

## **Sedimentological Characteristic of Bottom Sediment of Vietnamese Coastline**

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### **ABSTRACT**

During survey of SEAFDEC vessel in May, 1999, 39 samples of bottom sediments of Vietnamese coastline were collected. The samples were analyzed for their sedimentological, micropaleontological characteristics as well as for their total organic matter and mineralogical composition of sediments. The study area can be divided into three parts: northern, central and southern part. Northern and southern parts are characterized by a wide, shallow continental shelf, while central part has very narrow continental shelf.

Generally, in the southern part sand is more spread, especially in the front of the Maekong river mouth (25.64% of total sediments), sediments is coarser than in others (average mean size is 0.162mm), better sorted, less skewed. In the northern part, clayish silts, clayish, sandy silts are most spread, sediments are poor sorted, moderate skewed. Average mean size is 0.088mm. In the central part, clayish, silty sand is dominant. Average mean size is 0.1507mm. Sediments are poor sorted.

Result of study revealed an occurrence of 98 foraminifers species in the bottom sediments, 19 of them are plankton and 79 are benthos.

A content of total organic matter in the study area varies from 0.125% to 1.344%. High content of TOM is observed in the central part, as well as in the south western part.

A study on mineralogical composition has pointed out a presence of 35 minerals in bottom sediment.

### **Introduction**

Continental shelf of Vietnam has been studied since 1970. During 1970-1980 these studies were focused mainly on biological aspect, geological aspects were not concerned. After 1980, study of continental shelf of Vietnam was put forward. Some marine projects were carried out and works dealing with bottom sediment were published [Nguyen Huu Cu., 1991, Nguyen Van Tac, 1996, Nguyen The Tiep, 1995, Tran Duc Thanh, 1991, Trinh The Hieu, 1996]. Since 1991 geological mapping scale of 1:500,000 of nearshore shallow marine water (0-30 m water depth) has being carried out.

Implementing a collaboration between Southeast Asia Fisheries Development Center and Research Institute for Marine Products, in May 1999 researchers from Japan, Thailand, Malaysia and Vietnam have gathered on the vessel SEAFDEC to conduct research on the South China Sea- zone IV (Fig.1). One of the objectives of program is to study bottom sediments. This work focused only on information gathered and a result of analyses of bottom sediments collected during cruise in May, 1999.

### **Description of study area**

Study area is stretched from 103° E to 112°E and from 21°N to 7°N (Fig.1). This area can be divided into 3 parts: Northern, Central and Southern.

Northern part is from 21°N to 17°N and characterized by shallow, wide continental shelf.

Water depth is from 10m-15m to 25m-30m. Central part is from 17°N to 11°N and characterized by a narrow continental shelf. Its width is of 40km-50 km. After that the water depth is abruptly reached 1000m-2000m. Southern part is characterized by wide continental shelf. The water depth is from 20m-30m to 50m-60m

### Materials and Methods

Sampling process was carried out by corer and grab. From 58 surveyed stations, sampling was success only at 39 stations (Fig.1). Because of technical problems, bottom sediments were not taken at 19 stations, mainly in the Central part, where water depth is too deep, exceeds over 200m. From 39 stations, samples taken by corer only at 27 stations, at others process sampling was carried out by grab. Upon retrieval of core or grab, some parameters of bottom sediments were recorded: color, stratification, texture and length of collected sediment.

In laboratory, 5cm of sample was cut from top of core and 200 gr. from grab were taken for different analyses.

Following analyses were implemented in the Institute of Geology:

Grainsize analysis

Total organic matter analysis

Micropaleontological analysis

Mineralogical analysis

For grainsize analysis, depending on texture of sediments two methods were chosen for analysis: sieving and pipette methods. If a content of coarse fraction ( $> 0.063\text{mm}$ ) is less than 20 %, then a pipette method was applied. This method determines the concentration of a suspension at a series of predetermined depths as a function of settling time. A pipette was used to withdraw a solution at intervals from 30s to 24 h depending on a fractions. The solid concentration from each fraction is determined by evaporation. Sand-size particles in sample are separated by wet sieving, then mechanically classed by dry sieving. In the case if a content of fine fraction ( $< 0.063\text{mm}$ ) is less than 20 %, then sieving method is applied. Sediments are reported in mm.

For sieving method, 100grams of splitted sample were taken for analysis. A standard sieves with an interval of  $10 \pm 10$  was used. Sediments were sieved using a sieve shaker for 15 minutes. After that each fraction was weighed, recorded and used for making cumulative curve and determination of sediment parameters: Md, So, Sk and K.

For pipette analysis, carbonate and organic matters were removed from sediments using HCL and  $\text{H}_2\text{O}_2$  respectively. Then a dispersing agent such as sodium hexametaphosphate was added to sediment solution. This solution is put into one litre cylinder and filled up with distilled water. Using the Stocks law, at different time and distance, from this solution, fractions of 0.1-0.05, 0.05-0.01, 0.01-0.005, 0.005-0.001 and less than 0.001mm were taken by pipette. After that, samples were dried and weighed for calculation percentage of each fraction. Using percentage of fractions to make a cumulative curve. From the cumulative curve (Fig.2), sedimentological parameters were calculated as follow [Petijohn, 1975].

$$So = \sqrt{\frac{Q_1}{Q_3}} \quad Sk = \sqrt{\frac{Q_1 * Q_3}{Md^2}} \quad K = \frac{Q_1 - Q_3}{2(P_{10} - P_{90})}$$

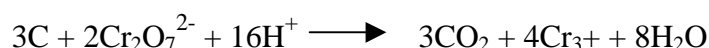
Where  $Q_1$ -grainsize corresponds to 25 % on the curve,  $Q_3$  – grainsize corresponds to 75%,

P10- grainsize corresponds to 10% and P90- Grainsize corresponds to 90% ( Fig.2)  
Md- is a grainsize of sample that corresponds to 50% on the curve

For micropaleontological analysis, 50 grams of sample was taken for analysis. Using microscope MBC-10 for determining foraminifer species. Each species was determined and established its abundance in sample according to 3 categories: High, intermediate and low.

For mineralogical analysis, fraction 0.1mm - 0.125mm was chosen for analyze. Determine mineral and its abundance in sample using microscope MBC-10.

Method Thurin was used for determination total organic matter of bottom sediment.  $K_2Cr_2O_7$  was used for oxidation of organic matter as follow:



Diphenylamine was used as color indicator during titration, obstacle of  $Fe^{3+}$  is surmounted using  $H_3PO_4$ .

## Result and Discussion

### *Grainsize composition* ( Table1, Fig. 3, 4, 5, 6 )

In general, the study area can be divided into 3 parts: Northern, Central and Southern with its particular features, so grainsize characteristic will be reported separately for each region.

#### *Northern part*

For this area an average medium size (Md) of bottom sediment is 0.088mm ( very fine sand). The lowest value is 0.0041mm ( clay) and the highest is 0.25mm ( medium sand). Two of ten stations ( St.2, 8) have highest value of Md ( 0.25mm and 0.23mm respectively). Three other stations ( St.3, 6, 9) have low value of Md ( from 0.0041 to 0.0046mm). From analyses one conclusion can be made that sediment in Northern part is poor sorted. An average value of sorting coefficient ( So ) is 3.46. The best sorted sediments are at station 2, where So is 1.16. The worst sorted sediments is at station 1 with a value of So of 5.35. At station 5, some gravels of 0.5cm are present in clayish silt . These are old tidal channel deposits.

Skewness ( Sk) of sediments in the Northern part is not too high. The average value of Sk is 0.832. The lowest value is 0.32 ( St.8) and the highest is 1.03 ( St.9). The average value of kurtosis of sediments in the Northern part is 0.229, varies from 0.332 to 0.055.

#### *Central part*

In general, sediments in central part are coarser than in the northern part. The average value of Md is 0.1507mm ( medium sand). The highest value of Md is 0.45mm and the lowest is 0.0082mm. Bottom sediments in the central part are poor sorted, more skewed compared with sediments in the North and South. Average value of So is 5,29. The highest value of So is 18.46 ( worst sorted) and the lowest is 1,2 (well sorted). Skewness of sediments in the Central part varied from 0.98 to 0.48. An average value is 0.758. Kurtosis of sediments is from 0.229 to 0.084, average value is 0.187.

#### *Southern part*

The range of Md in the Southern part is quite wide, with an average value is 0.162mm. The highest value of Md is 0.5mm at station 38 and the lowest value is 0.0028mm at station 55. Sediments in the front of the Maekong River mouth are coarser, mainly sand and silty sand. In opposite, in the western part ( Gulf of Thailand ) sediments are finer, mainly silty clay and clayish silts. Bottom sediments in the Southern part are better sorted compared with others regions. Their average value of So is 2.57.



Maximum value is 7.63 and minimum is 1.1. In general, sediments in the front of the Maekong river mouth are very well sorted (So is of 1.1 to 1.5). In the west (Gulf of Thailand), sediments are poorer sorted (So is of 2.89 to 7.63). The average skewness value of sediments is 1.02, ranging from 1.53 to 0.31. Average kurtosis is 0.194, varies from 0.493 to 0.055.

Generally, an average value of Md for whole area is 0.1335mm, the maximum value is 0.5mm and the minimum is 0.0028mm (from coarse sand to clay). The average value of So is 3.773 and varied from 1.1 (the best sorted) to 18.46 (the worst sorted). Bottom sediments in the Central part are poorer sorted. Sediments in the Southern part, especially in the front of the Maekong river mouth are very well sorted. An average skewness value for whole area is 0.87, varied from 0.31 to 1.53. An average kurtosis of sediments for whole area is 0.203.

#### **Texture** (Table 2, 3, Fig.7, 8, 9, 10, 12)

Generally, in the study area can be distinguished 6 types of bottom sediments: sand, silty sand, clayish-silty sand, clayish silt, clayish-sandy silt, and silty clay. Sand is the most spread in the study area. Its occurrence frequency is 35.89%. This is concerned with sand formation in the front of the Maekong river mouth, where sand occupied 33.33% of total bottom sediment in the study area. In the Northern part, sand occupied only 2.56% and it is absent in the Central part. Clayish-silty sand is quite spread in the study area followed sand. Its occurrence frequency is 20.49%. It is more spread in the Central and Southern parts, where its occurrence frequency is 7.68%. Silty sand is less spread in the area. It occupied only 17.93% of total bottom sediments. Its high content is observed in the Central part (average value is 7.68%). The occurrence frequency of clayish silt in the study area is 10.24%, concentrates mainly in the North (5.12%), in other regions its content is quite low (2.56% for both areas). Silty clay and clayish-sandy silt have the same occurrence frequency in the study area (7.68%). They are widely spread in the southwestern part and absent in the Central part. In the Northern part, a content of clayish-sandy silt is higher than in the south (5.12 compared 2.56%).

From Table 3, it is clear that sand is the most spread in the study area. Its average percentage is 57.39% for whole area. Its highest value is observed in the South, where it reached 72.55%. Maximum content of sand is 100% and minimum is 0%. In the Central part the content of sand is lower (only 56.82%), with maximum content is 88.4% and minimum is 4.8%. For the Northern part the content of sand still much lower, reached only 42.8% in an average, varied from 100% to 0%.

Silt is composed 26.55% for whole area. It is more spread in the North, where it content reached 33.5%. In the Central area it decreases to 29.25% and is still lower in the South, only 16.9% in average. Maximum value of silt content is observed in the South, reached 70.2%, while in the North and Central only 54.3% and 59.5% respectively.

In the study area, clay occupied only 16.05%, more spread in the Northern area and in the south western part, where its average content is 23.68%. It decreases in the Central and South eastern parts (13.9% and 10.58% respectively).

#### **Color of sediments** (Table 5)

Overall 5 colors of sediments can be distinguished: Greenish grey, dull grey, brownish grey, light grey and dull yellow. For whole area the most popular color is dull yellow (28.2%), followed by dull grey (25.64%) and light grey (23.07%). The greenish and brownish grey colors are less spread (15.78 and 7.69% respectively). For the Northern part, a greenish grey color is dominant (10.25%), while others are less than 5%. In the Central part a dull grey is the most popular (10.25%) compared with others only 2.56%. The picture of color is different for the Southern part, where dull yellow color is the most spread, occupied 23.07%. Light grey color is of 15.38% and dull grey occupied only 10.25%. Greenish grey and brownish grey have very low occurrence (5.12% and 2.56% respectively).

### **Total organic matter ( TOM) ( Table 4, Fig. 11)**

Average value of total organic matter in Vietnamese coastline is 0.77276%, varies from 0.125% to 1.344%. Maximum value is observed at station 55 and 13, minimum value is at station 44. Generally, in the front of the Maekong river mouth, where sand is dominant, the value of TOM is very low (0.12% - 0.14%). This value is higher in the Northern part, where minimum value is 0.48% and maximum is 1.326%. Average value of TOM for the Northern part is 0.8755%.

For the Central part, the average value of TOM reached 0.778%, varies from 0.395 to 1.34%. In the Southern part, the value of TOM is very low in the front of the Maekong river mouth, (a content of TOM is of 0.125%). It increases in the western part, where silty clay and clayish silt are dominant ( content of TOM is from 0.238 to 1.344%).

### **Micropaleontological characteristic. (Table 6)**

Total of 98 species of benthos and plankton foraminifers were found in bottom sediments of Vietnamese coastline, from which 19 species are plankton and 79 species are benthos foraminifer (Table 6, In general can be distinguished 3 regions:

1. Northern part from Mong Cai to Deo Ngang. Beside most common species such as *Quinqueloculina akneriata*, *Quinqueloculina elongata*, *Quinqueloculina oblonga*, *Pseudorotalia indopacifica*, *Globorotalia menadii*...., some special temperate species are present in this area: *Buccella* sp., *Ammonia beccarii*, *Trochammina inflata*, *Trochammina nitida*, especially *Brucella* sp. is present only in the Northern part. They are rich in clayish silt, sandy silt.

2. Central part from Deo Ngang to Vung Tau

This region is characterised by a presence of complex of foraminifer, which are typical species of shallow, warm ocean with high content of salt ( over 33‰). Following species have a high occurrence: *Calcarina hispida*, *Calcarina spengneri*, *Marginopora vertebralis*, *Elphidium crispum*, *Elphidium hispidulum*, *Quinqueloculina parkerii*. Especially *Calcarina hispida*, *Marginopora vertebralis*, *Amphistegina madagaskariensis* are present only in the Central part.

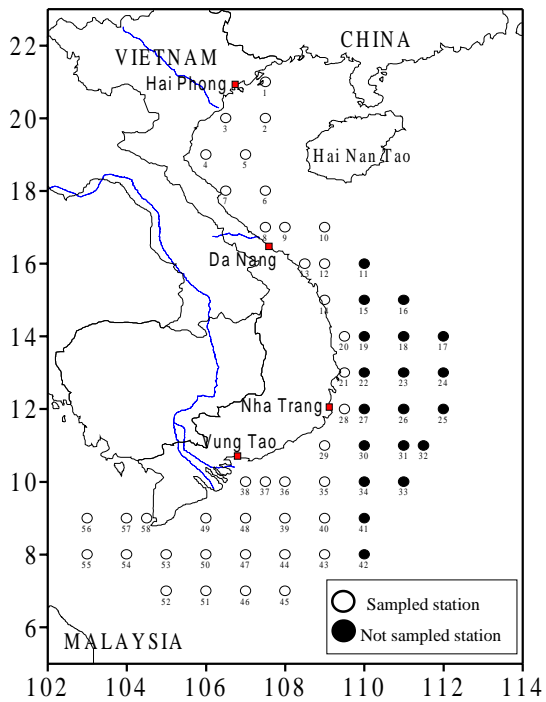
3. Southern part , from Vung Tau to Ha Tien

Sediments in the southern part are rich of foraminifers. Especially at station 51, about 30-35% of bottom sediment consists of foraminifers. Here, foraminifers have a big size (0.5-2 mm). These are *Globigerinoides trilobus* and *Globigerinoides sacclifer*. A result of study has revealed 94 foraminifers species in the southern part, most of them are benthos ( 75%). Plankton foraminifers occupied only around 25%. Some species are more abundant in this area such as *Amphistegina madagascariensis*, *Asiarotalia holocenia*, *Asiarotalia mekongensis*, *Asiarotalia multispinosa*, *Quinqueloculina* sp, *Operculina complanata*. A complex of foraminifers in the southern part is characterzied for tropical, warm sea.

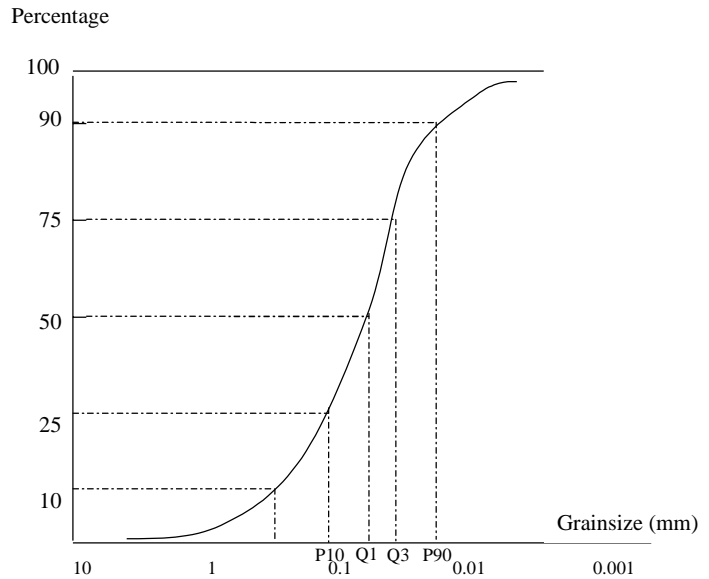
### **Mineralogical characteristic**

Study area is characterised by a wide spectrum of minerals. Mineral composition of bottom sediments in the study area varies in different parts. There are 30 minerals in a sand fraction (Table 7). For fine silt and clay fraction, according to previous study ( Nguyen Van Tac, 1996), following minerals are present: Kaolinite, montmorillonite, hydromica, chlorite and calcite.

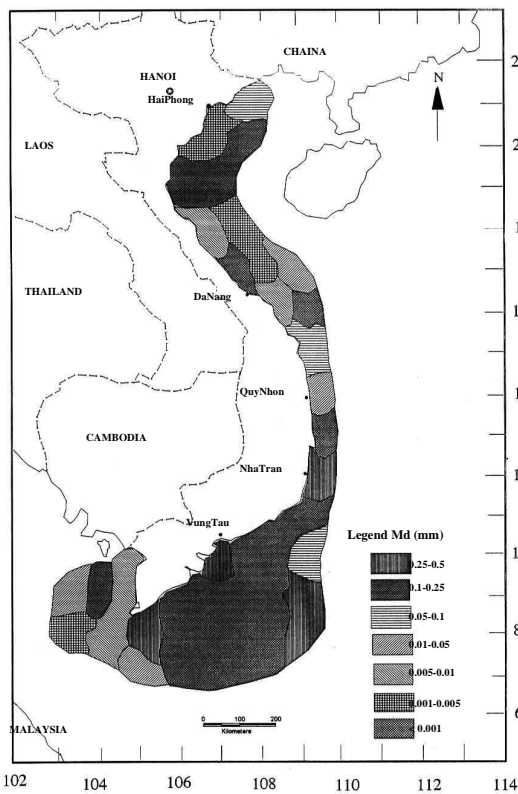
In sand fraction, quartz is dominant in sediments. In most samples, quartz composed 95-98% of sediments. Following quartz, in the study area, muscovite, feldspar, ilmenite and limonite are the most abundant in bottom sediments. The others have a low occurrence, varies from 0.001 to 0.1%. Central part is characterized by a high content of ilmenite, monazite, cassiterite and zircon, while in the northern part, ilmenite, garnet, actinolite, limonite are dominant in a heavy fraction.



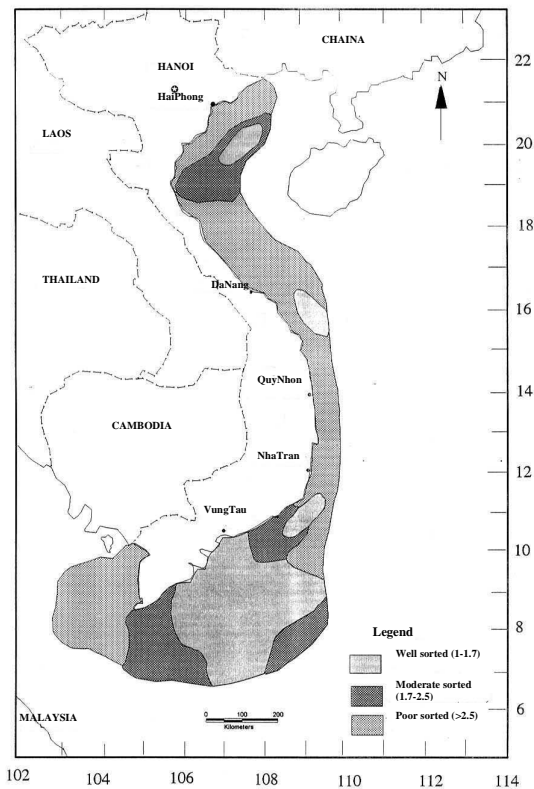
**Fig. 1.** Sampling location in Vietnamese coastline.



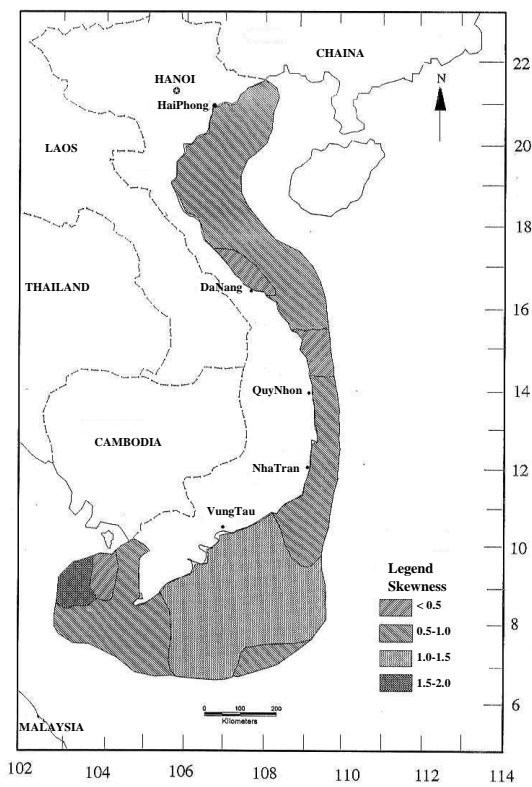
**Fig. 2.** Cumulative curve.



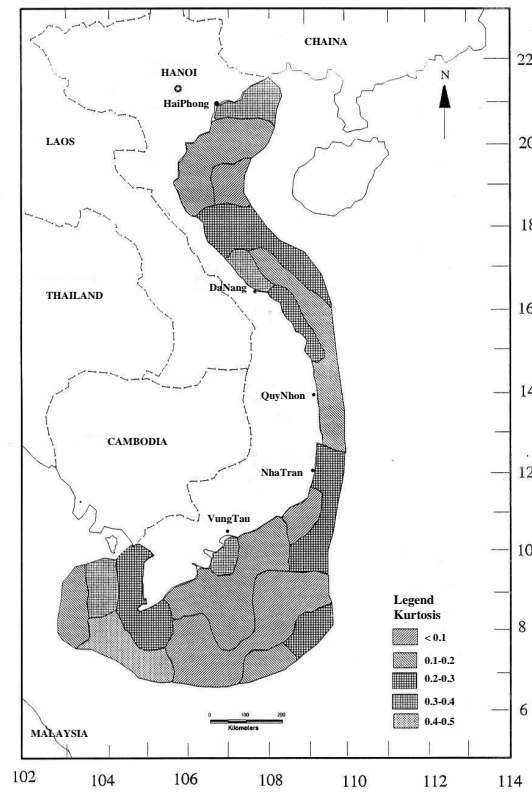
**Fig. 3.** Pattern of sediment mean size distribution in Vietnamese coastline.



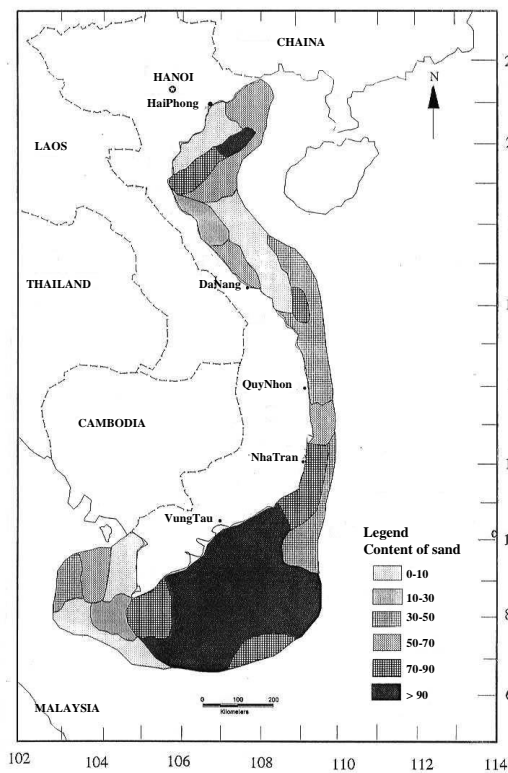
**Fig. 4.** Pattern of sediment sorting distribution of Vietnamese coastline.



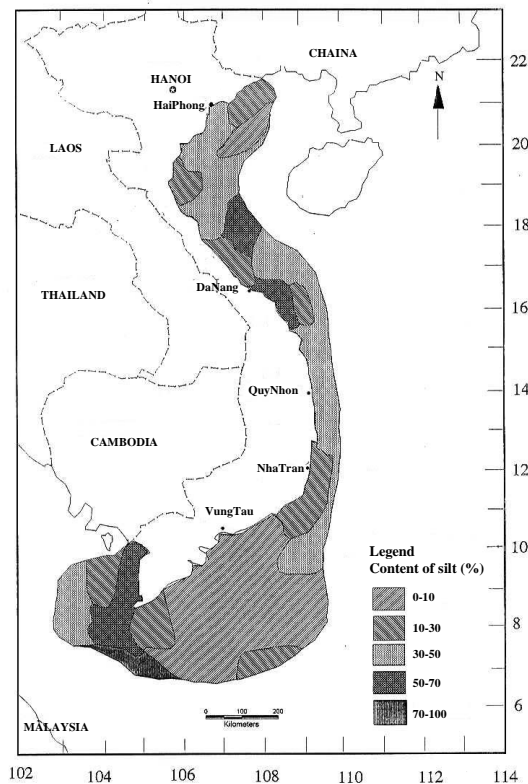
**Fig. 5.** Pattern of sediment skewness distribution in Vietnamese coastline.



**Fig. 6.** Pattern of sediment kurtosis in Vietnamese coastline.



**Fig. 7.** Sand content distribution of Vietnamese coastline.



**Fig. 8.** Silt content distribution of Vietnamese coastline.

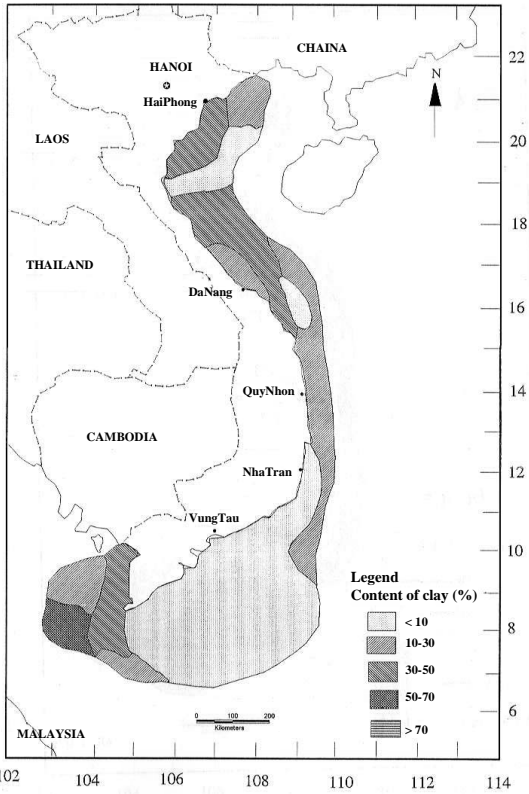


Fig. 9. Clay content distribution of Vietnamese coastline.

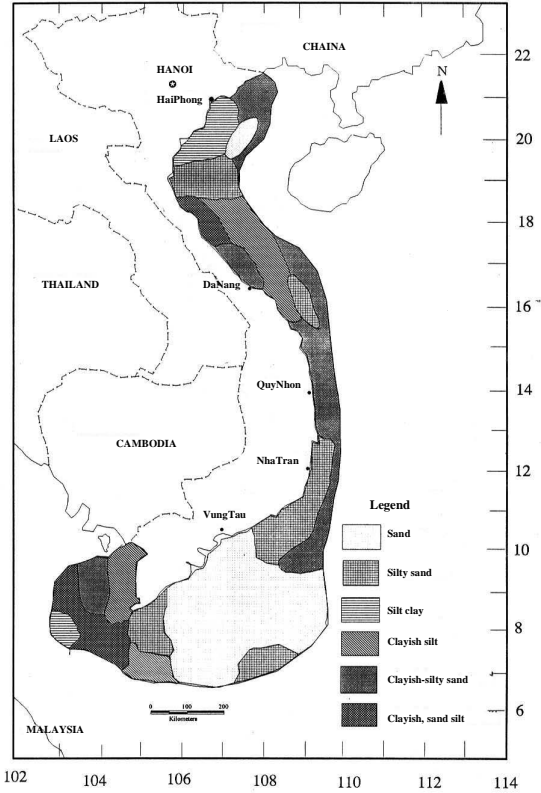


Fig. 10. Pattern of sediment distribution in Vietnamese coastline.

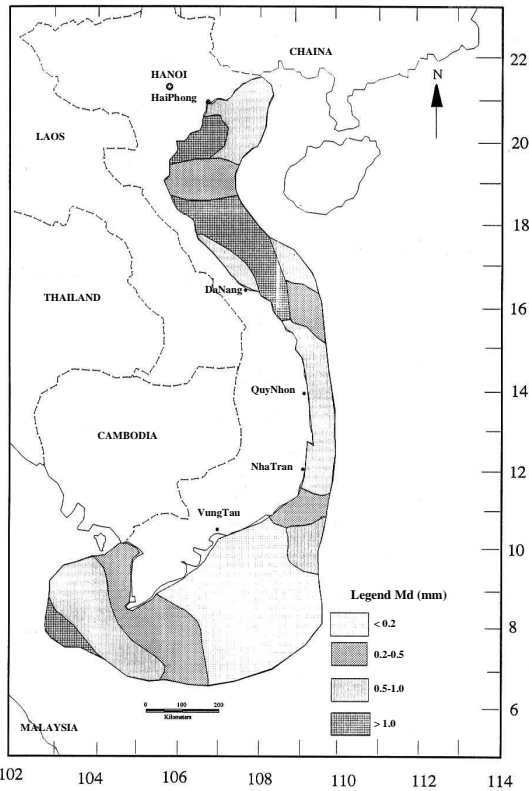


Fig. 11. Distribution of organic matter in bottom sediment of Vietnamese coastline.

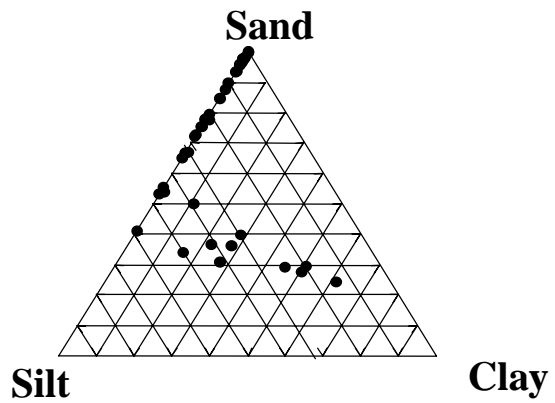


Fig. 12. Diagram distribution of sediment.



**Table 1.** Statistical sedimentological parameters of bottom sediments in Vietnamese coastline.

	Md (mm)				So				Sk				K			
	Average	Max	Min	Range	Average	Max	Min	Range	Average	Max	Min	Range	Average	Max	Min	Range
Northern part	0.088	0.25	0.0041	0.2459	3.46	5.35	1.16	4.19	0.832	1.03	0.32	0.71	0.229	0.332	0.055	0.277
Central part	0.1507	0.45	0.0082	0.4418	5.29	18.46	1.2	17.26	0.785	0.98	0.48	0.5	0.187	0.229	0.084	0.145
Southern part	0.162	0.5	0.0028	0.4972	2.574	7.63	1.1	6.47	1.02	1.53	0.31	1.22	0.194	0.493	0.055	0.338
For whole area	0.1335	0.5	0.0028	0.4972	3.773	18.46	1.1	17.35	0.87	1.53	0.31	1.22	0.203	0.493	0.055	0.338

**Table 2.** Percentage of sediment in Vietnamese coastline.

	Sand (%)	Silty sand(%)	Silty clay (%)	Clayish silt (%)	Clayish-silty sand(%)	Clayish-sandy silt(%)
Whole area	35.89	17.93	7.68	10.24	17.93	10.24
Northern part	2.56	5.12	2.56	5.12	5.12	5.12
Central part	0	7.69	0	2.56	5.12	2.56
Southern part	33.33	5.12	5.12	2.56	7.69	2.56



**Table 3.** Percentage of sand, silt and clay in Vietnamese coastline.

	Sand (%)				Silt (%)				Clay (%)			
	Average	Max.	Min.	Range	Average	Max.	Min.	Range	Average	Max.	Min.	Range
Northern part	36.6	100	0	100	28.36	50.07	0	50.07	35.0	72.82	0	72.82
Central part	47.68	79.8	0.98	78.82	30.93	44.91	20.2	24.71	21.38	54.11	0	54.11
Southern part	66.45	100	0	100	17.96	58.53	0	58.53	15.69	80.0	0	80.0
Whole area	50.24	100	0	100	25.75	58.53	0	58.53	24.01	80.0	0	80.0

**Table 4.** Distribution of total organic matter in Vietnamese coastline.

	Whole area(%)	Northern part(%)	Central part(%)	Southern part(%)
Maximum	1.344	1.326	1.344	1.344
Minimum	0.125	0.48	0.395	0.125
Average	0.772	0.8755	0.7787	0.6864
Range	1.219	0.846	0.949	1.219

**Table 5.** Color distribution of bottom sediments in Vietnamese coastline (in percent).

	Greenish grey (%)	Dull grey (%)	Brownish grey (%)	Light grey (%)	Dull yellow (%)
Whole area	15.38	25.64	7.69	23.07	28.20
Northern part	10.25	5.12	2.56	5.12	2.56
Central part	0	10.25	2.56	2.56	2.56
Southern part	5.12	10.25	2.56	15.38	23.07

**Table 6.** Occurrence of foraminifera in Vietnamese coastline.

No	Species	North part	Central part	Southern part
1	<i>Adelosina pulchella</i>	+	+	+
2	<i>A. philipinensis</i>	+	+	+
3	<i>Ammonia annectens</i>	+	+	+
4	<i>A. beccarii</i>	+++	+	+
5	<i>A. japonica</i>	+++	+	+
6	<i>Amphistegina lessonii</i>	+	+	+++
7	<i>A. madagascariensis</i>			+++
8	<i>Articulina sulcata</i>	+	+	+
9	<i>A. pacifica</i>	+	+	+
10	<i>Asiarotalia holocenia</i>			+++
11	<i>A. mekongensis</i>			+++
12	<i>A. multispinosa</i>			+++
13	<i>Asterorotalia pulchella</i>			+++
14	<i>A. multispinosa</i>			+++

Table 6. (Continued).

No	Species	North part	Central part	Southern part
15	<i>Bigenerina nodosaria</i>	+	+	+
16	<i>Bigenerina sp.</i>	+	+	+
17	<i>Bolivina dinatata</i>	++	++	++
18	<i>B.nitida</i>	+	+	+
19	<i>B. punctata</i>	++	++	++
20	<i>Bucella sp.</i>	++		
21	<i>Casidulina globosa</i>	+	+	+
22	<i>Calcarina hispida</i>		+++	
23	<i>Cellanthus craticulatus</i>	++	++	++
24	<i>Cibicides lobatus</i>	+	+	+
25	<i>Calcarina spengneri</i>		+++	
26	<i>Cibicides sp.</i>	+	+	+
27	<i>Dentalina communis</i>	+	+	+
28	<i>D. elongata</i>	+	+	+
29	<i>Discorbis sp.</i>	+	+	+
30	<i>D.procerus</i>	+	+	+
31	<i>Elphidiella indopacifica</i>		+	
32	<i>Elphidium advenum</i>	+	+	+
33	<i>E. hispidulum</i>		++	
34	<i>E. crispum</i>		+++	
35	<i>E. macellum</i>	+	+	+
36	<i>Eponides sp.</i>	+		+
37	<i>E. praecinctus</i>	+	+	+
38	<i>E. procerus</i>	+	+	+
39	<i>Gladulina laevigata</i>	+	+	+
40	<i>Hauerina sp.</i>	+	+	+
41	<i>H. ornatisima</i>	+	+	+
42	<i>Lagena costata</i>	+	+	+
43	<i>L.crenata</i>	+	+	+
44	<i>L. elongata</i>	+	+	+
45	<i>L. sulcata</i>	+	+	+
46	<i>Marginopora vertebralis</i>		++	
47	<i>Nonion sp.</i>	+	+	+
48	<i>N. japonicum</i>	+	+	+
49	<i>Nonioninella sp.</i>	+	+	+
50	<i>Operculina ammonoides</i>	+	+	++
51	<i>O. complanata</i>	+	+	+++
52	<i>O. venosa</i>	+	+	+
53	<i>Peneroplis pertusus</i>	+	+	+
54	<i>P. planatus</i>	+	+	+
55	<i>Pseudorotalia indopacifica</i>	++	++	++
56	<i>P.papuanensis</i>	+	+	+
57	<i>P. schroeteriana</i>	+	+	+
58	<i>Quinqueloculina akneriata</i>	++	++	++
59	<i>Q. bouenana</i>	++	++	++
60	<i>Q. elongata</i>	++	++	++
61	<i>Q. lamarckiana</i>	++	+	++
62	<i>Q. oblonga</i>	++	++	++
63	<i>Q. parkerii</i>		+++	
64	<i>Q.philippinensis</i>	++	++	++
65	<i>Q. seminulina</i>	++	++	++
66	<i>Q. reticulata</i>	+	+	+
67	<i>Reussella spengnerii</i>	+	+	+
68	<i>R. spinulosa</i>	+	+	+
69	<i>Reophax sp.</i>	+	+	+
70	<i>Robulus sp.</i>	+	+	+
71	<i>Sigomoidella pacifica</i>	+	+	+
72	<i>Spiroloculina communis</i>	++	++	++
73	<i>S. manifesta</i>	+	+	+
74	<i>S. spengnerii</i>	+	+	+
75	<i>Trochammina inflata</i>	+++	+	+



**Table 6.** (Continued).

No	Species	North part	Central part	Southern part
76	<i>T. nitida</i>	+++	+	+
77	<i>Triloculina tricarinata</i>	+	+	+
78	<i>T. trigonula</i>	+	+	+
79	<i>Textularia conica</i>	++	++	++
80	<i>T. foliacea</i>	++	++	++
81	<i>Uvigerina proboscidea</i>	+	+	+
82	<i>Globogerina bulloides</i>	++	++	++
83	<i>Globigerina sp.</i>	+	+	+
84	<i>Globigerinoides conglobatus</i>	++	++	++
85	<i>G. obliquus extremus</i>	+	+	+
86	<i>G. obliquus oblicus</i>	+	+	+
87	<i>G. ruber</i>		+	+
88	<i>G. saculifer</i>	++	++	++
89	<i>G. trilobus</i>	++	++	++
90	<i>Globoquadrina altispida</i>	+	+	+
91	<i>G. dutertrei</i>	+	+	+
92	<i>Globorotalia acostaensis</i>	+	+	+
93	<i>G. cultrata</i>	+	+	+
94	<i>G. menardi</i>	+	+	+
95	<i>G. tumida</i>	+	+	+
96	<i>Hastigerina siphonifera</i>	+	+	+
97	<i>Neogloboquadrine dutertrei</i>	+	+	+
98	<i>Orbulina universsa</i>	+	+	+

\* Occurrence

+++ High

++ Intermediate

+ Low

**Table 7.** Occurrence of minerals in bottom sediments of Vietnamese coastline.

No.	Mineral	North part	Central part	Northern part	Remark
1	Quartz	+++	+++	+++	
2	Muscovite	+++	+++	+++	
3	Feldspar	++	++	++	
4	Limonite	+++	+++	+++	
5	Ilmenite	+++	+++	+++	
6	Leucosene	++	+	++	
7	Actinolite	++	+	+	
8	Tremolite	+	+	+	
9	Rutile	+	+	+	
10	Siderite	+	+	+	
11	Pyrite	+	+	+	
12	Anatase	+	+	+	
13	Disthen	+	+	+	
14	Epidote	++	+	+	
15	Olivine	+	+	+	
16	Pyroxene	+	+	+	
17	Garnet	+++	++	+	
18	Magnetite	++	++	++	
19	Zircon	++	++	++	
20	Monazite	+	++	++	
21	Caxiterite	+	+	+	
22	Apatite	+	+	+	
23	Topaz	+	+	+	
24	Sillimanite	+	+	+	
25	Chromite	+	+	+	
26	Hematite	+	+	+	
27	Tourmaline	++	++	++	
28	Sphene	+	+	+	
29	Glauconite	+	+	+	
30	Biotite	++	++	++	

## **Conclusion**

In the study area can be distinguished six types of bottom sediments: sand, silty sand, clayish-silty sand, silty clay, clayish silt and clayish-sandy silt. In general, sand, silty sand and clayish silty sand are dominant in the study area. Fine sediments: clayish silt, clayish-sandy silt and silty clay are abundant in the northern part and in the south western part (Gulf of Thailand ). In the south eastern part, especially in the front of the Maekong River mouth, sands are dominated and spread over a large area as a sand field. Bottom sediments in the South are better sorted, less skewed

Mineralogical, grainsize composition and texture of sediments prove that bottom sediments of vietnamese coastline are mainly terrestrially derived.

## **Acknowledgements**

We would like to express our sincere thanks to the authorities of Institute of Geology-NCST for their support and permission to participate in this project.

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