SEDIMENTOLOGICAL VARIATION IN BEACH SEDIMENTS OF THE BARRIER BAR LAGOON COASTAL SYSTEM, SOUTH - WESTERN NIGERIA.

*Rabiu Abdulkarim, Akinnigbagbe Edward Akintoye, Imo Daniel Oguwuike, Titocan mark Imhansoeleva, Ibitola Mayowa Philips, Faleye Bamidele Ruth, Shonde Olufunke Olubukola, Jimoh Olayinka Rasheed, Abe Oluwaseun Banji.

Marine Geology/Geophysics Department,
Nigerian Institute for Oceanography and Marine Research (NIOMR), Lagos, Nigeria.
abpero1@yahoo.com

ABSTRACT: A total of 32 sediment samples were collected from four selected beaches along the barrier bar complex, namely Alpha, Takwa Bay, Eleko and Badagry. They were studied in order to define the spatial trend in their textural characteristics. The sediment grain sizes were assessed by dry sieving. The coarseness of sediments reflects the local intensity of turbulence and wave energy dissipation; hence the mean grain size is greatest within the wave plunge point. Mean grain size closely reflect the energy level of the wave processes. Badagry and Alpha beach are of medium grained size with average mean value of (1.10 Φ and 1.14Φ respectively), Eleko beach sediment is coarsely grained with an average mean value of (0.56 Φ) while Takwa Bay beach sediment is fine grained and very well-sorted with an average mean value of (2.25 Φ.) The beach sediments along the barrier bar complex are in most parts clean although mixed with some shells in few places, moderate to well-sorted and mesokurtic in distribution. The dominant sedimentary structures identified are ripple marks. The absence of biogenic structures denotes an area of high energy. An inland improvement in sorting in several of the study area reflects a shallowing of the environment with decreasing wave action.
[Rabiu Abdulkarim, Akinnigbagbe Edward Akintoye, Imo Daniel Oguwuike, Titocan Mark Imhansoeleva, Ibitola Mayowa Philips, Faleye Bamidele Ruth, Shonde Olufunke Olubukola, Jimoh Olayinka Rasheed, Abe Oluwaseun Banji. Sedimentological Variation in Beach Sediments along the Barrier Lagoon Coastal System, Lagos, South West Nigeria. Nature and Science 2011;9(9):19-26]. (ISSN: 1545-0740). http://www.sciencepub.net.

Key Words: Barrier Bar Lagoon, Beach Sediments, Grain Size Distribution, Wave Plunge.

INTRODUCTION

The Barrier/Lagoon coastal system extends eastward for about 200km from the Nigeria/Benin Republic border to the western limit of the transgressive mud coast (Fig 1). Its general evolution and morphology has largely been determined by coastal dynamics and the deposition of fluvial sediments. The beaches of the barrier bar complex are erosive, probably due to lack of exoreic rivers, which would have compensated for the sand lost from the action of longshore current. The Barrier Lagoon complex is backed by the Badagry Creek, the Lagos Lagoon, Lekki Lagoon and numerous other creeks whose only connection to the sea is through the commodore channel in Lagos. The Barrier Lagoon coastal system consists of narrow beach ridges, which are aligned parallel to the coast. Beach sediments along the barrier complex show wide variation in textural characteristics. The sediment compositions are affected by wave/tidal action, littoral current and the petrographical compositions of the shore; hence the grain size distribution of beaches is a function of the hydrodynamic conditions. Sediments distributions along the beach are a result of complex interaction between sediment source, wave energy level and the general offshore slope on which the beach is constructed. (Komar, 1988) The intensity of the wave action in the littoral zone generally redeposits and sort materials of all grain sizes. Thus, the composition of beach sediment is not affected only by wave action but depends largely on the amount of clastic material supply to the coast. This study was carried out along the active beaches of the Barrier Bar complex due to their group position as the direct area of interaction between the land and the sea. The aim is to determine the variation in grain size distribution with a view to understanding the pattern of sediment transport in the near shore area. Knowledge of these characteristics is important in understanding the principles of shoreline dynamics necessary for the formulation of long-term plan for the effective management of coastal erosion.

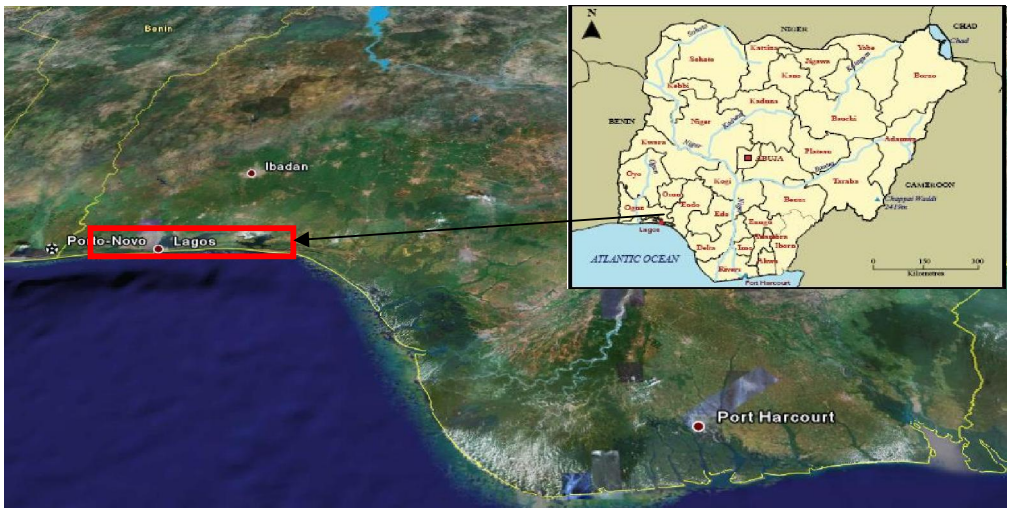

Figure 1: Map of Nigeria showing the study area in rectangle

DATA COLLECTION

During a geological survey along the beaches of the Barrier Bar complex, 32 beach sediments samples were collected from four selected beaches, this includes: Badagry, Alfa, and Takwa bay, and Eleko beach. The samples were collected from shallow trenches at 100 meters interval; using a plastic jar to ensure a uniform sampling depth of 5cm. Coordinates of the various sampling stations were taken using the global position system (GPS). Two samples representing the berm and fore shore were collected per profile. During this field work preference was accorded to the recording of sedimentary and biogenic structures owing to their hydrodynamic implications.

METHODOLOGY

A total of 32 sediments samples were analyzed to determine the spatial trend in their grain size distribution. 70 grams of each sample was oven dried at 50ºC in order to remove their moisture content. The dried and weighed sediments were transferred carefully to the uppermost (coarsest) of a stacked series of graded sand sieves, sieves were gently brushed of all material from the container using a fine sieve brush. A 62 µm sieve was placed at the bottom of the stack of sieves and care was taken by using a pan below the finest sieve to catch the last of any fine material which may still pass. The stacked column of sieves was now transferred to a Rotap sieve shaker for a period 10-15 minutes. When the finality of sieving was checked, the fraction of samples retained on each sieve was emptied on to a sheet of glazed paper and grains lodged in the sieve were removed with a sieve brush. The fractions were then transferred to a pre weighed dish for weighing. The analysis continues sieve by sieve through the series until, finally, the material passing through the last (62 µm) sieve and retained in the pan was also recorded**.** A graph of cumulative weight percent against sieve size was plotted. And from the cumulative frequency curve obtained grain size parameters such as average size (mean), spread of the sizes about the average (standard deviation) symmetry of preferential spread to one size of the average (skewness) and kurtosis or degree of concentration of the grains to the central size were determined.

RESULTS AND DISCUSSION

Alpha Beach

The statistical parameters of grain size distribution have been a major parameter in delineating the influence of deposional processes (Friedman, 1961; Folk, 1966). Generally, standard deviation and skewness are considered environmentally sensitive indicators while the mean is a reflection of the competence of the transport mechanism. The result of the granulometric analysis of samples from Alpha beach is presented in table 1. Appendix 1 shows the cumulative curve and individual particle size of each sample from which grain size parameters were calculated. The sediment distribution range medium to coarse sand, moderate to well sorted, finely skewed with mesokurtic distribution.

The mean, which is a reflection of the overall size of the sediment, has values ranging from (0.83 Φ to 1.54 Φ) which represents medium-coarse grained sand while the standard deviation which is a measure of the sorting has values ranging from (0.53 Φ to

0.85Φ) that represents moderate to well sorted. Skewness values range from (-0.02Φ to 0.19Φ) while kurtosis value lies between (0.76Φ and 1.12 Φ). The plot of individual particle size against phi size for the various samples shows bi-modal peaks, which suggests more than one source of sediment supply to the Alpha beach sand.

Badagry Beach

The result of grain size analysis of samples from Badagry beach is presented in table 2. The results show that the sediments are medium grained sand, moderately well sorted, finely skewed and mesokurtic. The mean which is a reflection of the overall size of the sediments has an average value of 1.10 Φ (medium sand), the standard deviation has an average value of 0.51Φ (moderately well sorted), skewness values ranged from – 0.10Φ to 0.27Φ (coarse to fine skewed), while kurtosis values lies between 0.96Φ and 1.39Φ (mesokurtic and leptokurtic). The plot of individual particle size against phi size showed uni-modal peaks and this suggests a single source of sediment supply to the Badagry beach.

TABLE 1: RESULT OF GRANULOMETRIC ANALYSIS OF ALPHA BEACH SEDIMENTS

Sample no	Mean	Standard Deviation	Skewness	Kurtosis	Description
AlF1A(BM)	1.54	0.53	0.19	1.09	Medium sand, Moderately well sorted, fine skewed, Mesokurtic.
ALF1B(WL)	1.39	0.59	0.09	1.03	Medium sand, Moderately well sorted, Near symmetrical, Mesokurtic
ALF2A(BM)	1.33	0.77	0.13	0.94	Medium sand, Moderately sorted, Fine skewed, Mesokurtic
ALF2B(WL)	0.93	0.66	0.10	0.93	Coarse sand, Moderately well sorted, Fine skewed, Mesokurtic.
ALF3A (BM)	1.11	0.66	0.12	0.89	Medium sand, Moderately well sorted, Fine skewed, Platykurtic
ALF3B(WL)	1.02	0.64	0.06	1.12	Medium sand, Moderately well sorted, Near symmetrical, Leptokurtic.
ALF4A(BM)	1.02	0.85	-0.10	0.76	Medium sand, Moderately sorted, Coarse skewed, Platykurtic.
ALF4B(WL)	0.83	0.80	-0.02	0.93	Coarse sand, Moderately sorted, Near symmetrical, Mesokurtic.

Table 2: RESULT OF GRANULOMETRIC ANALYSIS OF BADAGRY BEACH SEDIMENT

Sample No	Mean	Standard deviation	Skewness	Kurtosis	Description
BD1A(BM)	1.28	0.57	0.17	1.29	Medium sand, Moderately well sorted, Fine skewed, Leptokurtic.
BD1B(WL)	1.17	0.51	0.10	1.009	Medium sand, Moderately well sorted, Fine skewed, Mesokurtic.
BD2A(BM)	1.10	0.57	0.18	1.06	Medium sand, Moderately well sorted, Fine skewed, Mesokurtic.
BD2B(WL)	1.15	0.67	0.27	1.39	Medium sand, Moderately well sorted, Fine skewed, Leptokurtic
BD3A(BM)	1.32	0.52	0.18	1.11	Medium sand, Moderately well sorted, Fine skewed, Leptokurtic.
BD3B(WL)	1.30	0.35	-0.10	1.21	Medium sand, Well sorted, Coarse skewed, Leptokurtic
BD4A(BM)	0.73	0.76	0.21	0.96	Coarse sand, Moderately sorted, Fine skewed, Mesokurtic
BD4B(WL)	0.77	0.72	0.19	0.98	Coarse sand, Moderately sorted, Fine skewed, Mesokurtic.

Takwa Bay Beach

The granulometric analysis results of sediments from Takwa bay is shown in table 3. The grain size is fine sand, very well sorted, near symmetrical and mesokurtic. The means has an average value of 2.25 Φ (fine sand), standard deviation has an average value of 0.34 Φ (very well sorted), skewness values ranged from -0.006 to 0.001 (near symmetrical to coarse skewed) while kurtosis value lies between 0.9 and 1.1 (Mesokurtic and Leptokurtic). The plot of phi size against the individual particle size showed uni-modal peaks. This suggests a single source of sediment to the Takwa bay beach sand.

Eleko Beach

The granulometric analysis result of Eleko beach sediments is shown in table 5. The result show that the grain size distribution of Eleko beach sediments ranged from moderately sorted sands to coarse grained sands, fine skewed with Mesokurtic distribution. The mean has an average value of 0.56Φ (coarse sand), while the average standard deviation is 0.83Φ (moderately sorted). The plot of phi size against individual particle size for the various samples showed a uni-modal grain size composition and this suggests a single source of sediment supply to the beach.

Table 3 RESULT OF GRANULUMETRIC ANALYSIS OF TAKWA BAY BEACH SEDIMENT.

Sample No	Mean	Standard deviation	Skewness	Kurtosis	Description
TK 1A(BM)	2.27	0.33	-0.001	1.05	Fine sand, Very well sorted, Near symmetrical, Mesokurtic.
TK2 A(BM)	2.29	0.29	-0.006	1.07	Fine sand, very well sorted, Near symmetrical Mesokurtic.
TK 2B(WL)	2.24	0.3	0.006	0.9	Fine sand, Well sorted, Near symmetrical, Mesokurtic.
TK 3A(BM)	2.38	0.27	-0.10	1.11	Fine sand, Very well sorted, Coarse skewed, Leptokurtic.
TK3 B(WL)	2.18	0.43	0.001	0.9	Fine sand, Well sorted, Near symmetrical, Mesokurtic.
TK4 A(BM)	2.42	0.29	-0.08	1.08	Fine sand Very well sorted Near symmetrical Mesokurtic.
TK 4B(WL)	2.1	0.41	-0.05	1.03	Fine sand, Well sorted, Near symmetrical, Mesokurtic.

Table 4: RESULT OF GRANULOMETRIC ANALYSIS OF ELEKO BEACH SEDIMENT

Sample No	Mean	Standard deviation	Skewness	Kurtosis	Description
LK1A(BM)	0.55	0.74	0.03	0.91	Coarse sand, Moderately sorted, Near symmetrical, Mesokurtic
LK 1B(WL)	0.33	0.92	-0.105	0.72	Coarse sand, Moderately sorted, Coarse skewed, Platykurtic.
LK 2A(BM)	0.81	0.75	0.06	0.99	Coarse sand, Moderately sorted, Near symmetrical Mesokurtic.
LK 2B(WL)	0.66	0.97	0.17	0.76	Coarse sand, Moderately sorted, Fine skewed, Platykurtic.
LK 3A(BM)	0.90	0.75	0.17	1.04	Coarse sand, Moderately sorted, Fine skewed, Mesokurtic.
LK 3B(WL)	0.01	0.89	-0.34	0.90	Coarse sand, Moderately sorted, Strongly coarse skewed, Mesokurtic.
LK 4A(BM)	1.18	0.64	0.1	1.23	Medium sand, Moderately well sorted, Fine skewed, Leptokurtic.
LK 4B(WL)	-0.05	1.02	-0.65	0.78	Coarse sand, Poorly sorted, Strongly coarse skewed, Platykurtic.

BM Represents the Berm
WL Represents the Waterline or Foreshore

Sedimentary Structures

Sedimentary structures constitute the most attribute of sedimentary sequence. Richardson, 1961; Simon et al, 1963; demonstrated that beach sediments can pass through a sequence of bed forms (flat-bed ripples, dunes and dune outwash) with increasing flow condition. Observation of primary sedimentary structures along the beaches of the barrier bar complex shows some variation of bed forms ranging from Rhomboid to Cuspate ripples as illustrated in (figures 1a, 1b, 1c and 1d). The backshore also contains buried channels, which are roughly parallel to the beach crest. Such channels are typically irregular and the sand that fills them is deposited with irregular structures. Also common are unsorted materials like charcoal, shells, debris and conglomerate distributed in the channel fill.
Also the beach sands show little or no biotubation. This is however expected in areas of high wave action and strong currents where the bottom is continually shifting and burrowing organism are very rare. Close looks at the sedimentary structures show that they are always pointer to the flow direction.

Fig 1A: Small scale primary sedimentary structures: Cuspate ripples with traces of mineral concentrations (location Takwa bay beach)

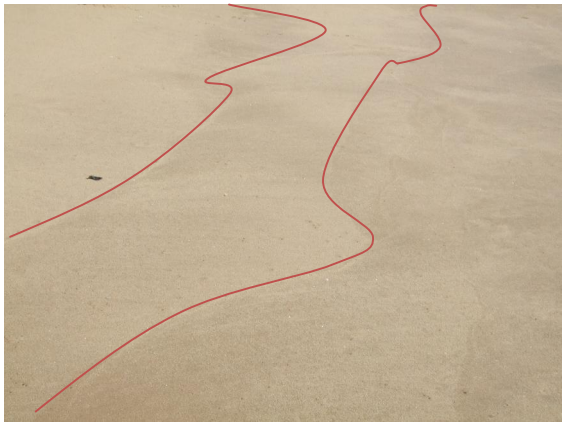

Fig 1B small scale sedimentary structures: Linear ripples. (Location Alpha beach)

Fig 1c: Primary Sedimentary Structures: Rhomboidal (location: Eleko beach).

Fig: 1d Primary Sedimentary Structure: Cuspate Ripples (Location Badagry).

CONCLUSION

For the effective management of erosion along the barrier bar coastal system, shoreline changes and the sedimentology of beaches have to be well appreciated. Hence the result of this study will be useful for the understanding of the sedimentary processes along the barrier bar coastal system. This study and other ocean dynamic studies will be needed to comprehend the regional sedimentary processes necessary for planning and decision making of the coastal projects along the barrier bar coastal system. Mean grain size distribution closely defines the energy level of the wave processes. Badagry and Alpha beaches are of medium grain size distribution with average mean value of (1.10Φ to 1.14Φ respectively), Eleko beach sediment is coarsely grained with an average mean value of (0.56Φ) while Takwa Bay beach sediments are fine grained and very well sorted with average mean value of (2.25Φ.) From this, we can deduce that Eleko beach is under the influence of very high energy followed by Badagry and Alpha beaches which are under the influence of moderate energy and then Takwa Bay beach which is under the influence of low energy. The beach sediments along the barrier bar complex are in most parts clean although mixed with some shells in few places, moderate to well sorted and mesokurtic in distribution. The sedimentary structures clearly display the flow direction which will really be helpful when planning for construction of structures on these beaches.

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Correspondence to:
Rabiu Abdukarim
Marine Geology/Geophysics Department
P.M.B. 12729, Lagos, Nigeria.
Telephone: +234-(0)-7087259784
Email: abpero1@yahoo.com

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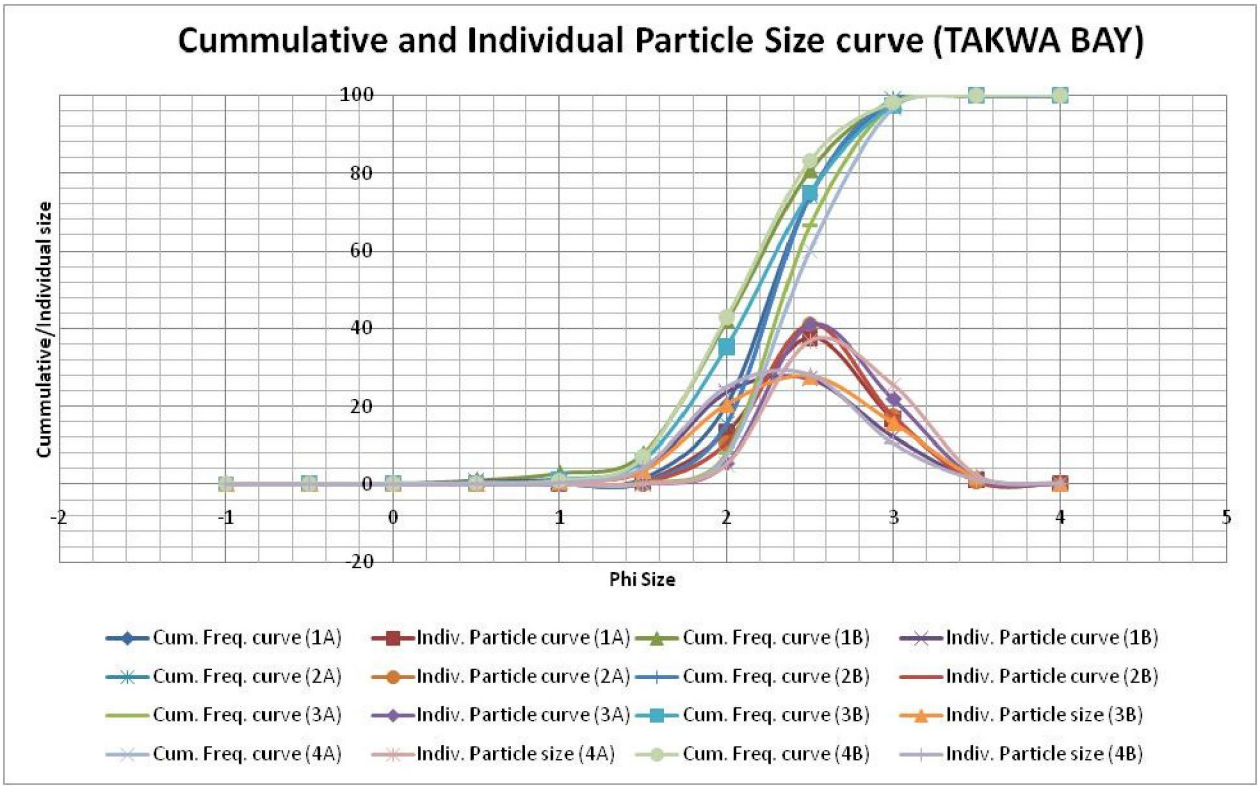
APPENDIXES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Cummulative/Individual size
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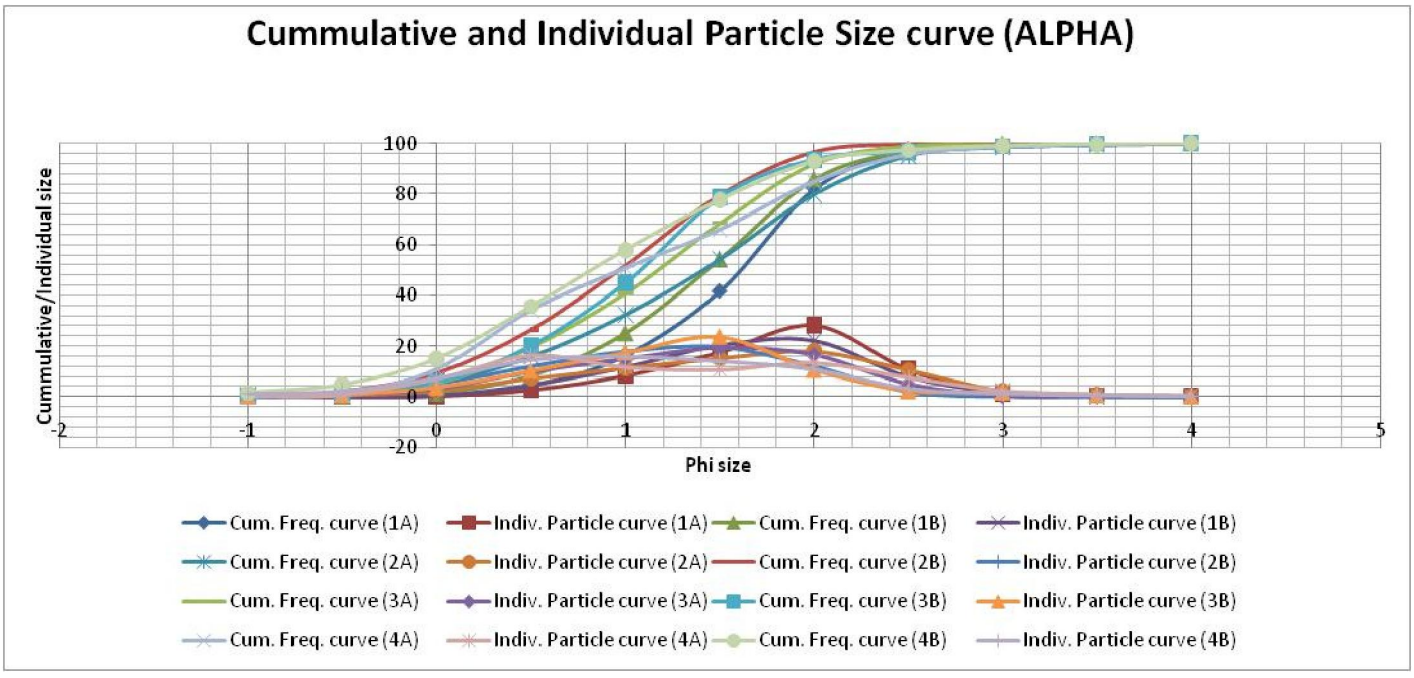
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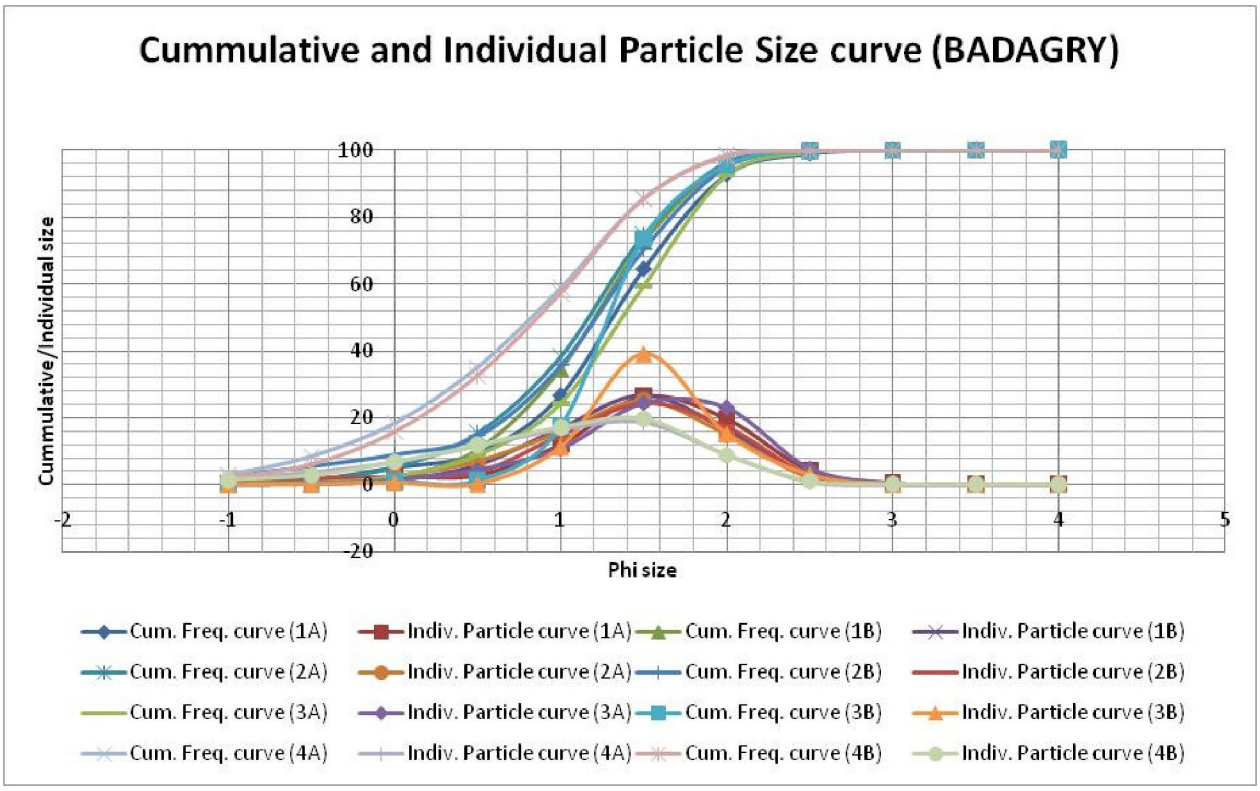
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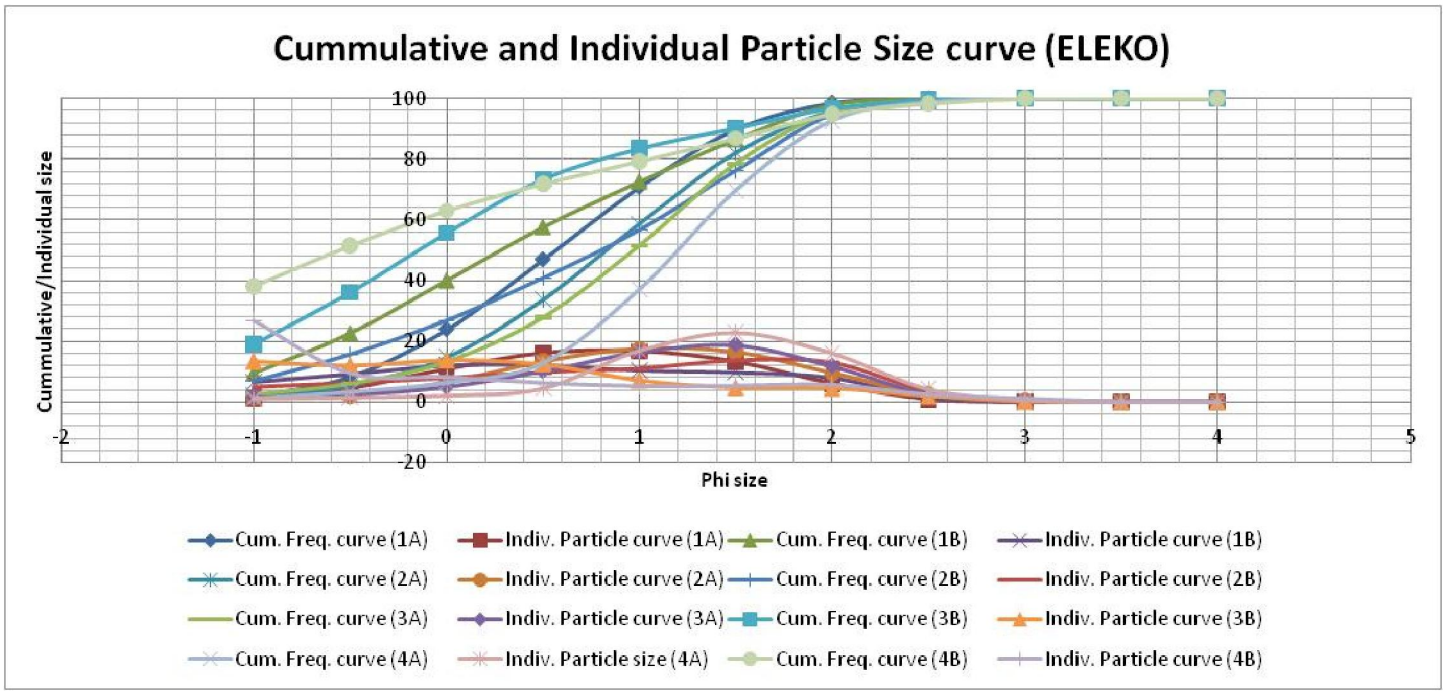
Cummulative and Individual Particle Size curve (ELEKO)
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