Sedimentological Characteristics of the Sediments of the South China Sea, Area I: Gulf of Thailand and East Coast of Peninsular Malaysia

Mohd-Lokman Husain[1]
Harith, M.R.[1]
Maurice, J.[1]
Rosnan, Y.[1]
and
Kassim K. K. Y.[2]

[1]Faculty of Applied Science and Technology, University Putra Malaysia Terengganu (UPMT)
21030 Kuala Terengganu, Malaysia.
[2] Marine Fishery Resource Development and Management Department
South East Asian Fisheries Development Center, 21080 Kuala Terengganu, Malaysia

ABSTRACT

Two batches of eighty sediment samples were cut from the first centimeter of sediment cores collected during September 1995, representing the pre-monsoon period, and April 1996, representing the post-monsoon period, at the same location. The sample were collected within the waters of the Gulf of Thailand and the eastern board of Peninsular Malaysia. The sediment samples were analyzed for their sedimentological characteristics using the techniques of sieving and laser diffraction. In general the sediments of the Gulf of Thailand is finer, better sorted, more peaked than that of the Malaysian waters. Skewness of sediments from Thailand waters was more positively skewed than the Malaysian sediments for the pre-monsoon period but tended to be more negatively skewed for the post-monsoon period. It is also interesting to note that in general, the sediments collected during the post-monsoon period are finer, better sorted, more positively skewed and less peaked than the sediments collected during the pre-monsoon period. This is true for both the sediments collected from the Gulf of Thailand and the Malaysian waters. Near-shore sediments were also found to be the coarsest, followed by the off-shore sediments.

Introduction

In the study of the oceans, the bottom sedimentological properties not only play a major role in determining the richness of benthic life and productivity i.e. the diversity of benthic organisms but is also an important parameter that closely relates to pollution and mineral resources in the ocean. Studies on ocean sediments have begun since the early 1900s and the geophysical properties of ocean sediments have been used as environmental indicators (Wentworth, 1929; Krumbein 1937, 1938; and Folk, 1966). The bottom sedimentological properties of the South China Sea, nevertheless, are not well documented. This may be partly attributed to the prohibitive cost associated with the need for a research vessel, experienced crews and proper equipment. Some of the more extensive reports concerning the South China Sea sediments are those published by University Pertanian Malaysia and Kagoshima University through their joint expeditions aboard Kagoshima Maru. The expeditions were referred to as Matahari expeditions and were conducted in 1985, 1986, 1987 and 1989. These expeditions, however, cover only small portions at one time and was not expansive in coverage even if the different study areas are all added together.

Beginning 1995 SEAFDEC's Marine Fishery Resource Development and Management Department (MFRDMD) in Malaysia and the Training Department in Thailand in collaboration with the Fishery Departments of Thailand and Malaysia and university researchers from both countries have embarked upon a broad program of information gathering on the South China Sea. The vessel used was a modern vessel-M.V. SEAFDEC. Cruises were done during the pre (September 1995) and post -monsoon period (April, 1996) covering area I, the Gulf of Thailand and the EEZ waters bordering the eastern board of Peninsular Malaysia. One of the objectives of the cruise is to study the sediment grain size distribution and some general characteristics of the seafloor sediments.

This report focuses only on the information gathered and data analyzed from the bottom sediment samples collected during the first and second cruises..

Description of Study Area (Fig. 1)

The study area stretches from the Gulf of Thailand in the north to the Malaysian waters off Johor coast in the south. The waters within the Gulf of Thailand are relatively enclosed and thus protected when compared to the open conditions of the Malaysian waters exposed to the broad and long expanse of the South China Sea.

Typical of the continental shelf, the water depth is rather shallow. The average depth is approximately 52 m. Stations located close to the shore have water depths of approximately 25 meters, while the area furthest from shore are in water depths of approximately 70 m.

The current direction in the South China Sea, particularly, is controlled by seasonal winds of the monsoon. The predominant wind is from the north during the northeast monsoon seasons and from the south during the northwest monsoon (Wrytki, 1961).

Materials and Method

Sediment samples were collected using a gravity corer. Upon retrieval of the core, several parameters were recorded: color, stratification and length of sediment collected. The cores were then capped, freezed and brought back to the laboratory for further analyses. During the pre-monsoon cruise, out of the 81 stations, sampling was successfully done for 80 stations. Station 27 was not sampled due to technical problems. For the second cruise of April 1996, sampling was only done for eighty stations only since there was some technical problems at station 2.

Laboratory Methods

One centimeter of sediment was cut from the surface of each core. The methodology chosen to analyze the sedimentological characteristics depended upon the amount of coarse (>63 microns) or fine sediments (<63microns) available in each sample. Samples consisting mostly fine sediments with less than 10% coarse sediments, were analyzed using a laser diffractometer. However, if the opposite occurs then the sediments were analyzed via sieving.

For sieving approximately 100 grams of split samples were passed through a set of ASTM standard sieves with intervals of approximately 0.25 ø. The sediments were sieved using a sieve shaker for 15 minutes. The sediments trapped on each sieve were then weighed, recorded and used in the determination of the sedimentological parameters: mean, median and skewness and kurtosis.

The sediments are reported in terms of phi unit following standard convention in the study of sediments. The formula for phi is as given below:

$$\textbf{Phi } (\phi) = -\log_2 D$$

ø = Particle diameter in phi
D = Particle diameter in mm

For laser diffraction analyses, the sediments are first removed off carbonate shell materials and organic matter using hydrochloric acid and hydrogen peroxide solutions respectively. Then a dispersing agent (sodium hexametaphosphate) was added to the sediments solution prior to passing it through the laser diffractometer. The particle size analyzer used in this study was the Malvern-E.

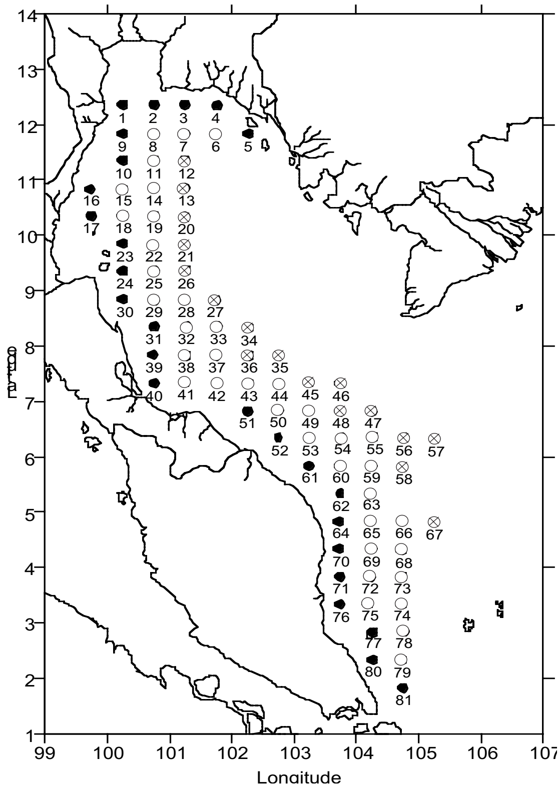

Fig. 1. Sampling locations within the Gulf of Thailand and West coast of peninsular Malaysia
(● Nearshore, ○ Midshore, ⊗ Offshore stations)

Data obtained from both methodologies were calculated using the method of moments as suggested by Griffiths (1967), McBride (1971) and Folk (1980) among others. Formulas used for the calculation of the sedimentological parameters are as given below:

$$Mean(X\phi) = \frac{\sum fm}{n}$$

$$Standard\text{-}Deviation(S\phi) = \sqrt{\frac{\sum f(m - X\phi)^2}{100}}$$

$$Skewness(Sk) = \frac{\sum f(m - X\phi)^3}{100\sigma^3}$$

$$Kurtosis\,(K\phi) = \frac{\sum f(m - X\phi)^4}{100\sigma^4}$$

f = weight percent (frequency) in each grain size grade present
m = midpoint of each grain size grade in phi values
n = total number in sample, which is 100 when "f" is in percent.

Color and texture of sediments were determined using the classification system and standard color proposed in the Japanese Standards for soil survey (Oyama, 1996).

Results and discussions

The result of this sedimentological investigation are divided into three sections: Sedimentological characteristics, texture classifications and color.

Sedimentological Characteristics (Tabs. 1A to 1G; Figs. 2 to 5)

Generally, the post-monsoon sediments are finer than the pre-monsoon sediments. The mean size of pre-monsoon sediments was 4.74ø (coarse silt) while the mean size of post-monsoon sediments was 5.50ø (medium silt). The distribution of medium silt is more widespread for post-monsoon compared to the pre-monsoon sediments (fig. 2). The range of mean size for post and pre-monsoon sediments were 6.60ø (fine silt) to 0.46ø (coarse sand) and 6.40ø (fine silt) to -1.10ø (granules). For both batches of sediments the coarsest and the finest sediments are found in the waters of Malaysia and Thailand respectively. Both sediment batches are poorly sorted but the values and also the sorting distribution as shown in figure 3 indicate that the post-monsoon sediments are better sorted compared to the pre-monsoon sediments. The mean sorting value for post-monsoon sediments is 1.57 compared to the mean sorting value of September sediment is 1.57 compared to the mean sorting value of 1.80 for the pre-monsoon period. The range between maximum and minimum values is however larger for the post-monsoon sediments (2.48) compared to the pre-monsoon sediments (1.34).

Comparatively, the post-monsoon sediments tend to be more positively skewed (average value 0.15) compared to the pre-monsoon sediments (average value 0.05). This trend is true for the Malaysian sediments but for the sediments collected from the Gulf of Thailand the post-monsoon sediments (0.09) tend to be slightly more negative compared to the pre-monsoon sediments (0.10) (fig. 4).

Additionally, the post-monsoon sediments also tended to be more peaked than the pre-monsoon sediments. This is clear from the larger average kurtosis values of 2.86 compared to 2.41 for the pre-monsoon sediments. The extent of extremely leptokurtic sediments is more widespread for the post-monsoon sediments as compared to the pre-monsoon sediments (fig. 5). For both sediment batches, the Thai sediments have higher kurtosis values than the Malaysian sediments, indicating a more stable depositional environment.

For the sediment samples collected during the pre-monsoon and post-monsoon cruises the differences in characteristics between the Malaysian and Thai sediments are quite different statistically (tabs. 2A to 2E). For the pre-monsoon sediments only the mean size was statistically significant in its difference between the Malaysian and Thai sediments. However, for the post-monsoon, the differences between the Malaysian and Thai sediments are statistically significant for all the parameters of mean size, sorting, skewness and kurtosis.

On a cross-shore basis the general fining trend from pre to post-monsoon sediments remains. The mean size of near-shore, mid-shore and off-shore sediments are finer for post-monsoon sediments compared to the pre-monsoon sediments. For both batches of sediment the near-shore sediments are the coarsest followed by off-shore sediments, while the mid-shore remains the finest. The mid-shore sediments for both batches are the most poorly sorted, while the near-shore sediments are the best sorted.

The differences between the Malaysian and Thai sediments can probably be attributed to the Thai sediments being sampled from the Gulf of Thailand which is comparatively enclosed and protected as opposed to the conditions of the Malaysian sediment sampling stations which are located in the exposed area of the South China Sea. On the other hand, the differences between the pre and post-monsoon sediments can most probably be attributed to the weather conditions prevailing during both seasons. The conditions during and before the sampling period are vastly different. The difference in cross-shore basis may be attributed to the near-shore region being most affected by wave, which tend to act as a siever to remove finer materials thus allowing only coarser materials to settle. Thus a smaller range of size and better sorting values.

Table 1a. Statistical parameters of bottom sedimentological characteristics.

	ALL STATIONS											
	Mn			S.D			Skew			Kurt		
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	4.74	5.50	0.76	1.80	1.57	-0.23	0.05	0.15	0.10	2.41	2.86	0.45
Min	6.40	6.60	0.20	1.02	0.51	-0.51	-0.84	-0.57	0.27	1.68	1.57	-0.11
Max	-1.10	0.46	1.56	2.36	2.99	0.63	0.90	0.90	0.00	3.91	4.62	0.71
Range	7.50	6.14	-1.36	1.34	2.48	1.14	1.74	1.47	-0.27	2.23	3.05	0.82
	MALAYSIAN WATERS											
	Mn			S.D			Skew			Kurt		
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	4.35	5.19	0.84	1.80	1.67	-0.13	0.01	0.21	0.20	2.38	2.69	0.31
Min	5.90	6.60	0.70	1.02	0.51	-0.51	-0.84	-0.57	0.27	1.68	1.57	-0.11
Max	-1.10	0.46	1.56	2.36	2.99	0.63	0.90	0.90	0.00	3.91	3.69	-0.22
Range	7.00	6.14	-0.86	1.34	2.48	1.14	1.74	1.47	-0.27	2.23	2.12	-0.11
	THAILAND WATERS											
	Mn			S.D			Skew			Kurt		
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	5.12	5.77	0.65	1.80	1.49	-0.31	0.10	0.09	-0.01	2.43	3.00	0.57
Min	6.40	6.49	0.09	1.42	1.03	-0.39	-0.73	-0.52	0.21	1.88	2.26	0.38
Max	3.40	4.43	1.03	2.29	1.88	-0.41	0.71	0.68	-0.03	3.55	4.62	1.07

Table 1b. Statistical parameters of bottom sediment with respect to shoreline.

	ALL NEARSHORE STATIONS											
	Mn			S.D			Skew			Kurt		
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	3.95	5.20	1.25	1.77	1.52	-0.25	0.16	0.18	0.02	2.37	2.97	0.60
Min	6.40	6.49	0.09	1.02	0.51	-0.51	-0.84	-0.52	0.32	1.76	1.94	0.18
Max	-1.10	0.46	1.56	2.36	2.80	0.44	0.90	0.73	-0.17	3.91	4.62	0.71
Range	7.50	6.03	-1.47	1.34	2.29	0.95	1.74	1.25	-0.49	2.15	2.68	0.53
	ALL MIDSHORE STATIONS											
	Mn			S.D			Skew			Kurt		
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	4.98	5.61	0.63	1.88	1.61	-0.27	0.06	0.16	0.10	2.33	2.84	0.51
Min	6.30	6.41	0.11	2.34	1.03	-1.31	-0.51	-0.57	-0.06	1.68	1.57	-0.11
Max	3.60	4.08	0.48	1.43	2.99	1.56	0.70	0.90	0.20	3.35	4.26	0.91
Range	2.70	2.33	-0.37	0.91	1.96	1.05	1.21	1.47	0.26	1.67	2.69	1.02
	ALL OFFSHORE STATIONS											
	Mn			S.D			Skew			Kurt		
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	5.43	5.71	0.28	1.72	1.58	-0.14	-0.08	0.07	0.15	2.56	2.74	0.18
Min	6.20	6.60	0.40	1.33	1.21	-0.12	-0.73	-0.56	0.15	1.91	1.90	-0.01
Max	4.50	4.43	-0.07	2.09	2.07	-0.02	0.47	0.49	0.02	3.55	3.76	0.21
Range	1.70	2.17	0.47	0.76	0.86	0.10	1.20	1.05	-0.15	1.64	1.86	0.22

Sept denote - September 1995 sediment
April denote - April 1996 sediment
Dif denote - Difference between September 1995 and April 1996

Table 1c. Statistical parameters of bottom sediment with respect to shoreline.

	ALL NEARSHORE STATIONS											
	Mn			S.D			Skew			Kurt		
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	3.95	5.20	1.25	1.77	1.52	-0.25	0.16	0.18	0.02	2.37	2.97	0.60
Min	6.40	6.49	0.09	1.02	0.51	-0.51	-0.84	-0.52	0.32	1.76	1.94	0.18
Max	-1.10	0.46	1.56	2.36	2.80	0.44	0.90	0.73	-0.17	3.91	4.62	0.71
Range	7.50	6.03	-1.47	1.34	2.29	0.95	1.74	1.25	-0.49	2.15	2.68	0.53
	NEARSHORE STATIONS (MALAYSIAN WATERS)											
	Mn			S.D			Skew			Kurt		
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	2.82	5.74	2.92	1.72	1.45	-0.27	0.07	0.14	0.07	2.36	3.10	0.74
Min	5.40	6.49	1.09	1.02	1.10	0.08	-0.84	-0.52	0.32	1.76	2.27	0.51
Max	-1.10	4.59	5.69	2.36	1.97	-0.39	0.90	0.73	-0.17	3.91	4.62	0.71
Range	6.50	1.90	-4.60	1.34	0.87	-0.47	1.74	1.25	-0.49	2.15	2.35	0.20
	NEARSHORE STATIONS (THAILAND WATERS)											
	Mn			S.D			Skew			Kurt		
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	4.81	4.43	-0.38	1.81	1.63	-0.18	0.22	0.24	0.02	2.38	2.71	0.33
Min	6.40	5.79	-0.61	1.42	0.51	-0.91	-0.35	-0.41	-0.06	1.88	1.94	0.06
Max	3.40	0.46	-2.94	2.29	2.80	0.51	0.71	0.61	-0.10	2.98	3.53	0.55
Range	3.00	5.33	2.33	0.87	2.29	1.42	1.06	1.02	-0.04	1.10	1.59	0.49

Table 1d. Statistical parameters of bottom sediment with respect to shoreline.

	ALL MIDSHORE STATIONS											
	Mn			S.D			Skew			Kurt		
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	4.98	5.61	0.63	1.88	1.61	-0.27	0.06	0.16	0.10	2.33	2.84	0.51
Min	6.30	6.41	0.11	2.34	1.03	-1.31	-0.51	-0.57	-0.06	1.68	1.57	-0.11
Max	3.60	4.08	0.48	1.43	2.99	1.56	0.70	0.90	0.20	3.35	4.26	0.91
Range	2.70	2.33	-0.37	0.91	1.96	1.05	1.21	1.47	0.26	1.67	2.69	1.02
	MIDSHORE STATIONS (MALAYSIAN WATERS)											
	Mn			S.D			Skew			Kurt		
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	5.38	5.82	0.44	1.68	1.58	-0.10	-0.05	-0.03	0.02	2.57	2.77	0.20
Min	5.90	6.39	0.49	1.33	1.21	-0.12	-0.53	-0.48	0.05	1.91	2.41	0.50
Max	4.70	4.43	-0.27	2.09	1.88	-0.21	0.47	0.24	-0.23	2.96	3.76	0.80
Range	1.20	1.96	0.76	0.76	0.67	-0.09	1.00	0.72	-0.28	1.05	1.35	0.30
	MIDSHORE STATIONS (THAILAND WATERS)											
	Mn			S.D			Skew			Kurt		
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	5.53	5.64	0.11	1.80	1.58	-0.22	-0.13	0.15	0.28	2.54	2.72	0.18
Min	6.20	6.60	0.40	1.54	1.30	-0.24	-0.73	-0.56	0.17	2.05	1.90	-0.15
Max	4.52	4.52	0.02	2.07	2.07	0.00	0.15	0.49	0.34	3.55	3.51	-0.04
Range	2.08	2.08	0.38	0.53	0.77	0.24	0.88	1.05	0.17	1.50	1.61	0.11

Sept denote - September 1995 sediment
April denote - April 1996 sediment
Dif denote - Difference between September 1995 and April 1996

Table 1e. Statistical parameters of bottom sediment with respect to shoreline.

	Mn			S.D			Skew			Kurt		
ALL OFFSHORE STATIONS												
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	5.43	5.71	0.28	1.72	1.58	-0.14	-0.08	0.07	0.15	2.56	2.74	0.18
Min	6.20	6.60	0.40	1.33	1.21	-0.12	-0.73	-0.56	0.17	1.91	1.90	-0.01
Max	4.50	4.43	-0.07	2.09	2.07	-0.02	0.47	0.49	0.02	3.55	3.76	0.21
Range	1.70	2.17	0.47	0.76	0.86	0.10	1.20	1.05	-0.15	1.64	1.86	0.22
OFFSHORE STATIONS (MALAYSIAN WATERS)												
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	5.38	5.82	0.44	1.68	1.58	-0.10	-0.05	-0.03	0.02	2.57	2.77	0.20
Min	5.90	6.39	0.49	1.33	1.21	-0.12	-0.53	-0.48	0.05	1.91	2.41	0.50
Max	4.70	4.43	-0.27	2.09	1.88	-0.21	0.47	0.24	-0.23	2.96	3.76	0.80
Range	1.20	1.96	0.76	0.76	0.67	-0.09	1.00	0.72	-0.28	1.05	1.35	0.30
OFFSHORE STATIONS (THAILAND WATERS)												
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	5.53	5.64	0.11	1.80	1.58	-0.22	-0.13	0.15	0.28	2.54	2.72	0.18
Min	6.20	6.60	0.40	1.54	1.30	-0.24	-0.73	-0.56	0.17	2.05	1.90	-0.15
Max	4.50	4.52	0.02	2.07	2.07	0.00	0.15	0.49	0.34	3.55	3.51	-0.04
Range	1.70	2.08	0.38	0.53	0.77	0.24	0.88	1.05	0.17	1.50	1.61	0.11

Table 1f. Statistical parameters of bottom sediment with respect to shoreline.

	Mn			S.D			Skew			Kurt		
NEARSHORE STATIONS												
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	2.82	5.74	2.92	1.72	1.45	-0.27	0.07	0.14	0.07	2.36	3.10	0.74
Min	5.40	6.49	1.09	1.02	1.10	0.08	-0.84	-0.52	0.32	1.76	2.27	0.51
Max	-1.10	4.59	5.69	2.36	1.97	-0.39	0.90	0.73	-0.17	3.91	4.62	0.71
Range	6.50	1.90	-4.60	1.34	0.87	-0.47	1.74	1.25	-0.49	2.15	2.35	0.20
MIDSHORE STATIONS												
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	4.70	5.77	1.07	1.97	1.48	-0.49	0.02	0.09	0.07	2.23	3.03	0.80
Min	5.30	6.41	1.11	1.64	1.03	-0.61	-0.51	-0.37	0.14	1.68	2.26	0.58
Max	3.70	4.88	1.18	2.34	1.76	-0.58	0.70	0.68	-0.02	3.20	3.58	0.38
Range	1.60	1.53	-0.07	0.70	0.73	0.03	1.21	1.05	-0.16	1.52	1.32	-0.20
OFFSHORE STATIONS												
	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif	Sept	April	Dif
Average	5.38	5.82	0.44	1.68	1.58	-0.10	-0.05	-0.03	0.02	2.57	2.77	0.20
Min	5.90	6.39	0.49	1.33	1.21	-0.12	-0.53	-0.48	0.05	1.91	2.41	0.50
Max	4.70	4.43	-0.27	2.09	1.88	-0.21	0.47	0.24	-0.23	2.96	3.76	0.80
Range	1.20	1.96	0.76	0.76	0.67	-0.09	1.00	0.72	-0.28	1.05	1.35	0.30

Sept denote - September 1995 sediment
April denote - April 1996 sediment
Dif denote - Difference between September 1995 and April 1996

Table 1g. Statistical parameters of bottom sediment with respect to shoreline. (Thai waters)

1G	Mn			S.D			Skew			Kurt		
NEARSHORE STATIONS												
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	3.95	5.74	1.79	1.77	1.45	-0.32	0.16	0.14	-0.02	2.37	3.1	0.73
Min	6.4	6.49	0.09	1.02	1.1	0.08	-0.84	-0.52	0.32	1.76	2.27	0.51
Max	-1.1	4.59	5.69	2.36	1.97	-0.39	0.9	0.73	-0.17	3.91	4.62	0.71
Range	7.5	1.9	-5.6	1.34	0.87	-0.47	1.74	1.25	-0.49	2.15	2.35	0.2
MIDSHORE STATIONS	Mn			S.D			Skew			Kurt		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	5.24	5.77	0.53	1.79	1.48	-0.31	0.09	0.09	0	2.43	3.03	0.6
Min	6.3	6.41	0.11	1.43	1.03	-0.4	-0.4	-0.37	0.03	2.09	2.26	0.17
Max	3.6	4.88	1.28	2.07	1.76	-0.31	0.69	0.68	-0.01	3.35	3.58	0.23
Range	2.7	1.53	-1.17	0.64	0.73	0.09	1.09	1.05	-0.04	1.26	1.32	0.06
OFFSHORE STATIONS	Mn			S.D			Skew			Kurt		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	5.53	5.82	0.29	1.8	1.58	-0.22	-0.13	-0.03	0.1	2.54	2.77	0.23
Min	6.2	6.39	0.19	1.54	1.21	-0.33	-0.73	-0.48	0.25	2.05	2.41	0.36
Max	4.5	4.43	-0.07	2.07	1.88	-0.19	0.15	0.24	0.09	3.55	3.76	0.21
Range	1.7	1.96	0.26	0.53	0.67	0.14	0.88	0.72	-0.16	1.5	1.35	

Sept denote - September 1995 sediment
April denote - April 1996 sediment
Dif denote - Difference between September 1995 and April 1996

Table 2a. T-test results for malaysian water vs. Thailand water

PARAMETER	Mean		Sorting		Skewness		Kurtosis	
	Sep-95	Apr-96	Sep-95	Apr-96	Sep-95	Apr-96	Sep-95	Apr-96
PROBABILITY	< 5%	< 5%	> 10%	< 5%	> 10%	< 10%	> 10%	< 5%
CONCLUSION	Significant	Significant	Not Significant	Significant	Not Significant	Significant	Not Significant	Significant
AVERAGE	4.35 > 5.12	5.19 > 5.77		1.67 > 1.49		0.21 > 0.09		2.69 > 2.46

Table 2b. T-test results for malaysian water vs Thailand water

PARAMETER	%Sand		%Silt		%Clay	
	Sep-95	Apr-96	Sep-95	Apr-96	Sep-95	Apr-96
PROBABILITY	< 5%	< 5%	> 10%	< 5%	> 10%	> 10%
CONCLUSION	Significant	Significant	Not Significant	Significant	Not Significant	Significant
AVERAGE	43.98 > 33.85	24.15 > 11.96		66.76 > 79.17		

Table 2c. Anova results for distance from shore (near, mid,offshore)

PARAMETER	Mean		Sorting		Skewness		Kurtosis	
	Sep-95	Apr-96	Sep-95	Apr-96	Sep-95	Apr-96	Sep-95	Apr-96
PROBABILITY	< 5%	< 10%	> 10%	> 10%	< 10%	> 10%	> 10%	> 10%
CONCLUSION	Significant	Significant	Not Significant	Not Significant	Significant	Not Significant	Not Significant	Not Significant
AVERAGE								

Table 2d. Anova results for distance from shore (near : mid : off - shore)

PARAMETER	%Sand		%Silt		%Clay	
	Sep-95	Apr-96	Sep-95	Apr-96	Sep-95	Apr-96
PROBABILITY	< 5%	> 10%	< 10%	> 10%	< 10%	< 5%
CONCLUSION	Significant	Not Significant	Significant	Not Significant	Significant	Significant
AVERAGE	50.43>36.35>27.36		44.52>46.26>53.53			

Table 2e. Anova results for distance from shore (near : mid : off shore) - Thailand waters

PARAMETER	Mean		Sorting		Skewness		Kurtosis	
	Sep-95	Apr-96	Sep-95	Apr-96	Sep-95	Apr-96	Sep-95	Apr-96
PROBABILITY	>10%	>10%	>10%	>10%	<5%	>10%	>10%	>10%
CONCLUSION	Not Significant	Not Significant	Not Significant	Not Significant	Significant	Not Significant	Not Significant	Not Significant
AVERAGE								

Table 2f. Anova results for distance from shore (near : mid : off - shore) - Thailand waters

PARAMETER	%Sand		%Silt		%Clay	
	Sep-95	Apr-96	Sep-95	Apr-96	Sep-95	Apr-96
PROBABILITY	> 10%	> 10%	> 10%	> 10%	> 0%	> 10%
CONCLUSION	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
AVERAGE						

Table 2g. Anova results for distance from shore (near : mid : off-shore) - Malaysian waters

PARAMETER	Mean		Sorting		Skewness		Kurtosis	
	Sep-95	Apr-96	Sep-95	Apr-96	Sep-95	Apr-96	Sep-95	Apr-96
PROBABILITY	< 5%	< 5%	< 5%	> 10%	> 10%	> 10%	> 10%	> 10%
CONCLUSION	Significant	Significant	Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
AVERAGE	2.82 > 4.7 >5.38	4.43 > 5.4 > 5.64	1.72 < 1.97 < 1.68					

Table 2h. Anova results for distance from shore (near : mid : off-shore) - Malaysian waters

PARAMETER	%Sand		%Silt		%Clay	
	Sep-95	Apr-96	Sep-95	Apr-96	Sep-95	Apr-96
PROBABILITY	< 5 %	< 5%	> 10%	> 10%	< 5%	< 5%
CONCLUSION	Significant	Significant	Not Significant	Significant	Significant	Significant
AVERAGE	64.66 > 41.19 > 28.12	38.12 > 23.56 > 12.91		56.13 < 66.05 < 76.46	11.18 < 14.31 < 20.08	5.75 < 10.36 < 10.64

Texture (Tabs. 3A to 3D)

The seafloor of the study area during the post-monsoon sampling seems to be more similar in texture compared to the pre-monsoon sampling. This is clear when texture classification is examined in the overall area of sampling and on smaller scales of the Gulf and the Malaysian waters. Overall, eight classifications of sediment texture, ranging from light clay to silt loam, are identified for the pre-monsoon sediments but only five are identified for the post-monsoon sediments. On a smaller scale, the variety of texture classification was also reduced from seven to five and from six to three in the Malaysian and Thai sediments respectively.

In the Malaysian waters, the dominant texture of clay loam, which makes up approximately 25% of the sediment classification for the pre-monsoon was changed to silt loam, for the post-monsoon sediments. Silt loam makes up approximately 62% of the texture classification. In the waters of the Gulf, the dominant texture of silty clay loam, which makes up approximately 50% of the bottom sediments for the pre-monsoon sediment was changed to silt loam (76%) for the post-monsoon sediments.

The near-shore region has more variability of sediment texture followed by the mid-shore region and the off-shore region for the pre-monsoon sediments. For the post-monsoon sediments, the near-shore region remains the most varied but with the mid-shore and the off-shore region having the same texture classification of three. The three different texture classifications for the mid-shore region of post-monsoon sediments is however, less than the mid-shore region of pre-monsoon sediments, which has five texture classifications.

Compared to Thailand the Malaysian seafloor have more sand (fig. 6). This is true for both periods of sampling and the difference is statistically significant. The silt and clay content did not differ statistically for the pre-monsoon sediments but is statistically significant in difference for silt for the post-monsoon sediments (tabs. 2A and 2B). The post-monsoon near-shore sediments have

Table 3a. Texture distribution of bottom sediments

	ALL			Malaysian Water			Thailand Water		
	Sept	April	Diff	Sept	April	Diff	Sept	April	Diff
Light Clay	3 (3.75%)	0	-3	2 (5%)	0	-2	1 (2.5%)	0	-1
Silty Clay	2 (2.5 %)	0	-2	0	0	0	2(5%)	0	-2
Clay Loam	13 (16.25%)	0	-13	10(25%)	0	-10	3 (7.5%)	0	-3
Silty Clay Loam	29 (36.25%)	15 (18.75%)	-14	9 (22.5%)	8 (21.62%)	-1	20 (50%)	7(16.28%)	-13
Sand	4 (5.0%)	1 (1.25%)	-3	4 (10%)	1 (2.70%)	-3	0	0	0
Sandy Loam	2 (2.5%)	1 (1.25%)	-1	2 (5%)	1 (2.70%)	-1	0	0	0
Loam	15 (18.7%)	7 (8.75%)	-8	5 (12.5%)	4 (10.81%)	-1	3 (6.98%)	3 (6.98%)	-7
Silt Loam	12 (15%)	56 (70%)	44	8 (20%)	23 (62016%)	15	33 (76.74%)	33 (76.74%)	29

Table 3b. Texture distribution of bottom sediments

	Nearshore			Midshore			Offshore		
	Sept	April	Diff	Sept	April	Diff	Sept	April	Diff
Light Clay	0	0	0	1 (3.23%)	0	-1	2 (9.25%)	0	-2
Silty Clay	1 (3.57%)	0	-1	1 (3.23%)	0	-1	0	0	0
Clay Loam	4 (14.29%)	0	-4	7 (22.58%)	0	-7	2 (9.25%)	0	-2
Silty Clay Loam	5 (17.86%)	2 (2.50%)	-3	12 (38.71%)	8 (25.81%)	-4	12 (57.14%)	5 (22.73%)	-7
Sand	4 (14.29%)	1 (1.25%)	-3	0	0	0	0	0	0
Sandy Loam	2 (7.14%)	1 (1.25%)	-1	0	0	0	0	0	0
Loam	9(32.14%)	4 (5.00%)	-5	5(16.13%)	2 (6.54%)	-3	1 (4.76%)	1 (4.55%)	0
Silt Loam	3 (10.71%)	19(23.75%)	17	5 (16.13 %)	21 (67.74%)	16	4 (19.05%)	16 (72.73%)	12

Table 3c. Texture distribution of bottom sediments Malaysian water

	Nearshore			Midshore			Offshore		
	Sept	April	Diff	Sept	April	Diff	Sept	April	Diff
Light Clay	0	0	0	0	0	0	2 (15.38%)	0	-2
Silty Clay	0	0	0	0	0	0	0	0	0
Clay Loam	1 (8.33 %)	0	-1	7 (46.67%)	0	-7	2 (15.38%)	0	-2
Silty Clay Loam	1 (8.33 %)	0	-1	2 (13.33%)	4 (30.8%)	2	6 (46.15%)	4 (30.8%)	-2
Sand	4 (33.33%)	1 (9.1%)	-3	0	0	0	0	0	0
Sandy Loam	2 (16.167%)	1 (9.1%)	-1	0	0	0	0	0	0
Loam	2 (16.67%)	2 (18.2%)	0	3 (20%)	2 (15.4%)	-1	0	0	0
Silt Loam	2 (16.67)	7 (63.6%)	5	3 (20%)	7 (53.8%)	4	3 (23.08%)	9 (69.2%)	7

Table 3d. Texture distribution of bottom sediments Thailand water

	Nearshore			Midshore			Offshore		
	Sept	April	Diff	Sept	April	Diff	Sept	April	Diff
Light Clay	0	0	0	1 (6.25%)	0	-1	0	0	0
Silty Clay	1 (6.25%)	0	-1	1 (6.25%)	0	-1	0	0	0
Clay Loam	3 (18.75%)	0	-3	0	0	0	0	0	0
Silty Clay Loam	4 (5%)	2 (12.5%)	-2	10 (62.5%)	4 (22.2 %)	-6	6 (75%)	1 (11/1%)	-5
Sand	0	0	0	0	0	0	0	0	0
Sandy Loam	0	0	0	0	0	0	0	0	0
Loam	7 (43.75%)	2 (12.5%)	-5	2 (12.5%)	0	-2	1 (12.5%)	1(11.1%)	0
Silt Loam	1 (6.25%)	12 (75.0%)	11	12 (75.0%)	14 (77.8%)	12	1 (12.5%)	7 (77.8%)	6

Sept denote - September 1995 sediment, April denote - April 1996 sediment

Dif denote - Difference between September 1995 and April 1996

more occurrences of sand compared to the pre-monsoon near-shore sediments. The difference in sand content (fig. 6) can probably be attributed to sea conditions. The roughness associated with the open sea would have caused the Malaysian waters to have less silt and clay since the water turbulence aids in dispersing the finer sediment further off-shore, while the semi enclosed condition of the gulf helps to reduce turbulence thus at the same contain the river discharges within the gulf.

The sand content of the near-shore sediments is highest followed by mid-shore and off-shore areas. This trend is true for both the Malaysian and Thailand waters during both sampling periods (tabs. 4A to 4G; figures 7 and 8). An interesting trend is that the amount of sand is significantly less in the post-monsoon sediments compared to that of the pre-monsoon sediments.

The trend for silt and clay is opposite to that of sand; they show a decreasing trend shoreward. The differences in their amount is statistically significant for the pre but not so for the post-monsoon sediments (tabs. 1 and 2). Sand being denser than silt and clay would settle earlier along their transport path. Thus accounting for more sand in the near-shore areas compared to mid or off-shore.

Color (Tabs. 5A to 5D)

Although colors is less important now in the study of sediments due to the advancement in the field of organic substances in soil, composition of primary and secondary minerals in the soil, it remains a useful tool in the field to describe soil characteristics since some color change may occur as a result of oxidation and exposure prior to further laboratory analyses.

Overall there are 4 classifications of sediment colors determined for the pre-monsoon sediments: dull yellow orange, light yellow, grayish olive and olive yellow. It is interesting to note, however, that only the dull yellow orange color was identified for the sediments in the Gulf of Thailand. However, caution must be exercised since the first 8 stations in the gulf of Thailand was not included in this description due to some technical error. But the dominance of the color is remarkable, especially when contrasting it with the myriad of other colors found in the Malaysian sediments.

The sediment color for the post-monsoon sediments did not seem to differ too much from the pre-monsoon sediments. Except for the dull yellow orange color, which were found in the pre-monsoon sediments all the three other color remains. The dull yellow orange color, which were identified for the pre-monsoon sediments, is substituted by dull yellow colored sediments. This color dominates the mid-shore and off-shore areas of both the Malaysian and Thailand sediments.

Besides the sediment source, pollution levels and oxidation process may be the contributing factors to this differences in sediment color. Further analysis and correlation with other chemical and biological parameters are needed before further any definitive conclusion can be made.

Conclusion

Three general trends can be discerned from the results. Firstly, the April ‘96 sediments are finer, better sorted, more positively skewed and more peaked than the September ‘95 sediments. Secondly, the Malaysian sediments in general are coarser, more poorly sorted and less peaked than the sediments collected from the Thai waters. Thirdly, the coarsest and best sorted sediments are found near-shore while the mid-shore region has the finest and most poorly sorted sediments.

Additionally, it can also be concluded that although there are some similarities between the waters of Thailand and Malaysia, nevertheless, the differences in the amount of sand changes the texture of the sediments and would thus influencing the structure and diversity of the benthic communities. The marked difference in the sediment colors also indicate the differences in the component of primary and secondary minerals within the soil of the gulf and the open ocean of the Malaysian waters. The geological structures of the respective country may be another factor that may have contributed to the differences in the sediment color and grain size distribution patterns. Additionally, it seems that the inorganic sediment within the gulf and the continental shelf of the Malaysian waters are mainly terrestrially derived.

Table 4a. Percentages of sand, silt and clay

	% SAND			% SILT			% CLAY		
NEARSHORE STATIONS	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	38.92	17.59	-21.30	47.72	73.43	25.71	15.95	9.00	-6.95
Minimum	7.80	0.00	-7.80	4.10	0.00	-4.10	4.10	0.00	-4.10
Maximum	100.00	100.00	0.00	76.30	95.01	18.71	32.60	18.15	-14.50
Range	92.20	100.00	7.80	72.20	95.01	22.81	28.50	18.15	-10.40
MALAYSIAN STATIONS	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	43.98	24.15	-19.80	45.16	66.76	21.60	15.84	0.09	-15.80
Minimum	13.90	1.94	-12.00	4.10	0.00	-4.10	8.10	0.00	-8.10
Maximum	100.00	100.00	0.00	70.70	86.83	16.13	29.90	18.15	-11.80
Range	86.10	98.06	11.96	66.60	86.83	20.23	21.80	18.15	-3.65
THAILAND STATIONS	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	33.85	11.96	-21.90	50.03	79.17	29.14	16.04	8.92	-7.12
Minimum	7.80	0.00	-7.80	26.90	39.27	12.37	4.10	2.28	-1.82
Maximum	64.70	52.72	-12.00	76.30	95.01	18.71	32.60	15.45	-17.20
Range	56.90	52.72	-4.18	49.60	55.74	6.34	28.50	13.17	-15.30

Table 4b. Percentages of sand, silt and clay

	% SAND			% SILT			% CLAY		
ALL NEARSHORE STATIONS	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	50.43	23.24	-27.20	44.52	69.68	25.16	13.15	7.07	-6.08
Minimum	7.80	0.00	-7.80	21.50	0.00	-21.50	4.10	0.00	-4.10
Maximum	100.00	100.00	0.00	67.00	90.47	23.47	28.50	14.47	-14.00
Range	92.20	100.00	7.80	45.50	90.47	44.97	24.40	14.47	-9.93
ALL MIDSHORE STATIONS	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	36.35	16.03	-20.30	46.26	74.50	28.24	15.97	9.46	-6.51
Minimum	11.80	1.49	-10.30	4.10	36.61	32.51	8.10	3.50	-4.60
Maximum	67.00	54.01	-13.00	67.30	74.50	7.20	32.60	9.46	-23.10
Range	55.20	52.52	-2.68	63.20	37.89	-25.30	24.50	5.96	-18.50
ALL OFFSHORE STATIONS	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	27.36	12.87	-14.50	53.53	76.53	23.00	19.10	10.71	-8.39
Minimum	13.90	1.49	-12.40	30.10	52.34	22.24	8.90	4.72	-4.18
Maximum	45.50	40.44	-5.06	76.30	90.02	13.72	29.90	18.15	-11.80
Range	31.60	38.95	7.35	46.20	37.68	-8.52	21.00	13.43	-7.57

Sept denote - September 1995 sediment
April denote - April 1996 sediment
Dif denote - Difference between September 1995 and April 1996

Table 4c. Percentages of sand, silt and clay

	ALL NEARSHORE STATIONS								
	% SAND			% SILT			% CLAY		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	50.43	23.24	-27.20	44.52	69.68	25.16	13.15	7.07	-6.08
Minimum	7.80	0.00	-7.80	21.50	0.00	-21.50	4.10	0.00	-4.10
Maximum	100.00	100.00	0.00	67.00	90.47	23.47	28.50	14.47	-14.00
Range	92.20	100.00	7.80	45.50	90.47	44.97	24.40	14.47	-9.93

	ALL NEARHORE STATIONS (MALAYSIAN WATERS)								
	% SAND			% SILT			% CLAY		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	64.66	38.12	-26.50	41.10	56.13	15.03	11.80	5.75	-6.05
Minimum	22.50	8.12	-14.40	21.50	0.00	-21.50	8.10	0.00	-8.10
Maximum	100.00	100.00	0.00	67.00	85.52	18.52	16.50	10.20	-6.30
Range	77.50	91.88	14.38	45.50	85.52	40.02	8.40	10.20	1.80

	ALL NEARSHORE STATIONS (THAILAND WATERS)								
	% SAND			% SILT			% CLAY		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	39.76	13.02	-26.70	46.23	78.99	32.76	13.82	7.67	-5.85
Minimum	7.80	0.00	-7.80	26.6-9	39.27	12.37	4.10	2.28	-1.82
Maximum	64.60	52.72	-11.90	64.30	90.47	26.17	28.50	14.47	-14.00
Range	56.80	52.72	-4.08	37.40	51.20	13.80	24.40	12.19	-12.20

Table 4d. Percentages of sand, silt and clay

	ALL NEARSHORE STATIONS								
	% SAND			% SILT			% CLAY		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	36.35	16.03	-20.32	46.26	74.50	28.24	15.97	9.46	-6.51
Minimum	11.80	1.49	-10.31	4.10	36.61	32.51	8.10	3.50	-4.60
Maximum	67.00	54.01	-12.99	67.30	74.50	7.20	32.60	9.46	-23.14
Range	55.20	52.52	-2.68	63.20	37.89	-25.31	24.50	5.96	-18.54

	ALL MIDSHORE STATIONS (MALAYSIAN WATERS)								
	% SAND			% SILT			% CLAY		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	41.19	23.56	-17.63	41.57	66.05	24.48	14.31	10.36	-3.95
Minimum	22.20	6.85	-15.35	4.10	36.61	32.51	11.00	4.83	-6.17
Maximum	67.00	54.01	-12.99	65.50	85.32	19.82	21.50	17.12	-4.38
Range	44.80	47.16	2.36	61.40	48.71	-12.69	10.50	12.29	1.79

	ALL MIDSHORE STATIONS (THAILAND WATERS)								
	% SAND			% SILT			% CLAY		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	31.81	10.58	-21.23	50.67	80.61	29.94	17.52	8.81	-8.71
Minimum	11.80	1.49	-10.31	27.20	59.79	32.59	8.10	3.50	-4.60
Maximum	64.70	35.89	-28.81	67.30	95.01	27.71	32.60	14.48	-18.12
Range	52.90	34.40	-18.50	40.10	35.22	-4.88	24.50	10.98	-13.52

Sept denote - September 1995 sediment
April denote - April 1996 sediment
Dif denote - Difference between September 1995 and April 1996

Table 4e. Percentages of sand, silt and clay

	ALL OFFSHORE STATIONS								
	% SAND			% SILT			% CLAY		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	27.36	12.87	-14.50	53.53	76.53	23.00	19.10	10.71	-8.39
Minimum	13.90	1.49	-12.40	30.10	52.34	22.24	8.90	4.72	-4.18
Maximum	45.50	40.44	-5.06	76.30	90.02	13.72	29.90	18.15	-11.80
Range	31.60	38.95	7.35	46.20	37.68	-8.52	21.00	13.43	-7.57
	ALL OFFSHORE STATIONS (MALAYSIAN WATERS)								
	% SAND			% SILT			% CLAY		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	28.12	12.91	-15.20	51.80	76.46	24.66	20.08	10.64	-9.44
Minimum	13.90	1.94	-12.00	30.10	52.34	22.24	12.80	6.19	-6.61
Maximum	45.50	37.10	-8.40	70.70	86.83	16.13	29.90	18.15	-11.80
Range	31.60	35.16	3.56	40.60	34.49	-6.11	17.70	11.96	-5.74
	ALL OFFSHORE STATIONS (THAILAND WATERS)								
	% SAND			% SILT			% CLAY		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	26.14	12.82	-13.30	56.35	76.63	20.28	17.51	10.82	-6.69
Minimum	14.80	1.49	-13.30	44.90	55.75	10.85	8.90	1.49	-7.41
Maximum	44.30	40.44	-3.86	76.30	90.02	13.72	22.80	15.45	-7.35
Range	29.50	38.95	9.45	31.40	34.27	2.87	13.90	13.96	0.06

Table 4f. Percentages of sand, silt and clay - Malaysian waters

	NEARSHORE STATIONS								
	% SAND			% SILT			% CLAY		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	64.66	38.12	-26.50	41.10	56.13	15.03	11.80	5.75	-6.05
Minimum	22.50	8.12	-14.40	21.50	0.00	-21.50	8.10	0.00	-8.10
Maximum	100.00	100.00	0.00	67.00	85.52	18.52	16.50	10.20	-6.30
Range	77.50	91.88	14.38	45.50	85.52	40.02	8.40	10.20	1.80
	MIDSHORE STATIONS								
	% SAND			% SILT			% CLAY		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	41.19	23.56	-17.60	41.57	66.05	24.48	14.31	10.36	-3.95
Minimum	22.20	6.85	-15.40	4.10	36.61	32.51	11.00	4.83	-6.17
Maximum	67.00	54.01	-13.00	65.50	85.32	19.82	21.50	17.12	-4.38
Range	44.80	47.16	2.36	61.40	48.71	-12.70	10.50	12.29	1.79
	OFFSHORE STATIONS								
	% SAND			% SILT			% CLAY		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	28.12	12.91	-15.20	51.80	76.46	24.66	20.08	10.64	-9.44
Minimum	13.90	1.94	-12.00	30.10	52.34	22.24	12.80	6.19	-6.61
Maximum	45.50	37.10	-8.40	70.70	86.83	16.13	29.90	18.15	-11.80
Range	31.60	35.16	3.56	40.60	34.49	-6.11	17.10	11.96	-5.14

Sept denote - September 1995 sediment
April denote - April 1996 sediment
Dif denote - Difference between September 1995 and April 1996

Table 4g. Percentages of sand, silt and clay - Thailand waters

	NEARSHORE STATIONS								
	% SAND			% SILT			% CLAY		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	39.76	13.02	-26.70	46.23	78.99	32.76	13.82	7.97	-5.85
Minimum	7.80	0.00	-7.80	26.90	39.27	12.37	4.10	2.28	-1.82
Maximum	64.60	52.72	-11.90	64.30	90.47	26.17	28.50	14.47	-14.00
Range	56.80	52.72	-4.08	37.40	51.20	13.80	24.40	12.19	-12.20
	MIDSHORE STATIONS								
	% SAND			% SILT			% CLAY		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	31.81	10.58	-21.20	50.67	80.61	29.94	17.52	8.81	-8.71
Minimum	11.80	1.49	-10.30	27.20	59.79	32.59	8.10	3.50	-4.60
Maximum	64.70	35.89	-28.80	67.30	95.01	27.71	32.60	14.48	-18.10
Range	52.90	34.40	-18.50	40.10	35.22	-4.88	24.50	10.98	-13.50
	OFFSHORE STATIONS								
	% SAND			% SILT			% CLAY		
	Sept.	April	Diff.	Sept.	April	Diff.	Sept.	April	Diff.
Average	26.14	12.82	-13.30	56.35	76.63	20.28	17.51	10.82	-6.69
Minimum	14.80	1.49	-13.30	44.90	55.75	10.85	8.90	1.49	-7.41
Maximum	44.30	40.44	-3.86	76.30	90.02	13.72	22.80	15.45	-7.35
Range	29.50	38.95	9.45	31.40	34.27	2.87	13.90	13.96	0.06

Sept denote - September 1995 sediment
April denote - April 1996 sediment
Dif denote - Difference between September 1995 and April 1996

Table 5a. Colour distribution of bottom sediments

	ALL	Malaysian Water	Thailand Water
Dull Yellow	34 (51.51%)	20 (64.52%)	14 (40.00%)
Dull Yellow Orange	4 (6.06%)	2 (6.45%)	2 (5.71%)
Grayish Olive	11 (16.66%)	1 (3.24%)	10 (28.57%)
Olive Yellow	17 (25.76%)	8 (25.81%)	9 (25.71 %)

Table 5b. Colour distribution of bottom sediments

	Nearshore	Midshore	Offshore
Dull Yellow	3 (18.75%)	15 (55.56%)	15 (71.43%)
Dull Yellow Orange	0 (0%)	0 (0%)	4 (19.05%)
Grayish Olive	4 (25.00%)	5 (18.52%)	2 (9.25%)
Olive Yellow	9 (56.25%)	7 (25.93%)	0 (0%)

Table 5c. Colour distribution of bottom sediments Thailand water

	Nearshore	Midshore	Offshore
Dull Yellow	1 (10.00%)	6 (42.86%)	6 (60.00%)
Dull Yellow Orange	0 (0%)	0 (0%)	2 (20.00%)
Grayish Olive	4 (40.00%)	4 (28.57%)	2 (20.00%)
Olive Yellow	5 (50.00%)	4 (28.57%)	0 (0%)

Table 5d. Colour distribution of bottom sediments Malaysian water

	Nearshore	Midshore	Offshore
Dull Yellow	2 (33.33%)	9 (69.23%)	9 (81.81%)
Dull Yellow Orange	0 (0%)	0 (0%)	2 (18.18%)
Grayish Olive	0 (0%)	1 (7.69%)	0 (0%)
Olive Yellow	4 (66.66%)	3 (23.08%)	0 (0%)

Table 5e. Colour distribution of bottom sediments for April 1996 sediments

	All	Malaysian water	Thailand Water
Dull Yellow	34 (51.51%)	20 (64.52%)	14 (40.00%)
Dull Yellow Orange	4 (6.06%)	2 (6.45%)	2 (5.71%)
Grayish Olive	11 (16.66%)	1 (3.24%)	10 (28.57%)
Olive Yellow	17 (25.76%)	8 (25.81%)	9 (25.71%)

Table 5f. Colour distribution of bottom sediments for April 1996 sediments

	Nearshore	Midshore	Offshore
Dull Yellow	3 (18.75%)	15 (55.56%)	15 (71.43%)
Dull Yellow Orange	0 (0%)	0 (0%)	4 (19.05%)
Grayish Olive	4 (25.00%)	5 (18.52%)	2 (9.25%)
Olive Yellow	9 (56.25%)	7 (25.93%)	0 (0%)

Table 5g. Colour distribution of bottom sediments for April 1996 sediments Thai water

	Nearshore	Midshore	Offshore
Dull Yellow	1 (10.0%)	6 (42.86%)	6 (60.00%)
Dull Yellow Orange	0 (0%)	0 (0%)	2 (20.00%)
Grayish Olive	4 (40.00%)	4 (28.57%)	2 (20.00%)
Olive Yellow	5 (50.00%)	4 (28.57%)	0 (0%)

Table 5h. Colour distribution of bottom sediments for April 1996 sediments Malaysian water

	Nearshore	Midshore	Offshore
Dull Yellow	2 (33.33%)	9 (69.23%)	9 (81.81%)
Dull Yellow Orange	0 (0%)	0 (0%)	2 (18.18%)
Grayish Olive	0 (0%)	1 (7.69%)	0 (0%)
Olive Yellow	4 (66.66%)	3 (23.08%)	0 (0%)

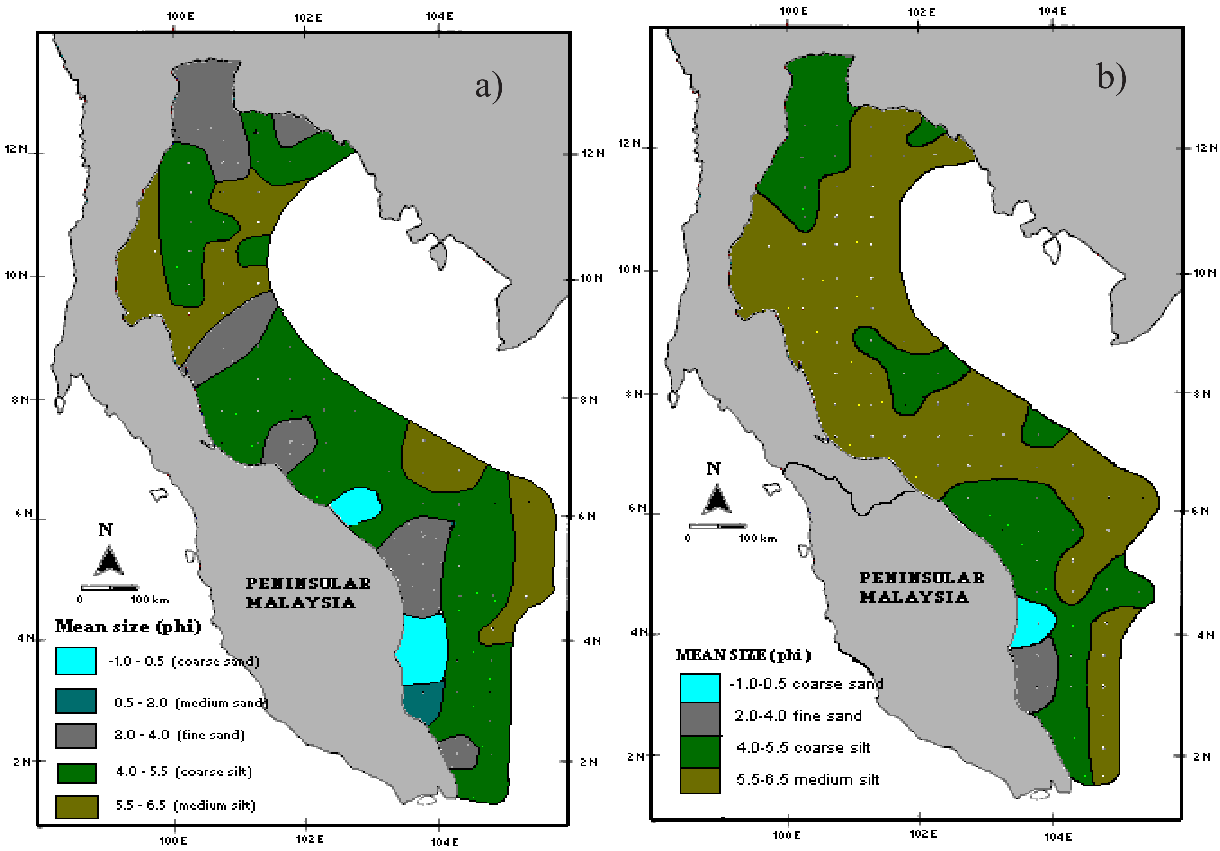

Fig. 2 Patterns of sediment mean size distribution in September of 1995 (a) and April of 1996 (b)

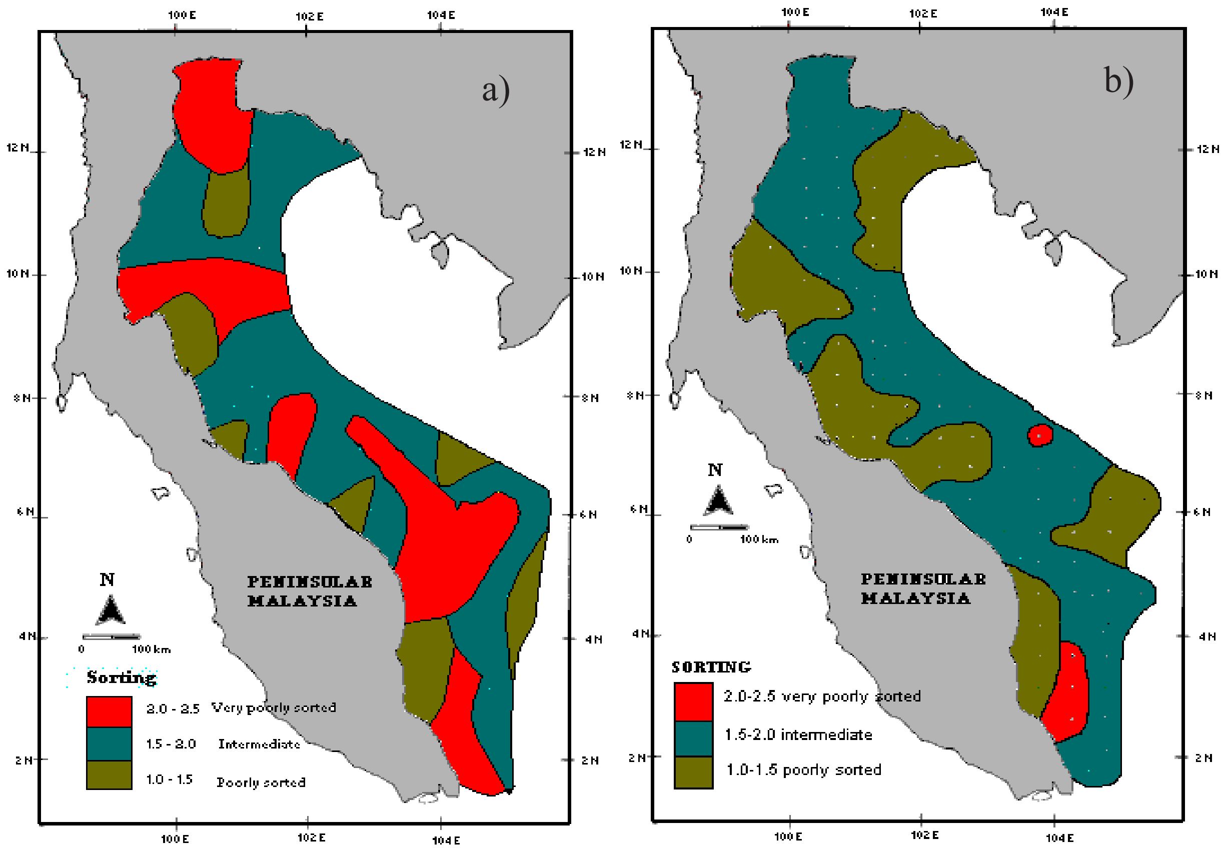

Fig. 3 Patterns of sediment sorting distribution in September of 1995 (a) and April of 1996 (b)

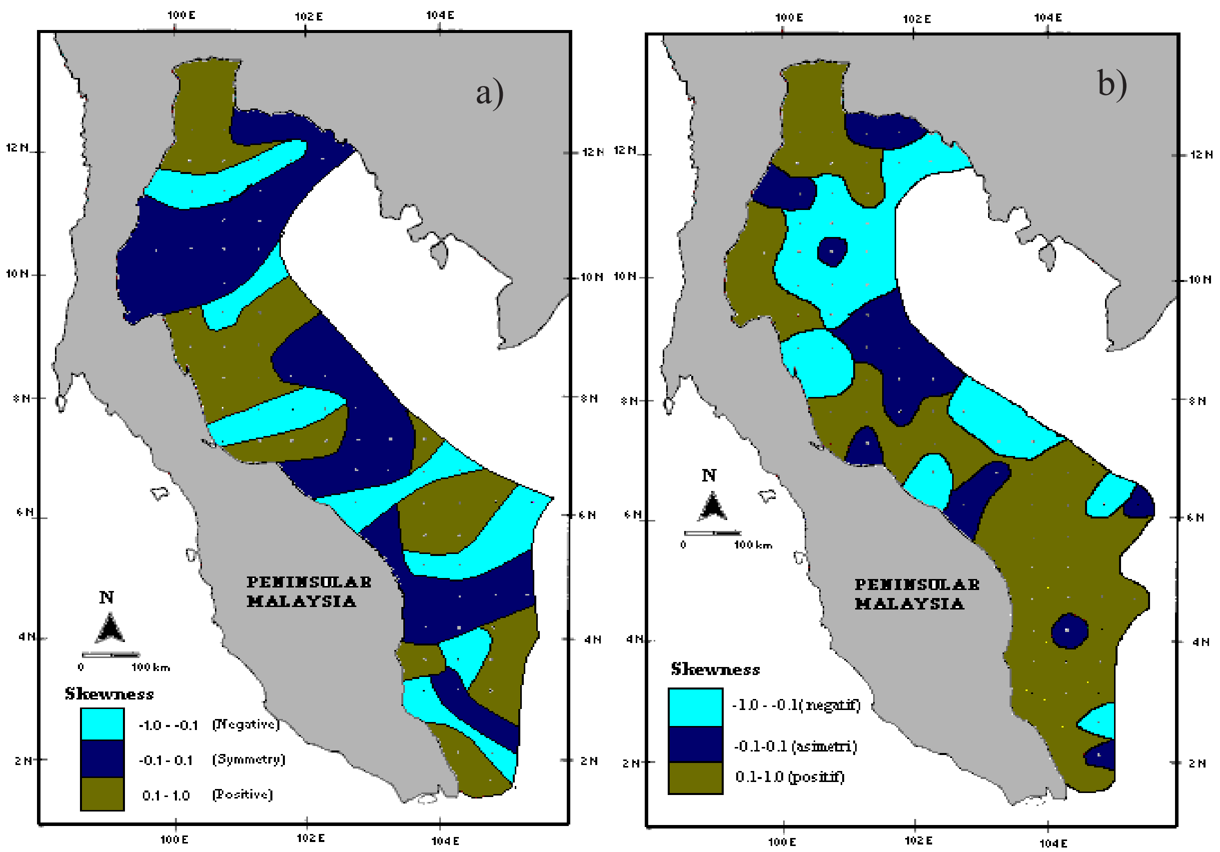

Fig. 4 Patterns of sediment skewness distribution in September of 1995 (a) and April of 1996 (b)

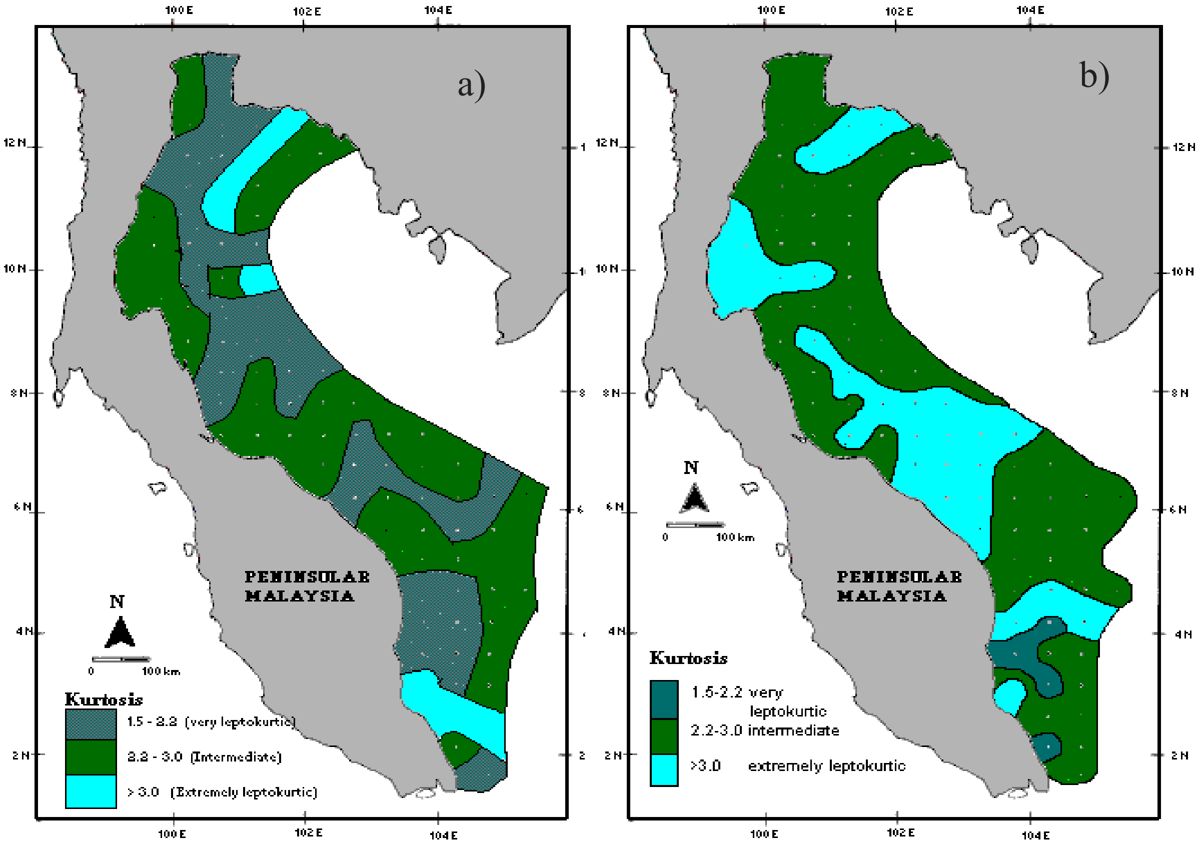

Fig. 5 Patterns of sediment kurtosis distribution in September of 1995 (a) and April of 1996 (b)

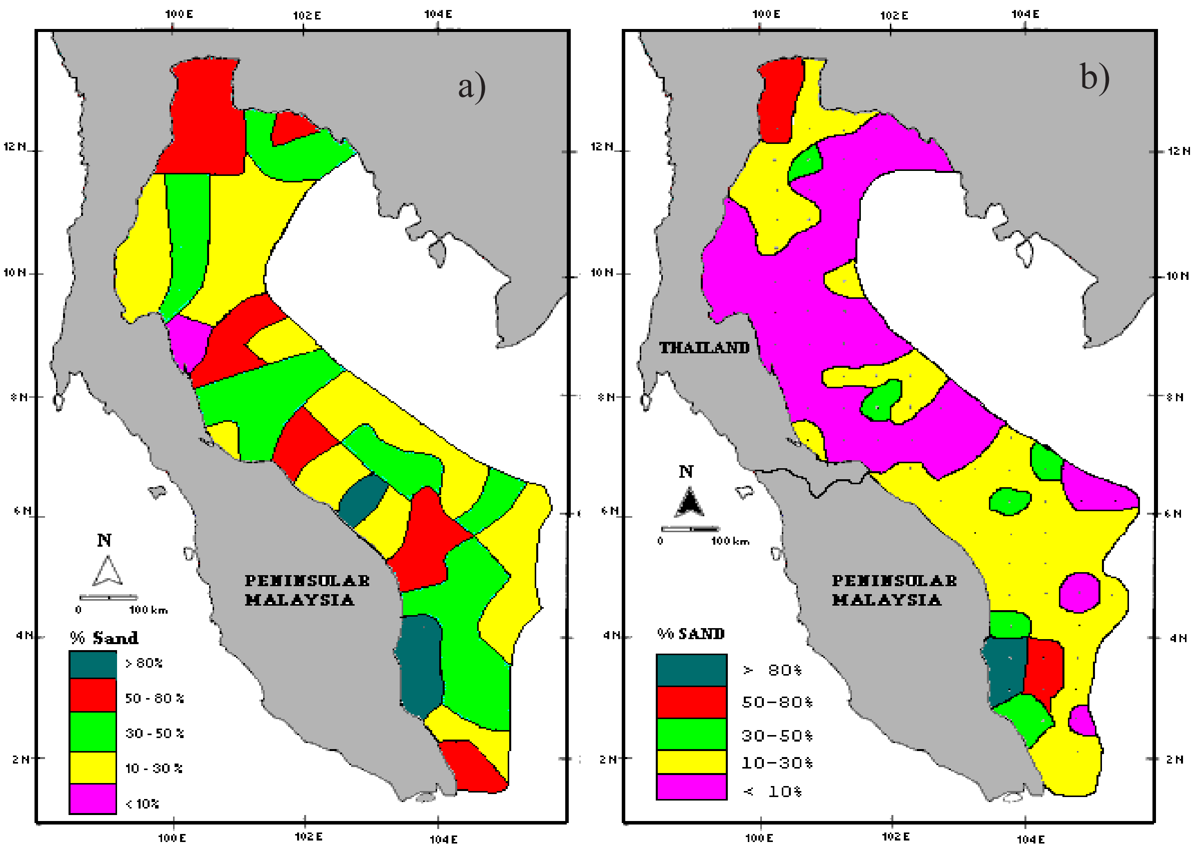

Fig. 6 Sand content distribution in September of 1995 (a) and April of 1996 (b)

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