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Seasonal variations of textural and heavy minerals of the Karamana river sediments and beach sediments of Trivandrum, Southern Kerala

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Abstract

Kerala, south western state of India is known for its abundant heavy mineral deposits along the coast. Beach placer deposits in Kerala is known for ilmenite, rutile, zircon, monazite, sillimanite and garnet. The grain size study of the sediments from Karamana river, flowing in the southern part of Kerala. Sediments from different parts of the river basin is studied, which enabled to understand the grain size variations with course of the river from the Peppara dam to Thiruvallam, very near to coast. Mineralogy of the river vary from one place to another depending different factors like host rocks in the province, climate conditions of the area, agents of transport and hydraulic condition during deposition, also can predict the actual source area associated with heavy mineral. Textural and heavy mineral studies of the placers of beach and Karamana river basins indicating the river is one of the important contributors of sediments to the western coast of the southern part of Kerala. Samples from various parts of the river indicate that the sediment is medium sand, moderately sorted, fine skewed and platykurtic. The characteristics of grain size distribution are related to the source rocks, process of weathering, and different sorting processes during transportation and deposition. The total heavy mineral percentage shows it is prominently enrichment in fine sand and very fine sands.

Keywords: *Textural analysis, Heavy minerals*

1. Introduction

Kerala, south western state of India is known for its abundant heavy mineral deposits along the coast. Beach placer deposits in Kerala is known for its huge deposits of heavy minerals like ilmenite, monazite, rutile, zircon sillimanite and garnet. By definition, heavy minerals are generally considered to be those having a specific gravity of 2.9 or greater. In placer deposits, however, it is possible for such heavy minerals to be selectively concentrated during transport and deposition of unconsolidated sediments because of their high density. Mineralogy of sediments from river vary

from one region to another depending on a number of factors like host rocks from where the sediments originated, climate conditions of the area, agents of transport and hydraulic condition during deposition, also can predict the actual source area associated with heavy mineral. The study aims to get idea of the source area for beach placers of southern part of Kerala state. Carried out textural and heavy mineral studies of the placers of beach and Karamana river, one of the important contributors of sediments to the western coast of the southern part of Kerala. The sediment is generally influenced by weathering processes especially velocity of wave and river morphology. Conventionally, this work epitomizes the seasonal

variation of textural studies and heavy mineral concentration of the beach sediments and Karamana river sediments of Thiruvananthapuram district of Kerala state, India. Karamana river originates from the Western Ghats and join to Arabian sea have an approximate length of 68 kms. half of the total district is covered on the planar region and other half is flowed in Western Ghats regions. The area comes under the tropical humid zone with a tropical monsoon climate. It falls inside the water shed caused by the Western

ambience of 2192 sq. km which house the capital city of Kerala State. This coastline was formed by sediments carried out by small rivers and recycled sediments of waves and currents. The Karamana river has its origin in the Chemmunjimottai and Agasthyamalai of the Nedumangadu hills at an altitude of about 1860 meter. It flows in Southern direction through Thiruvananthapuram corporation and joins the Arabian sea near Pachallur. Karamana river has a length of 68 kms and basin area of 702 km²

3. Sampling locations

Total 13 locations were fixed for the sampling of beach sediments, and sediments collected during pre-monsoon, monsoon and post monsoon seasons from the mid water line. For the analysis of river sediments, collected samples from 9 locations along the Karamana river.

Beach sediment sampling locations	River sediment sampling location
1. Pozhiyoor (Pzhr)	Thiruvallam
2. Poovar (Pvr)	Maruthoorkadavu
3. Chowara (Chw)	Trikkannapuram
4. Vizhinjam (Kvl S)	Choozhattukotta
5. Kovalam (Kvl N)	Kundamankadavu
6. Poonthura (Ptr)	Puliyarakonam
7. Kochuveli (Veli)	Aruvikkara
8. Puthenthope (Pthp)	Uzhamalaikal
9. Muthalapozhi South	Peppara dam
10. Muthalapozhi North	Thiruvallam
11. Anjengo (Anj)	Maruthoorkadavu
12. Varkala (Vrkl)	Trikkannapuram
13. Vettakada (Vtkd)	Choozhattukotta

Ghats and experiences intense rainfall for about six months in a year. The coastal state has hot and humid climate during April- May and pleasant, cold climate in December- January. The mean maximum temperature is only around 35⁰ C, it is oppressive in the moisture-laden atmosphere of the plains. Humidity is high and rises to about 90 per cent during the South-West Monsoon. The average rainfall is around 150 cm per annum. It is significant that the district gets rainfall both from the South-West and the North-East Monsoons.

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2. Location of the study area

The study area lies in the coastal belt of Thiruvananthapuram, the southernmost district of Kerala State, is situated between North latitude of 8° 16' 59" and 8° 49' 59" East longitude of 76° 28' 59" and 77° 16' 59", covers a geographical

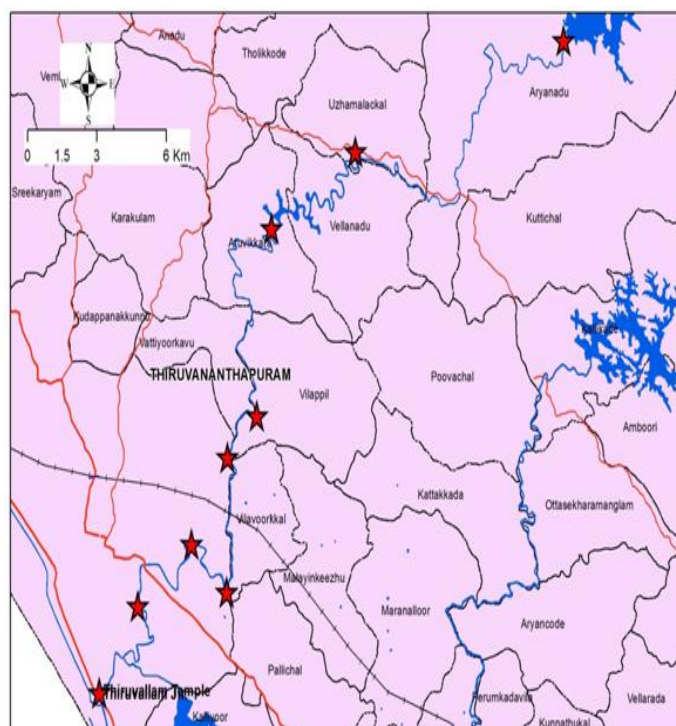


Fig.1. Sampling locations of Karamana river

4. Field work and Laboratory analysis

Coastal sediments have been collected from 13 locations during the following periods monsoon, post monsoon and pre monsoon starting from Pozhiyoor to Vettakada along the coastal stretch of Thiruvananthapuram district and River sediments have been collected from 9 locations starting from Peppara dam in the Western ghats to Thiruvallam, near to Arabian sea.

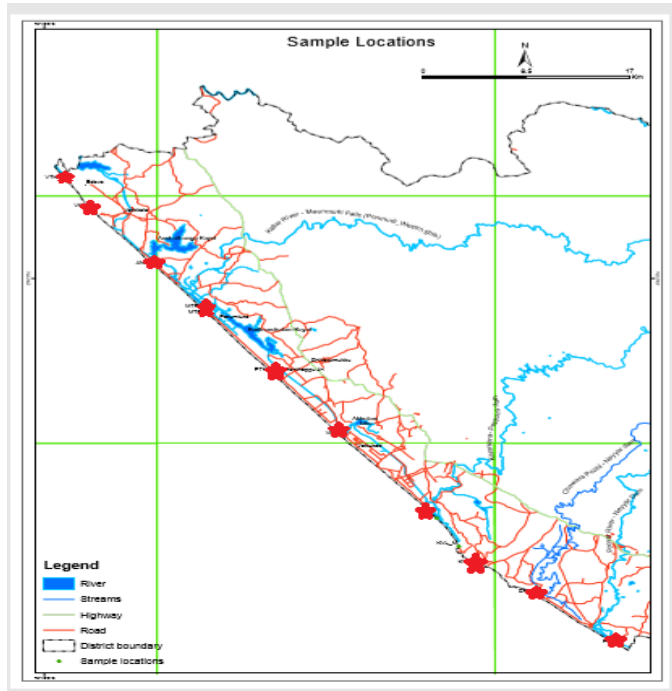


Fig.2. Sampling locations of beach sediments

Approximately 250g of sediments were collected by a PVC pipe of 3 inches diameter. The pipe is carefully inserted into the sediment layers to a depth of 40cm, taking all possible care against contamination and collected in a plastic bag and labeled. River Sample were collected along the meandering portion of the river where the major deposition site of silt clay particle etc. In laboratory, care was taken to prevent contamination or mixing of the sediments during processing. The sediment samples were treated with distilled water for removal of salts and dried. After that a sub sample weighing about approximately 150grams is obtained by coning and quartering. Samples were then treated with 10% dilute HCl to remove carbonate and organic matter. Then the samples were washed with fresh water and dried on a hot air oven for about an hour. After drying, about 20gm and 100gm of samples were obtained by coning and quartering for heavy mineral separation and sieve analysis. The separated 100gm of samples for sieving analysis were sieved with mechanical shaker for half an hour with an arrangement of half phi intervals, the ASTM sieve selected were of numbers 20,30,45,60,80, 120,170 and 230. The fractions retained on each sieve was weighed on a single pan balance and the weight percentage computed for further statistical analysis. 20gm samples were subjected to bromoform liquid to separate heavy minerals from the sample. Density separation is based on the fact that different minerals have different densities.

5. Result and analysis

The textural and heavy mineral analysis of the sediments from Karamana river from different locations have been investigated, which enabled to understand the grain size variations with course of the river from the Peppara dam to Thiruvallam, coastal region. The sediment samples from different parts of the river indicate that the sediment size is medium sand, moderately sorted, fine skewed and platykurtic. The characteristics of textural and heavy minerals in the sediments are related to the source rocks, weathering processes and sorting processes during transportation and deposition. Different statistical parameters of clastic sediments have shown the relationship between different parameters such as mean size, sorting, skewness and kurtosis.

Table.2. Results of river sediments

Location	Statistical parameters	Description	Heavy minera l %
Thiruvallam	Mean	Medium Sand	13.47 %
	Sorting	Moderately Sorted	
	Skewness	Fine Skewed	
	Kurtosis	Platykurtic	
Maruthoor kadavu	Mean	Medium Sand	05.95 %
	Sorting	Moderately Sorted	
	Skewness	Fine Skewed	
	Kurtosis	Platykurtic	
Thrikkanna puram	Mean	Medium Sand	12.67 %
	Sorting	Moderately Sorted	
	Skewness	Fine Skewed	
	Kurtosis	Platykurtic	
Choozattu kotta	Mean	Medium Sand	09.12 %
	Sorting	Moderately Sorted	

	Skewness	Fine Skewed	
	Kurtosis	Platykurtic	
Kundaman kadvu	Mean	Medium Sand	31.49 %
	Sorting	Moderately Sorted	
	Skewness	Fine Skewed	
	Kurtosis	Platykurtic	
Puliyara konam	Mean	Medium Sand	10.07 %
	Sorting	Moderately Sorted	
	Skewness	Fine Skewed	
	Kurtosis	Platykurtic	
Aruvikkara	Mean	Medium Sand	10.07 %
	Sorting	Moderately Sorted	
	Skewness	Fine Skewed	
	Kurtosis	Platykurtic	
Uzhamal akkal	Mean	Medium Sand	17.85 %
	Sorting	Moderately Sorted	
	Skewness	Fine Skewed	
	Kurtosis	Platykurtic	
Peppara dam	Mean	Medium Sand	10%
	Sorting	Moderately Sorted	
	Skewness	Fine Skewed	
	Kurtosis	Platykurtic	

The major heavy minerals, which present in the river sediments include the opaque, garnets, hypersthene, glaucophane, tourmaline, hornblende, zircon and biotite. Analysis shows that the concentration is a maximum of around 31 % in the Kundamankadavu region. The lowest concentration of 1.3% is observed near to Aruvikkara dam region. The general distribution of heavy minerals in the region indicates the equally distribution of heavy minerals from east to west along the river. The spatial distribution of heavy minerals indicates

major concentrations in the Kundamankadavu, Uzhamalaikkal and Thiruvallam areas, at the extreme east Peppara dam the sediments have 10% heavy minerals.

Table.3. Results of beach sediments

Location	I-Monsoon	II-Post Monsoon	III-Pre Monsoon
Pozhiyoor	Medium Sand	Medium Sand	Medium Sand
	Well Sorted	Moderately Well Sorted	Moderately Well Sorted
	Fine Skewed	Symmetrical	Fine Skewed
	Mesokurtic	Leptokurtic	Leptokurtic
Poovar	Medium Sand	Medium Sand	Medium Sand
	Moderately Well Sorted	Well Sorted	Moderately Well Sorted
	Symmetrical	Symmetrical	Symmetrical
	Leptokurtic	Leptokurtic	Mesokurtic
Chowara	Medium Sand	Medium Sand	Coarse Sand
	Moderately Well Sorted	Moderately Well Sorted	Moderately Well Sorted
	Coarse Skewed	Symmetrical	Symmetrical
	Mesokurtic	Mesokurtic	Mesokurtic
Vizhinjam	Medium Sand	Medium Sand	Coarse Sand
	Moderately Sorted	Moderately Well Sorted	Moderately Well Sorted
	Symmetrical	Fine Skewed	Symmetrical

	Mesokurti c	Leptokurti c	Platykurti c
Kovalam	Medium Sand	Medium Sand	Medium Sand
	Moderately Well Sorted	Moderately Well Sorted	Moderately Well Sorted
	Symmetrical	Fine Skewed	Symmetrical
	Platykurti c	Mesokurti c	Mesokurti c
Poonthura	Medium Sand	Fine Sand	Fine Sand
	Well Sorted	Moderately Well Sorted	Moderately Well Sorted
	Very Fine Skewed	Symmetrical	Coarse Skewed
	Mesokurti c	Platykurti c	Platykurti c
Veli	Medium Sand	Medium Sand	Medium Sand
	Well Sorted	Well Sorted	Well Sorted
	Symmetrical	Fine Skewed	Fine Skewed
	Mesokurti c	Platykurti c	Leptokurti c
Puthenthop	Medium Sand	Medium Sand	Medium Sand
	Well Sorted	Well Sorted	Well Sorted
	Fine Skewed	Symmetrical	Fine Skewed
	Platykurti c	Mesokurti c	Mesokurti c
Muthalappuzhi	Medium Sand	Medium Sand	Medium Sand
	Well Sorted	Moderately Well Sorted	Well Sorted
	Symmetrical	Symmetrical	Symmetrical

	Mesokurti c	Mesokurti c	Leptokurti c
Anjengo	Medium Sand	Medium Sand	Medium Sand
	Moderately Well Sorted	Moderately Well Sorted	Moderately Well Sorted
	Fine Skewed	Symmetrical	Symmetrical
	Mesokurti c	Mesokurti c	Mesokurti c
Varkala	Medium Sand	Fine Sand	Medium Sand
	Moderately Well Sorted	Moderately Well Sorted	Moderately Well Sorted
	Fine Skewed	Symmetrical	Symmetrical
	Platykurti c	Mesokurti c	Mesokurti c
Vettakada	Medium Sand	Fine Sand	Medium Sand
	Well Sorted	Moderately Well Sorted	Moderately Well Sorted
	Symmetrical	Symmetrical	Fine Skewed
	Mesokurti c	Mesokurti c	Mesokurti c

Grain size analysis midwater line samples of beach sediments for monsoon, pre monsoon and post monsoon were carried out and the result is shown in the above table. Seasonal analysis of result shows drastic changes in the mean, standard deviation, skewness and kurtosis and heavy mineral concentration along the beach sediments. Heavy mineral concentration along the beach shows highest at Poonthura with 81% of heavy mineral on monsoon season. Kovalam shows drastic changes from pre monsoon to monsoon variation in heavy mineral concentration. Beach sediments from northern part of Trivandrum district have lesser amount of heavy mineral concentration compare to the southern part.

Table 4. Heavy mineral concentration in beach sediments

Heavy mineral %	monsoon	post monsoon	pre monsoon
Pozhiyoor	28.3	1.09	1.09
Poovar	17.32	1.09	8.44
Chowara	4.47	1.28	0.34
Vizhinjam	15.65	10.63	0.23
Kovalam	46.23	18.8	0.045
Poonthura	81.09	52.8	67.76
Veli	10.8	6.02	4.94
Puthenthop	1.58	1.16	0.91
Muthelapozhi	1.51	1.27	
Anjengo	0.3	4.27	1.72
Varkala	7.9	0.18	3.47

Conclusions

The grain size study of the Karamana river sediments and beach sediments from different locations of the Trivandrum coast have been investigated, which enabled to understand the grain size variations with course of the river from the Peppara dam to Thiruvallam, near to coast. Samples from different parts of the river indicate that the sediment size is medium sand, moderately sorted, fine skewed and platykurtic. The textural and various statistical parameters of sediments from river sediment and beach sediments are related to the source rocks mostly of the high grade

metamorphic rocks from western ghats, different processes of weathering and erosion of the grains and sorting processes during transportation and deposition. The total heavy mineral analysis shows both river and beach sediments are rich in heavy minerals. The major minerals are garnets, hypersthene, hornblende, zircon, ilmenite and rutile. The percentage of heavy minerals along the sediments from Karamana river ranges from 6% at Maruthoorkadavu to 31% at Kundamankadavu. The distribution of heavy minerals in the different locations are showing the transport of heavy minerals from the Mountain ranges to coast by the fluvial action of the river. The general distribution of heavy minerals in the region indicates the equally distribution of heavy minerals from east to west along the river. Distribution of heavy minerals in the river sediments indicates major concentrations in the Kundamankadavu, Uzhamalaikkal and Thiruvallam areas. Sediments from the Peppara dam, which is located at the upper part of the river shows 10% heavy minerals. Seasonal wise studies about the distribution of heavy minerals and grain size parameters were studied along the coastal region of Trivandrum, shows drastic changes in the grain size parameters and heavy mineral deposits. Beach placer of Poonthura shows 81% of heavy mineral concentration on monsoon season. Sediments from Kovalam shows drastic changes from pre monsoon to monsoon variation in heavy mineral concentration.

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