CHAPTER II

THE STUDY AREA

This chapter describes the study area, aiming to present the overall environmental setting of Changwat Prachuap Khiri Khan. The descriptions will be general topography, regional geology, bathymetry, climate, coastal sediment and coastal processes respectively.

2.1 General topography

Changwat Prachuap Khiri Khan is the province in the western region of Thailand. It is on the upper peninsula that lies in the west of the Gulf of Thailand, bounded by latitude 10^0 57' to 12^0 39' north and longitude 99^0 8' to 100^0 04' east with and area approximately 6357.62 km^2. The elevation ranges from 0 – 10 m above the present mean sea level. The long mountain range N – S direction limited the western boundary. To the east of the mountain range, colluvial and alluvial plain are dominant with some isolated hills. Beaches in the eastern part of the province are normally straight and long. However, there also exits some tidal flats near the river mounts. The study area has 3 rivers flowing eastwards to the sea supplying the terrestrial sediments. There are also a few semi – enclosed bays in the area of which the almost rounded one is Prachuap Khiri Khan bay.

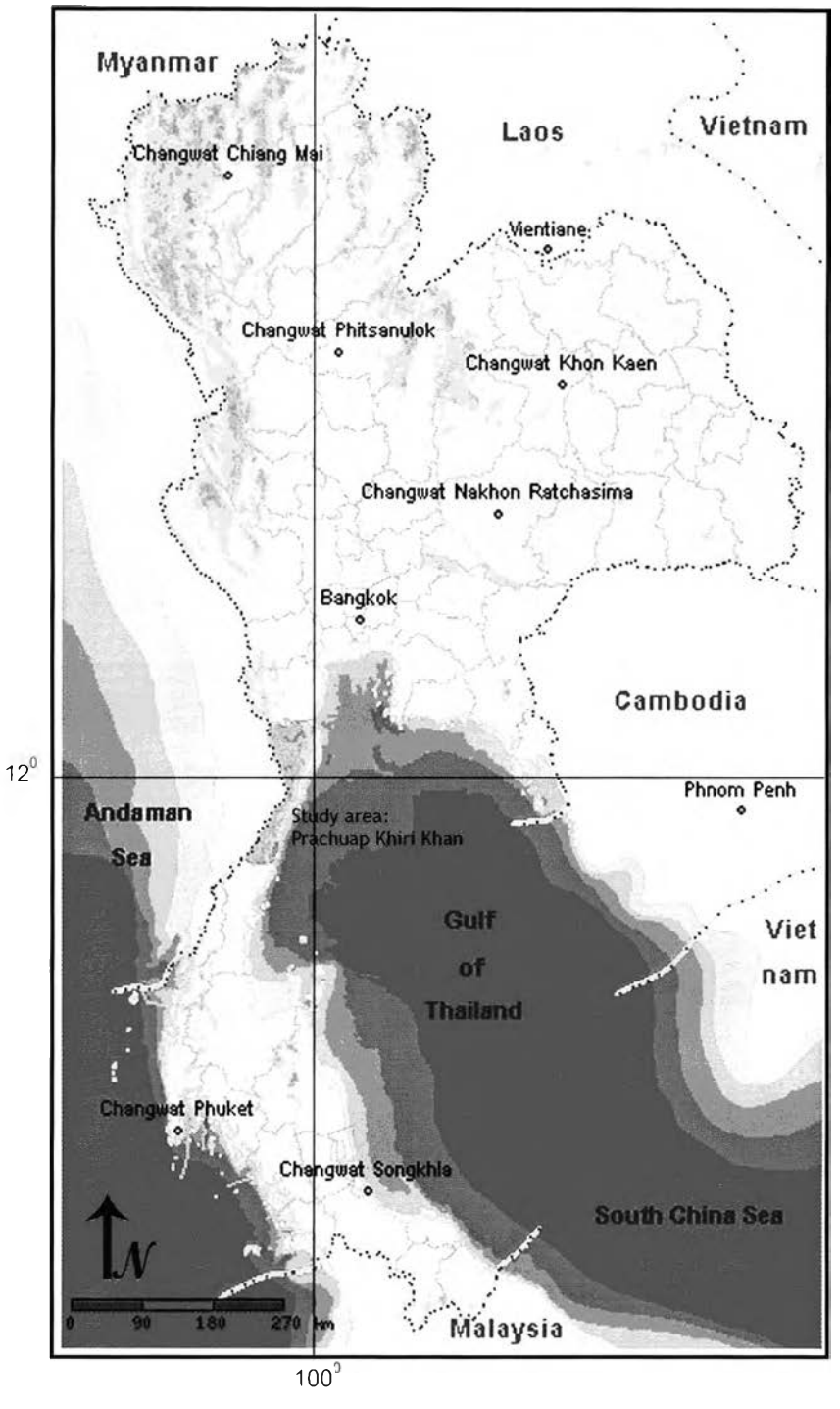

Figure 2.1 Map showing the location of Changwat Prachuap Khiri Khan (Thinknet, 2006).

2.2 The study area

The details of study areas are divided into 3 segments, as below.

1. Pranburi truncated barrier area
2. Prachuap Khiri Khan bay area.
3. Wanakorn beach area.

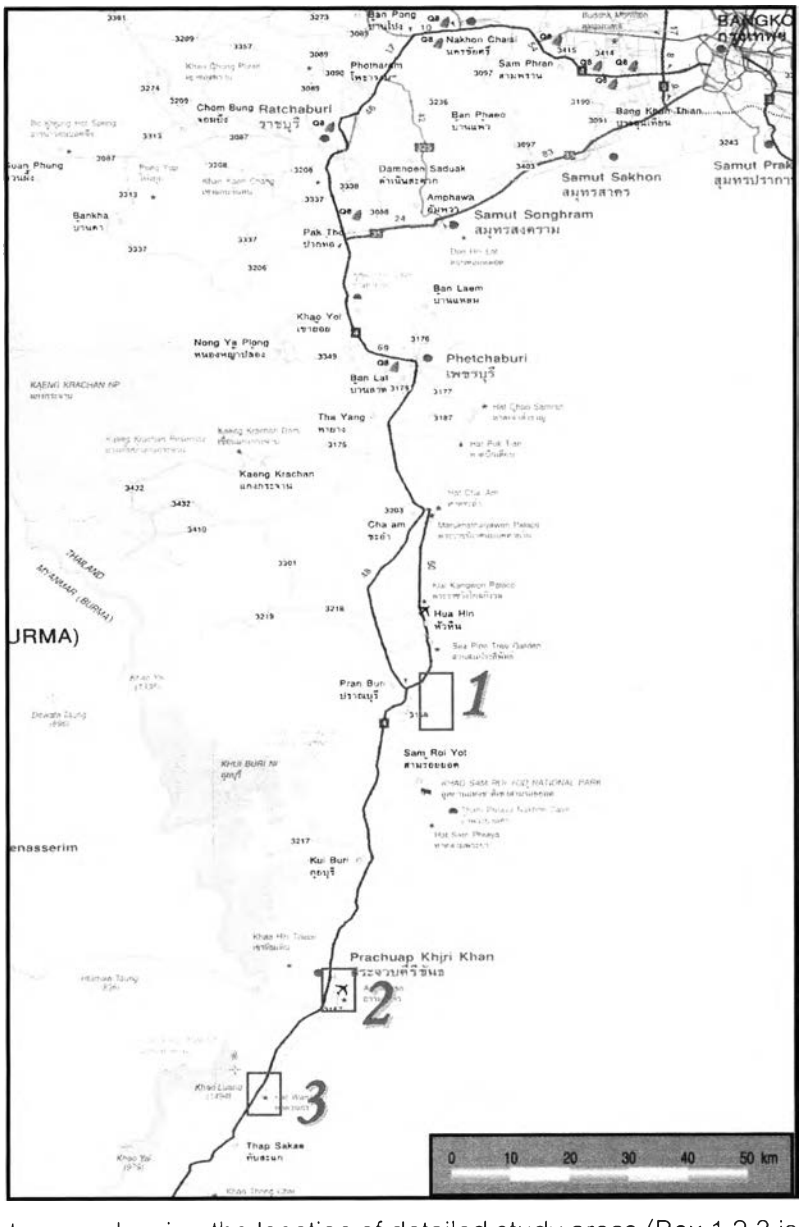

Figure 2.2 Route map showing the location of detailed study areas (Box 1,2,3 is Pranburi, Prachuap Khiri Khan and Wanakorn area respectively) (Highway map, 2002).

2.2.1 Pranburi truncated barrier area.

Pranburi area is dominated by truncated beach ridges plain, small sand spit developing in the north, at least 3 major erosional events detected from air-photos probably occurred in Holocene. Sea wall was constructed but erosion seems to occur, especially during storm season.

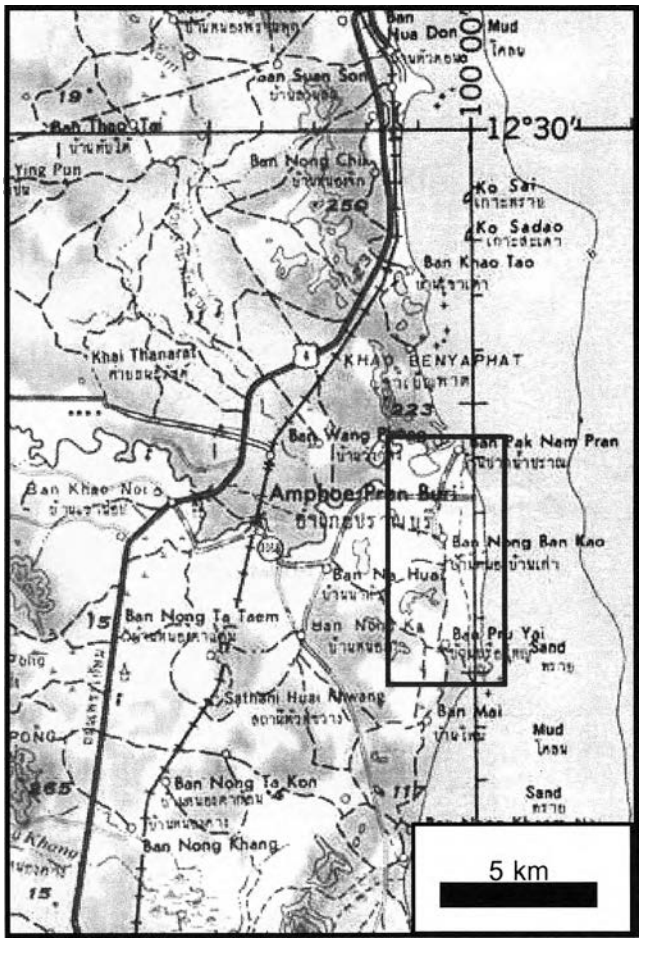

Figure 2.3 Topographic map showing the location of Pranburi truncate barrier study area (in the Box) (Map sheet ND 47 – 15 Royal Thai Survey, 1973).

2.2.2 Prachuap Khiri Khan bay area

Prachuap Khiri Khan area is dominated by semi-enclosed bay with tombolo connected the former islands both in the north and south. One major tidal channel is in the middle part of the bay supplying terrestrial sediment to the coast.

The over – riding control on sedimentation in this coastal sector is the size and location of the limestone pinnacles that form the prominent headlands and offshore islands. These modify wave refraction and littoral sediment movements that, in turn, are responsible for the pattern of barrier sand accumulation. The present sandy shoreline is deeply embayed between headlands creating closed sediment compartments; no littoral sediment by – passes the area which is a major obstacle to alongshore sand transport.

Of the three active fans in the hinterland, only northern one has relatively large catchments. Almost certainly, the fans are the sole source of sand for the barriers which, because of reduced wave energy in the bays, are subdued features composed (in the case of the Holocene deposits) of fine sand. The Holocene system is made up of prograded beach ridges that show a number of primary and secondary features: they form a prograded cuspate foreland / tombolo in the lee of Khao Lom Muak headland and there has been considerable modification by fluvial erosion of the barrier surface where the river enters the sea on the northern side of the town (Figure 2.4).

Some distance inland from the coast is a 1,200 m wide Pleistocene barrier system intersected by a number of flood channel – ways; its distribution is somewhat uncertain in the area immediately south of town. The alignment of the old barrier deposits suggests that beach sedimentation at this time was less influenced by the offshore islands than has been the case during the Holocene.

In contrast to the clear evidence of coastal progradation in the Prachuap Khiri Khan embayment, the coast to the north is eroding. In the southern – most part of this long embayment, a small receded barrier onlaps modern flood plain / estuarine deposits; a short distance to the north, old fan deposits are presently undergoing erosion at the rear of the beach. Towards the centre of the embayment, coastal recession is so severe that in has threatened a railway line which, according to local reports, has been relocated further inland. Heavy mineral concentrates are presently being mined from the beach face where the receded barrier is in contact with the fan deposits. Probably the eroding fan is the source of the heavy minerals in the beach although this needs to be tested by comparing their mineralogies (Roy, 1989).

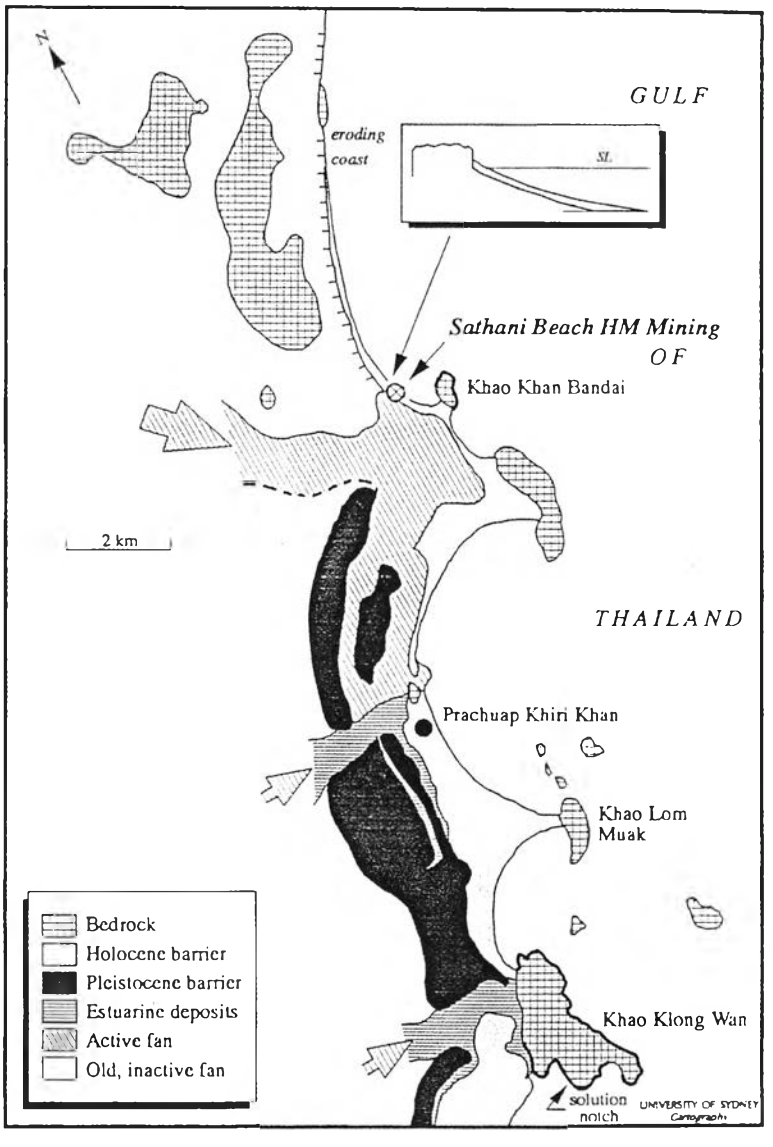

Figure 2.4 Coastal geology of Prachuap Khiri Khan embayments (Roy, 1989).

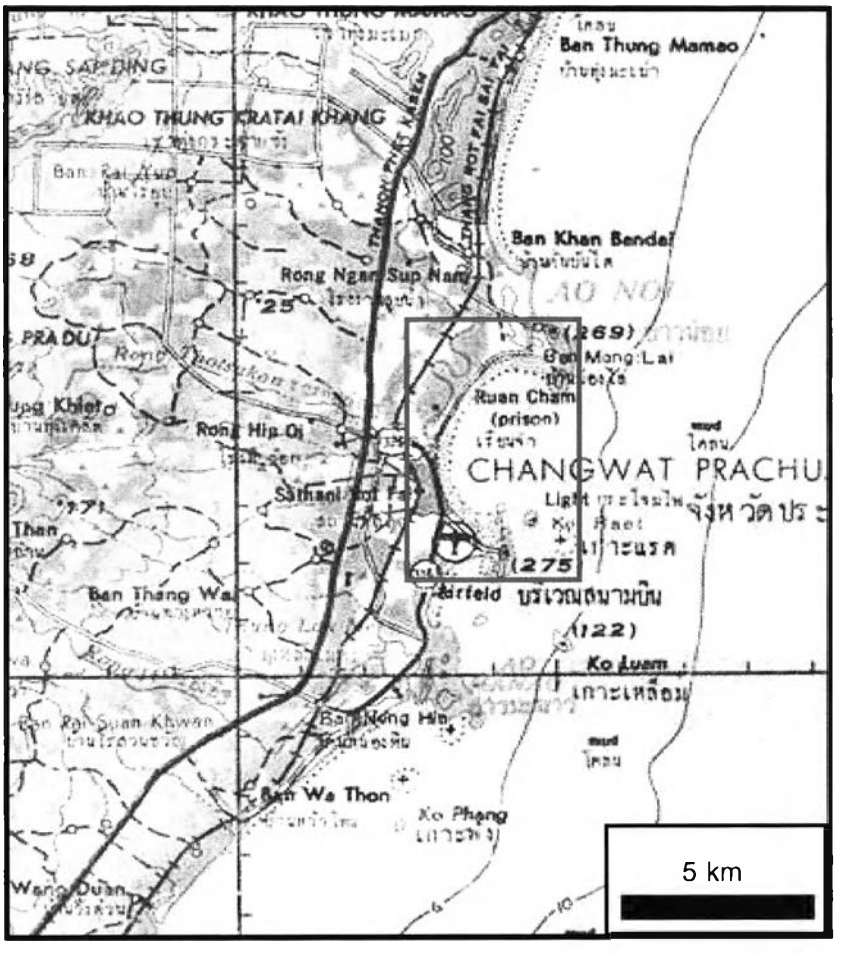

Figure 2.5 Topographic map showing the location of Prachuap Khiri Khan area (in the Box) (Map sheet NC 47 – 3 Royal Thai Survey, 1973).

2.2.3 Wanakorn beach area.

Wanakorn area is the straight beach ridges plain located in the south of Prachuap Khiri Khan Bay. Depositional styles of beach ridges indicate main longshore current moving to the north. Granite washed and headlands are the major source of beach sediments in this area.

A dual barrier system extends southwards for a distance of 7 km from the Khao Klong Wan headland and terminates in an eroding sector of coast. The Holocene barrier widens towards the north, its inner part might be of Pleistocene age. In contrast, the old barrier shows no alongshore variation in width.

Because this coastal sector is protected by the headland, net littoral drift is northwards under the influence of southeasterly waves. Small groynes have been built on the beach face in an attempt to stop sand entering the Klong Wan estuary mouth which is located hard up against the limestone headland.

Limestone cliffs in this area have well developed solution notches approximately at present sea level. Notches are horizontal weathering zones cut slowly into limestone rocks by chemical processes related to the sea and its tidal fluctuations. There is no sign of a higher – level notch that could be related to a higher than present sea level during the last interglacial maximum. Possibly, the notch here is a composite feature formed during more than one interglacial high – stand of the sea. The implication is that the ground surface has subsided very slightly in the last 100,000 years ago (Roy, 1989).

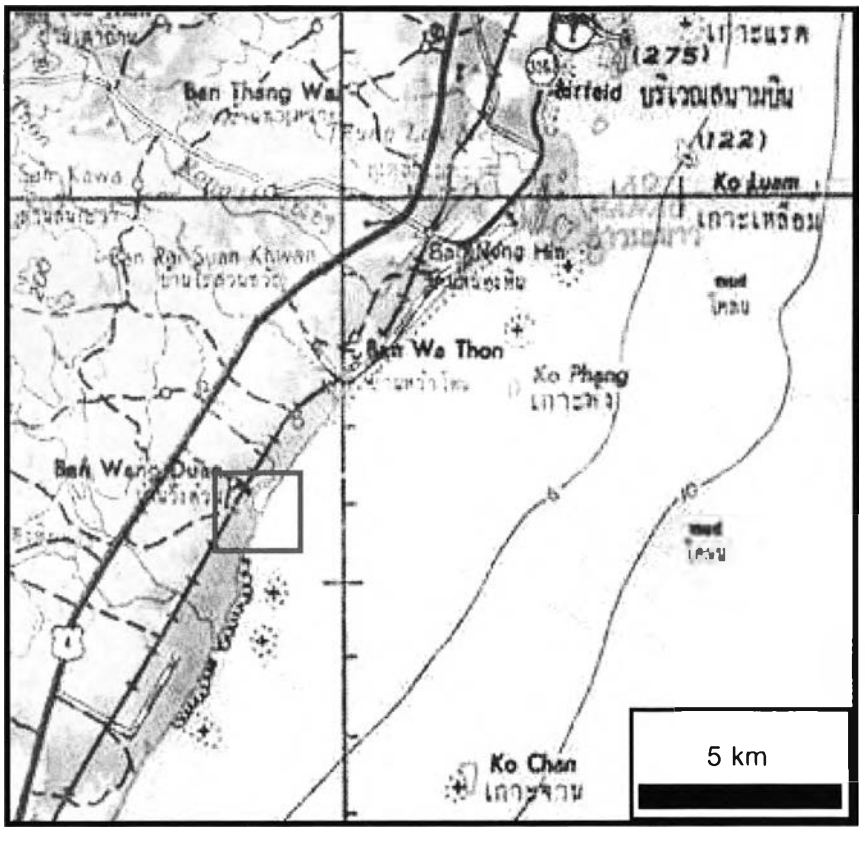

Figure 2.6 Topographic map showing the location of Wanakorn area (in the Box) (Map sheet NC 47 – 3 Royal Thai Survey, 1973).

2.3 Regional geology

The regional geology and geomorphology of Changwat Prachuap Khiri Khan are provided in this section. The description of geology and geomorphology in this section is combined from a result of the interpretation of remote sensing data and previous geological data done by the Geological Survey Division, DMR (Figure 2.8 and 2.9).

Generally, the rocky headlands in the study area are Permian limestone, which constitutes more than half of the mountains in the area. The limestone shows karst topography, monad nock in lowland areas and isolated rock headlands and islands along the coastline.

Cambrian-Ordovician rocks represent the oldest unit in the area. Rocks are composed of massive thick bed quartzite and mica-schist. Quartzite shows foliation of mica, and is characterized by yellowish brown with abundant fractures and some spots of mica group mineral as biotite and muscovite and rare feldspar.

Ordovician limestone is exposed at Khao Kalok in the north of Sam Roi Yod National Park. Ordovician limestone is characterized by dark gray color with recrystallised calcite, dolomite and sometimes grades into marble, and is grouped as Khao Kalok Formation.

Silurian – Devonian rocks are composed of brown to yellowish brown quartzite and gray siltstone. They appear as isolated hills in the north of the Sam Roi Yod National Park as rocky headlands with strong weathering. Siltstone is somewhat metamorphosed. The shows generally northeast bedding and are grouped as Khao Sa Woe Rat Formation (DMR, 1976).

Carboniferous rocks are pebbly sandstone. Pebbles are mainly quartz, quartzite, and feldspar with minor occurrences of granite, slate, sandstone and limestone. These

rocks appear at Sam Roi Yod National Park. This unit is named as Khao Phra Formation in Kaeng Krachan Group (DMR, 1976).

Carboniferous – Permian metamorphic rocks are also recorded in the area. They contain thick – bedded chert alternating with tuffaceous mudstone, pyrite – bearing shale, and quartzite

Permian limestone covers about 60 percent of rock exposures on the study area. Permian limestone is described as gray to bluish gray, massive, bedded and fossiliferous indicating a reef palaeo – environment (DMR, 1976). It is interbedded with light brown feldspathic sandstone and calcareous sandstone. Karst tography with sinkholes is dominant. Notches and caves are remarkable features appearing at the base of limestone cliffs and can be found extensively alone the limestone headland. A high relief limestone mountain area from the Sam Roi Yod National Park thought to have been influenced by uplifting of a major north – south fault (DMR, 1976). The majority of fault and joint systems are in the northeast – southwest direction. The limestone range shows characteristics of a monocline trending northeast.

Granites are the most common intrusive rocks found in study area. They are Cretaceous in age (DMR, 1976), mainly porphyritic granite, biotite – hornblende muscovite granite and fine – grained tourmaline granite. They are predominantly found along the western part in central to southern of the area.

Quaternary sediments from the coastal plains of the area include terrestrial and transitional deposits. Terrestrial deposits contain alluvium, floodplain and colluvium. Abundant alluvium transports via valleys and small channels from highland areas of the Gulf (Choowong, 1996).

Transitional deposits include brackish, marine and beach sand sediments. Mangroves are good indicator of brackish environment and occupy more than fifty percent of the coastal plain. Estuarine sediments contain peat and sand lenses and some shell fragments. Beach ridges are well preserved along the coastal plains.

Figure 2.7 Granite washed that show in Wanakorn beach area.

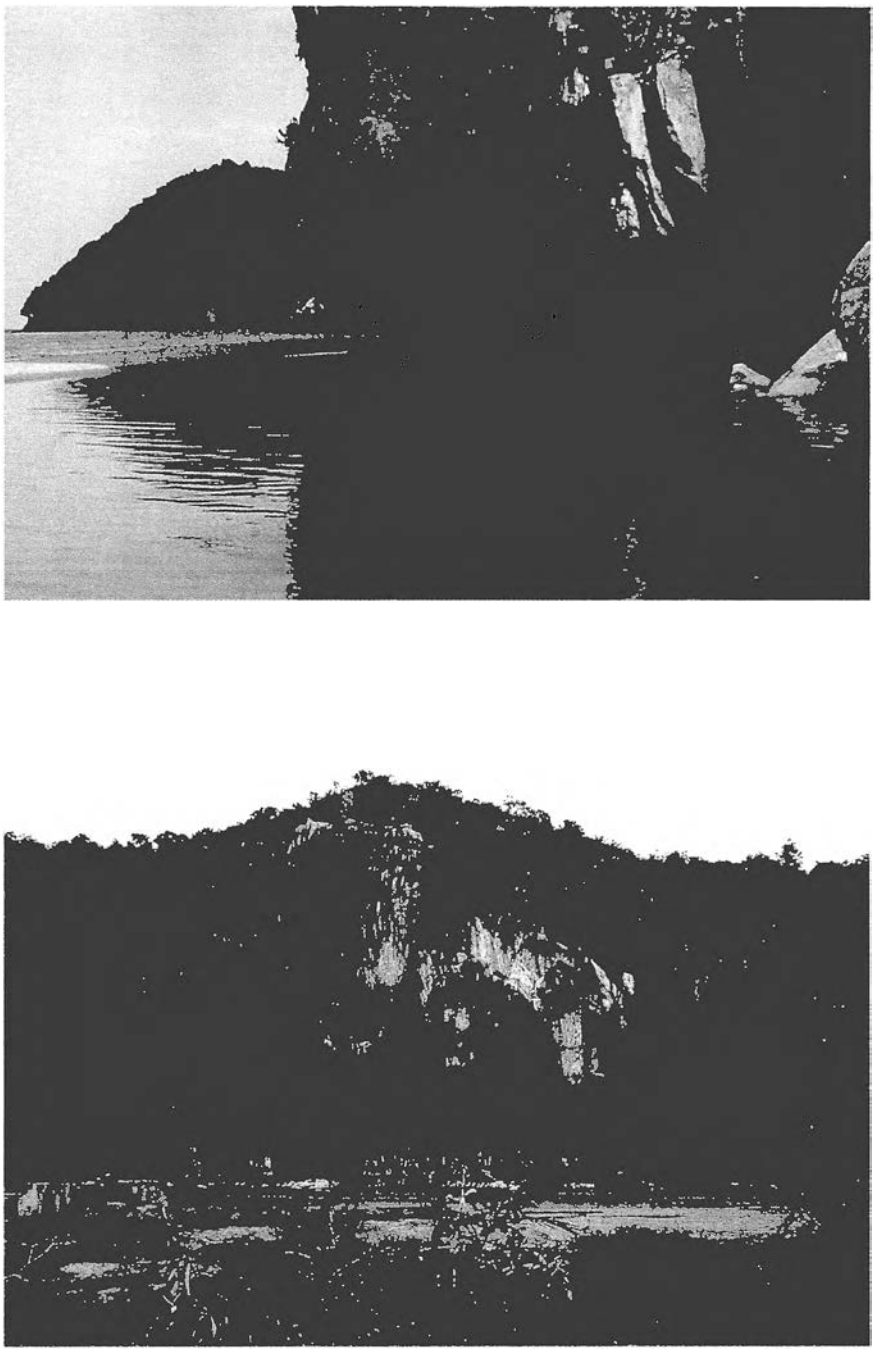

Figure 2.8 Limestone and karsts topography in the study area.

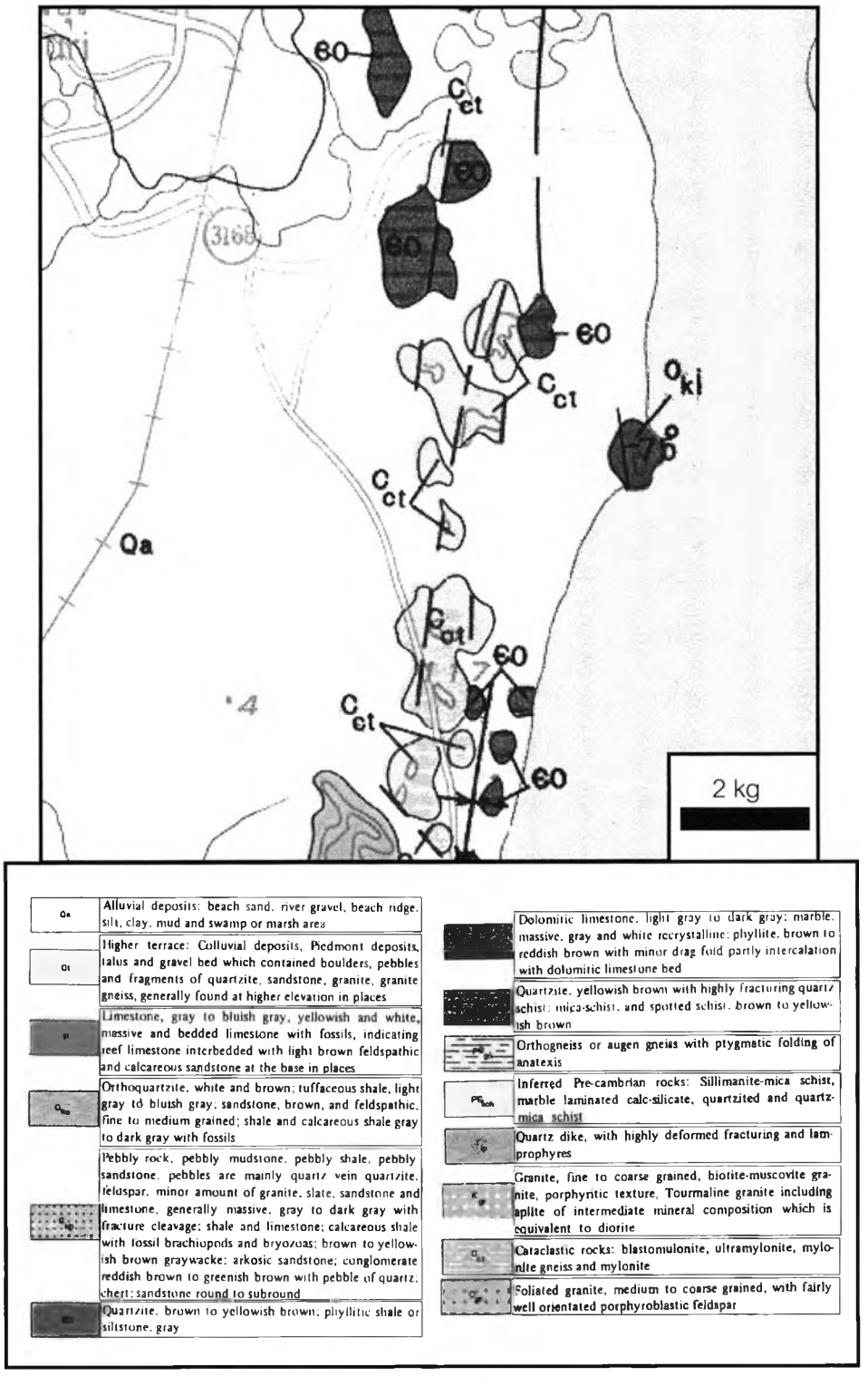

Figure 2.9 Part of geological map of Amphoe Hua Hin sheet ND 47-15 showing geology of Pranbury truncated barrier area(DMR, 1976).

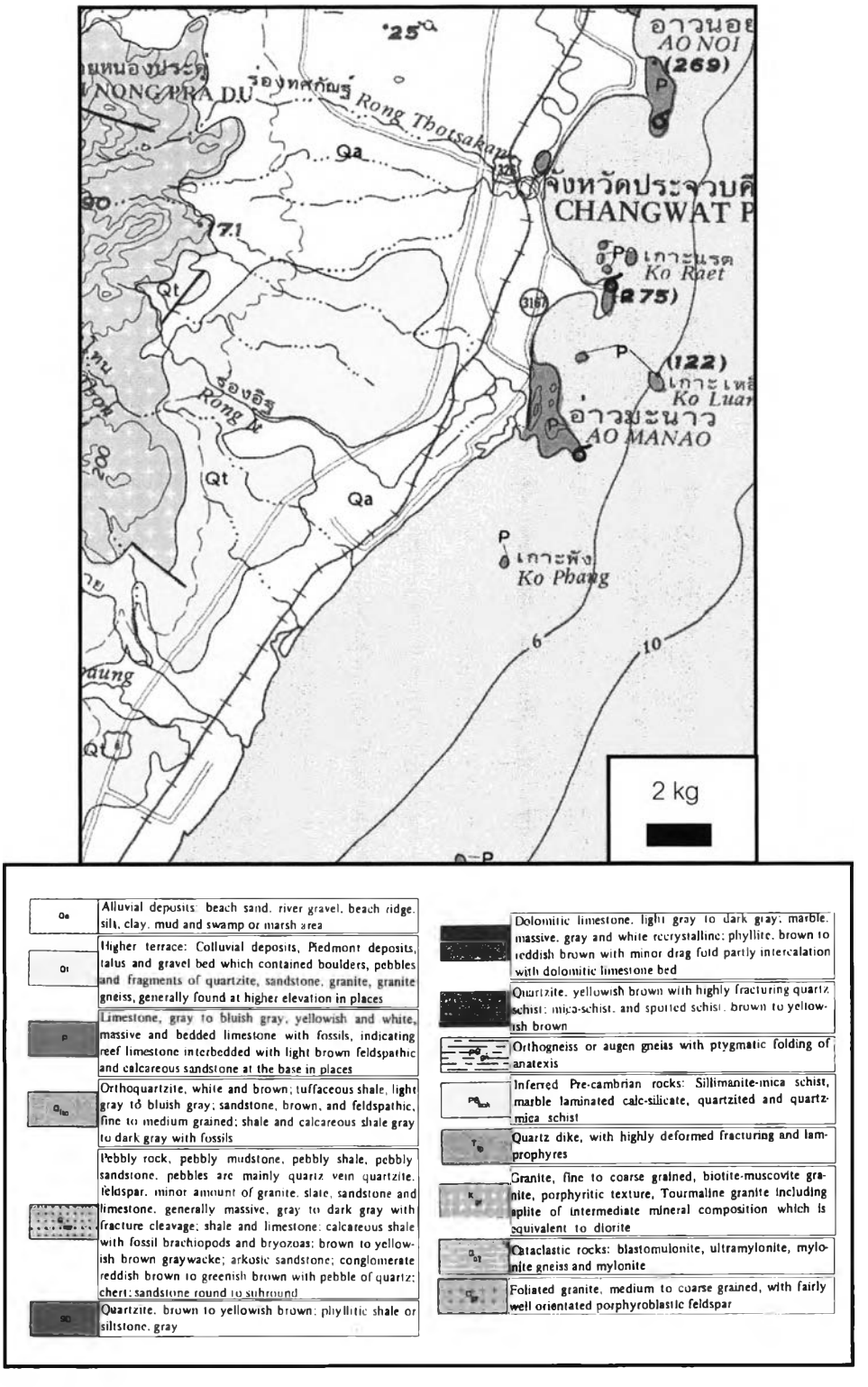

Figure 2.10 Part of geological map of Changwat Prachuap Khiri Khan sheet NC 47-3 showing geology of Prachuap Khiri Khan Bay and Wanakorn beach area (DMR, 1976).

2.4 Bathymetry

The bathymetry will be mentioned in main scale of the Gulf of Thailand. The continental shelf of the Gulf of Thailand and the South China Sea is thought to have emerged during the late Quaternary sea – level changes. Old barriers at depth 20 – 25 m offshore in the Gulf of Thailand are among evidence of the emergence of the Gulf (eg. Kohpina et al., 1983; Kengkoom, 1992). Barriers at a similar depth have also been investigated on the Sunda shelf and near peninsula Malaysia (Tjia, 1987). Due to the shallow bathymetry of the Gulf of Thailand (maximum depth less than 85 m), changes in sea level during the late Quaternary have had a dramatic effect on the size of the Gulf's water mass and this in turn affects wave generation, current movements and rainfall pattern (Roy, 1989).

Little was known about bathymetry of the Gulf of Thailand until the Thai DMR launched a project on offshore mineral exploration in 1986. Achalabhuti (1980) described Quaternary sediments encountered in pipeline drilling in the Gulf of Thailand as being very fine grained with scattered lignite beds indicating that a low energy freshwater swampy environment existed at times of lowered sea level. Seismic stratigraphy done from the south of Sam Roi Yod National Park by Offshore Mineral Exploration of the Thai DMR revealed that there is a mud blanket with maximum 12 m overlain alluvium substrate. The gently sloping sea bed from Prachuap Khiri Khan is underlain by a mud blanket, lens – shaped in cross section and up to 22 m thick (Roy, 1989). In the northeastern coastal region, seismic stratigraphy showed four main sedimentary units to a depth of 60 m at about 20 km offshore.

The complex basement rocks beneath the Gulf of Thailand include granite, gneiss, sandstone and limestone with depth varying from 400 m to 1,800 m, extending throughout the Gulf of Thailand (Nutalaya and Rau, 1981).

2.5 Climate

The climate type of study area belongs to tropical savanna climate (Aw), according to Koppen's classification: Aw – climate. Southwest monsoon winds and rains regularly occur normally between mid – May and October, causing flood seasons and frequently produce tropical storms that are less severe than typhoons. Northeast monsoon occurs between November and mid – February. The directions of longshore drift from the Gulf of Thailand also reflect the interaction between winds and current. The climate is generally divided into three seasons. Firstly, the rainy season with tropical storms normally coming from mid – May to November. Secondly, the dry winter season starts annually from November until February. Finally, the summer period occurs from the end of February to mid – May.

The southwest monsoon blows from about mid – May to November. Rainfall peaks in September with up to 2,200 mm/year. The average rainfall is about 1,400 mm/year and about 90% of the precipitation falls in the rainy season.

The mean annual temperatures in the area range from 27^0 - 30^0C; with maximum temperature up to 39^0C occurring in April and the minimum temperatures down to 9.9^0C in December or January.

There are variations in annual humidity from the study area. The relative humidity is greater in the rainy season (mid – May to November) than the summer season (February to mid – May).

Sediment transporting system in the area depends largely on wind and wave conditions. The study area is located in a tropical climate with two major wind and wave conditions. The rainy season from mid – May to November is characterized by moderate to heavy rain as a result of air masses traversing. The southwest winds also generate moderate waves along the east coast. However, cyclones are generated as a result of

retreat of southwestern monsoon during September to October, which bring strong winds and intense waves. Conversely during November to mid – February, the northeast monsoon represents of a reversal of air movement and waves are generally small. Winds are normally moderate during the northeast monsoon season with stronger winds during the season's end (Vongvisessomjai et al., 1992). Wind decrease during the southwest monsoon season.

2.6 Coastal sediments

Coastal lithofacies such as barrier sands and estuarine muddy sediments are less extendsively developed that are piedmont fans in the Prachuap Khiri Khan area. They occur mainly around clusters of rocky islands and headlands that have provided protected environments for coastal sediments to prograde trough out the Quaternary. Coastal embayments adjacent to these accretionary areas contain prominent sand barriers but intervening sectors of coast, especially in the north, are sediment starved and have eroded into old fan deposits. The source of the coastal sediments is form the land via active fluvial systems and through marine erosion of old fans exposed at the coast (Roy, 1989).

2.6.1 Estuarine depositional environments

Unlike the Rayong – Chantaburi coast, large drowned valley estuaries do not occur. Instead estuaries of the interbarrier type occupy low, coast – parallel zones between barriers of different ages, or they occur as shallow swampy – in part brackish – areas behind old barrier systems. Tidal ranges in this part of the gulf are about 2.0 m but during periods of heavy rain, it is certain that these low areas become fluvially dominated.

As in many other parts of Southeast Asia, intertidal mangrove areas and brackish coastal swamps in Thailand are suffering widespread destruction in the interest of developing commercial prawn farms for export. The longer – term socio economic and

environmental impacts on the coastal fishing industry, and on small coastal fishing communities, of destroying natural fish nursery grounds have yet to be determined (Roy, 1989).

2.6.2 Coastal sand barriers

Wave – formed accumulations of sand on this coast have elevations of 1.5 to 4.0 m above mean sea level (depending on wave exposure) and widths ranging from 20 m to 1,500 m. The barrier deposits are in the thicknesses of barriers in southeastern Australia and reflects the much lower – energy wave climate of the Gulf of Thailand. Sand sizes vary from coarse to fine and compositions range from immature to semi – mature depending on source rock types, wave sorting and duration of subaerial weathering.

Barrier types include mainland beaches on coasts undergoing marine erosion, small stationary barriers with a single beach ridge and prograded barriers made up of multiple beach ridges. Wind – blown sand accumulations are not well developed except in the southern part of the region where some barrier surfaces are capped with low foredunes (Roy, 1989).

2.7 Coastal processes

This section explains coastal processes in term of the processes of wind, current, wave and tide influences in the study area.

2.7.1 Monsoonal wind

Base on geographical feature, there are 2 types of monsoon in the area: northeast and southwest monsoons. The northeast monsoon occurs during mid – October to February due to migration of cold weather from Asian continent to equator around Indian Ocean. The northeast monsoonal wind is significant to wave occurrence in western area. The southwest monsoon occurs during May to September because temperature in the continent is higher than temperature of water in the ocean. This monsoonal wind effects coastal area in western and eastern parts of the area (Snidvongs, 1998).

2.7.2 Tropical cyclones

The tropical cyclones in the area are generated from South China Sea, which can be divided based on their intensity into 3 types;

- Tropical depression: its central velocity is lower than 63 km/hr.
- Tropical storm: its central velocity is between 63 to 118 km/hr.
- Typhoon: its central velocity is more than 118 km/hr.

The intensity of the tropical cyclones can be increased, if they move pass the sea or the ocean. In contrast, their intensity decreases, if they move pass the continent or mountain. They initially generate in South China Sea and then move to the Gulf of Thailand.

2.7.3 Waves

In general, waves in the area are the small wave. Their height is normally lower than 2 meters. However, during the monsoon wind, wave heights can be generated more than 5 meters.

2.7.4 Tides

Tides are the changing in sea level in vertical direction. The styles were different depending on topography and gravity from the moon and the sun. There are 3 types of tides in the area with average 1.5 meters in tidal range (Siriphong, 1985);

- Diurnal: one time of high tide and low tide in one day.
- Mixed, semidiurnal dominated: two times of high tide and low tide in one day.
- Mixed, diurnal dominant: mostly in one time of high tide and low tide in one day, but sometime two times of high tide and low tide also occurred.