

## Origin of Amphibole-Rich Beach Sands from Tila-Mati, Karwar, Central-West Coast of India

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**Abstract:** The pocket beach at Tila-Mati, Karwar, central west coast of India, is characterised by the occurrence of amphibole-rich (chiefly tremolite-actinolite) coarse sand in the zone of minimal impact of waves and currents.

In the total sediment, grain size and sphericity are directly proportional while a decrease in sphericity results in an increase of amphiboles (60-80%). This is probably due to the elongated nature of the amphibole grains which are abraded in a low energy environment. The Tila-Mati beach sediment has been derived locally by erosion of amphibole schist exposed in a cliff adjacent to the beach.

**Keywords:** Amphibole, Karwar, Beach sands, Karnataka.

### INTRODUCTION

The nearly N-S trending small beach at Tila-Mati (between Polem to the north and Majali to the south) north of Karwar, is unique by the presence of amphibole rich (60-80%) sand. Despite earlier studies in adjacent areas by Chavadi and Nayak (1987), Mislankar (1988), Mislankar and Antao (1992) and Hanamgond and Chavadi (1993), there has not been any report on this occurrence. This note provides an account of its derivation from amphibole schist and deposition.

A cliff (3-4 m) made of massive metabasalt of Archaean age (Zainuddin and Narayanamurthy, 1981) is exposed to the south and north of Tila-Mati beach. Dykes of dolerite and amphibole schist to the south and huge basaltic boulders (dia. 1-1.5 m) to the north of this beach act as natural barriers for NW and SW wave movements. The study area and the vicinity receive an average rainfall of 2964 mm, and the mean temperature during summer is 32°C but along the coast it is as high as 36.5°C (Gazetteer 1870-1879, North Kanara).

### AREA OF STUDY

The sediment of the small, sheltered beach at Tila-Mati (Lat. 74°:4'30", Long. 14°:51'30"E) located between the open beaches of Polem to the north and Majali to the south is made of grayish black granules to coarse sand, resembling black gingilly (sesame, *sesamum indicum*) and hence its name (Tila-Gingilly and Mati-sand). The beach is approximately 150 m long and 50-60 m wide with a gentle slope and has minimal fluvial input, unlike the Polem and Majali beaches which are under the influence of the Kali river (Veerayya and Pankajakshan, 1988).

### SAMPLING AND LABORATORY PROCEDURE

Three representative samples were collected along a central transect, one each at low-, mid- and high-tide marks. Samples of rocks, boulders and dykes were also collected from the vicinity.

Sediment samples were washed, cleaned and shell freed. Sub-samples of about 100 gm, were sieved at 1/4 $\phi$  interval for about 15 minutes and the various fractions were weighed to the nearest milligram.

Folk and Ward (1957) graphic measures were calculated from sieve data. The percent-

age of pebbles, granules and sand were also tabulated. The long (L), intermediate (I) and short (S) axes of grains coarser than 0.0  $\phi$  were directly measured with vernier calipers while on finer grains the axes were measured under a microscope (Blatt, 1959). Sphericity, form and maximum projection sphericity were computed from this data (after Sneed and Folk, 1958). Grain mounts and rock samples were thin-sectioned for mineralogical studies, including XRD analysis. Materials finer than 1.5 $\phi$  were subjected to heavy liquid separation.

## RESULT AND INTERPRETATION

Table I gives the content of various size classes in Tila-Mati beach sediment. The low tide sample shows higher percentage of pebbles and granules than mid- and high-tide mark samples. The samples are negatively skewed,

moderately well sorted (0.53  $\phi$ ) to moderately sorted (0.82  $\phi$ ) and the mean size ranges from 0.06 to 0.38  $\phi$ . The cumulative frequency curves indicate presence of three subpopulations, viz., traction, saltation and suspension. The low tide sample shows a well mixed double saltation population. Among the subpopulations, suspension population comprises about 1% of the total showing poor mixing with the saltation population. Frequency distribution curves show weak bimodality.

The grains coarser than -1.0  $\phi$  are composed of basaltic and schistose fragments along with vein quartz which are very well rounded and have high sphericity. With a decrease in sphericity an increase in amphiboles (60-80%) and substantial decrease of vein quartz and rock fragments are noted (Table II).

A plot of sphericity values in Sneed and

Table I. Weight percentage of size fraction and size parameters.

Sample	Percentage content						Size parameters (Folk and Ward, 1957)			
	Pebbles	Granules	Very coarse sand	Coarse sand	Medium sand	Fine sand	Mean Mz $\phi$	Std dev $\phi$ $\sigma$	skew ski	Kurt KG
High	0.38	6.48	18.56	66.0	8.53	0.05	0.38	0.62	-0.39	1.17
Mid Tide	0.00	4.66	15.96	70.42	8.65	0.30	0.38	0.53	-0.12	1.36
Low Tide	1.55	14.79	24.44	51.86	7.20	0.16	0.06	0.82	-0.16	1.07
Average	0.64	8.64	19.65	62.76	8.12	0.17	0.27	0.65	-0.22	1.20

Table II. Grain size variation with sphericity, form and percentage of mineral genetic type.

Size in $\phi$	No. of grains studied	Maximum Projection sphericity	Std. deviation	S/L	L/I L-S	Percentage of amphiboles No. of count H.L. separation	
-2.0	6	0.660 (0.55-0.69)	0.08	0.456 (0.33-0.50)	0.543 (0.50-0.63)	Basaltic and schist rock fragments + vein quartz	
-2 to 1.5	51	0.624 (0.37-0.86)	0.12	0.456 (0.21-0.80)	0.446 (0.18-0.80)		
-1.5 to 1.0	70	0.610 (0.36-0.89)	0.19	0.409 (0.20-0.84)	0.506 (0.16-1.0)		
-1.0 to 0.5	14	0.582 (0.48-0.86)	0.15	0.370 (0.28-0.75)	0.600 (0.50-0.77)	63% Amp	65% Amp
-0.5 to 0.0	12	0.494 (0.38-0.58)	0.07	0.300 (0.12-0.42)	0.500 (0.28-0.63)	65% Amp	60% Amp
0.0 to 0.5	10	0.638 (0.43-0.83)	0.12	0.456 (0.21-0.76)	0.517 (0.19-0.85)	60% Amp	70% Amp
0.5 to 1.0	14	0.509 (0.36-0.63)	0.18	0.267 (0.16-0.65)	0.608 (0.23-0.92)	68% Amp	76% Amp
1.0 to 1.5	16	0.381 (0.23-0.48)	0.14	0.178 (0.07-0.24)	0.561 (0.18-0.73)	80% Amp	75% Amp
1.5 to 2.0	20	0.480 (0.31-0.62)	0.17	0.240 (0.16-0.33)	0.624 (0.21-0.84)	78% Amp	80% Amp

Values in Bracket indicate the range, L= long, S= short and I= intermediate axis, Amp= Amphiboles

Folk (1958) diagram suggests, the compact-bladed to bladed to bladed-elongated nature of the sediment particles (Fig.1). Irrespective of the size class the Tila-Mati beach sediments show a high degree of rounding (Powers, 1953).

The rocks exposed on this beach are metabasalts and amphibole schist. Metabasalts have plagioclase, opaques and pyroxene altered to amphiboles while amphibole schist has abundant euhedral and elongated tremolite-actinolite (confirmed by XRDA) grains with one set of perfect cleavage, strong pleochroism in green to straw yellow and set in a ground mass of epidote and quartz. The crystals have a dominant elongation along C-axis. The sediment finer than  $+2.0\phi$  constitutes 1% of total and consists of quartz and feldspar as light minerals with minor amount of tourmaline, epidote, zircon, green hornblende and opaques.

## DISCUSSION

The textural aspects such as weak bimodal-

ity, sorting and near monomineralic composition of the Tila-Mati sediments suggest a single source of supply. Alternatively, the sediments have not undergone transportation for longer distance or time as noted by a decrease in sphericity with decrease in size. Sediment winnowing could lead to negative skewness (Daune, 1964).

Although swash and backwash of waves results in double saltation population (Kolmar, 1973), roundness and sphericity could also be critical parameters to cause effective deposition (Isla, 1993). We have noted such evidences from the low tide samples which show well mixed double saltation population in comparison to the high- and mid-tide samples. This is attributed to the roundness and sphericity of the coarser particles which rolled down and were deposited during a period of deceleration (Isla, 1993).

Sphericity is not only a function of grain-size but could also be due to mineral constituents. We observe that the amphiboles of Tila-Mati are deposited in a non-variable low

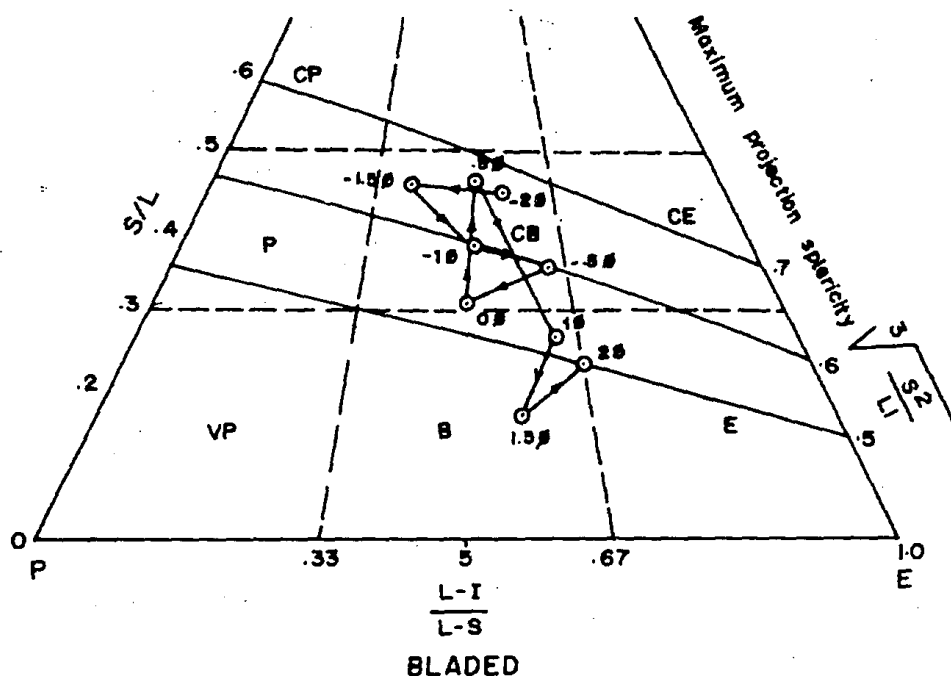


Fig.1. Sphericity form diagram for beach sediments of Tila-Mati, (after Sneed and Folk, 1958).

energy environment (Visser, 1969) as these sediments show poor mixing of saltation and suspension populations. Further, the smallest pebbles have low sphericity as noted by Dobkins and Folk (1970) in low energy beaches.

Besides the above factors, weathering of the amphibole schist as a result of thermal contraction of its constituent minerals can be considered a causative factor for release of grains. A coarser grained rock will disintegrate more rapidly than a finer grained one, chiefly due to the thermal expansion of individual grains (Carroll, 1970). This results in the formation of a nearly monomineralic beach sediment. Further, presence of well-rounded, elongated and low sphericity grains suggest domination of abrasion (Bluck, 1967).

## CONCLUSION

The amphibole schist releases grains of

tremolite-actinolite under conditions of tropical weathering and these are deposited in the adjacent Tila-Mati beach. Grains acquired an elongated nature with low sphericity and higher roundness as a result of size reduction by abrasion and not by breakage along cleavages. The deposition is inferred to be a result of overpassing phenomena during which effects of swash and backwash appear to be inconsequential or minimal.

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