Replenishment Dynamics at Verugal Beach Heavy Mineral Deposit

Dissanayake D.M.C.J.B, Igalawithana T.D,
Karunarathne A.V.P.I ,Maduranga S.W.M,Udayakumara P.W.G,
Amalan K and * Rathnayake N.P

*Corresponding author -nalinratnayake@gmail.com

Abstract: Eastern coast of Sri Lanka is abundant with heavy minerals, particularly at Pullmuddai where Sri Lanka's only heavy mineral processing plant is situated. Verugal is one other areas where there is a rich, heavy mineral deposit that has the potential to be exploited.Heavy mineral beach sand deposits are dynamic in which the composition and the amount of reserves vary with time due to changes in coastal waves and currents. Therefore, a proper understanding of the replenishment dynamics is required to develop a comprehensive mine plan for the extraction of heavy mineral sand. This study focuses on the understanding replenishment mechanism at Verugal Beach Heavy Mineral Deposit. Samples from test pits were collected along the transect perpendicular to the beach at approximately 500 m interval from visible deposit at Verugal area representing bothsouthwestern monsoon and northwestern monsoon. Collected samples were subjected to sieve analysis to understand the grain size distribution and grain counting through reflected microscope to understand the heavy mineral concentration. Variations in deposit dimensions with seasonal weather changes along withspecific heavy mineral concentrations andreplenishment rates can be used to develop a proper mining plan to commence sustainable extraction.

Key Words: Verugal Aru, Heavy mineral beach sand, Ilmenite, Beach Replenishment, grain counting

1. Introduction

Eastern coast of Sri Lanka is an area with a few of the richest beach mineral sand deposits in the world. Most of these areas consist of heavy minerals, basically derived from weathering of igneous and metamorphic rocks (Fernando, 1986). The area which is called the Verugal Aru is located on the eastern coast around 50 kilometers southward from Trincomalee consisting of a heavy mineral sand deposit spreading along an area more than three kilometers.

Heavy mineral sand deposits are dynamic deposits, which are

changing vertically and horizontally with the time. Studies about the patterns of replenishment process will help design a mining plan to extract the heavy mineral sand in the most effective way. This is really important to extract mineral sand from the deposit for a longer time period.

2. Methodology

2.1 Beach topographic surveys

A topographic beach survey was conducted along transects of 500 m interval within the 4 km stretch from Kathiraweli south to south most river mouth of Mahaweli River. At each location, seasonal beach profile variation was measured from 2013/2014 from 2 m beneath the mean sea level (MSL) to a fixed point on the back shore. At each profile location, measurements were taken perpendicular to the shoreline from the fixed position. Therefore, the positions of the transects and bearings were accurately reproduced at each repeated monthly measurement. Vertical measurements were taken with 1 m shore along intervals using surveying level.

2.2 Sampling

Representative sampling was performed along the same transects using testsfor the whole mineral sand deposit. Test pits were madefrom mean sea level, 5, 10, 20 and 30 m.At each location, 3 samples were collected at depths of 0.3 m, 0.7 m, 1 m respectively. The sample size was roughly 2 kg.

2.3 Laboratory analysis

Grain size analysis was carried out using 15 sets of sieves with mesh size ranging from 2000 microns to 45 microns. GRADISTAT (version 4.0) software was used to analyze the particle sizes. Information on grain size characteristics were used to interpret the depositional environment and the transport mechanism of sediments. Panning was conducted to separate and obtain heavy mineral fractions of samples. Grain counting under a microscope conducted to account volumetric percentages of each heavy mineral type in the samples.The results were reproduced using Bromoform analysis and magnetic separation. Bromoform analysis of selected panned samples was taken to cross check the accuracy and reliability of the panned samples. Thin section analysis was carried out to verify the identification of mineral types. Magnetic separation was conducted to reproduce the results of grain count.

3. Results and Discussion

3.1 Distribution of mean grain sizes

The difference in mean grain size variation of the Verugal heavy mineral deposit was observed before and after the North-East monsoon. Mean grain size of the sand particles has decreased along

southward during both monsoon periods. However, it had better sorting of during North-East monsoon rather than South-West monsoon.

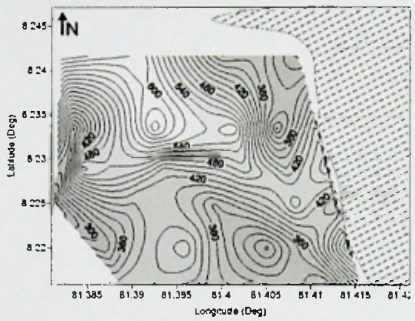

Figure 1:Mean grain size distribution before North-East monsoon in Verugal beach

Along the transects mean grain sizes were comparatively very coarsewith 300-400 µm size grains were found from mean sea level up to 10 meter distance.Finer fraction of heavy minerals found beyond 30 meter distance. This is mostly due to transportation of sediments due to on shore wind shear followed trapping due to beach vegetation.

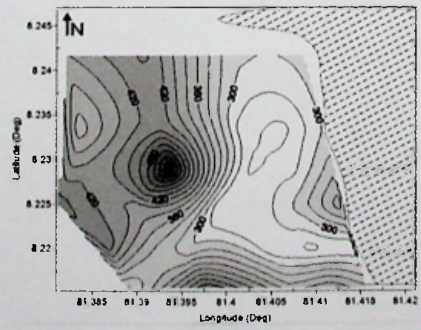

Figure 2*Mean grain size* after North-East monsoon in Verugal beach

3.2 Beach topography variation

Topography of the deposit area is subjected to a significant change in the Monsoon period. Beach width increases during the South-West monsoon and erodes in the North-East Monsoon (Figure 3). Beach widths increase in the southward direction from the river mouth of Verugal in both periods.

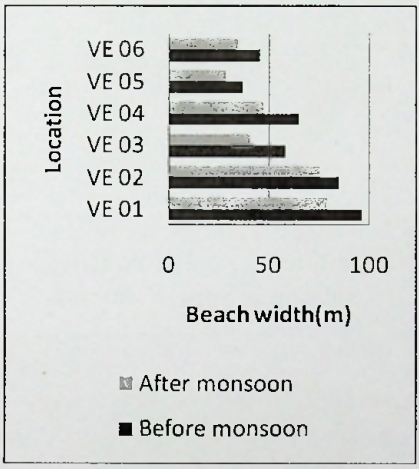

Figure 3: Seasonal Beach width variation in Verugal beach

3.3 Heavy mineral distribution

Distribution of heavy mineral in the deposit was plotted using contour maps comparing two seasons (Figure 4 and 5).

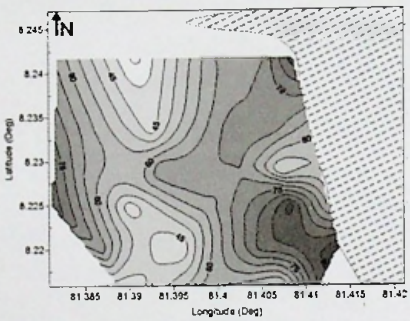

Figure 4: Heavy mineral distribution before North-East monsoon in Verugal Aru beach

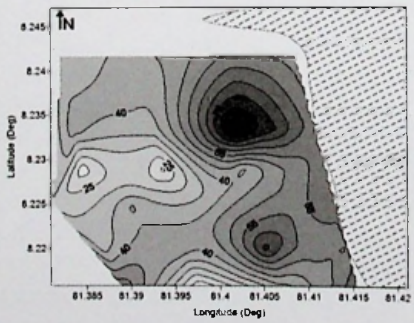

Figure 5: Heavy mineral distribution after North-East monsoon in Verugal Aru beach

Heavy mineral distribution of the deposit has decreased in the North-East monsoon period rather than South-West monsoon. Because of increased river discharge during North-East monsoon heavy mineral concentration is higher in river mouth area. With the longshore currents, heavy minerals have transported towards south in the South-West monsoon. Heavy mineral concentration has decreased towards land side, but there is a significant increase in 30 meter distance due to wind transported finer heavy minerals trapped by vegetation. In general Ilmanite is the dominant mineral in the deposit and is mainly distributed near mean sea level. Garnet and Zircon distribution have increased towards the land side due to settlement of particles according to the specific gravity of minerals. Ilmanite percentage has reduced after North-East monsoon and the percentage of Garnet and Zircon has increased. Other minerals do not show any significant variation.

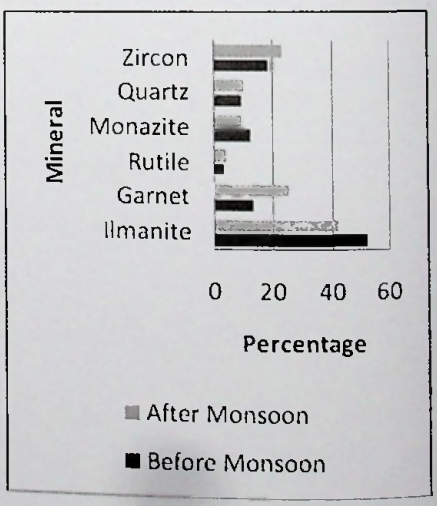

Figure 6: Mineral compositions of Verugal heavy mineral deposit

5. Conclusions

The Verugal Aru mineral sand deposit is dominated by river sediments which are mostly composed of fine to medium grained sand. The grain size of the sand has decreased along the shoreline from river mouth to southward. The heavy mineral distribution of the deposit is higher near the mean sea level area due to natural panning process created by the waves in the South-West monsoon. The deposit is dominant with Ilmanite, Garnet and Zircon respectively. Most suitable time to commence mining of the deposit is October to November during the inter-monsoon period.

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