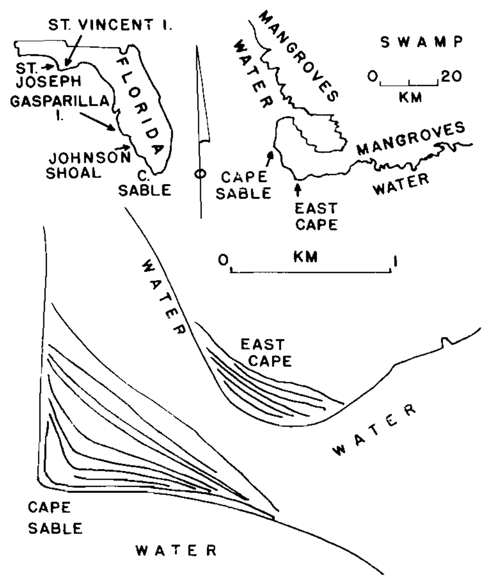

Figure 6. The Cape Sable area, in extreme southern Florida (Everglades National Park), at two scales. Top right: the system is surrounded on all sides by water or mangrove swamps. The lower maps give greater detail for two capes, showing representative beach ridges. These have been growing recently, from offshore (shell debris). Ridge tips taper in both directions. There was no shore-parallel transport through the mangrove swamps.

been migrating toward the land for at least six decades (Figure 4). In the wave shadow behind the shoal, a system of beach ridges has appeared. The sand in these ridges came from the offshore shoal, and could not have come from the small island to which they are attached (which lies landward of them).

Isla del Carmen (Figure 5), in the state of Campeche, Mexico, is made up of two main beach ridge plains, plus a scattering of other ridges (TANNER, PARKER and ALVAREZ, in preparation). For most of the ridges there are clear terminations; their location does not permit any significant amount of shore-parallel transport.

Cape Sable, Everglades National Park, in extreme south Florida (Figure 6), is made of ridges which taper off in both directions, to the east into the zero energy environment of Florida Bay, and to the west into the very low energy mangrove coast which extends northwestward to the vicinity of Everglades City, Goodland, Marco Island, and Cape Romano. The youngest ridge has been growing in historical times. The only possible source of sand is the floor of Florida Bay, offshore of the mainland (but behind the reef).

More examples could be cited. Where the evidence is clear, as in these cases, the sand was not transported in shore-parallel fashion, but rather from the nearby water. The fact that any given beach ridge or set is attached to the mainland is therefore not evidence that the mainland was the source of sand, despite the close association. The valid test must be made where ridge tips are not attached; examples are in the thousands.

Wide Inlets

In many instances, beach ridge plains develop kilometers from the nearest island or mainland. The inlets adjacent to these examples are so wide that they are residuals; that is, they were never cut, or eroded, and in fact they do not now constitute channels in the usual sense, but instead are what is left of "open water," after a few widely-spaced islands developed off the mainland coast (TANNER, 1966).

Dog Island (SPICOLA, 1984) provides a good example. The inlet to the southwest is more than three kilometers wide, and the one to the northeast is about 10 km wide. These inlets were never closed; therefore one does not have to infer anything. Because the adjacent islands have been growing, lengthwise, these inlets have been getting narrower, not wider. In the past, they were wider than they are now. Hence adjacent islands or spits cannot have been the source of the sand on Dog Island.

GRAIN SIZE

STAPOR (1980) made a detailed grain size study of the Atlantic Ocean beaches from the Georgia state line southward to Cape Canaveral (also STAPOR and MAY, 1983). He found that there was no systematic change in grain size or shell content, along this stretch, but rather that the mean size, and other pertinent parameters, reflect the existence of coastal cells, or compartments (Figure 7). Within each compartment there are trends, but very little leakage from one cell to another. These data require that the source of sand have been offshore.

EMMERLING and TANNER (1974) studied beaches in the vicinity of Niterói, Brazil, and found distinct cells, or compartments. The changes in grain size, and in sorting, were such that there could not have been any important shore-parallel transport of sand. Instead, the grain size patterns indicate an offshore source.

SCHADE (1985) studied in detail the eastern part of St. George Island, in the Florida Panhandle. He found that grain size parameters, particularly the mean and the standard deviation, varied in an irregular fashion from one end to the other, and displayed no detectable trend. The prevailing winds are from the east, but the northeastern tip of St. George Island is several kilometers distant from the

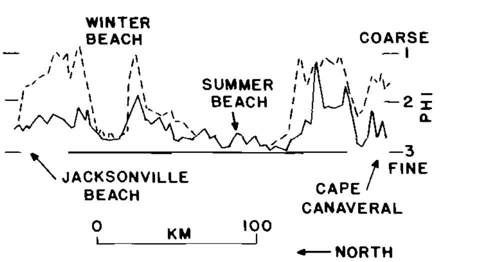

Figure 7. Mean grain size, quartz fraction, for summer (solid line) and winter beaches (dashed line, where different), east coast of Florida; Jacksonville Beach southward to Cape Canaveral (redrawn from STAPOR, 1980). Coarse spikes separate the beach into segments, or cells, which persist from season to season. This diagram shows that there is no systematic change in grain size in the shore-parallel direction; instead, coarse (or fine) material came onto the beach, from specific areas offshore, and there is no "river of sand." Dune samples and calcium carbonate content show the same pattern.

nearest possible sand source, and is growing out into the inlet. Therefore he was forced to conclude that sand on the island was derived from offshore.

A study of Coorong Beach (190 km long), in Australia (SHORT and HESP, 1984) showed similar grain size behavior: no systematic trend such as one would expect to develop as a result of shore-parallel movement, hence onshore motion.

Sedimentological work on the sea beach of Dog Island (EMMERLING, 1975) did show regular changes in grain size parameters, but those changes were precisely the opposite of what would be necessary in order to derive the sand from an adjacent spit, point or headland (although in fact there is no adjacent spit, point or headland).

Grain size analysis of ridge sands on St. Vincent Island showed no trends along the ridges, whereas a more detailed study of the central part of each ridge (DEMIRPOLAT *et al*, 1986) showed systematic changes which could be linked clearly with other evidences for sea level changes, but not with the idea of shore parallel transport.

SPECIAL CASES

Mexico

Acapulco, Mexico, separates two long narrow beach ridge plains, each extending for 100 km or more, in opposite directions (TANNER, 1974). Except for the volcanic remnant, where the city is located, the system of ridges extends in a more-or-less straight line along the Pacific coast for about 250 km. The domninant wave system in this area is Pacific Ocean swell: long low waves, with a relatively large period. Because such waves are generated a great distance away, one must realize that they do not change in wave height, or wave energy content, from one end of these beach ridges to the other. Each one is indeed attached to the mainland at each end, but the ridges are evenly spaced and of constant size, with no sources of mainland sand at any point. The sense of transport must have been sea-to-land.

The east coast of the Yucatan peninsula, Mexico, is marked by a few beach ridges here and there, as is the north coast. In each of these areas, there is no good source of sediment for ridge construction, except offshore.

The Ciudad del Carmen, Campeche, Mexico, was built at the west end of a coastal island. At Playa Norte ("North Beach"), on the north edge of the city, accretion has been taking place for some few decades, and the measured growth rate is meters per year. The new material is almost entirely fresh unbroken shell. To the west is a wide inlet, and west of there, quartz sand beaches. To the east of Playa Norte is eroding coastline, but the material made available by that erosion consists of old, broken, weathered shells. The new shells at Playa Norte came from one place only, and that is offshore. The fact that each new beach ridge (made of shells) is attached at each end, does not change the fact that the source was out on the shallow part of the shelf, and that shore-parallel transport has been unimportant.

East of Vera Cruz, Mexico, in the vicinity of Anton Lizardo, is a system of perhaps 20 beach ridges. They are oriented north-south, and extend from Anton Lizardo to the south. They must not be confused with the dune ridges which are located west of that town, and which extend westward to, and beyond, the village of Mandinga. The dune ridges are also oriented north-south, but these latter have a tuning-fork-bifurcation geometry which is different from anything seen on the beach ridge plain. The beach ridges are curved so that they are attached to the mainland at both north and south ends. The non-parallelism of the ridge set is such that the deposition was maximum near the middle of the length of each ridge; this indicates an offshore source.

The Marismas Nacionales ("National Wetlands") in the Mexican states of Nayarit and Sinaloa (Pacific coast), have been studied in detail. CURRAY, EMMEL and CRAMPTON (1969) noted about 280 beach ridges, with "striking" parallelism, and inferred correctly that they represent successive accretion from longshore bars. TANNER (1975) studied the same coast, and observed that many of the ridges terminate in the swamp. The parallelism with each other, the parallelism with the modern beach, the terminations in the swamp, and the fact that older ridges tend to be isolated from the mainland, all indicate an offshore source of sand.

Florida

Sanibel Island, on the west coast of the Florida peninsula, is made of many sets of shell beach ridges (MISSIMER, 1973; STAPOR and MATHEWS, 1980). To the south, the ridges are recurved around the end of the island. There is no other island or headland for 40 km, so no source of sediment may be found in that direction.

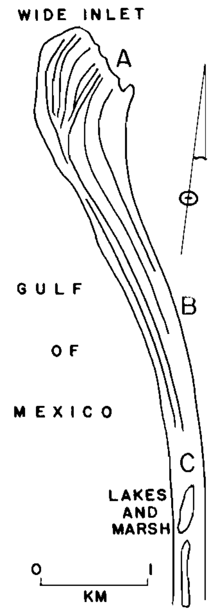

Figure 8. Northern end of Gasparilla Island, west coast of Florida, with selected beach ridges (see Figure 6 for location). The north tips of the ridges show gradual enlargement toward the inlet, at *A*, the result of wave refraction. At *B* are the southern ends of the oldest ridges. No ridge on this map extends south beyond the lakes, ponds and marshes near *C*. This island, like many others, started with a nucleus (*A* to *B*), then grew seaward from offshore sand.

The barrier islands to the north are in good part quartz sand (SILBERMAN, 1979; NEALE, 1980; NEALE *et al.*, 1983), and the beaches contain highly variable amounts of shell material. The grain size parameters show that those islands are part of a complicated compartmented system, in which there is little or no shore-parallel transport. The variable shell contents, having no systematic trends, show the same thing. As NEALE *et al.* (1983) concluded, the shells must have been supplied from offshore.

Gasparilla Island, north of Neale's study area, provides one more example from the Florida Gulf coast (Figure 8). This small but isolated beach ridge plain shows that the complicated system of cells studied by him extends much farther north than the boundary of his research, and therefore is truly not local.

Venezuela

A wide beach ridge plain is located north of the city of Maracaibo on the west side of the Gulf of Venezuela (TANNER, 1971). The ridges are parallel (masked locally by dunes), and oriented roughly north-south (Figure 9). Sand could not have come from the south, because of (a) the mouth of Rio Limón, a wide non-alluvial stream, and (b) the entrance to Lake Maracaibo, a very wide relatively shallow lake, both to the south. The sand could not have come from the north, because a very long narrow rock peninsula juts out, to the east, past the beach ridge plain, in that direction. Furthermore, because of the shape of the Gulf of Venezuela, important waves can not approach from directions that would provide shore-parallel transport. Therefore these ridges were built from offshore.

THE dq/dx MODEL

In the dq/dx model (TANNER, 1974), x is distance along the beach (shore parallel), and q is volume rate of sediment transport (L^3T^{-1}) (Figure 10). The model was devised, specifically, to permit the investigator to get a numerical handle on what is commonly called the river of sand. If one can measure dq (volume eroded, or volume deposited) at various points on the beach, the data can be integrated, graphically or numerically, to produce a good estimate of q at any given point. Application of the model quickly produced a series of surprises.

The first surprise was that a long beach commonly cannot be treated as if it were a continuous system. That is, efforts to use a quantified version of the "river of sand" concept showed that the river of sand must be very short. The second surprise was that the more work that was done, the shorter the river of sand got. In order to treat the data, it was necessary to devise the statement dq/dy, where y is measured along the orthogonal of the incoming wave; a statement that transverse transport, in many cases at least, is more important than shore-parallel motion.

The third surprise was the realization that dq/dx contains a lot more guidance than was sought originally. Consider the case where parallel beach ridges are straight and of uniform height (*e.g.*, near Acapulco, Mexico). The volume of sand added to the youngest ridge, within any reasonable time limit, such as 20 or 30 years, must have been con-

Figure 9. Beach ridge plain north of Maracaibo, Venezuela, with selected ridges. Sand in these ridges cannot have come from the south, across the wide mouth of the non-alluvial River Limón, nor from the north, where a rocky peninsula extends seaward about 100 km. Almost perfect parallelism shows that the ridges were built from the floor of the Gulf of Venezuela.

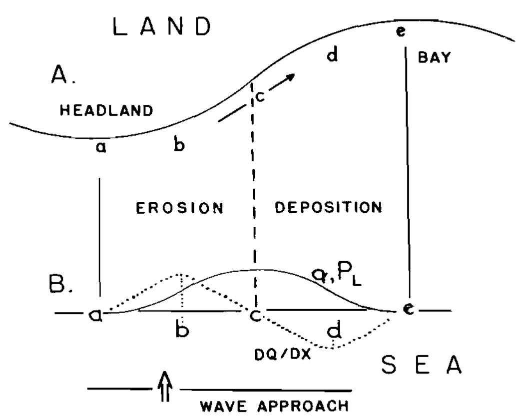

Figure 10. The "a-b-c..." model for shore-parallel transport of sand. Top (A) is an idealized map, showing locations of five key points (*a* through *e*) in the model. Below (B) is a plot of P_L (littoral component of wave power), q (delivery rate of sand, volume per unit time), from *a* to *e*, and the first derivative of that curve (dq/dx). Because q is volume in motion, dq/dx, where positive, is erosion (sand added to transport), and where negative, is deposition (sand subtracted from transport). Point *b* identifies maximum erosion, and *d* marks maximum deposition. These diagrams are useful for discussion, but the dq/dx model works well only for short reaches of beach.

stant from place to place. Because deposition on the beach face is subtraction of sand from the transport system, we now have $dq/dx = -c$, and c must have a non-zero value, or there would be no deposition. The Pacific ocean swell which strikes this section of the Mexican coast must have constant wave height (H) from one end to another, hence constant wave energy density (E). For swell the beta angle (angle of wave aproach) must be constant along this straight coast. Therefore the littoral component of power (P_L), which is a function of both E and beta, must be constant. Because, for any given sand pool, q is a simple direct function of P_L, we now have $q =$ constant. In words, this means that, under the stated conditions, the rate of shore-parallel transport must be a single value, from one end of the system to the other.

But dq/dx is a non-zero constant. If $q = c$, then dq/dx must be zero, rather than a non-zero constant. The two are contradictory. The best solution is to note that, for the beach ridges in question, shore-parallel transport was not important. The same logic applies to slightly-curved and to sub-parallel ridges. Even if departures from parallelism are marked, one can not deduce, from this fact alone, that shore-parallel motion was dominant.

Another way of looking at the implications in dq/dx is to try an integration, from one end of the beach to the other. The result is that q, at the updrift end of a long beach, must be orders of magnitude larger than q at the downdrift end. But the wave parameters do not differ that much, from one end to the other, if they differ at all. This exercise applies specifically to curved ridges, as well as to straight.

OTHER AREAS

It has been obvious for decades that at least a few beaches do not fit the "river of sand" model. For example, in a detailed review of work along the Florida Panhandle coast, TANNER (1974, p117) observed that, as maturity is approached, short segments of shore-parallel transport are slowly replaced by "no littoral [*e.g.*, along-shore] drift," and then used 11 pages (p118-128) to show that parallel or sub-parallel beach ridges (in various settings from Florida to the Pacific coast of Mexico) identify deposition from an offshore source. However, one might easily have dismissed this, and similar statements, as applicable only to truly exceptional areas which therefore may not be used to counter the "river of sand" concept.

The present paper is based on work along Atlantic, Pacific, Gulf of Mexico and Great Lakes coasts, in half-a-dozen different countries, on two continents. To make it more nearly global, one can refer to the literature, where similar statements are fairly common, but in each case referring to one locality or region.

WRIGHT (1976) compared the wave power on the New South Wales coast (Australia) with that on the Gulf of Mexico beaches of Florida, and concluded that the difference is a factor of 80. ROY *et al.* (1980), working on that Australian shoreline, stated that "...as offshore sand reserves were depleted, their |coastal sand bodies| rate of growth declined and eventually ceased" (p12), "Erosion is initiated once offshore reserves of marine sand are depleted..." (p13), and "...the bulk of the sand forming the barriers was derived from offshore sources by onshore rather than alongshore sand transport." This is the offshore-sand-pool concept, important opposite low-energy as well as high-energy coasts. In a later paper, ROY *et al.* (1981) made the same point.

SHORT and HESP (1982), also working in Australia, noted that "...wave induced sediment transport is generally shore-normal, and longshore sediment transport is minimal to absent"; "...large volumes of sediment were supplied to the coast from the continental shelf...".

THOM and ROY (1985) also described the southeast Australian coast, and drew the same conclusion. Further they reported that on their high-energy shore, landward transport of offshore sand was completed much earlier than on low, moderate, and moderate-to-high energy beaches elsewhere (*e.g.*, perhaps 8,000 yrs B.P., in contrast with dates like 500, 200 or 100 B.P., or in some cases still in the future).

CONCLUSIONS

Arguments which can be marshalled in support of the "river of sand" concept (such as attachment to a headland) do not really support that concept, but may be used just as well in some other model. The beach ridge systems described briefly, here, provide ample evidence that transverse transport was much more important than along-shore motion. Literature has been cited to show that the basic observations reported here can be made in other parts of the world also.

The "river of sand" idea may look like a good teaching model, for reasons of simplicity, but it does not represent very much of reality, and it does not advance our understanding of coastal sediment transport processes.

The preferred model is dominated by transverse transport: toward shore for accretion, and seaward for erosion. Whether or not this motion takes place precisely at right angles to the shoreline, or along some other path, is a difficult problem, but at least it is set in the proper framework. Movement parallel with the shore is limited to short reaches of the beach, to minor components of larger systems, or to temporary or rare events.

ACKNOWLEDGMENT

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☐ RESUMEN ☐

El concepto del "rio de arena" es básicamente unmodelo del transporte de arena a lo largo de la playa, con un comienzo (en un lugar especifico) y una final en otro lugar, como ocurre en una tuberia. Transporte de este tipo se puede ver en la naturaleza, localmente, pero el transporte más importante se desarrolla en el sentido transversal. Miles de crestas de arena tienen puntas con su final en las marismas o los pantanales, y no estando ligadas a ninguna fuente de arena, como un cabo. Los extremos de muchas de estas crestas de arena se producen por tapado o relleno no por truncamiento. Otras están limitadas en los dos extremos de tal forma que ninguno de los dos fueron el origen. Las desembocaduras a ambos lados de la cresta de arena muestran que la arena fue derivada desde aguas profundas. También estudios en granulometria no apoyan el modelo del rio de arena (movimiento paralelo a la costa) sino que muestran variaciones senoidales en los parámetros de tamaño: las arenas gruesas han debido de ser transportadas desde las zonas profundas. El modelo dq/dx (movimiento paralelo a la playa) falla en distencias largas: este modelo sólo se conserva en distencias más o menos pequeñas. Un modelo de transporte transversal (dq/dy) es mucho más satisfactorio (pero más dificil de usar). En la mayoria de los casos, el "rio de arena" es erróneo.--*Miguel A. Losada, Universidad de Cantabria, Santander, Spain*

☐ ZUSAMMENFASSUNG ☐

Der sogenannte „Sandfluss"-Begriff ist grundsätzlich ein Modell der Sedimentbeförderung: vom „Eingang" zum „Augsang" wird der Sand einen Strand entlang befördert. So ein Beförderung ist in der Natur zu beobachten, aber die Hauptbewegung des Sandes ist im rechten Winkel zum Weg vom „Sandfluss". Tausende Strandkämme haben Zipfel, die in Sumpfen zu Ende gehen; diese Zipfel wird nicht mit irgendeiner möglichen Sandquellen verknüpft; das ist oft der Fall mit beiden Enden. Die Enden sind normalerweise keine Abstumpfungen, sondern laufen zu spitz. Bei Anderen sind beide Enden verknüpft, aber in der Weise dass kein von beiden die Quelle war. Breite Buchte auf beiden Seiten von vielen Strandkammebene zeigen, dass die einzige echte Sandquelle küstenabgewandt zu finden wurde. Forschen der Kerngrösse zeigen keine strandparallele Bewegung sondern sinusförmige Verschiedenheiten der Grössenparameter: Stellen mit gröbere Kerne würden von küstenabgewandten Gebiete entstanden. Das dq/dx (küstenparallele) Modell verfehlt über lange Entfernungen, aber es passe vielleicht über kürzere Strecke; das dq/dy (küstennormale) Modell hat besseren Erfolg. Parallelismus der Kämme braucht auch eine küstenabgewandte Sandquelle. Endlich ist der „Sandfluss"-Begriff eine radikale Vereinfachung: unter den Forschungsgebiete geht er einfach nicht.--*Steohen A, Murdock, CERF, Charlottesville, Virginia, USA*

☐ RÉSUMÉ ☐

Le concept de "rivière de sable" est un modèle de transport sédimentaire: le sable est transporté le long de la plage à partir d'une source jusqu'à une sortie finale, comme la boue dans un drain. Localement en nature, on peut observer des transports de ce type, mais le champ de sable primaire est perpendiculaire au cours de la "rivière de sable". Des centaines de cordons de plage peuvent présenter des pointes se terminant dans les marais ou les marécages, sans qu'aucune source de sable ne puisse provenir d'une de leurs extrêmités. Ces pointes peuvent avoir une terminaison effilée et non tronquée, d'autres sont attachées aux deux extrêmités (mais dans une structure telle que chaque bout soit une source). De larges goulets, sis de part et d'autre de nombeuses plaines à cordons de plage montrent que la seule source de sable provient du large. Les études de la taille des grains n'indiquent pas un mouvement parallèle à la plage, mais soulignent des variations sinusoidales des paramètres de taille (des taches de sables grossiers ont dû dériver ça et là depuis le large). Le modèele dq/dy (mouvement perpendiculaire à la côte) tient mieux. Le parallèlisme des cordons requiert aussi une source au large. L'idée de "rivière de sable" est une simplification grossière poussée qui est généralement fausse dans les régions étudiées.--*Catherine Bressolier, EPHE, Montrouge, France*