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A note on the Relict Sand (?) and movement of sediments off Gopalpur, Orissa Coast, India*

P. C. SHRIVASTAVA AND B. R. RAO
Offshore Mineral Exploration & Marine Geology Division
Geological Survey of India, Calcutta

Introduction

Based on the proposal to develop Gopalpur (19°15′10″N : 84°54′30″E) to medium size port cum fishing harbour, the proposed site (Fig. 1a) was taken up for the study of movement of sediments by fluorescent tracers to assess the seasonal variations in the area. Shrivastava (1975) carried out a beach experiment during the southwest monsoon in the year 1971 and concluded that beach sands move northeasterly. The area was sampled on a fishing launch upto a depth of 12 m with the help of a Van Veen grab sampler and the locations were fixed with sextant bearings of shore objects, for locating a suitable site for an offshore experiment (Fig. 1a). The authors carried out the experiment during February-March, 1972.

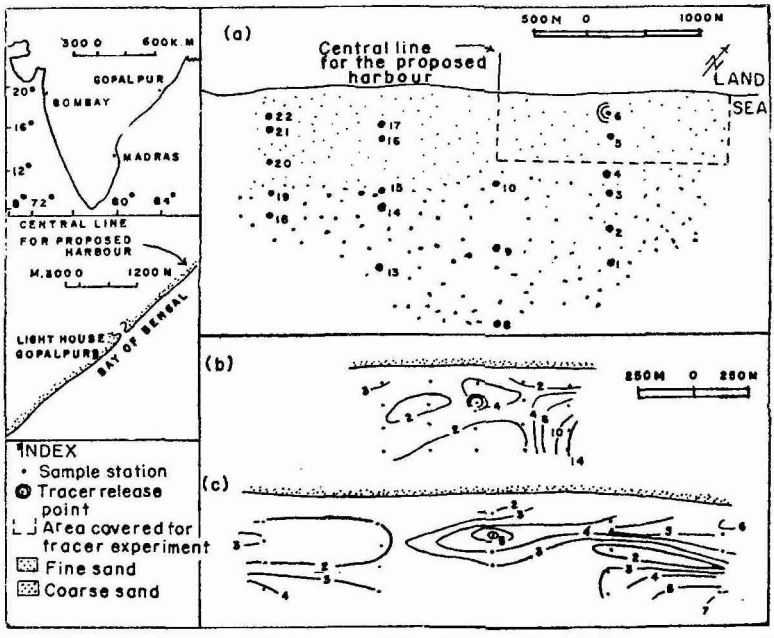

Figure 1. Location of the area; (a) sediments distribution, area covered for tracer experiment; (b) and (c) tracer concentration patterns after 180 and 5,850 minutes after the release of the tracers respectively.

Currents and waves

Northeasterly currents set in the middle of January and gain prominence in middle of February with a ½ knot velocity close to shore and 1½ knots at 12 miles off the coast. Northeasterly currents continue until July when the southwesterly currents

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begin (Bay of Bengal Pilot, 1953). Visual observation of wave heights during the period were estimated to be a meter approaching the coast from south.

Sediments

All the bottom samples were subjected to mechanical analyses through sieving at $\frac{1}{2}$ phi intervals to get an idea about their grain size parameters. Mean size, inclusive graphic standard deviation, inclusive graphic skewness and graphic kurtosis were calculated using Folk and Ward (1957) formulae and shown in Table I. These

TABLE I

GRAIN SIZE PARAMETERS

Sample No.	Median in ϕ	Mean size in ϕ	Inclusive Graphic Standard Deviation in ϕ	Inclusive Graphic Skewness	Graphic Kurtosis
1	1.58	1.61	0.8594	+0.0479	1.0420
3	1.68	1.70	0.7411	+0.1225	1.1860
4	1.66	1.73	0.8888	+0.1180	1.6100
5	3.31	3.30	0.5244	+0.0759	1.4230
6	2.80	2.75	0.6416	-0.1766	1.1890
8	1.55	1.60	0.7936	+0.1146	0.9625
9	1.56	1.57	0.8585	+0.0297	1.1030
10	1.79	1.82	0.8351	+0.1375	1.2460
13	1.51	1.52	0.7782	-0.0284	1.1790
14	1.48	1.46	0.6639	+0.1066	0.8250
15	2.90	2.89	0.8141	-0.0059	0.8880
16	3.30	3.32	0.4198	+0.0527	1.2800
17	2.98	2.94	0.7104	-0.1396	1.2870
18	1.95	1.97	0.7466	+0.0561	1.1710
19	1.55	1.57	0.7792	+0.0536	1.2120
20	3.15	3.03	0.8441	-0.1961	0.8072
21	3.25	3.25	0.4473	+0.0161	1.2960
22	2.91	2.87	0.6164	-0.1055	1.1550

indicated a sequence from coarse to very coarse sand with shell fragments in the breaker zone to fine to very fine sand to a depth of 8 m, followed by a coarse sand which has a different appearance. Plots of mean diameter vs skewness and standard deviation vs median diameter are effective measures to differentiate the different environments viz. beach, dune and river sands (Moiola and Weiser, 1968). To get an idea about the offshore (8-12 m depth) coarse sand patch, the mean diameter vs skewness was plotted (Fig. 2a) and indicated that it falls under the limits of beach environment (Moiola and Weiser, 1968). Coarse fraction analysis (Shepard and Moore, 1954) was carried out for one section (Fig. 2c) which has indicated relative

increase of terrigenous minerals and calcareous fragments seaward and decrease of foraminifera, molluscs, ostracoda, mica, etc. The anamolus coarse sand patch at a depth of about 10 m with constituents largely terrigenous seems to be of beach environment (Wimberley and Shepard *cf* Shepard and Moore, 1954). Generally, in the nearshore and coastal areas a progressive decrease in grain size is observed due to sorting effect of waves. In the present area, presence of coarse sand between 8 m and

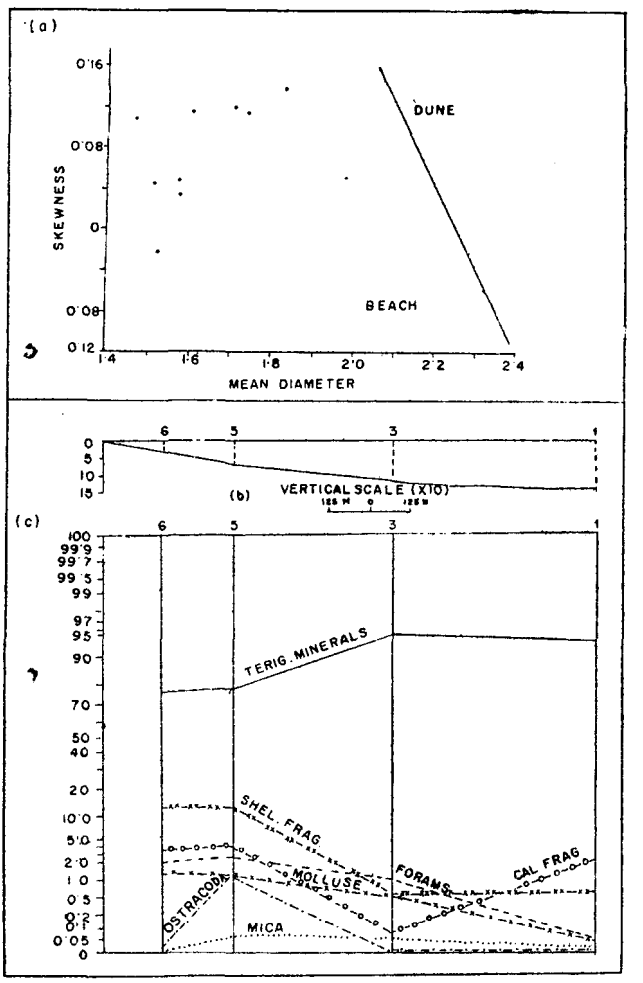

Figure 2. (a) Plots of mean diameter vs skewness; (b) Submarine profile across station 1 to 6 (c) Stations in coarse fraction constituents.

12 m depth cannot be explained except by grouping them under relict nature. While sampling in the area by Venkatesh and Rao (personal communication) revealed the presence of clay balls in that zone—characteristics of relict sand (Curray *cf* Wright and Frey, 1965). Subba Rao (1964) reported the presence of sandy sediments in this area extending up to the limits of the inner shelf (clastic sediments) and gave the age as Recent, probably subject to seasonal variations. Keeping in view about the relict nature of this sediment, the authors projected this depth data onto the Curray's sea

level changes curve (*cf.* Wright and Frey, 1965), it fell under the Holocene transgression (7,000 BP). An extremely rapid transgression, by normal geological standards, from 18,000 to 7,000 BP followed by rather pronounced slowing in the rate of rise of sea level occurred after 7,000 BP, might have given rise to this coarse sand zone in this area. This indicated that there is no tectonic disturbance in the coastal terrain during recent times.

Fluorescent tracer experiment

About 100 kg of fine sand was made fluorescent with auramine dye (Siddiquie and Shrivastava, 1970) and the same was released at a depth of about 3.5 m with the help of a mechanical device (Shrivastava, 1970) on 27-2-1972. The samples were collected on 27-2-1972 and 3-3-1972 around the release point with the help of a Van Veen grab. All the samples were washed, dried and counted under ultraviolet lamp for the presence of fluorescent grains. The concentration maps were prepared using corrected values for a standard elapsed time (Fig. 1b & c) with Ingle's method (1966). These indicated that the initial dispersion (Fig. 1b) after 180 minutes of the release was mainly by the breakers and receding tide. The dispersion pattern after 5880 minutes after the release (Fig. 1c) indicated that the sediments move northeasterly in concurrence to the northeasterly coastal currents (Bay of Bengal Pilot, 1953). This study indicated that northeasterly currents which set in January continue to be slow till February-March in this area.

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