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Dispersal of Clay minerals and their variation in the River channel, Distributary and Estuary Environments of Gosthani River, North Coastal Andhra Pradesh, East Coast of India.

RAVI KUMAR KANDULA

Andhra University, department of geology, Visakhapatnam, Andhra Pradesh 530003

ABSTRACT

The Clay mineral suites of Gosthani river especially in the estuary environment are characterized by high smectite with varying proportions of Illite and kaolinite, whereas the clay minerals in the river channel and distributary channel contain high kaolinite with varying proportions of smectite and Illite. These two characteristic clay suites are recorded in the river channel, distributary and estuary environments. The factors of differential settling and flocculation of clay minerals in the estuarine environment have minor or no effects on relative variation of clay minerals in the three different suites from the river channel, distributary and estuary environments. The mineral variation of kaolinite and smectite dominated zones are the major processes operative in the estuary environment.

Key words: smectite, Illite, kaolinite, river channel, distributary, estuary, environment

INTRODUCTION

The Gosthani River is a minor and moderate river along the east coast of India in north coastal Andhra Pradesh shows in fig:1. It is Originates in the Ananthagiri hill ranges of Eastern Ghats mobile belt and it flows initially through hilly terrain in NW-SE direction. This river enters the plains above the Tadipudi village where it flows in a South East direction with a length of 70km and before debouching in to the Bay of Bengal at Bhimunipatnam it is in the north of Visakhapatnam it shows in fig:2 and 3.

The major geological formations of the entire drainage basin consist of Eastern Ghats group of rocks these are belonging to Archean age most of the drainage basin experiences in semi-arid climate. The Sedimentological aspects of work have been carried out in the river channel, distributary and estuarine environments of the Gosthani river basin. Many authors have indicated that the detrital source is the overall dominating factor influencing the clay mineral distribution and the variation in the deltaic areas. The main objective of the present work is to study the clay mineral distribution and influence of source region and tidal currents in the estuary environments. The water is the main source to form or to distribute the clay minerals and the secondary minerals. these are found in the clay fraction of the soil which is the less than 2μm (0.002) these clay minerals occur as clay sized fraction of the soil.

Method of Study

Forty-three selected sediment samples were collected along the river channel, distributary and estuary environments these are selected samples that is 1-20 downstream from Tadipudi to Tagarapuvalasa and 23 samples are in the distributary, estuary environments. It shows in the fig:3 using vanveen grab sampler, water samples were collected at four stations in two different seasons during months of May and September 2019, using hydro bios water sampler provided with thermometer salinity was determined by titration method and the 43 clay sample fractions (<2µm size) were separated from the sediments using the standard method oriented amount of the 2µm size clay fractions. These samples were prepared by pipetting onto glass slides and dried at the room temperature for heat treatment.

The sample suspension was uniformly spread on porcelain plates and heated at 500^0 c. the glycolated and heated samples were subjected to X-ray diffraction (GE XRD- 700 diffractometer). The operating conditions are remained constant and were Ni- filtered Cu, K α radiation,0.2^o receiving silt. The diffractograms were taken from 2^o 2θ to 30^o 2θ at a scanning speed of 1^o 2θ per minute, the clay minerals were identified from the diffractograms those minerals are Smectite, Illite and kaolinite these glycolated samples were recognized at 17A^o, 10A^o and 7A^o respectively. The weighted peak area percentages of clay fractions from the river channel, distributary and estuary environments are given in table:1. The all mineral groups of the clay fractions shows more or less uniform concentration in the study area.

Results and Discussions

The average kaolinite in the river channel is 55.6 and ranges from 49 to 68.9 whereas the Illite varies from 14 to 42% (average 20.4%). The average content of the smectite in the river channel is 23.9 and ranges from 6 to 30%. In the Distributary channel Kaolinite varies from 23.10 to 50.10 and average value of 38.66 whereas the Smectite ranges from 25.70 to 62.50 with an average value of 39.36. The Illite shows an average value of 19.74 which is more or less similar to the river channel. The Average value of the river (20.40) and decrease in the estuary (av 17.60). In the estuary, Kaolinite varies from 14.90 to 46.50 with an average value of 29.50 whereas Smectite ranges from 36.70 to 77.70 with an average value of 53.40. The Illite shows an average value 17.60 which is slightly less than that of the river channel and Distributary channel average of (20.40 to 19.74) and ranges from 14.70 to 25.00 in the estuary environment. It is evident that the clay minerals of the estuary are different from that of the river channel. Smectite is much more dominant clay mineral in the surface sediments of the estuary, than those of the river channel and distributary channel. The estuarine circulation might cause dilution effect by smectite rich clay mineral suite, transported from the inner shelf to Bay of Bengal by tidal currents resulting the smectite is dominant clay mineral suite in the estuary environment.

The minor river basin of Gosthani consists of high relief with wide valleys as a result of which the runoff is considerably more with greater velocity during monsoon period and the remaining periods, the runoff is much less consequently the low discharge of the river channel and usually terminates in the head of the estuary itself, hence the circulation is controlled by tidal currents from the Bay of Bengal. The salinity and temperature parameter shows in the table:2 and it shows that there is some degree of density stratification due to variation in salinity levels. So, the tidal circulation maintains a two-layer flow that is net downstream flow in the surface layer and the net upstream flow in the bottom layer and it develops the partially mixed estuary environment. The Salinity levels are increases both downstream towards the mouth and downward in the water columns at all stations in the estuary environment and occasionally this stratification is changed by vertical mixing. The average surface salinities are less during the monsoon period whereas the mixing salinities and land word flow occur at summer period and the river runoff is minimal. Though the estuary is shallow and the bottom sediments are not much

agitated by the tidal currents because the sand bar is presence at the mouth of the river. Also, the large variation in the river runoff due to storms in Bay of Bengal can affect drastically the stratification and the landward bottom layered flow.

The selected samples for the analysis of smectite, Illite and kaolinite along the river, distributary and estuary environments are shows in fig:5, these principle peaks of clay minerals smectite (17 A^0), Illite (10 A^0) and kaolinite (7 A^0) are measured above the background of response using the glycolated samples of X-Ray diffractograms. These peaks of three clay minerals are measured with a polar planimeter and multiplied by the weighing. According to the X-Ray diffractometer analysis shows in the fig .5 and the clay fractions are shows more or less uniform concentration and it shows in table-1.The scatter plots of clay mineral distribution shows in the fig:4, and it expressed smectite Vs kaolinite in 4(a), kaolinite Vs Illite in fig 4(b) and Illite Vs smectite in fig 4(c), these plots can expressed the distribution of clay minerals in the river channel, distributary and estuary environments of the study area.

The results indicate that the Gosthani River mainly carries kaolinite along with Illite and smectite whereas the tidal currents introduce smectite into the estuary from the Bay of Bengal. The abundance of smectite (av 53.4%) in the estuarine sediments that are deficient in kaolinite (av 29.5%) compared to the river channel the kaolinite is rich (av 55.6%) and smectite is poor (av 23.9%). In the distributary channel the kaolinite (av 38.6%) and the smectite is (av 39.3%). The values show in the table:1 sediments suggests that a part the smectite was derived from the source area and the major part through tidal currents from Bay of Bengal brought by littoral currents from the south.

The percentage of Illite in the estuarine sediments (av 17.6%) is more or less similar to that of the river channel (av 20.4%) and distributary channel (av 19.7%). It is quite likely that this mineral could have been transported from the drainage basin. Similar landward transport of sediments within the estuaries was reported by earlier workers. Upstream transport of the marine clay suite into the Gosthani River by the bottom flow could have resulted in gradual dilution of the kaolinite rich suite derived from the river (55.6%) and distributary (38.6%) channels and the estuary sediment average kaolinite is 29.5%. the variation of kaolinite verses Illite shows through the scatter plots in the figure.

On the other hand, differential settling and flocculation seem to be effective fractionating processes within the estuary and marine environment. Differential settling by particle size or flocculation were operative in the estuary and maximum concentration of Smectite and Kaolinite at the head of the estuary. The higher concentration of finer size smectite in the estuary whereas fresh water and marine water mixing takes place initially and with lateral variation of clay minerals towards the river confluence. In the presence of such distribution pattern it is sumrised that the above process is operative in the estuary and in the absence of such distribution pattern it is sumrised that the above process is not operative in the estuary. However, the variation in the concentration of Smectite at different sample locations from 36 to 77% in the estuary may possibly indicate that the estuarine circulation exerted minor influence on the distribution pattern of the clay minerals. the conclusion of Diagenetic variation of Kaolinite to Smectite is the major process operative in the estuary environment. the x-ray studies help to study the sampling in the estuary and are necessary to understand the Diagenetic processes.

The clay mineral suite of the estuary is different from that of the river channel. Smectite is much more dominant in the clay mineral suite of the suspended as well as surface sediments of the estuary than in those of the river channel and Distributary channel. As a result, the circulation is controlled by tidal currents from Bay of Bengal. Thus, the estuary is a mixing zone between two distinct clay mineral suites, a river suite and a marine suite because of the following two factors (1) the river sediments are largely trapped within the estuary except during monsoon (2) the two-layer circulation in the estuary

introduces considerable quantities of sediments from Bay of Bengal. The hydrographic parameters (salinity and temperature) were studied at four stations during the months of September and May Table:2 shows.

The upstream transport of the marine clay suite into the Gosthani River by the bottom flow could have resulted in gradual dilution of the Kaolinite and Illite-rich suite derived from the river. The presence of more or less uniform concentration of Illite in the river channel and the estuary and the absence of two distinct clay suites within the estuary as reported by Feuillet and Fleischer (1980) rules out the possibility of dilution effects in the estuary. Further, if the decrease in concentration of Kaolinite from river channel (av.55.60) to the estuary (av.29.50) due to the dilution effects of estuarine circulation one should expect as similar low concentration of Illite in the estuary. the Gosthani River carry Kaolinite and Illite-rich suite whereas the tidal currents introduce Smectite-rich suite in the estuary from Bay of Bengal.

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Table-1

Clay mineral Percentages in less than 2μm Fraction of Gosthani river Channel, Distributary and Estuary environments.

S.no.	Sample Number	Smectite 17A^0	Illite 10 A^0	Kaolinite 7 A^0
River channel clay samples				
1	3	21.10	16.50	62.30
2	8	27.20	19.80	53.30
3	14	23.30	17.60	59.40
4	20	24.60	20.40	55.20
5	26	27.00	23.20	49.50
6	30	24.30	21.70	53.60
7	34	27.10	19.80	53.40
8	36	17.00	14.10	68.90
9	39	22.10	17.20	60.50
10	41	20.00	16.40	64.10
11	47	27.20	19.60	53.20
12	50	29.40	20.30	50.60
13	52	29.00	20.50	50.50
14	55	30.10	21.10	49.00
15	58	26.20	21.60	52.30
16	60	6.00	42.30	51.80
17	63	25.80	20.80	52.30
18	69	17.00	14.10	68.90
19	72	24.50	20.30	55.10
20	80	30.10	21.00	49.00
Average		23.90	20.40	55.60
Distributary clay samples				
S.no	Sample Number	Smectite 17A^0	Illite 10 A^0	Kaolinite 7 A^0
1	D-2	25.70	28.40	46.00
2	D-4	28.60	21.40	50.00
3	D-8	50.00	15.40	23.10
4	D-10	62.50	12.50	25.20

5	D-12	30.00	21.00	49.00
Average		39.36	19.74	38.66

S.no.	Sample Number	Smectite $17A^0$	Illite $10\ A^0$	Kaolinite $7\ A^0$
Estuary clay samples				
	Sample Number	Smectite $17A^0$	Illite $10\ A^0$	Kaolinite $7\ A^0$
1	E-2	52.40	19.10	28.60
2	E-3	60.10	17.20	22.80
3	E-4	55.20	20.10	25.30
4	E-5	55.60	16.80	27.60
5	E-6	77.70	17.50	14.90
6	E-7	40.30	18.30	41.50
7	E-8	51.80	14.70	33.40
8	E-9	48.60	12.10	39.30
9	E-10	53.80	19.10	26.50
10	E-12	61.60	15.40	23.10
11	E-13	50.40	22.30	27.40
12	E-14	61.60	15.50	23.20
13	E-15	50.10	15.30	33.40
14	E-16	50.20	20.10	30.30
15	E-17	53.50	15.30	30.90
16	E-18	58.20	16.20	25.80
17	E-19	43.80	25.00	31.20
18	E-20	36.70	16.70	46.50
Average		53.40	17.60	29.50

Table:2

Hydrography of the Gosthani Estuary at Bhimunipatnam in the month of May

Hydrographic Parameters	Water sampling stations (figures in the brackets indicate approximate distance from the river mouth in Km.			
	I	II	III	IV
	[1.0]	[1.5]	[1.8]	[2.0]
Temperature (°C)				
Surface	34.6	34.4	34.8	34.7
Bottom	34	33.8	34.2	34.3
Salinity (0/00)				
Surface	31.8	31.5	30.2	24.7
Bottom	33.5	33.7	33	28.7

Hydrography of the Gosthani Estuary at Bhimunipatnam in the month of Sep

Hydrographic Parameters	Water sampling stations (figures in the brackets indicate approximate distance from the river mouth in Km.			
	I	II	III	IV
	[1.0]	[1.5]	[1.8]	[2.0]
Temperature (°C)				
Surface	26.2	26.3	26.2	26.1
Bottom	25.8	25.6	25.7	25.7
Salinity (0/00)				
Surface	14.5	13.9	13.5	4.9
Bottom	28.8	26.5	20.6	14.3

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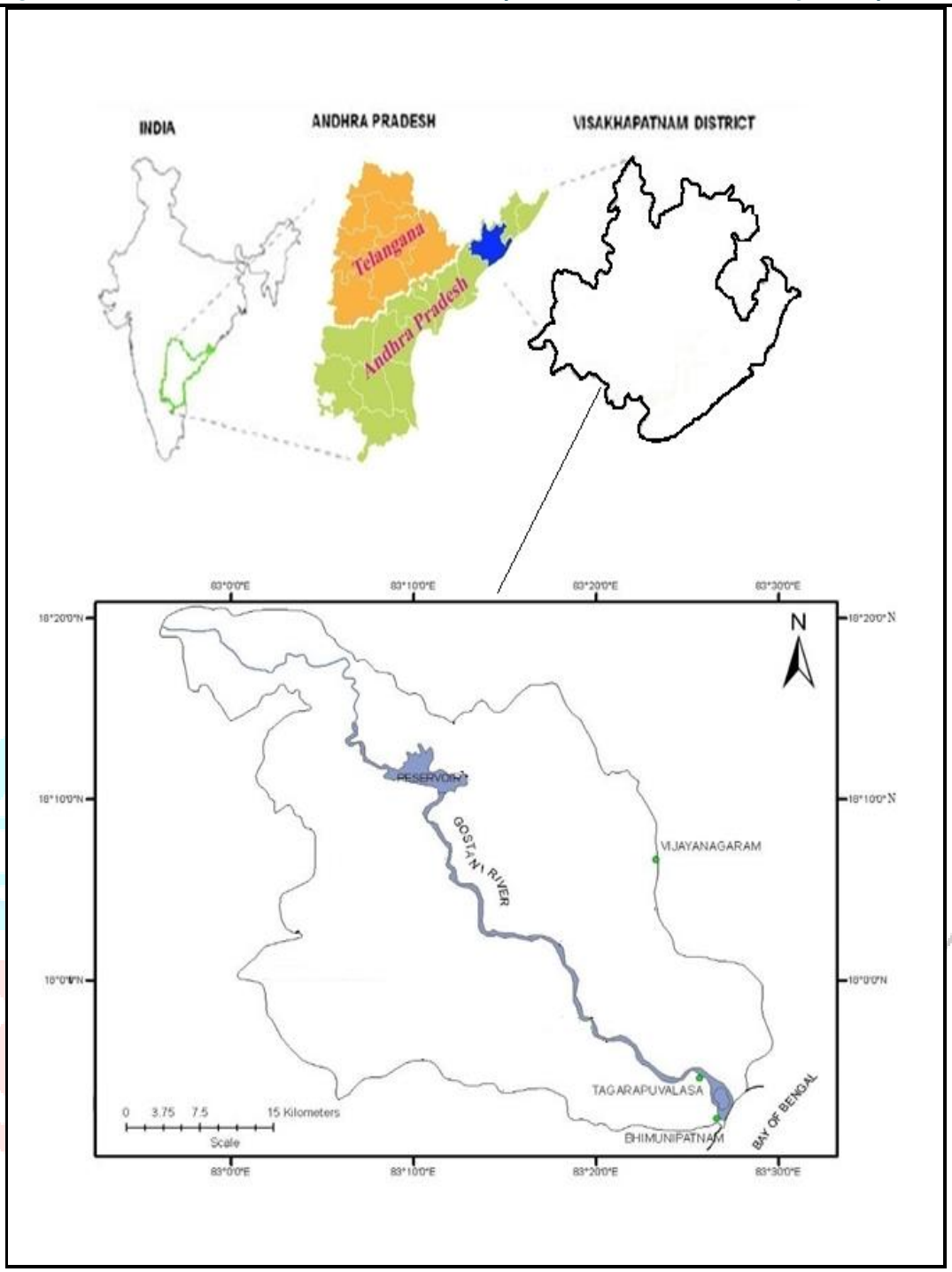

Fig:.1. Location map of the study area.

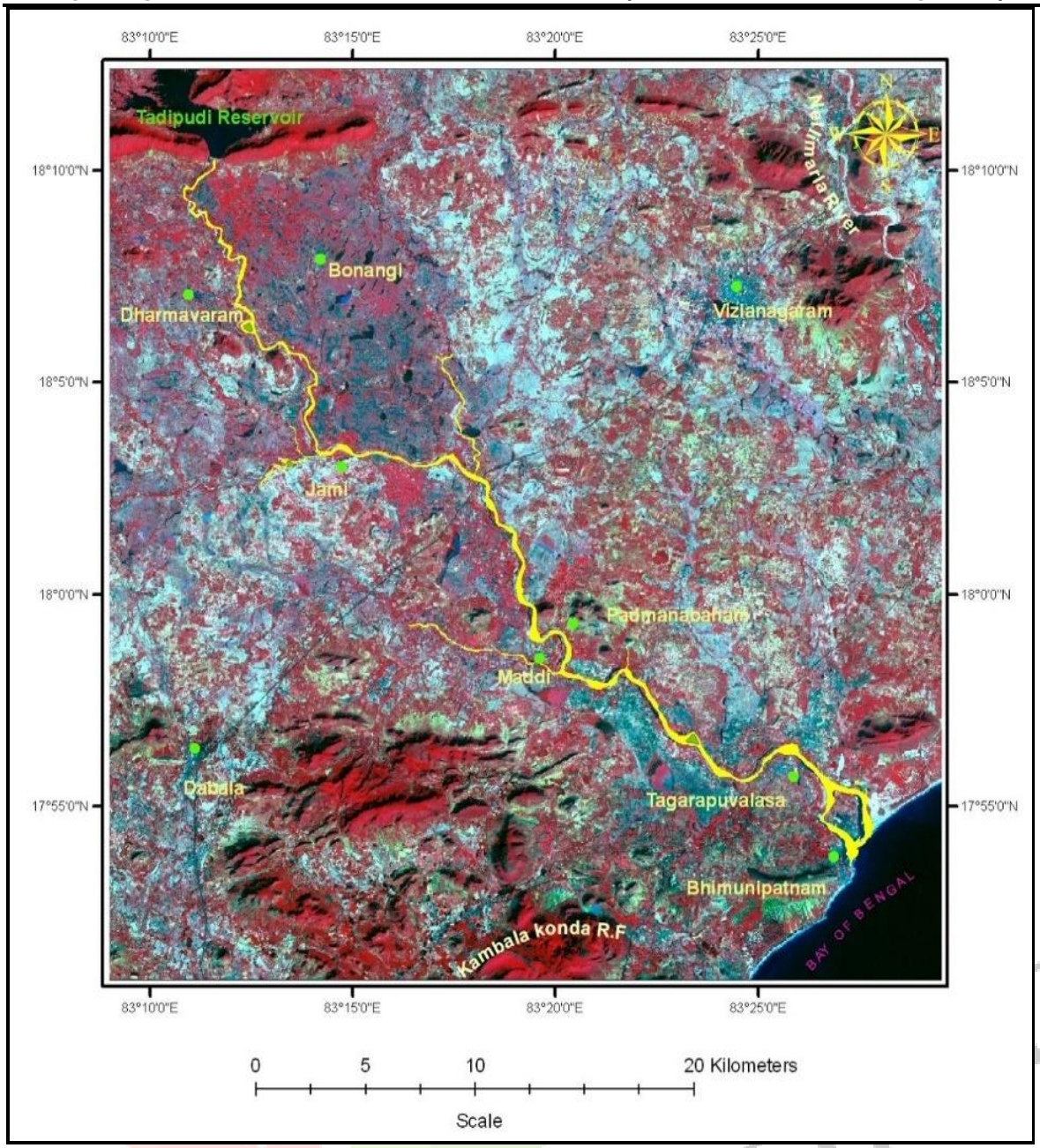

Fig:2 satellite map of the study area.

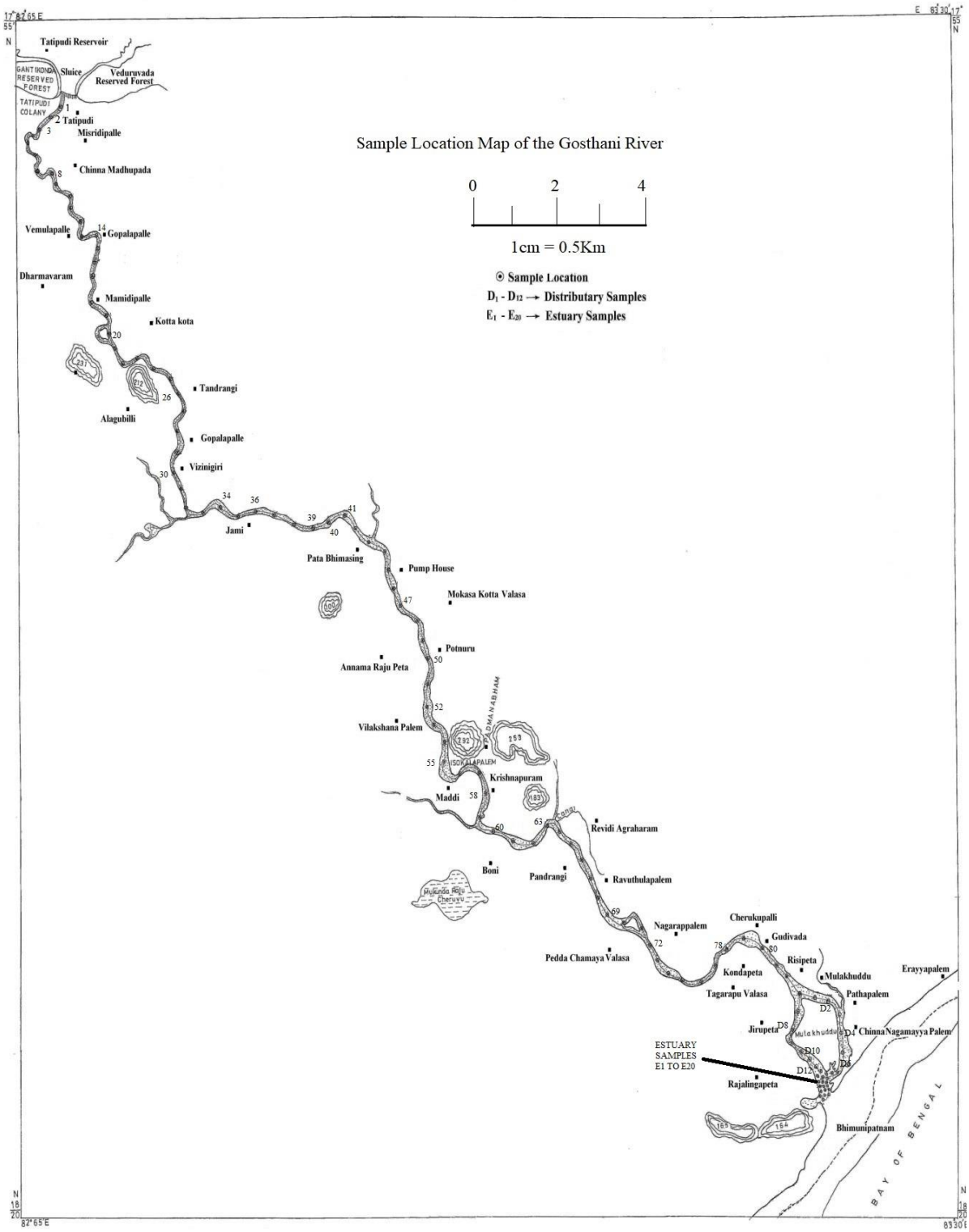

Fig: 3 Sample Location Map of the Gosthani River.

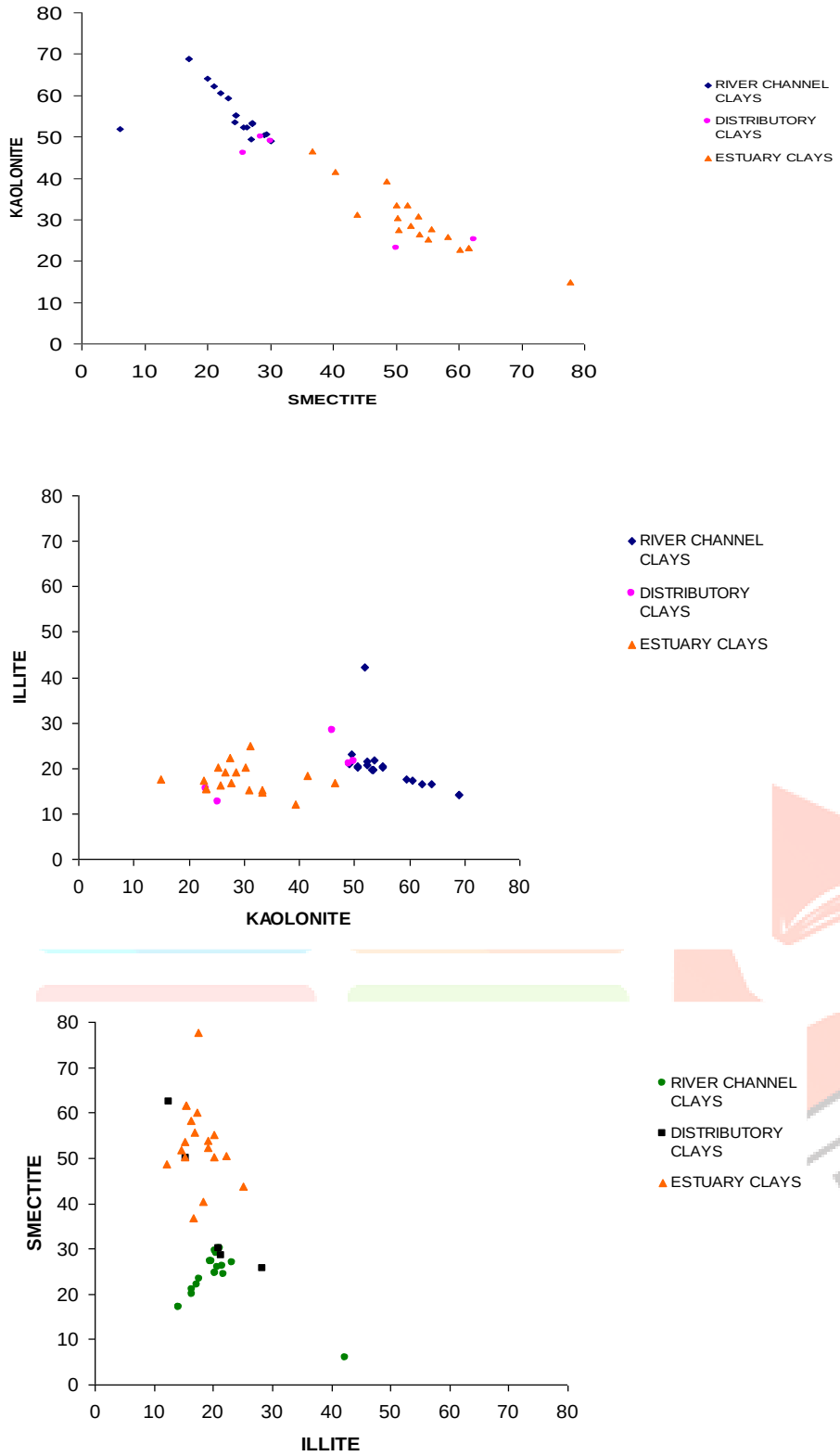

Fig:4 (a) Scatter Plot of Smectite Vs Kaolinite**;** 4(b) Scatter Plots of Kaolinite Vs Illite; 4(c) Illite Vs Smectite.

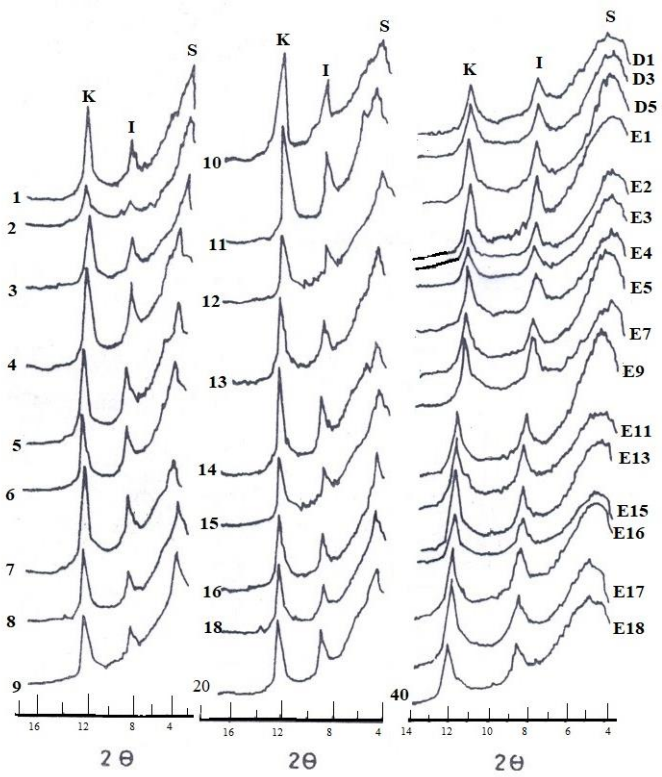

Fig:5 X-Ray diffractometer tracing of clay minerals from the Gosthani river channel, Distributary and Estuary environments. stations indicate **K** for Kaolinite, **I** for Illite and **S** for Smectite.