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CHARACTERISTICS OF OCEAN BOTTOM SEDIMENTS OFF VISAKHAPATNAM*

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ABSTRACT

Nearly seventy samples of the ocean bottom sediments have been collected over the continental shelf off Visakhapatnam on board INS JAMUNA. Grain size analysis has been carried out in the laboratory.

Statistical parameters such as the Standard deviation, skewness and kurtosis and the CM pattern have been studied in relation to the sorting and the zonal distribution of sediments in the area under study. The sediments beyond 30 fathom line consist of relict sands which indicate that the coast line in the past would have extended beyond the present 30 fathom line.

INTRODUCTION

THE continental shelf region off Visakhapatnam has been studied extensively by many workers since 1954 (Mahadevan and Poornachandra Rao, 1954; Subba Rao, 1964; Venkataratnam, 1968). This work is intended to study the inter-relationships of the various grain-size parameters and the distribution pattern of the above parameters over a small sample area, north of Visakhapatnam.

About seventy sediment samples from the ocean bottom have been collected over the continental shelf off Visakhapatnam on board INS JAMUNA during February 1969. The sampling was carried out along five parallel profiles in the NE-SW direction covering an area of 150 sq. miles between latitudes 17° 29′ N & 17° 46′ N and Longitudes 83° 23′ & 83° 41′E (Fig. 1). All the samples have been collected using Lafond-Dietz snapper. The profiles are almost parallel to the isobaths. The area under study covers the middle portion of the continental shelf off Visahkapatnam with water depths ranging from 30 to 42 fms.

The authors are thankful to the Commanding Officer, the officers and the crew of INS JAMUNA for their co-operation and assistance rendered during the collection of samples. The authors are also thankful to the Director, Naval Physical and Oceanographic Laboratory, Cochin for his encouragement in the work. The authors wish to place on record, their deep sense of gratitude to Shri Y. L. Dora, Department of Marine Sciences, Cochin University for going through the manuscript and also for his valuable suggestions in the present work.

LABORATORY METHODS OF STUDY

The samples have been analysed for the grain-size distribution by adopting the pipette analysis method for the silt-clay fractions and the sieving analysis for the sand

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fractions as recommended by Krumbein and Petti John (1938). In the pipette analysis, the pipette samples have been collected at time intervals starting from 58 seconds (corresponding to a grain size 4Ø) to 16 hrs 21 minutes (corresponding to a particule size of 10Ø).

The weight percentages of the respective size fractions and the cumulative percentages with unit interval have been calculated. They were plotted against the respective grain-sizes on a logarithmic probability sheet. Statistical parameters such as medium (Md), Mean size (Mz), standard deviation (σ_I) Skewness (SKI) and Kurtosis (KG) have been computed using the formulae of Folk and Ward (1957).

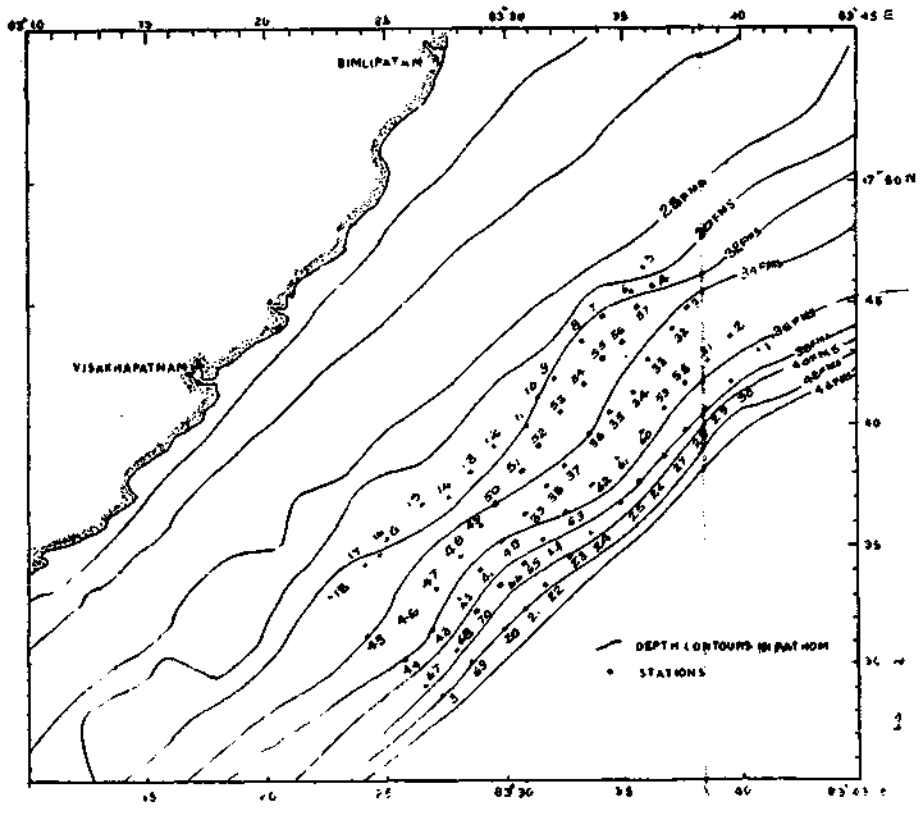

Fig. 1. Station positions and bathymetric conditions.

In Fig. 2, percentages of sand, silt and clay were represented on a triangular co-ordinate paper and the classification of sediments was made following Shepard (1954). The distribution of sediment types in the area was shown in Fig. 3. The distribution diagram of sand content was given in Fig. 4.

The distribution of various grain-size parameters, median, mean, standard deviation, skewness and kurtosis over the area were shown in Figs. 5, 6, 7, 8, and 9 respectively.

An attempt has also been made to study the CM Patterns with C (1% coarser particle) and M (the 50th percentile particle diameter) plotted on a double log sheet to classify the sediments (Fig. 10).

RESULTS AND DISCUSSION

Based on bathymetry, the area is divided into two sections. It can be seen from Fig. 1, that the isobaths from the 30 fm line to 36 fathom line are widely separated

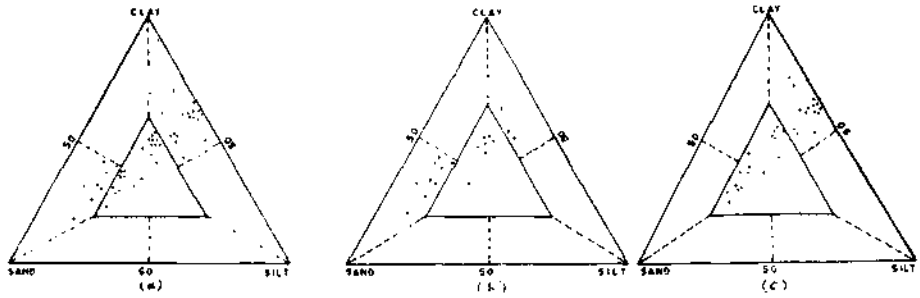

Fig. 2. Distribution of samples on sand-silt-clay diagram from: a. whole area, b. from section B, and c. from section A of Fig. 1.

and between 36 fm and 42 fm the isobaths are closely spaced. The statistical parameters also show a definite change in their behaviour around 36 fm line (exactly beyond 38 fm isobath in the southwest portion of the area and around 36 fm in the

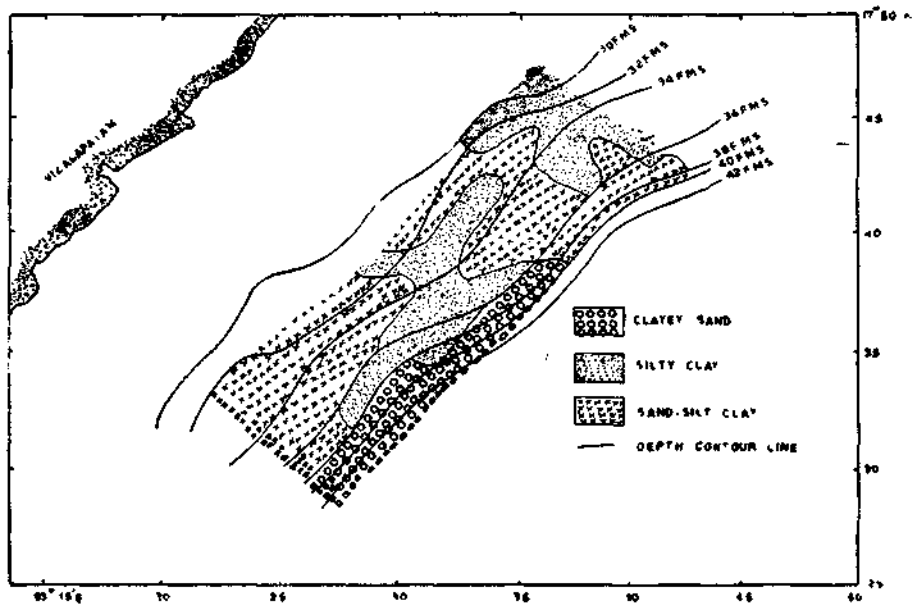

Fig. 3. Classification of sediments off Vizagapatnam based on sand-silt-clay diagram.

rest of the area). Henceforth the area is conveniently divided into two sections, section A representing the area between 30 and 36 fm isobaths and section B the area beyond 36 fm line.

Following the nomenclature of Shepard (1954), a majority of sediments are sand-silt-clays, the remaining are either silty-clays or clayey-sands (Fig. 2a). A comparison of Figs. 2b and 2c indicates the marked difference in the nature of sediments in the two sections of the area. While the sediments in section A are all either sand-silt-clays or silty-clays (Fig. 2c), the sediments in section B are mostly clayey sands or sand-silt-clays (Fig. 2b). Distribution pattern of sediments in the area (Fig. 3) reaffirms the above observed facts.

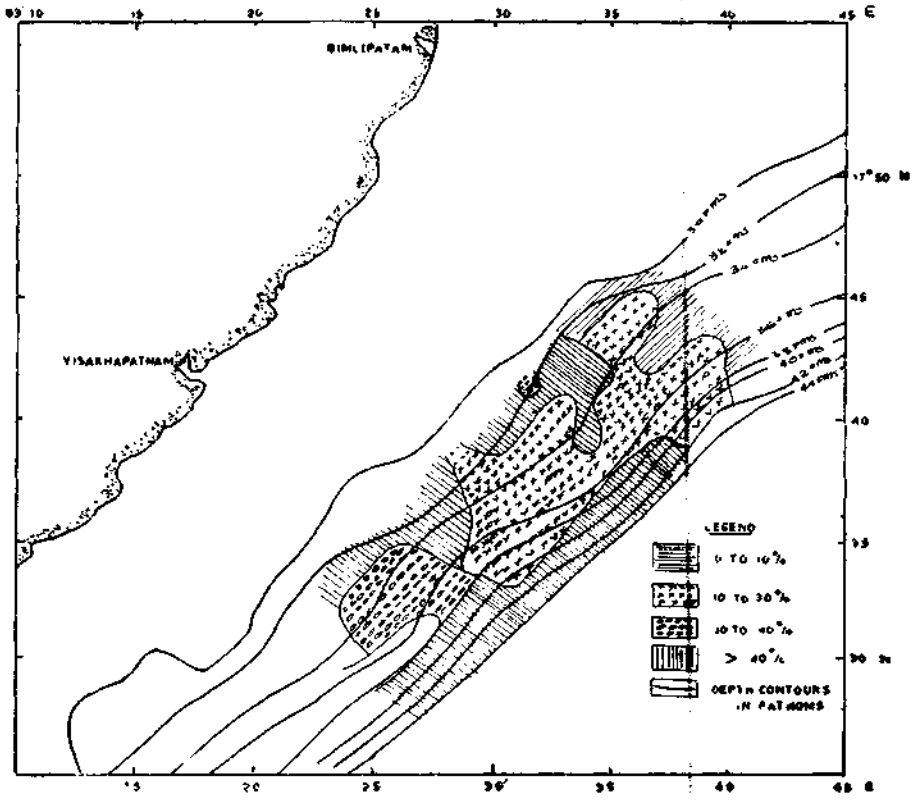

Fig. 4. Sand distribution.

The presence of silty-clays dividing the sand-silt-clays (Fig. 3) have not been reported by Subba Rao (1964). It may perhaps be due to the limited number of samples collected hy him. The closer sampling interval in the present work might have facilitated the demarcation of these smaller zones of sediments. This narrow band of silty-clays contain relatively good percentages of sand (10–30%) when compared to the silty-clays seen at the north-eastern parts of the area (Figs. 3, 4). The sand-silt-clays showed a tendency towards either silty-clays or clayey-sands in the area, when their sand-silt-clay percentages were plotted on a triangular co-ordinate paper.

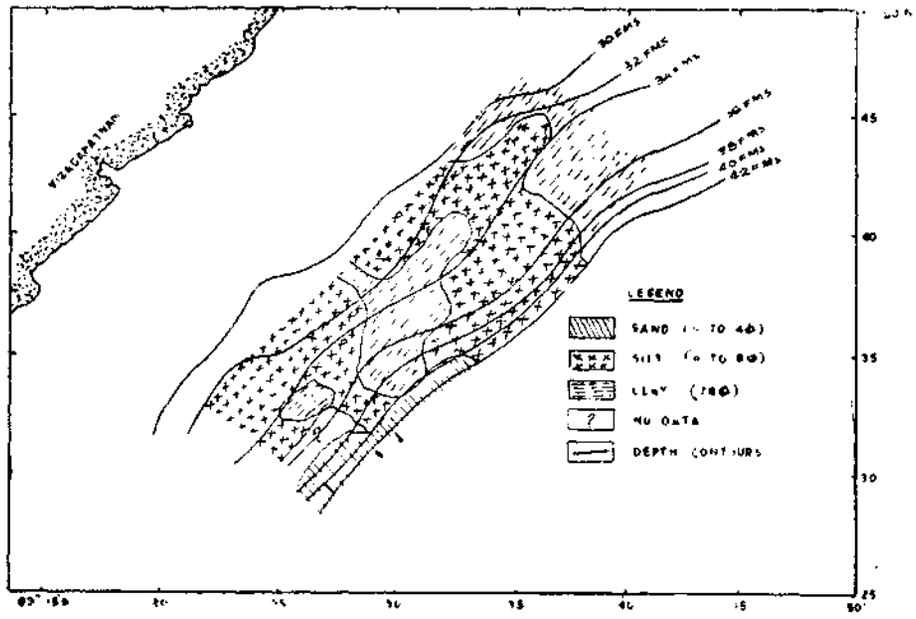

Fig. 5. Distribution of median diameter.

The study of the sand distribution pattern in the area shows that the highest percentage of sand content (more than 40%) between 30 and 32 fm and again beyond 38 fm (Fig. 4). It has been further observed that while the fine sands occur

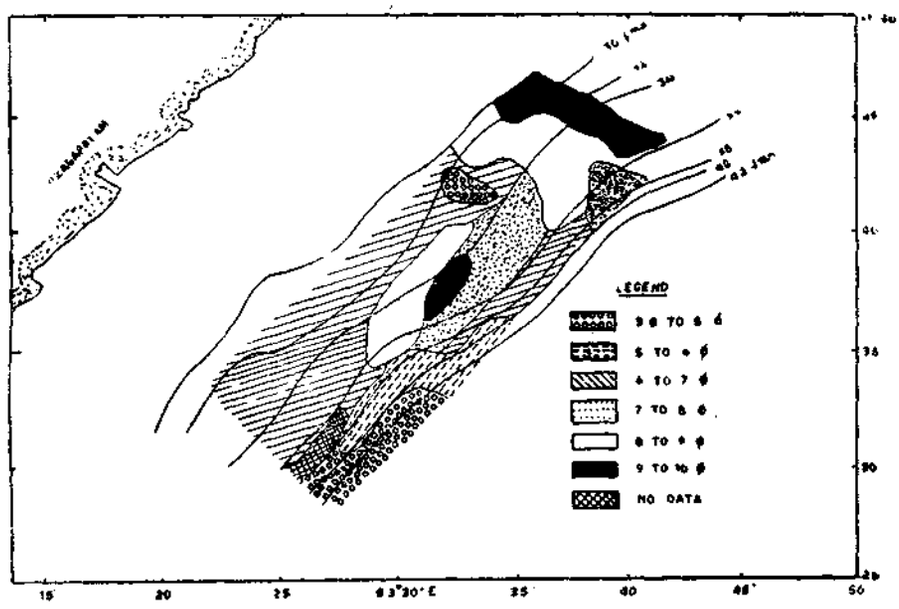

Fig. 6. Mean size distribution.

in the north-east and central part of the area, the sands beyond 38 fm line are coarser than elsewhere in the area.

The statistical parameters of the above sediments are summarised below.

The median diameter (Md) varies from 1.74 Ø to 9.95 Ø, average median diameter over the area being 6.8Ø. The medians are grouped into three groups, first group representing the sand range, second group the silt range and third group the clay range. The distribution diagram of median (Fig. 5) shows that the sediments with their medians falling in the silt and clay ranges are seen in section A whereas in section B, the medians cover the sand, silt and clay ranges. Beyond 38 fm line

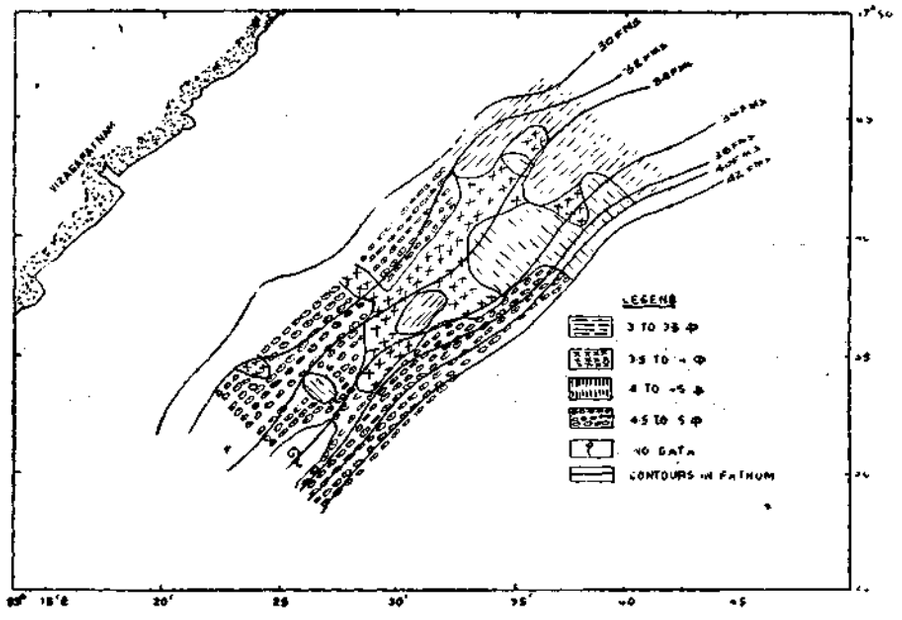

Fig. 7. Distribution of standard deviation.

there is a progressive decrease of medians in the south west-north east direction parallel to isobaths.

The meansize varies from 3.86 Ø to 9.45 Ø over the area, with the average mean size being 7.14Ø. The distribution diagram of mean size (Fig. 6), drawn with unit Ø interval, shows that most of the particles with their mean sizes fall in the fine silt (6 to 7Ø). In section A, the coarse clay (8 to 9Ø) dominate. In section B, the coarse silt (4 to 5Ø), the medium silt (5 to 6Ø) and coarse clay (8 to 9Ø) are dominating while in section A, the coarse clay (8 to 9Ø) dominates. The phi-mean of the sediments progressively increases in the SW–NE direction beyond 38 fm line.

The standard deviation ranges from 2.97Ø to 5.05Ø in the area, with the average value falling at 4.08Ø. According to the nomenclature of Folk and Ward (1957), all sediments from the area are either "very poorly sorted" or "extremely poorly sorted".

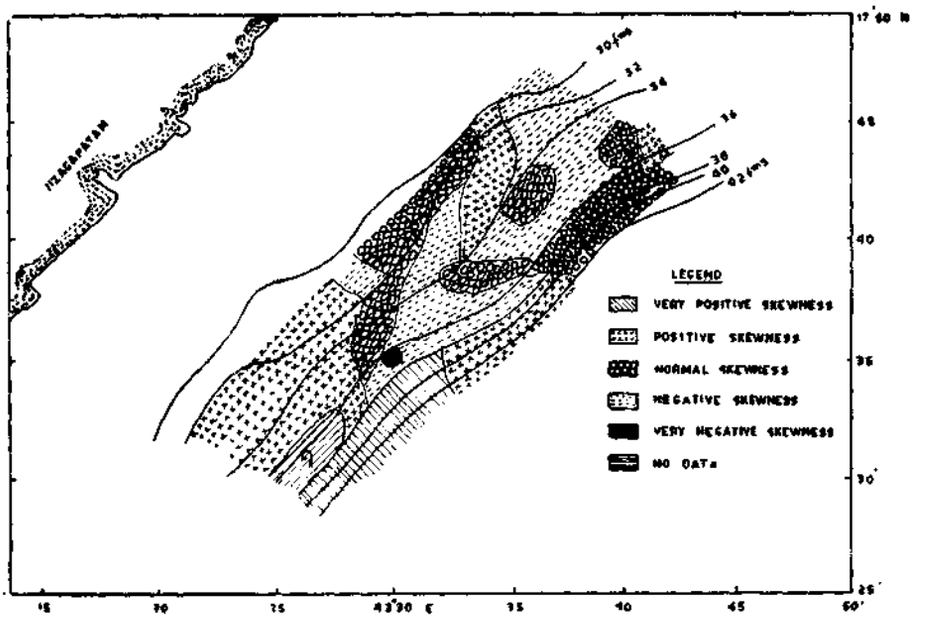

Fig. 8. Skewness distribution.

The standard deviation is mainly classified into four groups at 0.5ø interval. The distribution of all these four groups of standard deviation are shown in Fig. 7. It is observed that the north eastern and central portions of the area

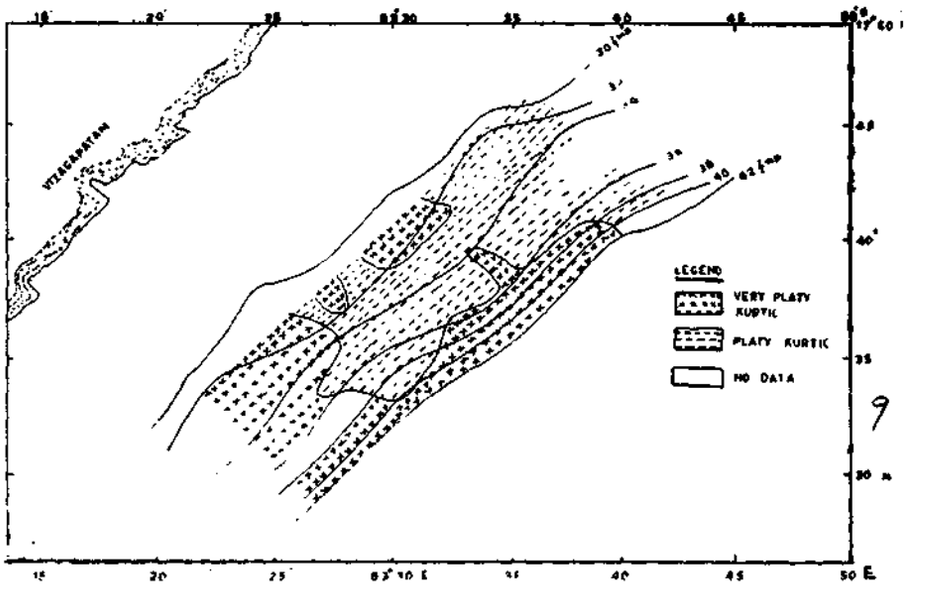

Fig. 9. Kurtic distribution.

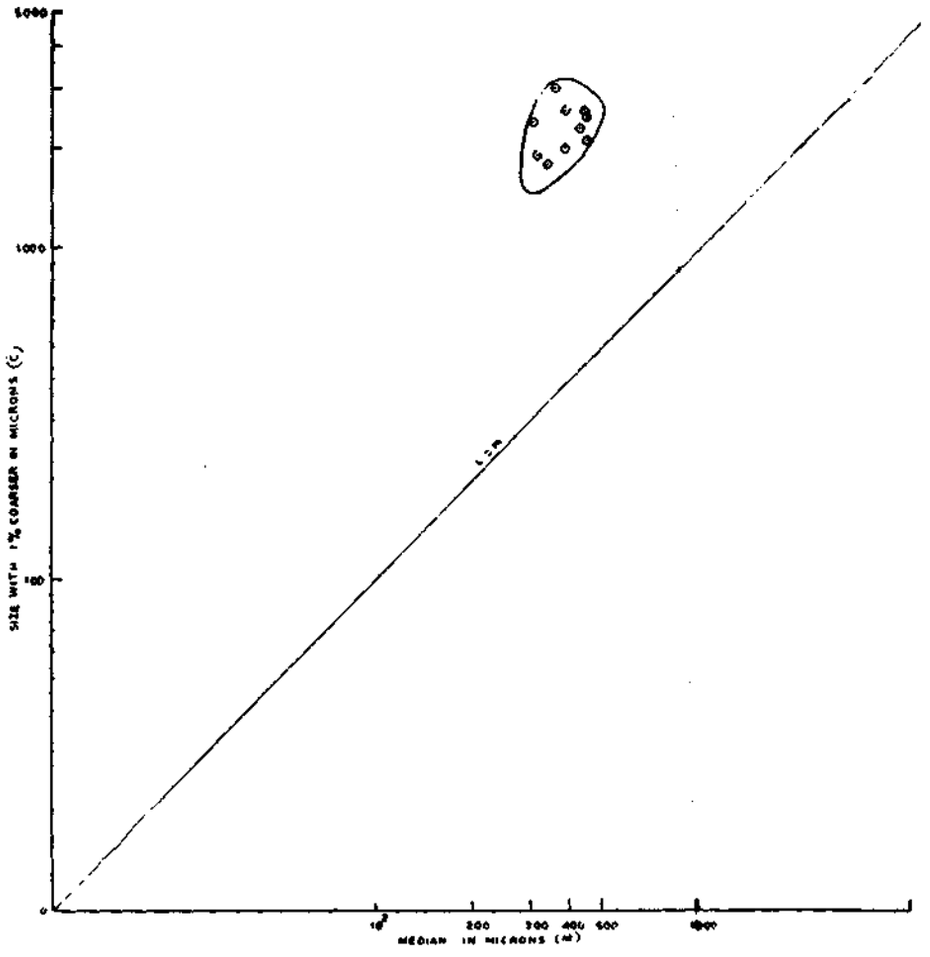

Fig. 10. CM pattern diagram of sediments beyond 38 fm depth off Vizagapatnam.

contain relatively better sorted sediments than those of in the south-west region. Section B is mostly covered up with extremely poorly sorted sediments.

Of the three types of sediments present in the area, the clayey-sands with a mean standard deviation of 4.89Ø show the worst grade of sorting. While the silty-clays with a mean standard deviation of 3.54Ø are relatively the best sorted of the three, the average sorting value of sand-silt-clays fall in between. A study of mean size and standard deviation (Figs. 6, 7) broadly shows that within the range of mean sizes in the area, the standard deviation decreases with an increase in the phi-mean size.

The skewness values range from—0.47 (very negatively skewed) to +0.71 (very positively skewed). The average skewness value for all samples is +0.06. Considering that the normal distribution gives a skewness of zero and that the limits of skewness are +1.00 and —1.00, the range of skewness values is moderate. From

Fig. 8, it is inferred that the "negatively skewed" sediment are mostly concentrated in section A. "Positively skewed sediments" are seen in both sections, where as the positively skewed sediments are observed only in section B. "Normally skewed sediments" are mostly observed at the boundaries and thus forms a link between the positively skewed and negatively skewed deposits. Beyond 38 fm line, the skewness progressively changes from "very positive" on the south-west side through "positive" in the middle to "symmetrical" on the north-east part.

In general,the sand-silt-clays and silty-clays in the region are "positively skewed" to "negatively skewed". On the contrary the clayey-sands in the area are all either "positively skewed" or "very positively skewed".

A comparison of Figs. 6 and 8 gives the variation of mean size in the area with skewness. The skewness values are very positive when the sediments have fine tails. With the increase of fines, the skewness gradually shifted from the positive side to the negative side through normal values of skewness. When the skewness values are negative the sediments have coarser tail.

The kurtosis values range is small, varying from 0.57 to 0.88. The mean kurtosis value for all samples is 0.71. According to Folk and Ward (1957), the sediments are either "platykurtic or "very platykurtic". The distribution diagram of these two types of kurtosis (Fig. 9) clearly indicates that the "platykurtic" sediments dominate in section A while the very platykurtic sediments are prominent in section B. Following in the SW–NE direction the sediments in section B progressively vary from "very platykurtic" to "platykurtic".

The clayey-sands in the area are very platykurtic, while the silty-clays are platy kurtic. Sand-silt-clays show both the tendencies in their behaviour.

CM PATTERNS

A few samples beyond 38 fm have been studied for CM pattern. From the CM pattern diagram (Fig. 10) it can be seen that the samples have their medians between 300 and 560 microns, and the C values varies from 1600 mircrons to 3000 microns. The CM pattern diagram in general shows a similarity with the CM pattern of beach samples obtained by Passega (1957) and also of Venkataratnam (1968) for the samples collected at 30 to 50 fm depth. Unfortunately, the samples studied in this way are very few in number. Hence, it has not become possible to give difinite conclusions in this respect.

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