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# GEOGRAPHICAL VARIATION IN COASTAL DEVELOPMENT

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OLIVER & BOYD · EDINBURGH

OLIVER AND BOYD
Tweeddale Court
14 High Street
Edinburgh EH1 1YL
A Division of Longman Group Limited

ISBN 0 05 002597 X

First published 1972



Printed in Great Britain by
Cox & Wyman Ltd., London, Fakenham and Reading

# PREFACE

In this book I have tried to assess the present state of knowledge on how and why the morphology of coasts varies from place to place, and in writing it, I am aware of metaphorically swimming against the present geomorphological tide in at least two respects. In the first place it is a book full of attempted synthesis and generalization in which words such as 'probably' and 'likely' occur with more than commendable frequency and in which very few statements are made in adequately quantified fashion. I have conceived it as an effort at stocktaking, in which the generalizations represent hypotheses erected with varying degrees of confidence on the basis of available fact and needing critical examination. I hope that I have managed to convey something of the degree of confidence which seems applicable in individual instances. It will be a long time before a definitive work on this theme is written: in the meantime a first attempt at assessing present knowledge and thought and pointing to 'probabilities' and 'likelihoods' seemed a worthwhile project. The 'probabilities' and 'likelihoods' will disappear only when we have far more data and can quantify the inputs and outputs of the world's coastal systems.

The book also deals with a topic which has become rather unfashionable in subaerial geomorphology, where the trend in recent years has been to be increasingly sceptical of many ideas on the climatic zonation of landforms. Until quite recently, coastal processes and forms were thought of as being essentially azonal and attempts, particularly by French geomorphologists, to introduce the idea of climatically controlled distributions have come comparatively late. It is to be hoped that this will enable climatic coastal geomorphology to profit from the mistakes of climatic subaerial geomorphology and in the discussion which follows I have tried to give due weight to all factors of locational variation.

Because it is part of my thesis that the development of thought on coastal processes and forms has been strongly influenced by the location of authoritative workers, it is desirable that I declare my own experience. Although I have seen at least something of the coast of every continent except Antarctica, and have visited extensive stretches of the North American coast, I am most familiar with the shores of Europe and Australia and this familiarity has possibly coloured some subjective judgements which are made in what follows. The Australian coast in particular, incorporating as it does a very wide range of environments, is a very profitable field for the study of coastal variation. Within the tropics I can claim only to have worked for short periods in Ceylon and Barbados and to have made more fleeting visits to other low latitude shores in Australia, the West Indies, Malaya, Hawaii, Samoa and Fiji. I have not seen coasts in the Arctic or Antarctic and my only experience of ice action has been during a winter and spring spent on the shores of Lake Huron.

Much of the discussion in this book is based on map and air photo work and on a reading of the now very extensive literature in coastal studies, but for practical reasons only a small fraction of this literature has been cited. Often the choice of a reference or references has been an invidious one, but as far as possible I have tried to pick those which will lead on to further reading. I have assumed familiarity with at least one of the basic English language texts in coastal geomorphology such as Guilcher (1958), King (1959), Zenkovich (1967) or Bird (1968), and have attempted in the main to proceed from where they stop. In places, however, it has been necessary to review briefly some old ground.

The maps and diagrams have almost all been drawn or redrawn by Mr G. van de Geer, to whom I am grateful for his interest in the work. Our wide use of Mercator's projection was determined by the desirability, where climatic factors are involved, of a cylindrical projection showing parallel straight lines of latitude and the additional desirability in many cases of being able to show true directions. In the result of course, high latitude coasts receive disproportionate prominence, but this disadvantage did not seem to outweigh the advantages. The frequently used base map (Fig. 1, for instance), emphasizing the continuity of oceans rather than land areas seemed to us to give a better perspective view of coastal distributions than do more conventional layouts and it has the fortuitous but, to an Australian worker, gratifying result of placing Australia near the centre of things. Because the aim has been to examine variations along oceanic shores, no attempt has been made to plot distributions in enclosed seas such as the Caspian, the Black Sea and the Great Lakes, in spite of the important work which has been carried out there.

Appropriate acknowledgement has been made where photographic illustrations have been provided from other sources and I am glad to be able to thank Eric Bird, David Hopley, Joe Jennings, Brian McCann and John Small for their help in this respect.

I am appreciative of the assistance of Joe Jennings and Keith Clayton, who read the manuscript and suggested improvements: they are in no way to blame for the imperfections which remain. I would especially like to acknowledge the encouragement given to me in the early stages of this work by the late David Linton and, in particular, the lengthy discussions I had with him on terminology, which helped greatly to clarify my ideas.

J. L. D.

## CONTENTS

# I INTRODUCTION

EARLY work in coastal geomorphology, as in geomorphology generally, was overwhelmingly concentrated in the temperate latitudes of the northern hemisphere and it was inevitable that the concepts which developed were derived from this background. In Europe the more northern countries—Britain, France, Holland, Denmark, Germany—rather than those bordering the Mediterranean contributed most to early ideas. In North America it was New England and the Maritime Provinces of Canada which provided most of the inspiration for D. W. Johnson's two influential books of 1919 and 1925. Russian work too was inevitably concentrated in northern middle latitudes with much of the early work being carried out in the Caspian or on the north coast of the Black Sea.

The environment in which these early studies were made cannot be thought of as particularly representative of most of the world's coasts. It was one of low temperatures and stormy seas, where glacial and periglacial processes were active during the Pleistocene. Mostly too it was one of semidiurnal tides and relatively large tidal ranges. In some cases arguments were developed from studies in large lakes, such as the Great Lakes, and from enclosed seas, such as the North Sea and the Baltic. Many early American ideas stem directly from Gilbert's studies (1885, 1890) of the fossil shorelines of glacial Lake Bonneville. It followed naturally that the early text books dealt essentially with coastal processes and forms prevalent in these regions. Johnson's great systematisation of 1919, *Shoreline processes and shoreline development,* dealt essentially with the North Atlantic only, yet was reissued in 1939 and had virtually no competition as a standard text right down into the 1950s. Beginning in the 1940s, but increasingly in the last two decades, the picture has changed radically with reports of detailed work from areas as diverse as California, the Gulf of Mexico, Surinam, West Africa, Madagascar, Australia, New Zealand and the Pacific islands. In 1958 McGill published a world map showing the distribution of major coastal features. More recent texts, such as those of Guilcher (1954, 1958) and Bird (1968), have been written by authors experienced in a variety of environments and this is reflected in their coverage. Zenkovich (1967), while taking the bulk of his examples from northern shores, pointed to the need to study the wide problem of coastal processes in relation to latitude. In a number of writings Tricart (1956, 1957, 1959, 1962) has been a leader in climatic coastal geomorphology and, in a series of geomorphological texts organized on a climatic basis, has devoted sections to the coast (notably Tricart and Cailleux, 1965).

## FACTORS OF GEOGRAPHICAL VARIATION

Three broad groups of factors may be recognized as important in influencing geographical variation in coastal development. They are physical factors operating from landward, physical factors in the sea, and, thirdly, biological factors operating along the shoreline itself.

### PHYSICAL FACTORS OF THE LAND

The first group includes factors such as lithology, structure, tectonic stability and subaerial denudation and accretion, and it is these that have been most widely identified in the past. One of the earliest distinctions—between 'Atlantic' and 'Pacific' type coasts made by Suess (1892)—was made on a structural basis and virtually all classifications proposed since have leaned heavily on variations in structure and subaerial erosion as methods of differentiation. Through the first half of the twentieth century, a supposed distinction between 'shorelines of submergence' and 'shorelines of emergence' was widely adopted. Suggested by Davis (1898) and developed first by Gulliver (1899) and more extensively by Johnson (1919), it was abandoned following the realization that the massive marine transgression of postglacial times had affected all coasts and that perhaps only the coasts of Hudson Bay and the Gulf of Bothnia and those of some tectonically active area such as New Guinea are rising at a rate sufficient to justify the appellation 'of emergence'. We now recognize that Johnson's 'shoreline of emergence' is really a special type of 'shoreline of submergence', formed where the post-glacial sea rose against a gently sloping, relatively undissected land mass. This, then, was really another distinction made on the basis of structure and subaerial erosional history.

Many classifiers, including Valentin (1952) and Shepard (1963) whose systems are probably most widely known, have differentiated coasts on the basis of other terrestrial factors. Control by volcanic and fault structures and the nature and extent of fluvial and glacial erosion and deposition have especially been used to divide coastal types.

That subaerial climates—and particularly Pleistocene climates—have differentiated coasts has also been appreciated to some extent for a long time, although usually in implicit fashion. Johnson (1919) for instance divided his 'shorelines of submergence' into 'ria shorelines' and 'fiord shorelines', so acknowledging the effect of a difference in Pleistocene climate. The contrast between coasts influenced by fluvial processes and those influenced by glacial processes has been noted by almost every classifier since.

One of the few attempts to be more explicit in outlining the role of subaerial climate was that of Aufrère (1934) who distinguished the following regions:

(*i*) Permanent ice cover—development virtually halted because of apparent absence of marine agents of modification.

(*ii*) Seasonal ice cover—coastal activity intermittent, glacial sediments important in supplying beaches.

(*iii*) Temperate humid—the coastal type considered 'normal' and inhabited by most geographers.

(*iv*) Hot, wet—characterized by the presence of corals, constructional features tend to grow in the wet season.

(*v*) Deserts—estuaries and deltas are absent, littoral sediments exclusively marine in origin.

(*vi*) Semiarid—seasonal continental influence, littoral lagoons take on the character of sebkhas.

The tentative and brief attempt by Aufrère has never been developed and seems to have been consistently overlooked in textbook discussions of classification systems.

## PHYSICAL FACTORS OF THE SEA.

Physical factors in the sea include wave regime, tidal type and range, and seawater characteristics. In strong contrast to the last, it has been almost completely ignored by coastal classifiers. There seems to have been no explicit recognition of the part played by variations in wave energy in giving rise to differences in coastal type until the writings of Price (1954a, for instance), although it has often been invoked since and is now generally recognized as a fundamental factor in causing shorelines to evolve in different ways (for example Tanner, 1960). Differences brought about by tidal variations have received perhaps even less attention and there has been little attempt to discuss systematically the effect of different tidal types and ranges. My own tentative discussion (Davies, 1964) is amplified and developed in later pages.

Seawater characteristics of significance include salinity, especially in estuarine, lagoonal or deltaic environments, carbonate content and temperature. As a corollary of temperature, the nature and distribution of sea ice is of obvious importance.

The apparent neglect of marine factors and the absence of much systematic discussion of their effect may be due in part to the way in which they influence the shoreline itself rather than the coastal zone as a whole. In consequence they often make a less obvious impact on the landscape than do subaerial factors. The question of scale in coastal categorization has been examined by Inman and Nordstrom (1971), who suggested that at least three major orders can be distinguished. They envisaged first order features with dimensions of something like 1000 km long, 100 km wide and 10 km high and owing their form to factors of global tectonics. Second order features might have a scale of about 100 by 10 by 1 km and be associated with large-scale processes of deposition and erosion as in the case of deltaic or fjord coasts. Third order features include such forms as beach berms and shore platforms, and higher orders could be introduced to incorporate microforms. First and second order features characterize the coast, third and higher order features the shore. In terms of our present discussion terrestrial factors are most important in relation to the coast, marine and biological factors in relation to the shore.

Another important reason for the relative neglect of marine factors is undoubtedly our general ignorance of their nature and significance until a surprisingly late date. It is true that there have existed for some time abundant data on variations of tidal range and type and that a great deal is known about associated current systems in constricted waters where they are most in evidence and constitute a navigation hazard: but our knowledge of waves and wave-induced currents has remained largely at the qualitative stage in spite of the big advances made in the last two or three decades. In the latter part of the nineteenth century and in the earliest part of this, constructional shore forms were widely interpreted in terms not of waves but of conveniently invoked currents and, as discussed by Jennings (1955), for instance, this way of thinking survived in some quarters until relatively recently.

Some workers have attempted to assess wave parameters from deduced relationships with other measurable features: Price (1955), for instance, suggested that wave energy could be broadly categorized by its relationship with the steepness of the offshore ramp. He used gradients of 1·5 and 2·5 feet per mile to separate low, moderate and high energy conditions. Since the 1950s a start has been made in collecting wave statistics derived from both ship-borne and shore-based instrumental wave recorders, but the amount of this information is so small that we are still dependent on visual observations of very varying quality in order to attempt an assessment of spatial and temporal variations in wave incidence. A large number of observations made on board ship has been collected in marine atlases, such as the *Monthly Meteorological Charts of the Oceans* issued by the British Meteorological Office and the US Navy *Marine Climatic Atlas of the World* (Washington, 1955-1959). Such data have been used as the basis of such regional accounts as that for the North Atlantic by Schubart and Mockel (1949) and that for South American coasts by Russell (1969). Judiciously modifed by wave hindcasting techniques, they were used by Meisburger (1962) to assess world wave height distribution and were the basis of the attempt by Bruns (1953) to review wave regimes generally. From the point of view of the coastal worker, shipboard observations have many limitations, some of which have been discussed by Burkhart and Cline (1961) and by Russell (1969).

Organized attempts to record visual information from the shore have so far been few, but where they have been made, as along coasts in the USA (Helle, 1958), they are potentially more useful than ship records because of the way in which they portray conditions on the shore itself. They have been used, for example by Tanner (1961), to assess energy variation.

My own attempt (Davies, 1964) to present a world picture of wave environments was based on a deductive approach, using the data of marine meteorology in conjunction with what is known of the factors of wave generation and propagation and comparing the conclusions thus reached with the observational records in existence. This sort of approach, used again in Chapter III, is also clearly limited by the data available, but it may be by following this line of attack that a really satisfactory inventory of world wave regimes will eventually be built up. Meanwhile, it must be freely admitted that here lies one of the fundamental weaknesses of any exercise in relating the distribution of shore forms with those of wave parameters.

### BIOLOGICAL FACTORS

Although they rate barely three paragraphs in Johnson's text of 1919 and do scarcely better in the much more modern work of Zenkovich (1967), coral reefs have long been appreciated as a feature giving rise to geographical variation. In fact, if one takes a world view, one of the most fundamental divisions is that between coralline and non-coralline coasts. This is virtually the same as the division made by Valentin (1952) between biogenous and non-biogenous coasts, and the fact that his coastal classification brings out this distinction clearly is one of its many virtues.

Salt marsh plants and mangroves have received considerable attention in relation to shore accretion and so have the plants of beaches and dunes. The part played by algae of a great number of families in building up or helping to destroy rocky coasts is well appreciated, even if not properly understood, and the same may be said for a great variety of animals which are active in rock destruction. Less is known of the significance of micro-organisms such as bacteria in modifying depositional and erosional processes.

However, whereas mangroves and reef-building corals are generally recognized as being distinctly zonal in distribution and effect, there has been very little discussion of the extent to which the influence of other organisms may be thought of as reflecting locational variables.

## BASES OF DISCUSSION

In the four chapters which follow, an attempt is made to examine in greater detail the extent to which it is possible to adduce geographical variation in the effect of all these factors. Then, in the next six chapters, comes a discussion of ways in which variation in the effect of the factors appears to be related to variation in process and form. Basically, three approaches have been used.

### COMPARISON OF REGIONAL STUDIES

The safest and most acceptable method of approach is to compare reports of actual studies made on different sections of coast. This must clearly remain the basic method in any assessment of regional variation and the fundamental way in which hypotheses, suggested by other lines of evidence, must be tested. Unfortunately, there are at present severe limitations to this method of approach, mainly due to the very unbalanced distribution of regional coastal studies and the way in which they often examine only a part of the shore system and are therefore not very useful for comparison. There are many more studies from Europe and North America than from elsewhere and, on coasts where studies have been more numerous, more of them have also been carried out in greater detail and on a higher plane of sophistication. Conversely, the less well-known coasts have been the sites of studies which have commonly been of a reconnaissance nature. Not only has this led to a frequent lack of comparability, but it has also presented the same traps into which some proponents of subaerial climatic geomorphology may have fallen. Initial generalizations made during reconnaissance studies have not always appeared so valid in the light of subsequent more detailed work (Stoddart, 1969b).

These limitations of the strictly inductive approach have convinced some workers that it is unwise to attempt further generalization until many more regional studies have been carried out. But it is common practice in science to use deductive procedures in which *a priori* models and working hypotheses are progressively tested and rejected until apparently correct explanations are attained. In the present context a major advantage of erecting hypotheses and attempting generalizations at this stage would seem to be that it enables further detailed studies to be directed to locations where such hypotheses may be tested and resources are thus used most economically. The study by Bird and Hopley (1969) on a hot, wet section of the Australian coast is an example of an attempt to test hypotheses of geographical variation by selecting what appears to be a critical stretch of coast.

## EXTRAPOLATION FROM SMALLER TO LARGER SCALES

The second approach involves extrapolation from the small scale to the large scale. One method involves using the results of model experiments. It can be demonstrated in a wind tunnel for instance that, if atmospheric humidity and sand moisture are increased, then threshold velocities for sand movement by wind are raised and from this it can be deduced that, in humid climates, winds of higher velocity are needed to move sand of given characteristics. In similar fashion, but perhaps with less confidence, many of the variables introduced into wave tank experiments may provide data capable of being matched in nature at the larger scale. This is an approach which has by no means been fully exploited and a good deal of work remains to be done.

A second way is by extrapolating from small scale to large scale in nature. Islands are often profitable places to study the effects of different environmental conditions in close proximity and many of the ideas put forward in the present book owe at least something to experience of the contrasting coasts of islands—in particular the different sides of Britain, Ireland, Ceylon, Barbados and Tasmania. That strongly developed single berms are characteristic of the east coast of Tasmania with a tidal range of about a metre, while double berms are found along the north coast with ranges of three to four metres is used as one argument for suggesting that this association may tend to occur on a world scale. One small basalt islet off the northwest corner of Tasmania has a sloping intertidal shore platform on its seaward exposed side and this changes to a sub-horizontal high tide platform on the sheltered landward side: this is used to support the idea that the development of sloping platforms generally is encouraged by high wave energy. These examples could be multiplied considerably.

Because of the greater difficulty of isolating particular variables, extrapolation within nature is clearly more dangerous than extrapolation from model to nature, but both methods provide valuable food for thought and appear worth pursuing, provided that their inherent limitations are constantly borne in mind.

## DISTRIBUTION OF KNOWN FACTORS

The third approach consists of using knowledge of the distribution of known factors affecting known processes. An example of this sort of thought sequence might be—wave abrasion increases with wave energy and tool supply, wave energy and tool supply are less in the tropics, so wave abrasion must be less. Or one could argue—water layer weathering is promoted by the frequent drying out of rock surfaces between tides, this in turn is favoured by high rates of evaporation, so water layer weathering is likely to be a more important process on coasts where humidity is low.

This sort of approach is obviously the most dangerous of the three, is susceptible to circular argument and needs continual checking by actual experience; yet it may throw up hypotheses which can be tested in the field and eventually yield more soundly based results.

## PROCESS VERSUS FORM

Convergence of form, whereby different processes may produce landforms of apparently similar appearance, is now widely recognized in geomorphology. It has led to the realization that it is often necessary to look for more than one mode of origin for a particular landform, and that such landforms are more safely defined descriptively than genetically. In coastal geomorphology for example, the many hypotheses which have been erected to explain the extensive barrier systems which occur on such coasts as those of eastern USA are not necessarily mutually exclusive (Schwartz, 1971). There have almost certainly been more ways than one in which barriers have been formed in different parts of the world, and we should not expect to find a simple correlation between barrier construction and a single environmental factor. However, there are identifiable processes which are conducive in different combinations to barrier formation and it is possible to attempt spatial analysis of these. In reviewing the history of climatic geomorphology, Stoddart (1968, 1969b) concluded that form is an ambiguous guide to origin and pointed to the desirability of identifying climatic parameters associated with particular processes rather than forms.

Features which owe their origin to a number of processes acting in combination may display a bewildering variety and be difficult to categorize for general discussion. In coastal geomorphology a good example is the shore platform, a common but very variable feature for which no universally acceptable classification exists. A great range of combinations of lithology, structure and process gives rise to an equally great range of possible forms. In spite of some brave attempts which have been made to classify by form, it seems much more meaningful and satisfying to try to isolate the genetic factors involved and to attempt to categorize these. At the same time the descriptive term 'shore platform' is preferable to terms like 'abrasion platform' and even 'wave-cut platform', which have definite genetic connotations.

In what follows, then, the emphasis is placed on geographical variation in factors and processes rather than in form, although it often appears possible to suggest that certain forms are clearly associated with certain environments.

# II PHYSICAL FACTORS OF THE LAND

The old distinction made by Suess (1892) between Pacific type coasts, where the structural grain is parallel to the coast, and Atlantic type coasts, where it is discordant, has taken on a new significance since the development and wide acceptance of the concepts of plate tectonics (for example, Le Pichon, 1968; Isacks, Oliver and Sykes, 1968). These concepts envisage lateral movement of enormous crustal plates away from zones of spreading towards zones of convergence, a process which has fundamentally affected

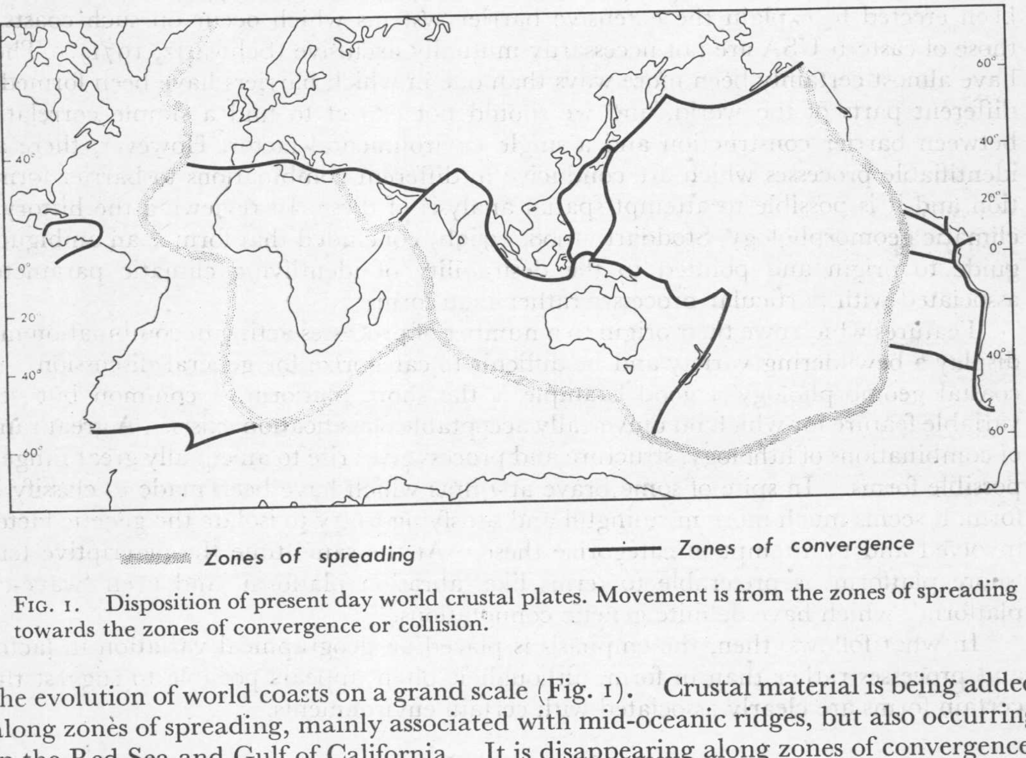


FIG. 1. Disposition of present day world crustal plates. Movement is from the zones of spreading towards the zones of convergence or collision.

the evolution of world coasts on a grand scale (Fig. 1). Crustal material is being added along zones of spreading, mainly associated with mid-oceanic ridges, but also occurring in the Red Sea and Gulf of California. It is disappearing along zones of convergence, normally associated with mountain chains and oceanic trenches. Some coasts lie along the edges of plates at zones of convergence and correspond closely to the Pacific coasts of Suess: others, which correspond to his Atlantic coasts, are imbedded in the plate and located away from zones of active crustal addition or subtraction.

Inman and Nordstrom (1971) have discussed first order coastal evolution in relation to the ideas of plate tectonics and have proposed a broad resulting classification which is given below. Fig. 2 is based on their distribution map for these categories, but with some amendment.

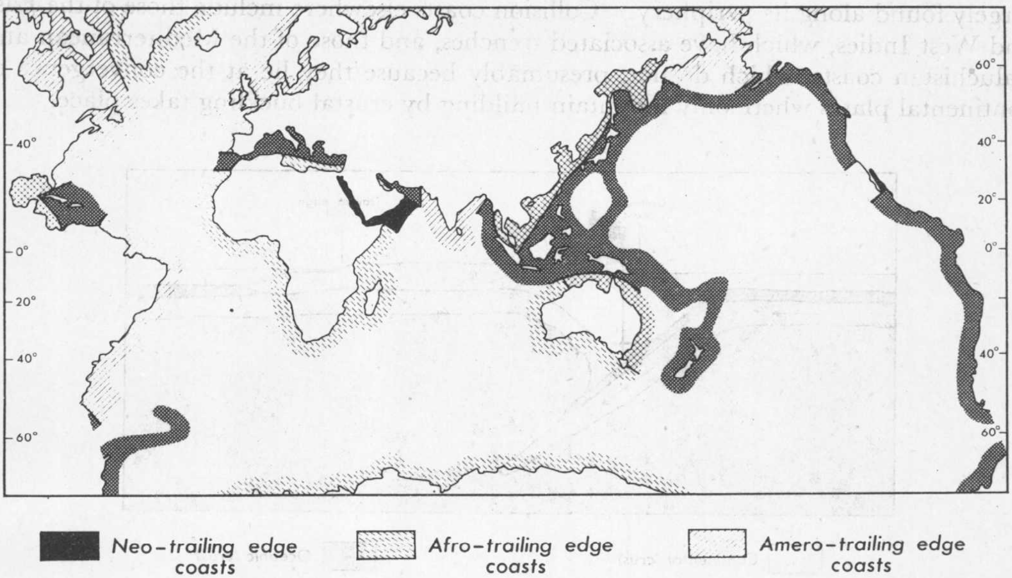


FIG. 2. A geophysical classification of coasts in terms of plate tectonics, mainly after Inman and Nordstrom (1971), but with some amendments and additions as discussed in the text. The outer coast of Baja California does not fit into any of the listed categories.

(*i*) *Collision coasts:* formed where two plates converge.
- (*a*) *Continental collision coasts:* where a continental margin is located along the zone of convergence.
- (*b*) *Island arc collision coasts:* where no continental margin is located along the zone of convergence.

(*ii*) *Trailing edge coasts:* where a plate-imbedded coast faces a spreading zone.
- (*a*) *Neo-trailing edge coasts:* where a new zone of spreading is separating a land mass.
- (*b*) *Afro-trailing edge coasts:* where the opposite continental coast is also trailing.
- (*c*) *Amero-trailing edge coasts:* where the opposite continental coast is a collision coast.

(*iii*) *Marginal sea coasts:* where a plate-imbedded coast faces an island arc.

## COLLISION COASTS

On island arc collision coasts, a relatively thin but dense oceanic plate is plunging beneath a relatively thin but less dense continental plate some distance from the edge of the continent. A deep linear oceanic trench is produced with which island-forming volcanoes are associated. On continental collision coasts, an oceanic plate is moving under a thicker but less dense plate at the continental edge, so that the crust bordering the continent is folded and raised (Fig. 3). Because the Pacific Ocean is underlain by the only oceanic plates, collision coasts with trench and mountain formation are very largely found along its periphery. Collision coasts elsewhere include those of the East and West Indies, which have associated trenches, and those of the Mediterranean and Baluchistan coasts, which do not, presumably because they lie at the convergence of continental plates where only mountain building by crustal buckling takes place.

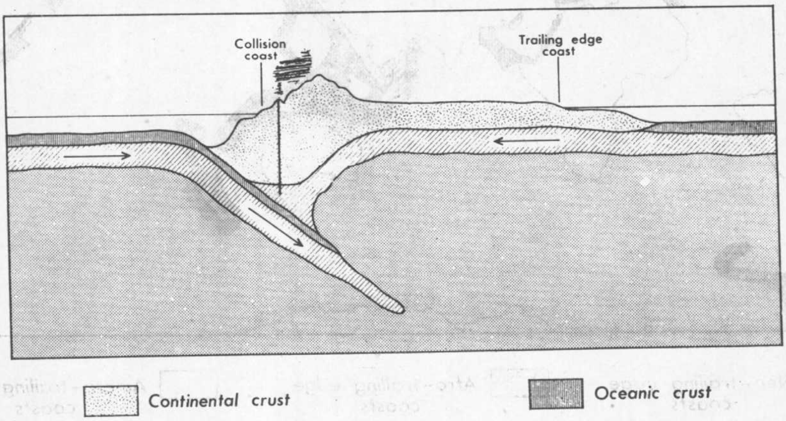


Fig. 3. Diagrammatic representation of a section through collision and trailing edge coasts, adapted from Inman and Nordstrom (1971). Arrows indicate the direction of movement of crustal plates.

Collision coasts are characterized by structural lineations parallel to the shore. They are relatively straight with high, tectonically mobile hinterlands and are fronted by narrow continental shelves. They are by far the most important loci of world volcanic and earthquake activity. The steep mobile hinterland is a potentially strong source of coastal sediment, and earthquake activity along associated trenches is a major cause of the catastrophic waves known as tsunamis (See Chapter IV).

It is along collision coasts that neotectonic effects are most evident and the direct interplay of endogenic and exogenic factors may be observed (Fig. 4). Stanley (1968) described changes along the Alaskan coast as a result of the 1964 earthquake and illustrated the effects of local emergence and submergence. There are numerous references to the way in which post-Pleistocene earth movements have changed Japanese coastal landscapes within historical time, some of them given by Yoshikawa and others (1968). Cotton (collected, 1955) has studied effects of similar deformation on New Zealand coasts. Neotectonic warping may affect the evolution of estuaries, as described by Pimienta (1953) from the Algerian coast, and uplift of the adjoining shelf may possibly bring sea floor sands within the range of onshore wave drifting, so leading to unusual accretion (Snead, 1967).

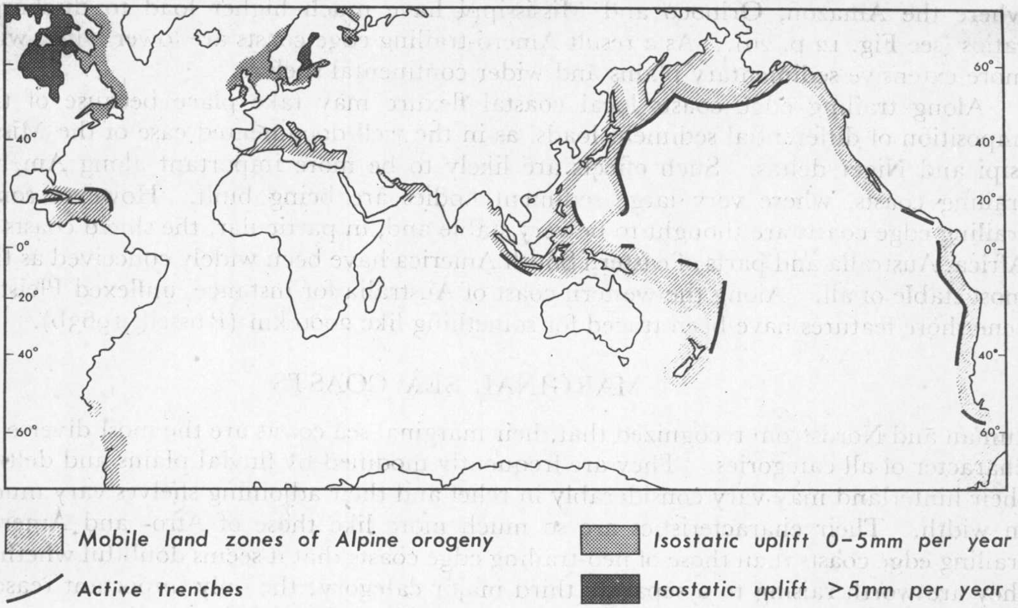


FIG. 4. Major types of coastal instability. Active trenches and mobile zones are related to zones of plate convergence, major areas of isostatic uplift to the removal of Pleistocene ice masses.

## TRAILING EDGE COASTS

Trailing edge coasts are plate-imbedded and contrast strongly with collision coasts in degree of tectonic activity. There is some volcanic and earthquake activity along neo-trailing edge coasts but the remaining categories show very low levels of movement. Neo-trailing edge coasts may have more or less precipitous hinterlands with virtually non-existent shelves, but in general the other categories are backed by plateau-like, hilly or low-lying areas and fronted by wide shelves. Major alignments along Afro- and Amero-trailing edge coasts reflect the alignment of zones of spreading and the occurrence of what have been termed transform faults (Wilson, 1965). Important changes in direction along the Atlantic coasts of Africa and South America, for instance, appear to be related to transform faults along the South Atlantic zone of spreading. As pointed out in earlier years by proponents of the continental drift hypothesis, structures dating from Precambrian and Palaeozoic orogenies are truncated, so that the grain of the country is markedly discordant with the coast.

The distinction between Afro- and Amero-trailing edge coasts is fundamental, because of its effect on global patterns of fluvial sedimentation (Mitchell and Reading, 1969). Where the coast on the other side of a continent is a collision coast, the high, tectonically active, rim yields a large sediment load to rivers flowing towards the trailing edge coast: where the opposite coast is itself a trailing edge coast this factor does not operate. Clear examples are the coasts of Africa, where rivers like the Congo and Niger carry relatively small loads, and the eastern coasts of North and South America,