



OTC 6065

Impact of Coastal Features on Beach Placers: A Case Study Using Remote Sensing Data

by B.G. Wagle, A.R. Gujar, and P.G. Misiñkar, Natl. Inst. of Oceanography

Copyright 1989, Offshore Technology Conference

This paper was presented at the 21st Annual OTC in Houston, Texas, May 1-4, 1989.

This paper was selected for presentation by the OTC Program Committee following review of information contained in an abstract submitted by the author(s). Contents of the paper, as presented, have not been reviewed by the Offshore Technology Conference and are subject to correction by the author(s). The material, as presented, does not necessarily reflect any position of the Offshore Technology Conference or its officers. Permission to copy is restricted to an abstract of not more than 300 words. Illustrations may not be copied. The abstract should contain conspicuous acknowledgment of where and by whom the paper is presented.

ABSTRACT

Black and white aerial photographs of the Central west Coast of India for a stretch of about 500 km (Bombay to Goa) were interpreted under mirror stereoscope to study the coastal features. Subsequently ground truth data was also collected to confirm the photographic findings. In total 200 representative beach samples were collected from high tide and low tide levels and analysed for its heavy mineral content. Photographic grey tone variation of the beach sediments were correlated to the differential concentration of heavies in the sediments. Impact of lithology, coastal geomorphology and drainage on the concentration of heavies was established.

Coast shows marine, fluvial and aeolian features and dendritic drainage pattern. Rivers carry lot of sediment load due to heavy rainfall and high relief in the catchment area. In aerial photographs beach sands show white, greyish white, dark grey and black tone depending upon the percentage of the black minerals. Comparison of the tonal variation with heavy mineral percentage reveals that light minerals show white tone and as the percentage of heavies increases the tone changes dark grey to black. Mineralogical study indicates that the heavy mineral percentage varies from 0.4 to 98.64 %. Where the concentration of heavies is more the rock type along the coast and in the catchment area of the rivers is Deccan basalt with appreciable

References and illustrations at end of paper

laterite cover and drainage intensity is high. As drainage intensity decreases and where the rock type is granite and gneisses the concentration of heavies is low or almost negligible.

INTRODUCTION

Remote sensing data provides a valuable, rapid and accurate tool for the study of coastal geomorphology. Use of aerial photographs has increased the efficiency of many geomorphic mapping by adding speed, economy and accuracy as well as adding certain geomorphic information that is impossible, difficult or increasingly impractical to obtain by routine field mapping method

During the interpretation of the aerial photographs the authors noticed the clear cut variation in the grey tone of the beach sediments in the area due to the differential concentration of black minerals in the material. To confirm the photographic finding the ground truth and about 200 representative beach samples were collected from high tide and low tide levels and analysed for its heavy mineral content. Photographic grey tone variation of the beach sediments were correlated to the differential concentration of heavies in the sediments

METHODS

An uncontrolled mosaic of B/W aerial photographs (1:25,000 and 1:20,000 approx) of the Central West Coast was prepared by

matching the images of the overlapped portion to give contiguity. This was followed by the area runwise under the mirror stereoscope to study the coastal geomorphic features. Acid insoluble residue of the samples was separated into light and heavy fraction by bromoform (sp.gr. 2.89) and the heavy mineral percentage by weight was calculated.

RESULT AND DISCUSSION

For identifying the coastal features, aerial photoelement analysis such as tone, texture, shape, size, form, pattern and associated features were taken into consideration. The coast is more or less straight, running in NNW - SSE direction. It shows marine, fluvial and aeolian features. Many of the coastal rivers are drowned river valleys. They are under tidal influences for most of their length. Some of these rivers have large estuaries at their mouth. The rivers however small are carrying a lot of sediment load due to the heavy rainfall and high relief in the catchment area.

The interpretation of photographs revealed drastic variation in grey tone of beach sediments. Some showed light to dark grey and greyish black to black tone depending upon differential concentration of black minerals in beach sediments. Though the occurrence of heavy mineral placer deposits along the beaches of this coast reported earlier, none has used remote sensing data. During ground truth collection, about 200 representative samples of beach sediments were collected. Depending upon the configuration and length of the beaches sample interval was decided to get the maximum possible coverage of all the beaches.

About 65 representative beach samples (one at high tide and one at low tide level from each station) were selected for heavy mineral studies. Acid insoluble residue of the sample was separated into light and heavy fraction by floating and sinking in heavy liquid (bromoform sp. gr. 2.89) and the heavy mineral percentage by weight for the sample was calculated (Table I).

Tonal variation when compared with the heavy mineral percentage of the sediments indicated that the beach sediments consisting of light mineral show the clear white tone and as the percentage of heavies increases the tone is grey to dark grey and with high content of heavies (i.e. >50%) the tone is dark grey to bluish grey. Whereas complete black tone

of beach sediments indicates the high percentage (upto 95 %) of the black minerals.

Mineralogical studies revealed that the heavy mineral concentration varies from 0.04 to 98.65 %. In general the heavies are more in the high tide level samples and highest percentage being in fine to very fine sand.

The close examination of the present result indicates that the concentration of the black sand is more in a particular region of the coast. This can be explained only on the basis of lithological, geomorphological and drainage differences of the area.

Based on our observations it is noted that in the study area the heavy minerals are more concentrated (upto 98 %) in the central zone (area - A) i.e. between Deogarh to Srivardhan. In the northern zone (area - B) between Srivardhan to Bombay the concentration of heavies decreases (3 to 30 %). Whereas in the south zone (area - C) i.e., south of Deogarh the abundance of heavies further decreases and almost negligible in some of the beach samples (Fig 1).

The coastal region (study area) falls in two lithological provinces. North of 16° 30' N latitude the coastal features are developed on Deccan basalt whereas south of 16° 30' N it is metamorphosed Dharwars overlying the crystalline base. Laterites of variable thickness are found to occur capping the coastal rocks at different levels from the high plateau of Sahyadri down up to the sea level.

In the central zone (area - A) where the concentration of placer mineral is more, the rocks are Deccan basalts with an appreciable thickness of laterites. In the northern zone (area - B) where the heavies are less concentrated the Deccan basalt still persists as the source rock but the laterite thickness becomes more and more thin and finally disappears towards north. Whereas in the southern zone (area - C) where the heavies are less or negligible the rock types are Dharwars and Precambrian granites and gneisses with laterite capping. This clearly indicates that the Deccan basalts and laterites are the main source of the black sand.

Geomorphological study indicated that the coastal forms are very much alike in these three zones. The contrast in the coastal forms within a distance of few hundred kilometers can be ascribed to the climate, lithology and the tectonic history of the different regional component of the coast.

The northern zone (area - B) is characterised by surface of plantation dotted with occasional hillocks and penetrated by creeks and tidal flats. In this zone the coastal relief being low and lack of high plunging cliffs accounts for the low contribution of sediments. In the central zone (area - A) where the heavies are abundant the coast is backed by laterite plateau and cliffs, some of which are fast wearing away. In this way the cliffs as well as the inland hills contribute tremendous amount of eroded material to beach and river sediments. Whereas in the southern zone (area - C) where the prevailing geomorphic forms are same as in the central zone (area - A) but because of different rock types the contribution of heavies are very low.

The drainage pattern indicates that all the above mentioned three areas (A, B and C) are well drained by rivers which are originating from the Sahyadri ranges. The overall drainage is dendritic. The rivers run mostly straight with sharp bends and meandering is a rare phenomenon⁸. Owing to the heavy rain fall, the rivers have a tremendous headward eroding capacity and hence they are the main transporting agent of the sediments. Taking into consideration the high density of the rivers in the central zone (area - A) high concentration of heavies can be explained, whereas the density of the rivers is low in the northern and southern zone (area B and C). In addition to this most of the rivers in the area - B run oblique to the coast before debouncing into the sea. Similarly many rivers in area - C run parallel to the coast for a considerable distance due to the formation of sand spits at their mouth (Gad and Karli rivers). Some of the rivers in the area B and C have wide estuarine river mouths. All these factors definitely account for the less concentration of heavies in northern and southern zone. This shows that in addition to the lithological conditions the geomorphic aspects of the coast as well as the processes of erosion and transportation also contribute towards the differential concentration of the heavies in the beach sediments.

In addition to the above factors - climate, sea-level and tectonics must have also played a decisive role for the contribution of sediments. Climate particularly the rainfall, has played a key role in the process of lateritization and indirectly contributed to the specific type of coastal development. Change in sea-level and coastal tectonics must have caused the emergent and submergent coastal features which in turn effect the coastal sedimentation.

CONCLUSIONS.

Aerial photographs can be used as an effective tool for identifying coastal geomorphic features and locating the black sand deposits. The study also indicates the influence of lithology, coastal geomorphology and drainage factors on the concentration of the black sand deposits. These inferences will be of great help for planning the exploration of beach placers.

ACKNOWLEDGEMENT

The authors are grateful to Dr. B.N. Desai, Director National Institute of Oceanography, for permission to publish this material and to Shri P.S.N. Murty for his encouragement in this work.

REFERENCES.

- 1) B.C. Roy : Geological Survey Professional Paper No 373, Washington, 1960.
- 2) L.A.N. Iyer : Record Geological Survey India, 74, 1939.
- 3) M.S. Krishnan and B.C. Roy : Record Geological Survey India 76, 32, 1939.
- 4) B.C. Roy : Record Geological Survey India 87: 432, 1958.
- 5) V.A. Altekar : Project Report Ilmenite at Ratnagiri, Maharashtra Mineral Corporation Bombay, 1961.
- 6) R.S. Mane and H.K. Gavede : Report on Prospecting of Ilmenite beach sands of Ratnagiri, 1974.
- 7) A. Sood ; Unpublished M.Sc. Dissertation Thesis, Geology Dept Delhi, 1982
- 8) B.G. Wagle : Geomorphology and Evolution of the coastal and offshore areas of Maharashtra and Goa, India Ph.D. Thesis (Unpublished), Bombay University, 1987.

TABLE 1 HEAVY MINERAL PERCENTAGES OF BEACH SAMPLES FROM THE
MAHARASHTRA COAST.
(L= LOW TIDE SAMPLES & H = HIGH TIDE SAMPLES)

SR NO	LOCATION	S	SAMPLE NO	SAMPLE WT (IN GMS)	WEIGHT HEAVY (IN GMS)	PERCENTAGE
1						
1	ALIBAG		215 L	06.89	0.24	3.84
2	---do---		216 H	08.00	0.44	5.50
3	REWADANDA		217 L	14.02	01.16	8.27
4	----do----		218 H	22.33	01.56	6.89
5	SRIVARDHAN		213 L	08.22	0.33	4.01
6	---do---		214 H	08.70	01.11	12.75
7	PANCHGAO		207 L	09.63	03.11	32.29
8	---do---		208 H	09.01	02.69	29.85
9	SALDURE		209 L	07.36	0.01	1.35
10	---do---		210 H	14.21	02.69	18.93
11	GUHAGAR		201 L	13.76	0.10	7.26
12	---do---		202 H	15.61	0.29	1.85
13	VELNESHWAR		205 L	11.58	0.67	5.78
14	---do---		206 H	12.20	01.58	12.95
15	NANDIVADE		23 L	22.32	01.30	5.82
16	---do---		24 H	15.78	0.85	5.38
17	SANKHOL		25 L	09.89	0.18	1.82
18	---do---		26 H	17.91	01.17	6.72
19	REEL		27 L	13.53	09.85	72.80
20	---do---		28 H	10.28	08.04	85.99
21	---do---		29 L	15.75	0.58	3.68
22	---do---		30 H	14.51	12.68	87.38
23	MALGUND		31 L	20.83	08.03	38.55
24	---do---		32 H	15.60	15.18	97.30
25	BHANDAR PULE		35 L	08.08	0.73	9.03
26	---do---		35 H	13.80	01.43	10.38
27	KALBADEVI		19 L	21.82	17.28	79.19
28	---do---		20 H	13.09	01.28	9.77
29	MIRYA		21 L	28.89	02.25	7.78
30	---do---		22 H	7.28	0.01	0.13
31	RAINAGIRI		1 L	11.38	0.16	1.40
32	---do---		2 H	20.58	0.02	0.09
33	PAWAS		15 L	11.56	0.07	0.60
34	---do---		16 H	13.31	03.21	24.11
35	GANESHGULE		11 L	16.21	0.33	2.03
36	---do---		12 H	13.00	05.22	40.15
37	FURNAGAD		7 L	20.15	19.50	96.77
38	---do---		8 H	7.40	07.30	98.64
39	WADA VETYE		43 L	17.56	0.48	2.73
40	---do---		44 H	09.33	06.05	64.84
41	---do---		37 L	11.44	04.07	35.57
42	---do---		38 H	14.26	04.93	34.57
43	AMBOLGARH		41 L	08.01	01.01	13.73
44	---do---		42 H	15.58	03.85	24.71
45	VIJAYDURG		45 L	9.80	1.59	16.22
46	---do---		46 H	11.95	0.39	3.26
47	PADWANEWADI		109 L	15.98	01.44	9.01
48	---do---		110 H	13.47	07.04	52.26
49	DEVGAD		111 L	13.71	0.09	0.65
50	---do---		112 H	10.30	0.08	0.77
51	MITHUMBRI		113 L	20.43	0.05	0.24
52	---do---		114 H	14.76	0.22	1.49
53	MITHBAU		119 L	13.26	0.04	0.30
54	---do---		120 H	15.55	0.04	0.25
55	PIRWADI		115 L	12.81	01.75	13.66
56	---do---		116 H	13.78	0.05	0.36
57	SARJECOT		121 H	10.28	01.33	12.93
58	---do---		122 H	13.70	09.44	68.90
59	DEOBAG		123 L	20.83	14.39	68.91
60	---do---		124 H	23.25	0.04	0.17
61	---do---		125 L	16.88	0.06	0.35
62	---do---		126 H	11.06	0.02	0.18
63	---do---		129 L	12.38	09.75	78.75
64	---do---		130 H	07.36	0.03	0.04

