CHAPTER I

INTRODUCTION

Coastal areas are ones of the most continually changing zones of the earth. Many geological processes are involved in the coastal conflict zone between the land and the sea, such as degradation and aggredation. The ever increasing use of coastal environments by man for industrial, residential, recreational and defense purposes has therefore made it necessary to gain a more complete understanding of processes and responses concerned. Major engineering problems have arisen whenever and wherever natural littoral processes have been interupted. The big designs of many coastal-defense structures, however, have not been changed over the last century, regardless of their degree of efficiency. A more academic attitude toward coastal defense has arisen just after the end of the World War II, closely paralleling with the exponential growth of oceanography, sedimentology, and marine geology during the same period.

The importance of investigating the coastal area in terms of concepts of open system and the steady state lies in its usefulness in predicting the changes that will occur. Particular interest is given when man interfere with natural shoreline processes by adding or removing sediment sources through construction of engineering works.

1.1 LOCATION OF THE AREA STUDIED.

The Sattahip Bay is situated on the eastern coast of the Gulf of Thailand near the head of the upper part of the Gulf. The Bay is shoal and encumbered with several reef-fringed islands which lie within and at the entrance extending from 100° 50' to 100° 56' east longitudes and from 12° 36' to 12° 40' north lattitudes. (Fig. 1.1.1)

This study is based on the examinations of part of the coastal area in the vicinity of the Royal Fleet Pier. The area studied extends approximately two kilometers on both sides of the pier (Figs. 1.1.2, 1.1.3) where sandy beaches are the main characteristics of the coastline.

1.2 PURPOSE OF THE STUDY.

The basic objective of this study is to investigate the small coastal area around the Royal Fleet Pier, which has a strategic significance for the naval operation, in great detail. The monitoring system has been set up to record several changes that take place within the area during the span of time between July 1975 and July 1976. The various aspects concerned are as follows.

a) The characteristics and distribution of sediment.

b) Series of topographic changes within the nearshore zone under the influences of sedimentation and erosion.

c) The hydrodynamic regime of the area.

FIGURE 1.1.1. ILLUSTRATING OF THAILAND, SHOWING LOCATION OF THE AREA OF INVESTIGATION.

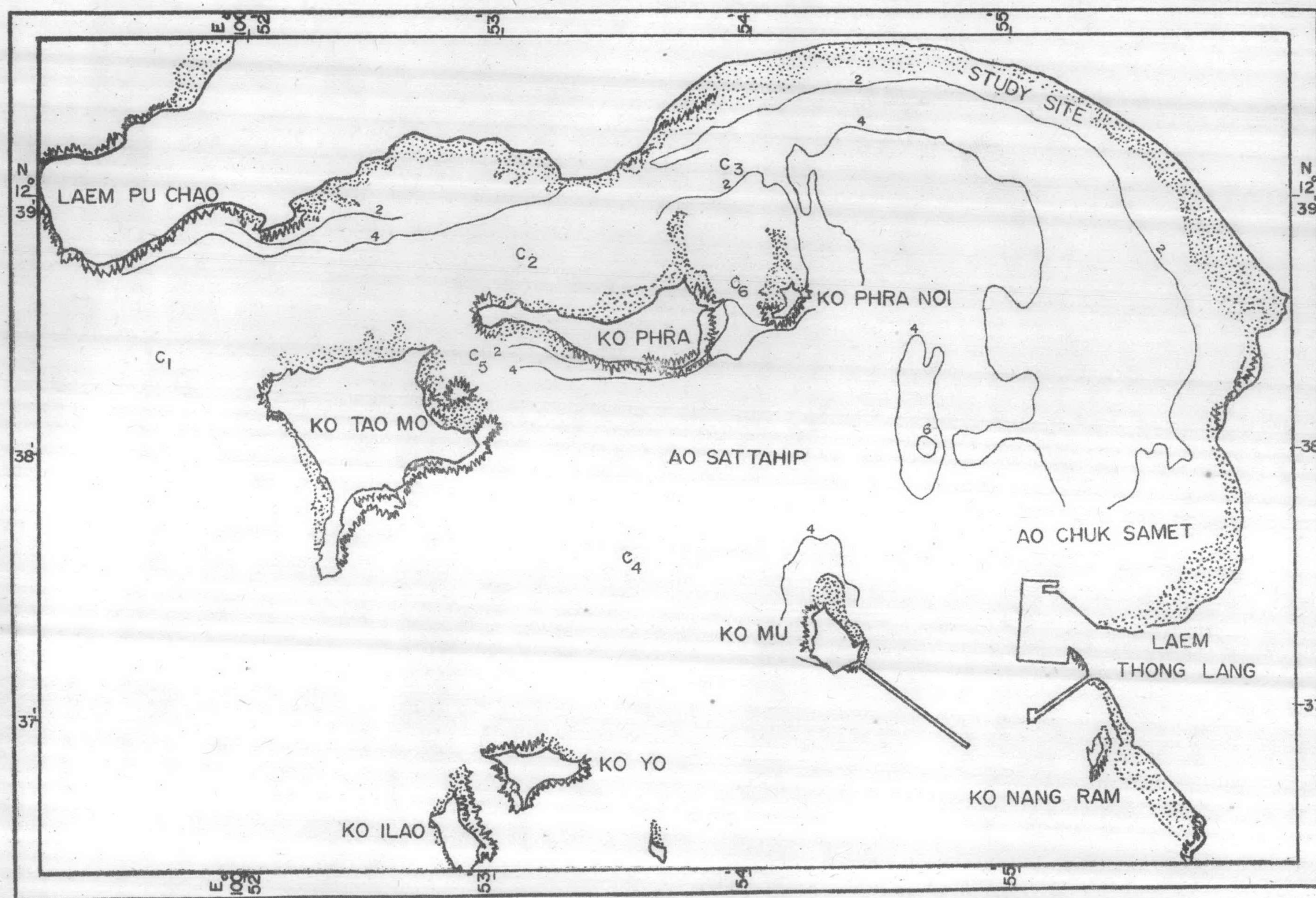


FIGURE I.I.2. MAP OF SATTAHIP BAY SHOWING STUDY SITE, STATIONS OF CURRENT MEASUREMENT, AND CONTOUR DEPTHS OF WATER IN METRES.

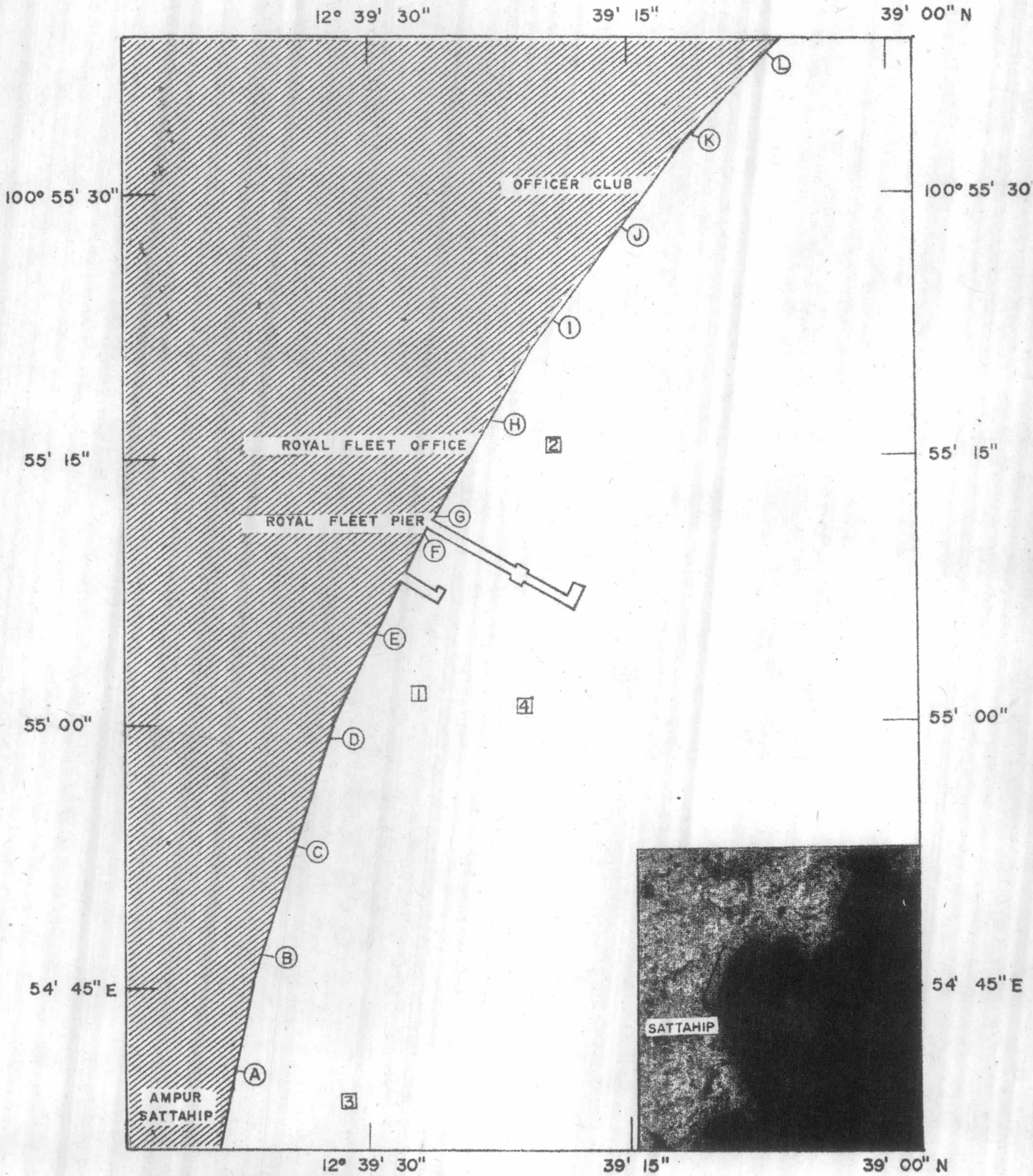


FIGURE 1.1.3. LOCATION MAP SHOWING STUDY SITE AND POSITION OF PROFILES ON SATTAHIP BAY.

d) Seasonal variation in the rates of sedimentation and erosion within the one-year cycle.

It is believed that the present base-line study over the period of one year could be served in the assessment of scientific and military purposes in predicting that what will happen in the hereafter.

1.3 PREVIOUS INVESTIGATIONS.

Despite the fact that numerous investigation on various aspects of the Gulf of Thailand, notably, oceanography, meteorology, marine geology and geophysics, marine biology and fisheries etc. have been considerably carried out, very little on detailed study of the coastal area has been done.

Among a few investigation previously undertaken in the vicinity of Sattahip Bay were the study of tide and sea level fluctuation at Sattahip by Siripong (1976). The most recent work on the sedimentological processes at Sattahip Bay had been carried out jointly by the Hydrographic Department of the Royal Thai Navy and the Asian Institute of Technology (1974, 1976). In addition, the surveys, investigations and studies undertaken by the NEDECO much earlier for the Port Authority of Thailand on the deep-seaport of Laem Chabang area in the upper part of the Gulf of Thailand had in part concerned with Sattahip (1972).

It is against the regional background that the present study on the small part of the coastline of Sattahip Bay is set.

1.4 GENERAL SETTING OF THE AREA.

1.4.1 Geological Setting.

Inferences from geological studies on land by Emery, Raymond and Reynolds (1971) and the stratigraphy including sedimentation in the Gulf of Thailand by Woollands and Haw (1976) suggest that the basin in the Gulf was formed during late Mesozoic-early Tertiary time. The block faulting along north-south and north northeast-south southwest trends was established. The main basinal areas in the centre of the Gulf are the north-south trend of the Pattani Trough and the northwest-southeast trends of the Malay Basin. Westward is a belt of narrow horsts and grabens and eastward is the broad shallow basement area of the Khmer Shelf. The Gulf itself is therefore the intra-cratonic basin type.

The sedimentation in the Gulf have started since then, with interruption by tectonic activity and erosion. The sediments are mainly of Neogene age, Oligocene has been reported but older Tertiary strata are lacking. However, no wells have fully penetrated the entire succession. The sediments are almost entirely continental and paralic whereas marine influences are present at time. The region is now rather stable tectonically.

Sattahip area shows a morphology of gentle sloping hills and mountains, steep slopes and cliffs are rare except when formed by marine, recent abrasion and in the few limestone mountains.

The prominent feature is a large batholith of acid rock, radiometric dating gives an age of Upper-Triassic to Lower-Jurassic. This sequence comprises shales, siltstones, sandstones, and limestones, locally metamorphosed to metaquartzites, slates, marbles and hornfels. Limestones are a subordinate part of this sequence and no fossils have been reported, the limestones occur interbedded with the arenaceous and argillaceous metasediments (Tanaosi Group), (Fig. 1.4.1).

The morphology of the coastline between Chonburi and Sattahip is clearly controlled by the geology or lithology.

The capes coincide exactly with the occurrence of (meta) sediments on the coast and the bays are located there where these rocks are missing.

Emery and Niino (1963), and Emery (1969, 1971), reported that the patterns of sediments exhibiting the presence of widespread modern silts and clays in the Gulf of Thailand, and that the Gulf is a sediment-filled structural basin. The thickness of these sediments in the Gulf may exceed the 3,000 metres shown by the magnetic survey during NAGA Expedition (1959-1961).

The bulk of the sediment about 86 percent is detrital in origin, authigenic and volcanic origin are minor not more than 0.3 percent of the total.

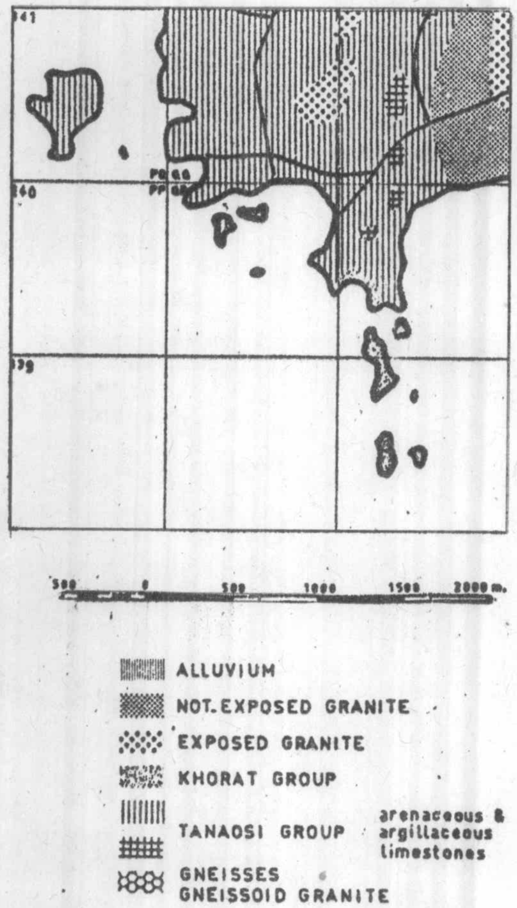


FIGURE 1.4.1. GEOLOGICAL MAP OF CHONBURI-SATTAHIP AREA, AFTER NEDECO (1972).

1.4.2 Climate

The climate of the coast of the Gulf of Thailand is different in the northern part and in the southern part. At Sattahip during 1967-1972 rainy season is from May to October with maximum precipitation of 411.99 mm. in May and mean precipitation of 247.65 mm. , the dry season is the rest of the year with mean precipitation of 24.64 mm. in January and with trace precipitation in April, Appendix F-3.Air temperature is maximum in May with 34.7° C and minimum in January with 17.8° C. Relative humidity show a minimum of 67.8 % in January and a maximum of 78.6 % in October. (Fig. 1.4.2 c).

Winds are mostly less than (0.9 m/sec) 1 Beaufort to more than 21 beaufort with the maximum frequency of wind speed 7-10 beaufort for 9 months and 4-6 beaufort for 2 months (September and October) of the years 1967-1972 (Appendix F-2, Fig. 1.4.2 b).

They blow into the Bay during the summer from the south and the southeast. In October when the northeast monsoon begins, the winds over the bay is from north and northwest. The south winds are more effective to transport sediments into the shore than the north winds (Appendix F-1, Fig. 1.4.2 a).

Winds and swells are strong in Chong Khram (Fig. 1.1.2) and the port area during the Southwest Monsoon season, during the Northeast Monsoon season about mid-September to October beginning,

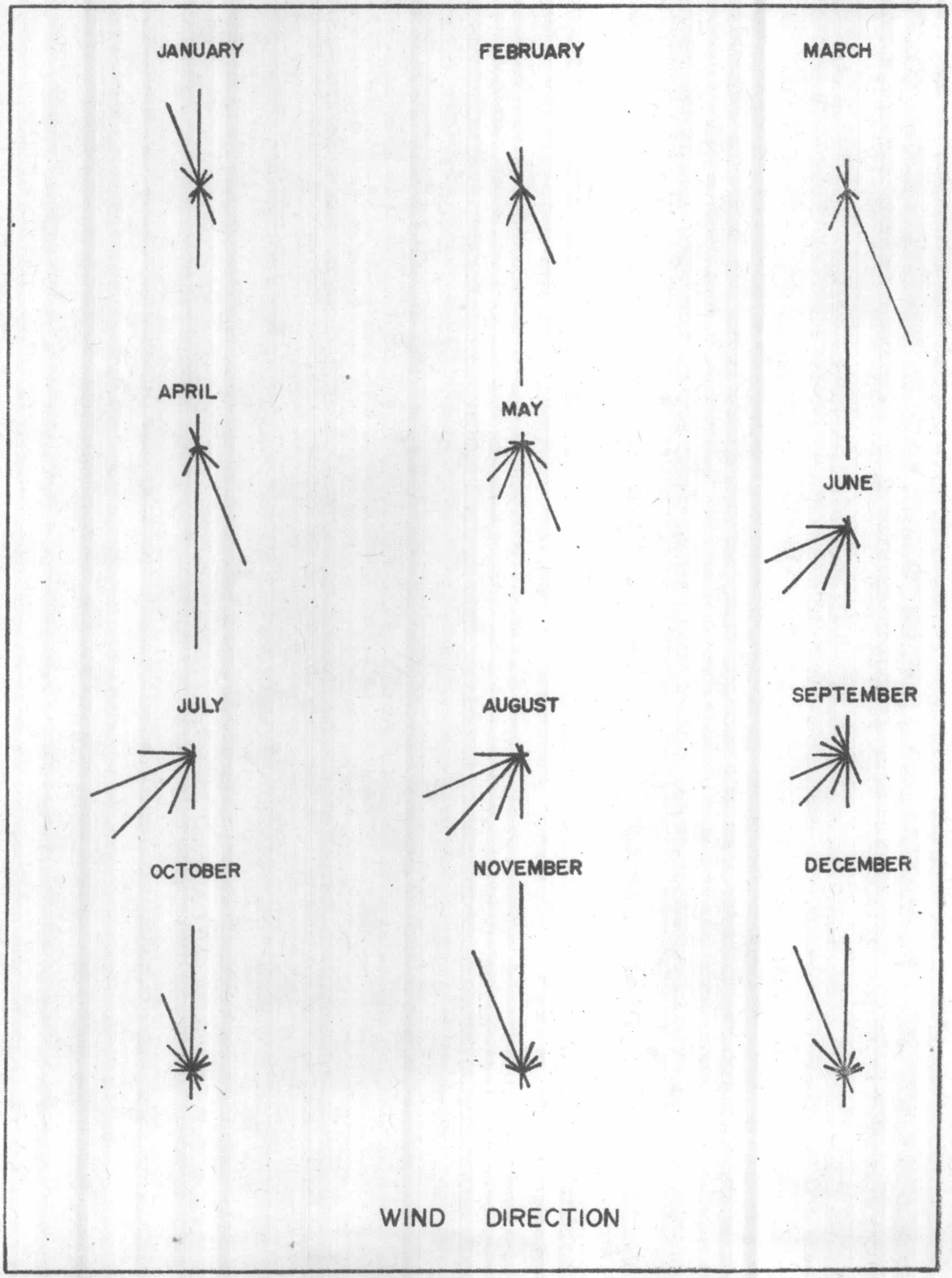


FIGURE I.4.2 a. PERCENTAGE FREQUENCY OF WIND DIRECTIONS, DATA COLLECTED AT U-TAPAO BETWEEN 1967 AND 1972.

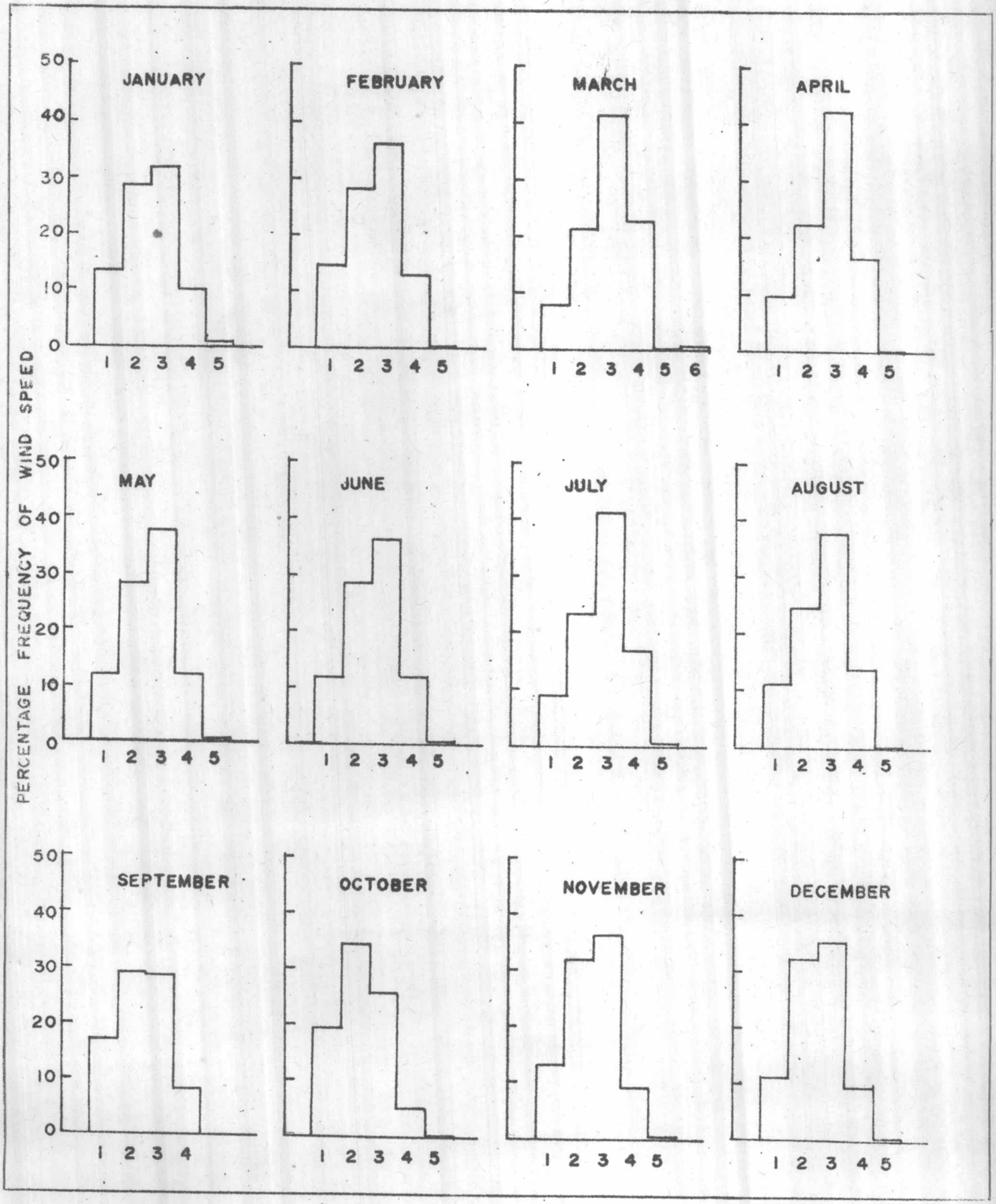


FIGURE I.4.2 b. PERCENTAGE FREQUENCY OF WIND SPEEDS IN BEAUFORT SCALE, AT U-TAPAO (1967 - 1972).

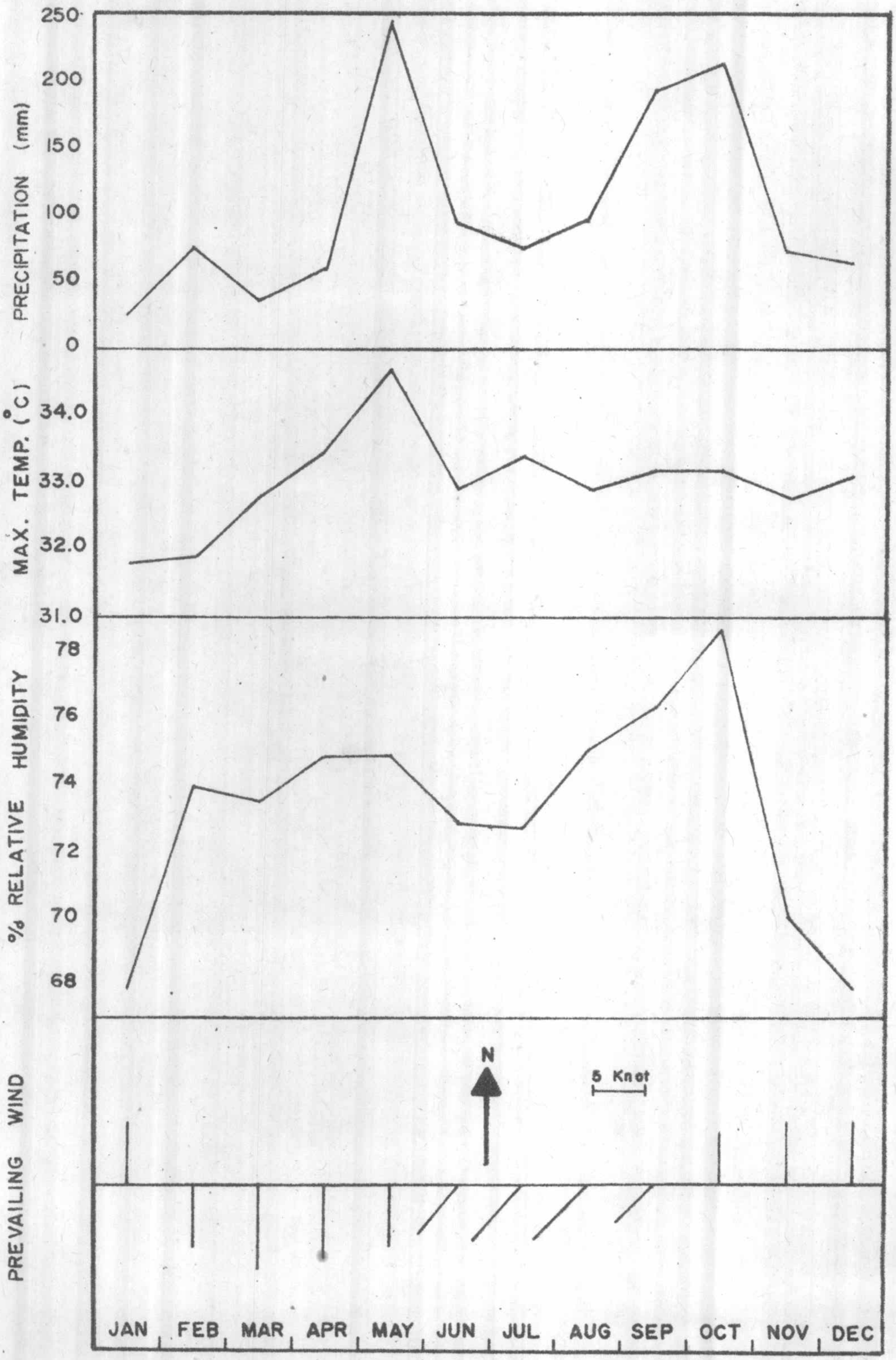


FIGURE 1.4.2 c. MONTHLY MEAN VALUES OF PRECIPITATION, AIR TEMPERATURE, % RELATIVE HUMIDITY, WIND SPEED AND DIRECTION (1967-1972).

reasonable shelter from winds and swells are afforded in this area.

1.4.3 Marine Conditions.

Results of the NAGA expedition 1959-1960 in the South China Sea and the Gulf of Thailand indicate that the Gulf of Thailand may be characterized as a classical two-layered, shallow water of low salinity which has been diluted by heavy precipitation and fresh-water runoff flows out at surface and the inflow of high salinity and relatively cool water from the South China Sea into the Gulf over the 67 metres sill in the entrance channel. The interplay of forces due to the variable winds, tidal currents, fresh water runoff and excessive precipitation gives rise to localized areas of divergence where low temperature, high salinity water is upwelled. These forces also establish area of convergence where high temperature, low salinity water sinks. The upwelling occur along the east side of the Gulf during winter and along the west side during the summer.

Upwelling may have begun in the west. The upwelled water of 33 ‰ reached the surface in the region south of Cape Liant (Sattahip) and must have been transported into the shallow water of the Bight by the strong southwest and south winds against the outflowing fresh water in August 2-14, 1960. (Robinson, 1974).

1.4.4 Tides and Currents.

Currents in the Gulf of Thailand are a complex mixture of tidal, wind-driven and density currents. The tide in the Gulf of

Thailand vary from diurnal to semi-diurnal with inequalities-to-mix diurnal and semi-diurnal type. In addition seiches have been observed with periods of approximately 40 minutes (Pukasab and Pochanasomburana, 1957) (Robinson, 1974).

Siripong (1976), The sea level fluctuation in Sattahip Bay, normally were due to the astronomical tide and partly due to the prevailing wind and by abnormally by the wind stress. The astronomical tide is the mixed tide prevailing diurnal (K_1+O_1/M_2+S_2 is 2.670).

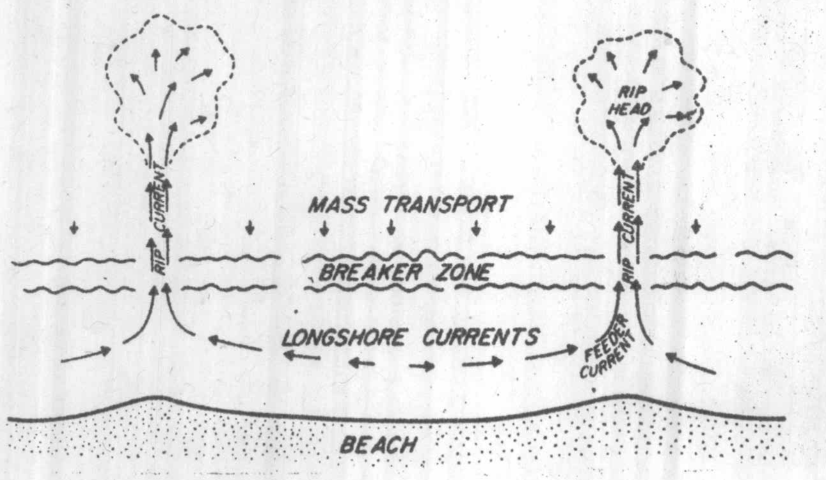
The mean sea level average over 11 months is 24.023 dms with the highest value in September and the lowest value in June.

The nearshore circulation of water in the nearshore zone are generated by the wave action. There are two wave-induced current systems which dominate the water movements in addition to-and-fro motions produced by the waves directly. These are :

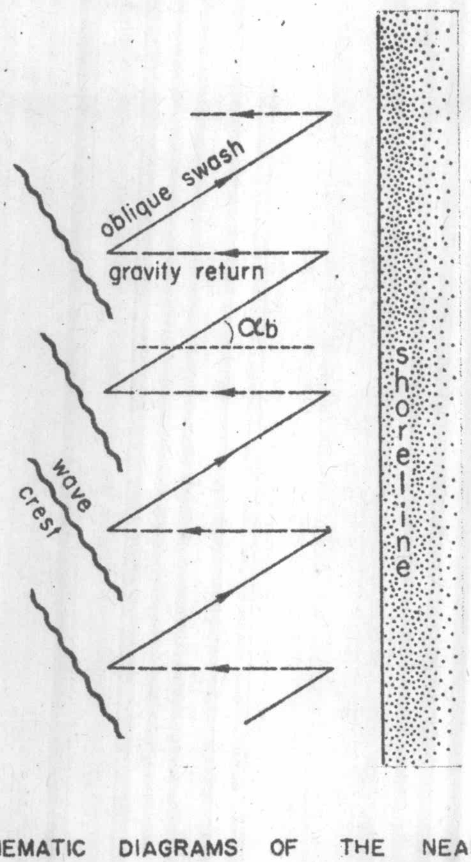
(a) a cell circulation system of rip currents and associated longshore current.

(b) longshore currents produced by an oblique wave approach to the shoreline that flow parallel to the beach inside of the breaker zone (Inman, 1971).

The cell circulation is shown in Fig.1.4.3. The most apparent feature of this circulation is the rip currents : strong, narrow currents that flow seaward from the surf zone. The seaward motion in the rip currents extends beyond the breaker zone for a distance



A (AFTER SHEPARD AND INMAN, 1950)



B
(AFTER KOMAR, 1971)

FIGURE 1.4.3. SCHEMATIC DIAGRAMS OF THE NEARSHORE CELL CIRCULATION SYSTEM A, THE ZIGZAG MOTION OF THE SEDIMENT ALONG A STEEP BEACH FACE UNDER THE WAVE SWASH B.

about equal to the width of the surf zone. The position of rip currents along a beach and the spacing between rip currents have significant implications in recreational planning and beach maintenance. Bowen and Inman (1969) suggested that a seaward-flowing rip current would tend to erode a channel for itself. Inman, Tait and Nordstrom (1971) presented models for the flushing of the nearshore pollutant such as mud or sewage by the rip currents. The circulation cells with rip currents exist on long straight beaches with regular bottom topography (Shepard and Inman, 1969, Inman and Jeffrey, 1965). Rip currents are fed by a system of longshore currents which increase in velocity from zero about midway between two adjacont rips, reaching a maximum just before turning seaward into the rips.

The velocity of the longshore current decreases quickly to zero outside the breaker zone and it is responsible for the net transport of sand or other beach material along the shore, Komar & Inman, 1970 and Iwata, 1970, suggested that the longshore transport of sediment has been related convincingly to wave activity. The larger the waves, the more the sediment will tend to stay in suspension and the longshore current no matter how weak, is competent to carries the sediment load in their directions.

Bowen (1969 a) and Bowen and Inman (1969) have demonstrated both theoretically and experimentally that variation in the wave set-up the rise in the mean water level above the still-water level due to the presence of waves produce the rip currents.

If sediment is being carried landward during the same period of the rip transport in zone between rips, the longshore currents may be of sufficient strength, so that this material is kept from being washed up onto the beach and is carried parallel to the shore until it encounters a rip, whereupon it is tramsported seaward.

In addition to longshore currents being generated by an oblique wave approach Fox and Davis (1973), working on Lake Michigan, the longshore current related directly to the barometric pressure time variation which generated the winds. The direct wind stress on the water within the surf zone can have a profound effect on the longshore currents (Harrison and Krumbein, 1964, and Sonu, Mc Cloy and Mc Arthur, 1967).

1.5 BEACH NOMENCLATURE.

The beach after Komar (1976), is an accumulation of unconsolidated sediment extending shoreward from the mean low-tide line to some physiographic change. But under this definition does not include any portion that is permanently underwater. The term "littoral" is used to denote this entire environment extending across the beach and into the water to a depth at which the sediment is less actively transported by surface waves. The term "nearshore zone" is particularly useful when discussing waves and currents within this enrironment and extends seaward from the shoreline to just beyond the region in which the waves break.

The terminology used to describe the beach profile are illustrated in Figs.1.5 a and b.

Backshore : The zone of the beach profile extending landward from the sloping foreshore to the point of development of vegetation or change in physiography (sea cliff, dune field, and so on).

Beach face : The sloping section of the beach profile below the berm which is normally exposed to the action of the wave swash.

Berm : A nearly horizontal portion of the beach or backshore formed by the deposition of sediment by the receding waves. Some beaches have more than one berm, while others have none.

Berm crest (berm edge) : The seaward limit of a berm.

Beach scarp : An almost vertical notched into the beach profile by wave erosion. Its height is commonly less than a meter, although higher example are found.

Breaker zone : The portion of the nearshore region in which the waves arriving from offshore reach instability and break. On a wide, flat beach secondary breaker zones may occur in which reformed waves break for a second time.

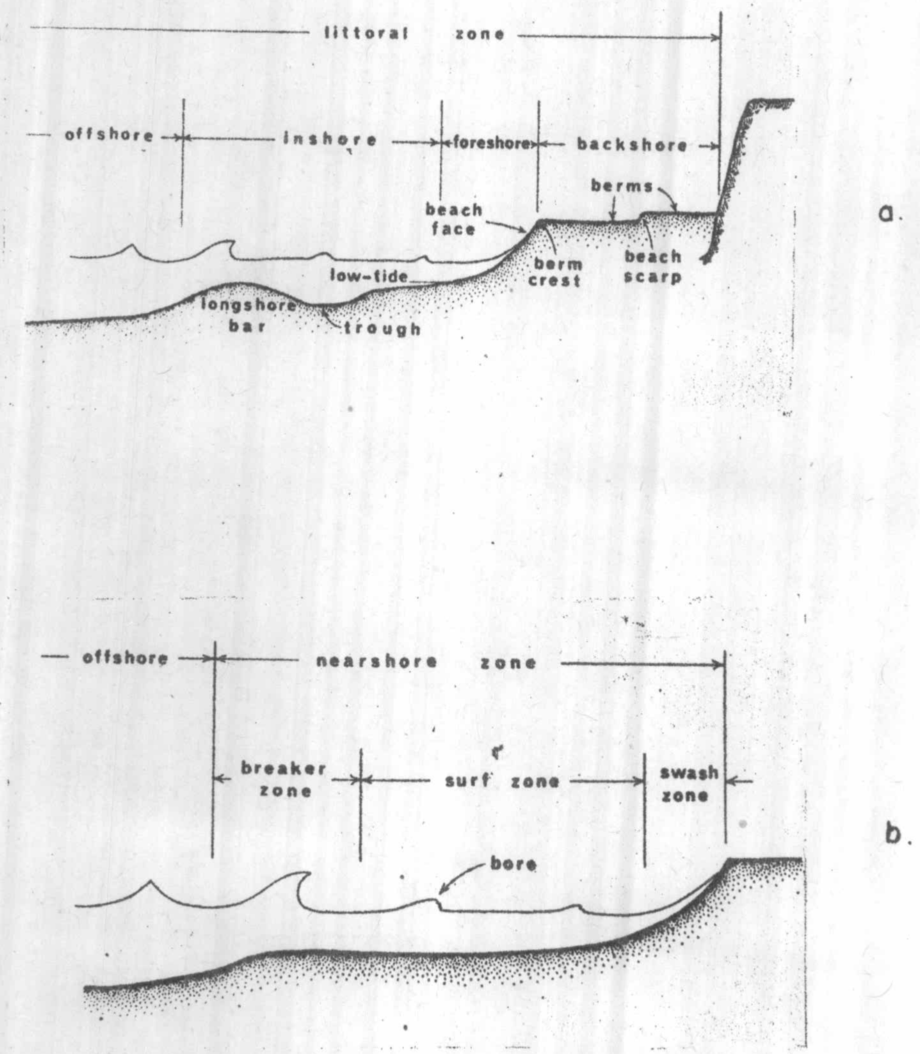


FIGURE 1.5. THE TERMINOLOGY USED TO DESCRIBE THE BEACH PROFILE a, THE WAVE ACTION AND CURRENTS IN THE NEARSHORE REGION b, (AFTER KOMAR, 1976).

<u>Foreshore</u> : The sloping portion of the beach profile lying between a berm crest or the upper limit of wave swash at high tide and the low-water mark of the backrush of the wave swash at low tide.

<u>Inshore</u> : The zone of the beach profile extending seaward from the foreshore to just beyond the breaker zone.

<u>Offshore</u> : The comparatively flat portion of the beach profile extending seaward from beyond the breaker zone (the inshore) to the edge of the continental shelf.

<u>Longshore bar</u> : A ridge of sand running roughly parallel to the shoreline. It may become exposed at low tide. At times there may be a series of such ridges parallel to one another but at different water depths Shepard (1952). Longshore bars are very common adjacent to straight beaches.

<u>Longshore trough</u> : An elongated depression extending parallel to the shoreline and any longshore bars that are present. There may be a series at different water depths.

<u>Surf zone</u> : The portion of the nearshore region in which borelike translation waves occur following wave breaking. This portion extends from the inner breakers shoreward to the swash zone.

<u>Swash zone</u> : The portion of the nearshore region in which the beach face is alternately covered by the uprush of the wave swash and exposed by the backrush.