

Textural behaviour of innershelf sediments off Mangalore, west coast of India

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Modern sediments are constrained to a water depth of 41m and mixed sediments at water depths more than 41m in Arabian Sea off Mangalore. Mixed sediments are inferred to represent cross shelf transportation of modern silt+clay to the relict sand zone. Sedimentological analysis also indicates a longer period of shelf environment earlier to the transgression/regression cycles of the Holocene-Pleistocene epochs. Down core variation of different sedimentological parameters is more prominent in the outer-innershelf core.

Various investigations have added to the milieu of the marine geological scenario concerning the inner shelf and beaches of Mangalore and its adjacent areas. Paucity of sedimentologic data renders a hypothetical appreciation of the beach and innershelf. The present study aims at understanding the texture and nature of sediment distribution in the inner shelf off Mangalore.

The Nethravathi river drains the hinterlands and debouches into the study area (Fig.1). Five core samples (C1 to C5) were collected at different depths (11.4m, 21.1m, 31.8m, 41.3m, 50.9m respectively). While detailed granulometric analysis have been carried out on surface samples (top 5cm) of each core, two extreme cores (C1, C5) have been considered for down core study. The inner-innershelf core (C1) is of 55cm long and that of the outer-innershelf core (C5) is 35cm long. Textural characteristics of sediment samples were analysed following the earlier works^{1,2}. Textural parameters were computed using the standard formulae³. Sediments have been classified following Shepard⁴.

Surface samples

In the case of surface samples (core tops) clayey silt is distributed up to 31m water depth with a patch of sand-silt-clay at around 21m water depth. The Mz of these samples ranges from 3.13 ϕ to 7.92 ϕ and Md ranges from 2.59 ϕ to 7.08 ϕ . The

mean size of C1-1, C2-1 and C3-1 fall in the silt range, where as, the extreme sample (C5-1) falls in the sand range and C4-1 falls very close to the boundary between coarse silt and fine sand. There is an abrupt decrease in the phi mean grain size at a water depth beyond 41.3m, with a minor increase at 21.1m. All the sediments are poorly sorted. These samples are near symmetrical (C2-1), fine skewed (C1-1) or very fine skewed (C3-1, C4-1 and C5-1). Three samples (C1-1, C2-1 and C4-1) are mesokurtic and one each is platykurtic (C3-1) and leptokurtic (C5-1) (Table 1).

Inner-innershelf core (C1)

In the case of the inner-innershelf core, clayey silt is distributed up to around 40cm core depth and at 50-55cm core depth, the sediments are sand-silt-clay. The Mz of these samples ranges from 6.57 ϕ to 8.09 ϕ and Md ranges from 5.90 ϕ to 7.48 ϕ . Except the sample C1-2, the Mz of the other samples fall in the fine silt to very fine silt range, whereas, the Mz of the C1-2 is in the clay range. All the samples are very poorly sorted. These are either fine skewed (C1-1, C1-2 and C1-4) or very fine skewed (C1-3) and are either mesokurtic (C1-1, C1-2 and C1-3) or leptokurtic (C1-4) (Table.1).

Outer-innershelf core (C5)

In the outer-innershelf core, silty sand is distributed up to 15cm core depth and below this the sediments are silty clay with a patch of sand-

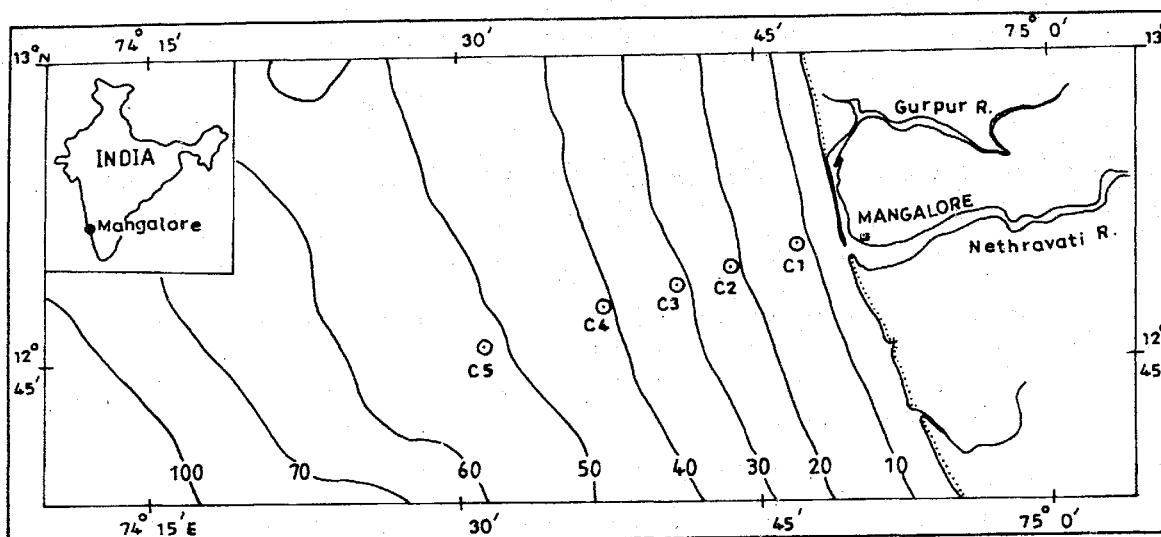


Fig. 1—Location of the study area with bathymetry

Table 1—Granulometric data and sediment types

Sample no.	Core depth ϕ (cm)	M_z ϕ	M_d ϕ	σ_1	SK_1	K_G	Sand %	Silt %	Clay %	Sediment type
C1-1	0-5	7.20	6.50	3.27	0.27	1.02	8.61	56.91	34.47	clayey silt
C1-2	15-20	8.09	7.48	3.17	0.21	0.92	4.67	51.10	44.21	clayey silt
C1-3	35-40	6.91	6.00	2.89	0.49	0.91	6.05	63.91	29.94	clayey silt
C1-4	50-55	6.57	5.90	3.56	0.20	1.27	21.46	52.48	26.05	sand-silt-clay
C5-1	0-5	3.13	2.59	3.59	0.30	1.26	65.94	21.15	12.90	silty sand
C5-2	5-10	3.38	2.57	3.76	0.37	1.14	66.30	19.67	14.02	silty sand
C5-3	10-15	3.41	2.63	3.66	0.36	1.07	64.03	21.90	14.05	silty sand
C5-4	15-20	7.66	8.19	4.29	-0.19	1.05	16.97	29.10	53.91	silty clay
C5-5	20-25	9.24	9.02	3.26	-0.06	1.08	7.65	28.82	63.52	silty clay
C5-6	25-30	6.76	7.37	4.58	-0.19	0.91	22.62	33.48	43.88	sand-silt-clay
C5-7	30-35	8.82	8.47	3.33	0.00	1.15	10.42	31.88	57.68	silty clay
C2-1	0-5	5.47	5.48	4.25	0.03	1.05	24.34	48.67	26.97	sand-silt-clay
C3-1	0-5	7.92	7.08	2.94	0.37	0.83	3.64	55.84	40.51	clayey silt
C4-1	0-5	4.14	2.95	3.60	0.51	1.04	61.37	21.05	17.56	silty sand

silt-clay at 25-30cm core depth. The M_z of these samples ranges from 3.13 ϕ to 9.24 ϕ and M_d ranges from 2.57 ϕ to 9.02 ϕ . Mean grain size ranges from clay (C5-5 and C5-7) to very fine sand (C5-1, C5-2 and C5-3) through very fine silt (C5-4) and fine silt (C5-6). All the samples are very poorly sorted. C5-1, C5-2 and C5-3 are very fine skewed, C5-4, C5-5 and C5-6 are coarse skewed and C5-7 is near symmetrical. These sediments are either leptokurtic (C5-1, C5-2 and C5-7) or mesokurtic (C5-3, C5-4, C5-5 and C5-6) (Table 1).

The sand-silt-clay percentage of the surface samples shows an increase of sand percentage from

41m water depth onwards. Table 1 also shows a high concentration of sand (64 to 66%) at 0-15cm core depth of the outer-innershelf core (C5). The remaining percentage is constituted by silt+clay. This sand may be relict deposit formed during the lower stands of sea level, which later got submerged during the transgressive phase. The silt and clay of these samples are modern and brought to this environment by the present day rivers. Nair & Hashimi⁵ while discussing about the cohesive (recent mud) and non-cohesive (relict calcareous sand) sediment boundary of the western continental shelf of India pointed out the existence

of a transition zone between 50 and 70m water depth, where these two sediment types intermingle resulting in textures such as sandy clays and sandy silts. Cross shelf transport of river-borne sediments can take place by the process of convective diffusion⁶. Narayana & Venkatesh Prabhu⁷ reported such mixed sediments from the shelf of Honnavar, central west coast of India (further north of the present study area).

In the case of the surface samples (core tops), when water depth increases, sand content also increases and silt+clay percentages and Mz (in phi) decreases. The textural analysis of the core tops also reveals the dominance of poorly sorted silt and clay grade sediments in the nearshore (up to 31m water depth).

The inner-innershelf core contains clayey silt and sand-silt-clay sediments. The lower part of the outer-innershelf core (15-35cm core depth) also contains silty clay and sand-silt-clay sediments. So the explanation given by Hashimi *et al*⁸ can be applied to the sediments of these core depths which were deposited in the recent geologic past.

All the samples studied (both surface samples and core samples) are very poorly sorted. In the case of the mixed sediments, the mixing of the relict sand with the modern silt+clay results in poor sorting and hydrodynamic processes operating at this depth are incapable of sorting these two types of sediments.

Except one of the surface sample (C2-1) and 15-35cm core depth of the outer-innershelf core, all other samples are either fine skewed or very fine skewed. The fine skewed nature suggests excess of

fine particles, implying low energy conditions prevailing in the depositional environment. The sediments of 15-30cm core depth of the outer-innershelf core exhibit coarse skewed nature and further down (30-35cm core depth), the sediments are near symmetrical. The presence of silty and clayey sediments below the relict (or mixed) sediments in the outer-innershelf core (ie., at 15-35cm core depth and may be further down) indicates a longer period of shelf environment earlier to the transgression/regression cycles of the Holocene-Pleistocene epochs. The sudden decrease of sand percentage and sudden increase of clay percentage at 15cm core depth of the outer-innershelf core indicates absence of gradual facies change.

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