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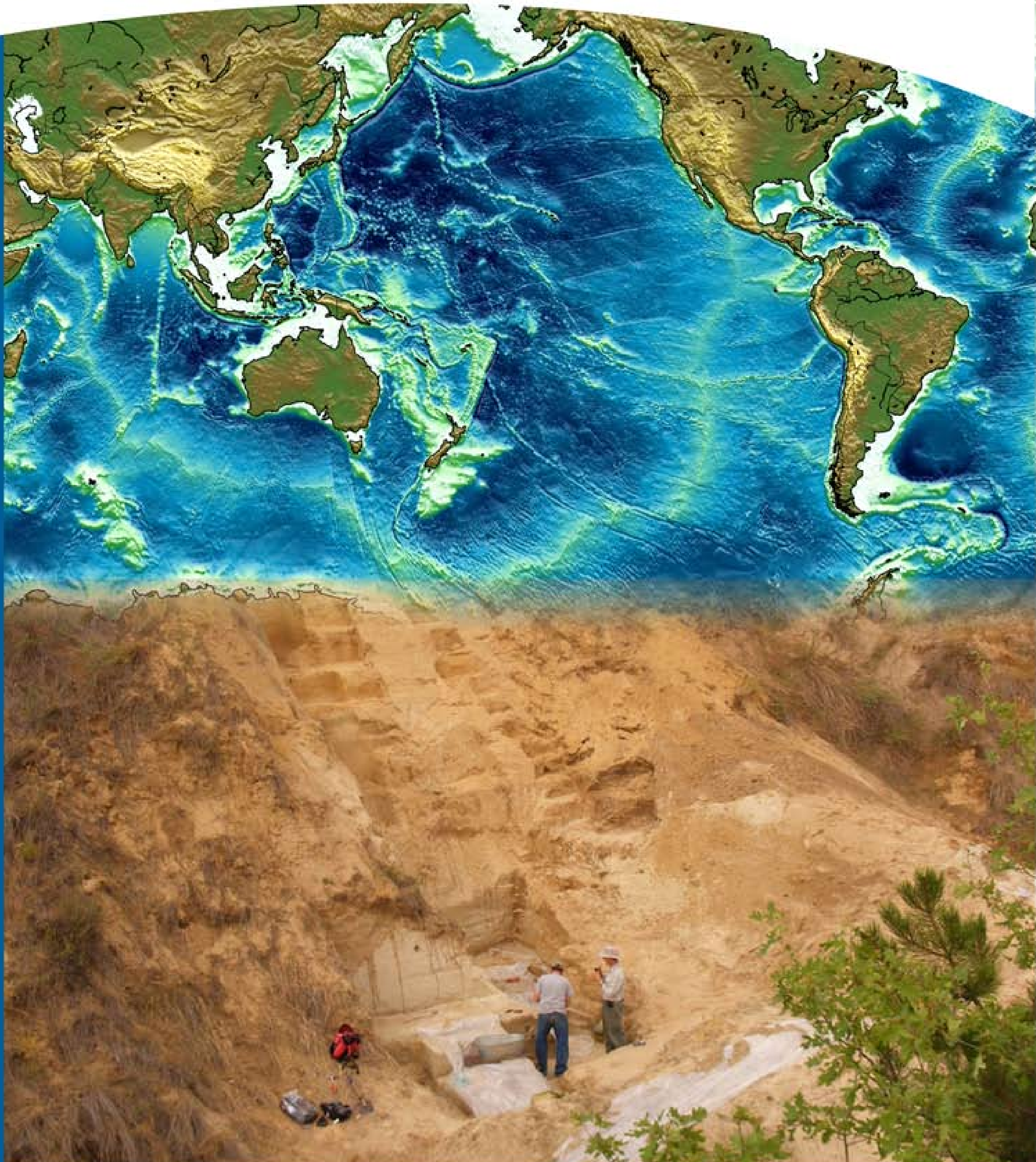

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Research Paper

TEXTURAL ANALYSIS AND HEAVY MINERAL DISTRIBUTION STUDIES OF COASTAL SEDIMENTS FROM PORTONOVA TO GADILAM RIVER, ALONG THE EAST COAST OF TAMIL NADU

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The present study consist the determination of the grain size distribution in surface sediments and their heavy mineral contents. Data obtained from this study fine sand (2.067 ϕ-2.343 ϕ), well-to moderately-sorted (0.385 ϕ-0.508 ϕ), near symmetrical to fine skewness and very fine skewness (-0.031 ϕ-0.400 ϕ), mesokurtic to leptokurtic and platikurtic represents dominant grain size in study area. Linear Discriminant Functions (LDF) interpretation of most of the locations falls under beach processes, shallow agitated water, shallow marine and turbidity current. Heavy minerals also identify different size fragments from nearby cliffs may also be present and even predominate under specific circumstances north and south of the study area. The heavy mineral assemblages found in this study are dominated by Ilmenite, Sillimanite, Garnet, Hypersthene, Hornblende, Leucoxene, Rutile, Topaz, Augite, Apatite, Zircon and Monazite. The present studies focused textural characteristics of sediments, depositional environmental conditions, heavy mineral assemblages and their provenances

Keywords: Grain size; heavy minerals; beach; Gadilam River, Uppanar River, Vellar River

INTRODUCTION

Coastal sediments have been studies by numerous authors (Rajamanickam and Gujar, 1984, 1985 and 1997; Chaudhri *et al.*, 1982; Angusamy and Rajamnickam, 1993; Ramanathan *et al.*, 2009; Anithamary *et al.*, 2011; Rajmohan *et al.*, 2012; and Suganraj *et al.*, 2013). The beah sediments are very importants in the depositional history of a given region (Gujar *et al.*, 2007). Geology and climatic conditions play a vital role to control the sediment dynamic nature of the river. The sediments may be derived from offshore and catchments area deposits of the clay and silt, and evidence was found to suggest that these deposits are being eroded by tidal currents (Venkatramanan *et al.*, 2011). Grain size distribution is affected by other factors such as distance from the shoreline, distance from the source (river), source material, topography and transport mechanisms (Abuodha, 2003). Heavy

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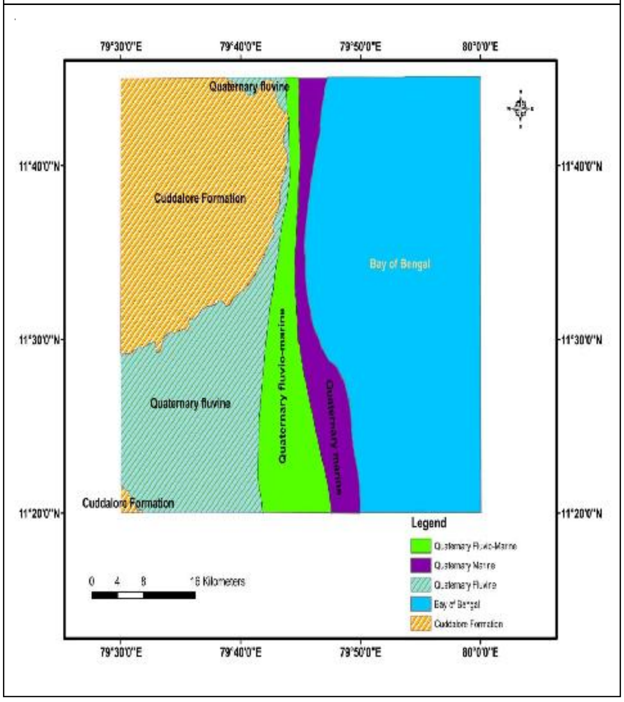
minerals have been exploiting in provenance studies by numerous authors; they serve to define petrographic provinces and to identify source areas (Krynine, 1946; Feo-Codecido, 1956; Callender and Folk, 1958; Hubert, 1962; Gravenor, 1979; Morton, 1985; Statteger, 1987; and Angusamy and Rajamnickam 2000).

GEOLOGY OF THE STUDY AREA

The study area is located on the East coast of Tamil Nadu, Cuddalore district. The study area lies between11° 50' to 11° 10' N latitude and 79° 45' to 79° 55'E longitude. The district is underlain by various geological formations ranging in age from the oldest Achaean rocks to recent sediments. Specifically to study area, it is covered by Quaternary formations consisting of Marine sedimentary plain, fluvial flood plains and fluvio marine plains. The other part is covered by tertiary formation consisting of Cuddalore formation (Figure 1). Generally, the Quaternary landforms of East coast of India generally denote features of emergence characteristics, while that of west coast are mostly dominated with features of submergence characteristics.

Figure 1: Geology Map of the Study



METHODS AND MATERIALS

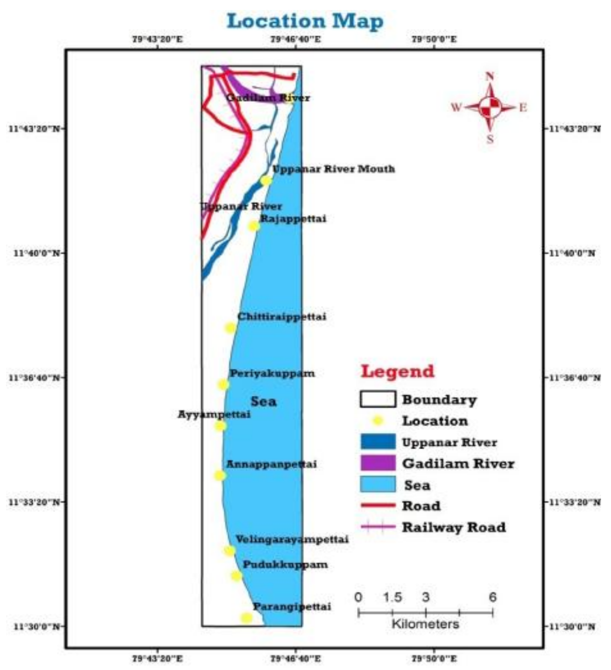
Sampling

Surface sediments were collected at different locations along the shore and near the mouth of rivers. The sediment samples were packed in a clean polyethylene bags and G.P.S data were recorded for each sampling point. Sampling map of the study area is shown in Figure 2. The collected samples were taken to the laboratory and dried and under further pre-treatment. The samples were analyzed for their texture, depositional conditions and heavy mineral assemblages.

Sieve Analysis

The dried surface samples were subjected to

Figure 2: Sampling Location Map



coning and quartering methods. The weighed 100 g of samples were then subjected to 10% HCl treatment to remove all carbonate material such as shells and washed with distilled water then dried in the oven after that samples were weighed. Then Sieving was carried out using ¼ phi interval ASTM sieves in a Ro-Tap shaker for 20 minutes. The sieved samples were weighed in a single pan electronic balance to an accuracy of 0.1mg. The weight and cumulative percentages of individual size fractions were calculated. The statistical parameters such as Graphic Mean (Mz), Inclusive Standard Deviation (σ_1), Inclusive Graphic Skewness (Sk_i) and Inclusive Graphic Kurtosis (K_G) was calculated following the technique proposed by Folk and Ward (1957).

Heavy Mineral Separation

Dried samples were separated for light and heavy minerals by using bromoform (Sp.gr.2.89), following standard procedures Milner (1962). Since the concentration of heavies will be always more in the size range between 88 and 250 micron sized sediments (Sinha and Khan, 1965). The heavy minerals were identified under Censico TN UXL petrological microscope by using the line method described by Galehouse (1969). The different diagnostic properties suggested by Folk (1957), Milner (1962), Phillips and Griffen (1986) and Rothwell (1989) were applied for the easiest identification. From the results of line counting method and percentage of individual minerals in the sediments was obtained.

RESULTS AND THEIR INTERPRETATION

Grain Size Analysis

Mean:

It is an average size of sediments and is influenced by the source of supply, transporting medium and energy conditions of the depositing agent. Mean size indicates the central tendency or the average size of sediment and in terms of energy; it indicates the average kinetic energy/ velocity of depositing agent (Sahu, 1964). Phi mean size of sediments fluctuates between 2.343ϕ and 2.067ϕ with an average mean size 2.230ϕ (Figure 3). Out of 10 locations, 100% of Samples are fine sand category. Of all the locations, the sediments dominated by fine grained nature.

Standard Deviation

It is expressed by graphic standard deviation (σ) of Folk and Ward (1957), as it covers the tails of the distribution. Standard deviation provides information on the extent to which particle sizes are clustered about the mean, and hence defines the concept of sorting (Friedman and Sanders, 1978). The sorting maximum values as 0.508, the minimum value as 0.385, with an average of 0.451(Figure 4). Out of ten locations, eight locations samples are well sorted nature and two location samples fall under moderately well sorted nature. The wide range of sorting and fluctuating

Figure 3: Variation of Graphic Mean of the Study Area

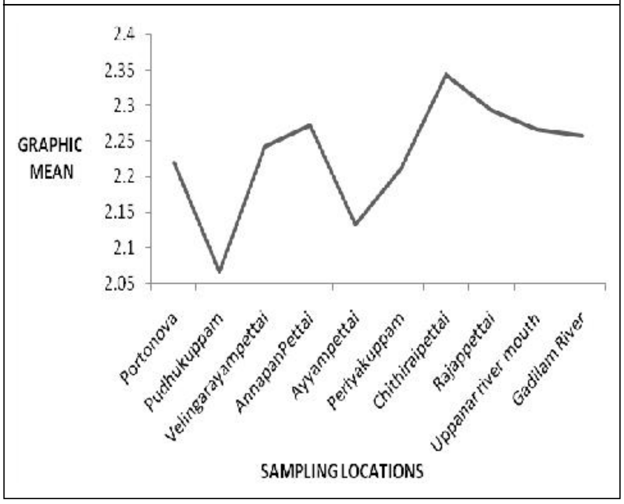


Figure 4: Variation of Graphic Standard Deviation of the Study Area

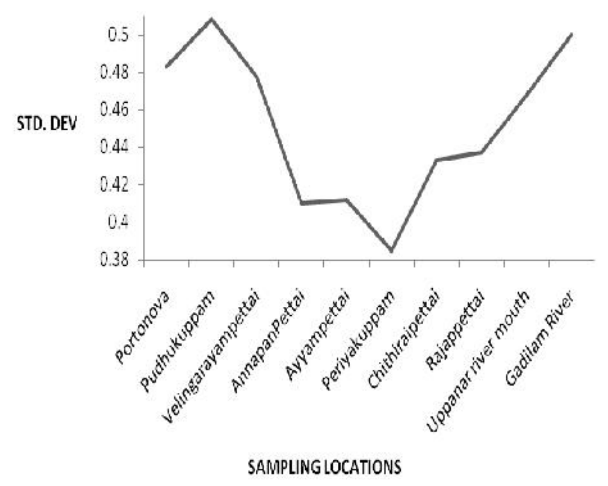
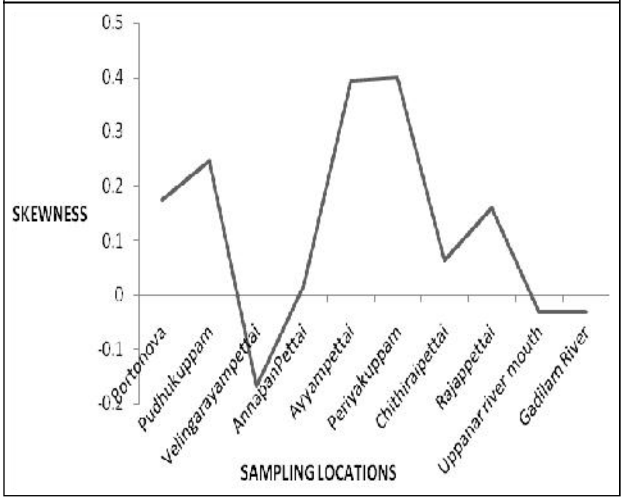


Figure 5: Variation of Skewness of the Study Area



trend of sorting values attributed to the influence of rivers and monsoon changes along the coast. Samples collected near the river mouths exhibit predominantly the moderately well sorted to well sorted character.

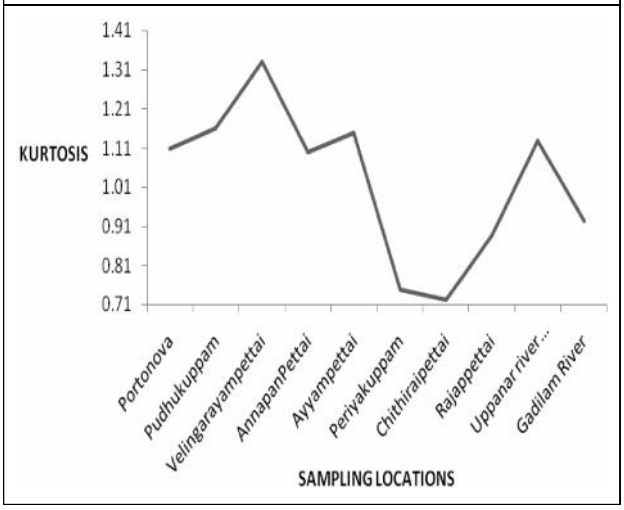
Skewness (Sk_i)

It is used to determine the symmetry of the central part of the distribution. It reflects the symmetry or asymmetry of the frequency distribution of the sediments. Skewness is considered to be a very sensitive parameter to environment (Folk and Ward, 1957; Friedman, 1961; Duane, 1964; and Chappel, 1967) and is quiet helpful in understanding the processes operating in the near shore areas. It is measuring the asymmetry of the frequency distribution, marks the position of the mean with respect to the median (Sahu, 1964). In the study area 70% of samples exhibit positive skewness and 30% of samples exhibits negative skewness (Figure 5). The minimum skewness value is -0.168 and the maximum skewness value are 0.400 with an average skewness of 0.122. The skewness varies widely as 40% Nearly Symmetrical, 30% Fine skewed, 20% very fine skewed and 10% coarse skewed.

Kurtosis (K_G)

It is a measure of peakedness of frequency distribution. According to Cadigan (1961), it is also a function of internal sorting or distribution. Kurtosis is a measure of ratio between the sorting in the tails of the curve and the sorting in central portion. According to Folk and Ward (1957), Friedman (1961 and 1967) and Cadigam (1961) Kurtosis is helpful in understanding the deposition of deltaic sediments. Samples from Chithiraipettai (Figure 6) shows a minimum kurtosis value of

Figure 6: Variation of Graphic Kurtosis of the Study Area



0.723 and maximum of 1.330 was observed at Velingarayampettai, with an average value of 1.026. Out of 10 locations, four location samples (40%) fall under mesokurtic character, three locations (30%) under platykurtic and leptokurtic nature.

DEPOSITIONAL ENVIRONMENT

Depositional sedimentary environment has been variously defined. A depositional environment can be defined in terms of physical, biological, chemical or geomorphic variables. According to Sahu (1964), the variation in the energy and the fluidity factors seem to have excellent correlation with the different processes and the environments of deposition. In the littoral (beach) zone, there is constant pounding of waves making the beach deposit better sorted and more uniformly distributed than the shallow marine deposits where the wave action is less prominent and more variable (Sahu, 1964). In the study area with reference to the Y1 values, all the locations fall under beach processes. Y2 values except Uppanar River mouth (Beach Process) all the locations of fall in shallow agitated water. With reference to Y3 and Y4 values all the locations exhibit shallow marine of 100% condition of deposition and turbidity current.

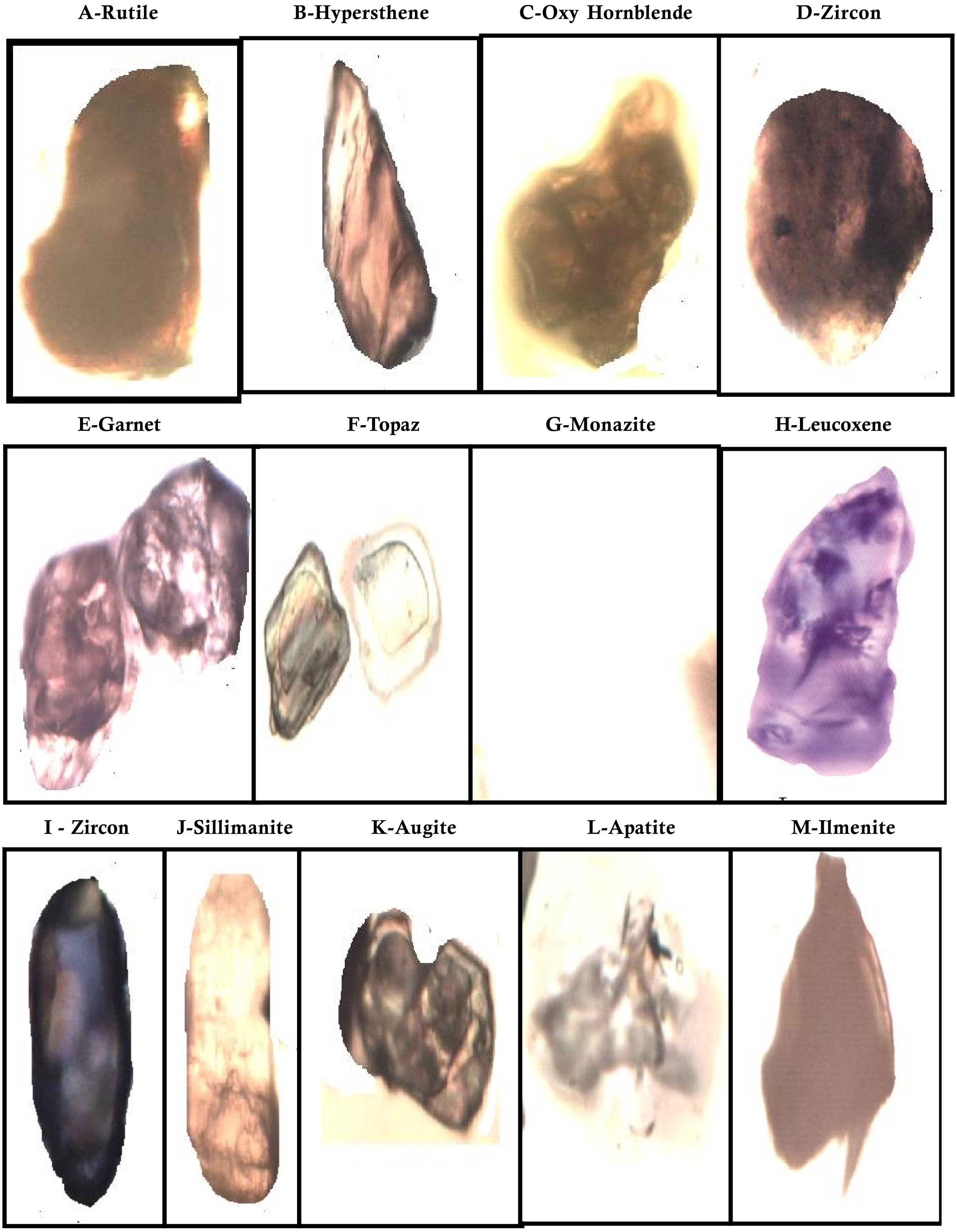
HEAVY MINERALS

Heavy-mineral assemblages have been widely used to trace the source of the basinal sandstones (Neihesel, 1962; Pilkey, 1963; Hubert and Neal, 1967; Morton, 1985; Dill, 1998; Rimington *et al.*, 2000; and Wong, 2002). On the other hand, parent rocks whose heavy mineral suites include species that become easily weathered and eliminated may result in daughter sediments with a strongly diverging heavy mineral assemblage (Yang *et al.*, 2003). Heavy minerals recorded in the decreasing order as Ilmenite, Sillimanite, Garnet, Hypersthene, Hornblende, Leucoxene, Rutile, Topaz, Augite, Apatite, Zircon and Monazite.

Opaque mineral ilmenites were identified under reflected light by its greyish white with brown tint colour and are anisotropic. The opaques show rounded to sub rounded nature. Ilminite grains show various features (Plate-I (M)). Most of the grains are sub-angular to rounded with moderate relief. Sillimanites are long, slender, elongated, prismatic or irregular in shapes (Plate-I (J)). Prismatic grains are colourless, whereas, fibrolites appear with a pale green or pale brown hue. Garnets are less and mostly brown in colour recognized by its high relief, absence of cleavage and isotropic characters. Garnet with etched margins and pitted surface are seen (Plate-I (E)). Amphibole is represented by hornblende. The grains are of variable shapes, i.e., slender, prismatic, subhedral to anhedral, showing perfect prismatic cleavages (Plate-I (C)).

Hypersthenes belonging to pyroxene group of minerals. Hypersthenes are subhedral to anhedral with sharp, angular or rounded corners. Shades of pink, pale reddish brown and green with distinct red to green are the distinctive pleochroic colours (Plate-I (B)). Leucoxene occurs as rounded grains with pitted surface. Light bluish tint along with brown inclusion (Probably rutile and ilmenite) (Plate-I (H)). Apatite is having low relief. Grains are having inclusions. Grains are oval to nearly round with low birefringence (Plate-I (L)). Elongated of Rutile grains is mostly dark red and brownish red colour showing distinct pleochroism. It has high relief and high refractive index. It shows straight

Plate 1: (A - M)


A-Rutile
B-Hypersthene
C-Oxy Hornblende
D-Zircon
E-Garnet
F-Topaz
G-Monazite
H-Leucoxene
I - Zircon
J-Sillimanite
K-Augite
L-Apatite
M-Ilmenite

extinction. It occurs as subhedral forms (Plate-I (A)). Rutile occurs as subrounded to slender, prismatic grains with well developed terminations or breakage patterns and high Refractive Index (RI).

Topaz is a yellowish blue and colorless. It often found in association with granitic pegmatite and valued as a gemstone varieties. Topaz appears as rounded grains, commonly marked by crescent shaped indentations, mostly colourless, first order grey, white or pale yellow interference colours (Plate-I (F)). Augite is green in color; the crystals are prismatic showing prominent cleavages, meeting at right angles (Plate-I (K)). It occurs as prismatic crystals with a rectangular or octagonal cross section. Crystals have partially hollow etchings. Zircons are identified in pink and colorless. The pink variety almost shows rounded edges and corners (Plate-I (D & I)). Inclusions of spherical cavities probably gas filled. Monazite is a honey bee color. Monazite is a very dense mineral (Plate-I (G)). Monazite is colorless or faintly colored from yellow to brown, but is clearly distinguishable from Rutile. Prismatic crystals of Monazite show extinction of about 40° to 43°.

CONCLUSION

Cuddalore coastline has varied dynamic geomorphological and geological features. In the study area sediments dominated by fine grained nature. The mean size indicates 100% fine sand distribution at all the location. Majority of the samples exhibit moderately well sorted to well sorted character. Samples collected near the river mouths exhibit moderately well sorted to well sorted character. The skewness value of all the locations clearly indicates the dominance of positive values. The positive skewness values indicate the influence of river in bringing the sediments and ultimately the monsoon changes. The predominance of fine skewed sediments in the study area indicate excessive riverine input. Linear discriminant function values the sediments dominantly deposited by beach processes in shallow agitated water under shallow marine condition where turbidity was more. Heavy mineral compositions in the study area indicate a mixed provenance of granitic, pegmatitic, metamorphic and cretaceous rocks in the upland. Angular to sub angular nature of the minerals indicate a short distance transport.

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