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# Sedimentology of the Fluvial deposits, the Old Brahmaputra River, Mymensingh, Bangladesh

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***Abstract:*** *The Old Brahmaputra is a tributary of the Brahmaputra River that finally falls into the mighty Meghna River at Bhairab Bazar, Bangladesh. The morphology of this river indicates that it is a meandering river. The sedimentary sequences are composed of alternate beds sands and clay. The coarser sand beds were deposited at high energy condition of the river. The present study reveals that Fm, Sh and Sp facies constitute the lithological succession of the study area. The massive clays with peds were formed in the backswamp when the depositional basin became shallow and lost its energy. Textural studies of the sand samples exposed along the left bank of the Old Brahmaputra near Mymensingh town shows that the graphic mean sizes vary from 3.41 to 3.50ϕ, very fine sand. The sediments are well sorted that indicates the marine transgression of the Bengal Basin at the time of deposition. The sands are strongly coarsely skewed. The scatter plots of the deposits decipher that they deposited either in river or beach environments.*

***Keywords:*** *Old Brahmaputra, sand, well sorted, river, beach.*

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## I. Introduction

The Old Brahmaputra River is a tributary of the Brahmaputra River that originates from Bahadurabad Ghat and flows through Gaibandha, Jamalpur, Sherpur, Mymensingh, Kishoreganj, Norshindi districts of Bangladesh and falls into the Meghna River at Bhairab Bazar. The average width of the Old Brahmaputra River is 200 meter and it is a meandering river. The present study is conducted on the left bank of the Old Brahmaputra River, Mymensingh, Bangladesh. The study area is bounded by the latitude 24.751677ºN and 24.770391ºN, longitude 90.401125ºN and 90.423170ºE (Figure 1). The sedimentary sequences composed of mainly alternate beds of sands and clays. The sediments exposed along the left bank and bars of the Old Brahmaputra River near Mymensingh town can be classified as Older and Younger deposits. The sediments exposed along the river bank are older than the present day bar sediments. The color of the present day bar sediments, especially the finer part (clays), indicate that they are derived from the near source sediments of Pleistocene deposits, Madhupur clay.

The textural analysis is important tools to decipher the depositional environments of the sediments. Grain size analysis is also important to the engineers, agriculturalists and hydrogeologists. The present research work is conducted to determine the mean grain size of the sands and their distributions in the study area. The frequency curves were drawn to show the mode of the sediments and the cumulative frequency curves were made. Different bivariate plots were constructed to reveal the depositional environments (Friedman, 1967).

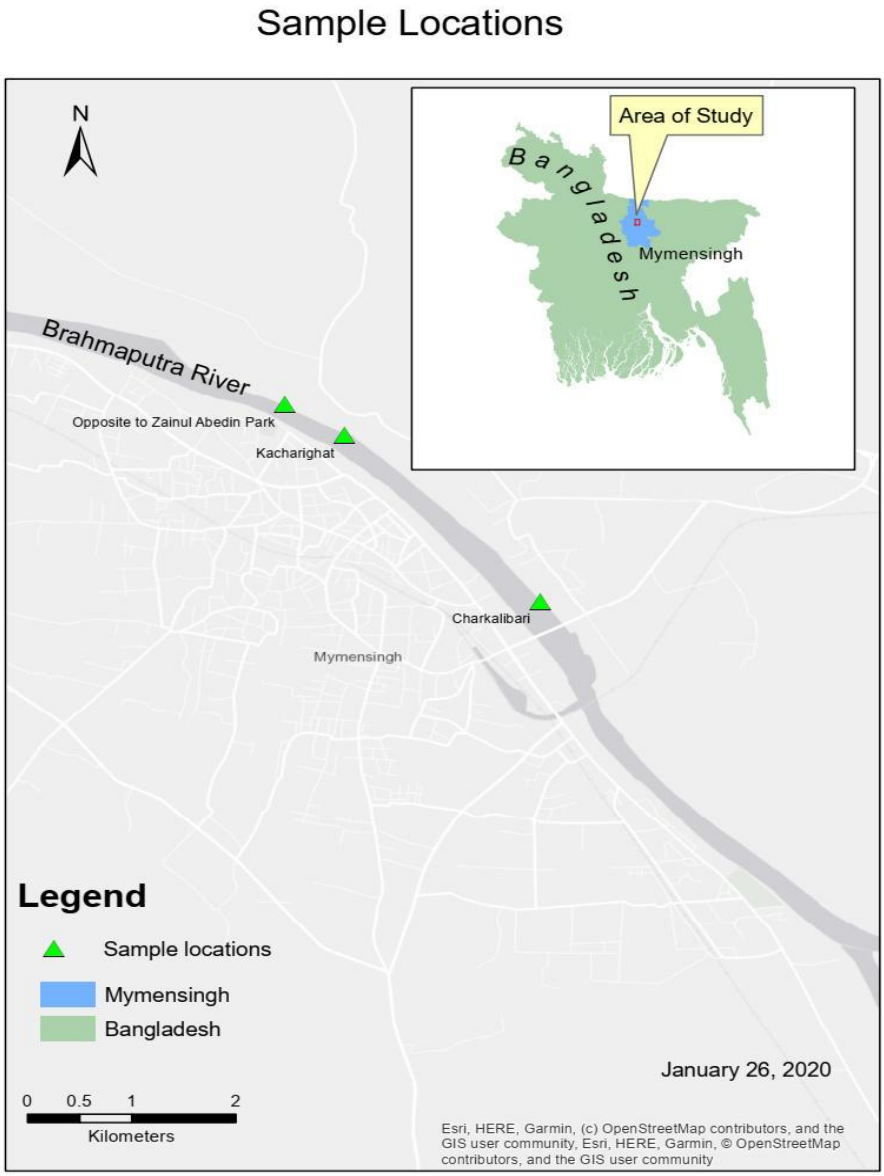



Figure 1: Map of the study area

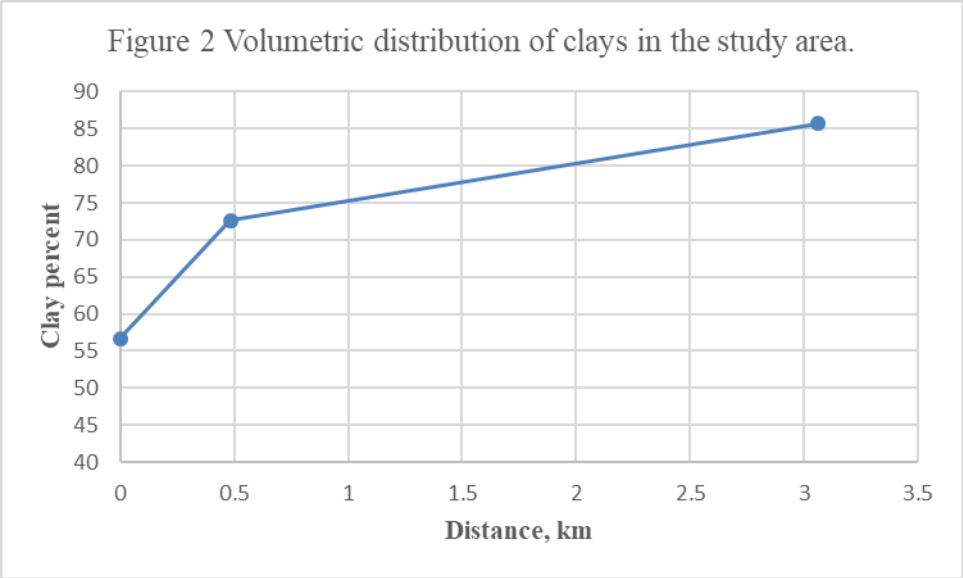
## II. Methodology

Fluvial sediments are exposed along the vertical sections throughout left bank of the Old Brahmaputra River, Mymensingh town. The sedimentary deposits are examined and logged in details at three locations. The average vertical thickness of the sections was 2.88 meters. The sedimentary deposits were categorized to number of facies according to Miall, 1985, 2013. Facies identification and interpretations were based on texture, colour, composition and sedimentary structure of the deposits (Roy et al, 2001). The grain size analysis of sediments was completed in the laboratory following a standard procedure for sieve analysis of five sand samples (Saha et al. 2017).The sand samples were dried in a thermostatically controlled oven dryer for twenty-four hours at 105°C temperature and then kept two hours open to bring the sand samples at room temperature.100 grams of each of the samples weighed using an electronic balance. The samples were then sieved using LAO SOUNG resting sieve shaker. Each of the samples was sieved for 25 minutes and grains retained on each sieve were weighed. The frequency curves and cumulative frequency curves were drawn using the distribution of the sediments. The MS Excel program was used to deduct the graphic measures.

## III. Result

**Facies Analysis**

The field observations reveal that sand, silt, clay and their admixtures comprise the studied sedimentary deposits of the study area. The amount of sand, silt and clay vary at different locations. Figure 2 reveals that the volumetric percentage of the clay increases in the downstream directions. The lithofacies identified here are Fm, Sh and Sp.




**Clay (Fm):** This is the most abundant facies exposed along the left bank sediments of the Old Brahmaputra River, Mymensingh. These are massive clay with minor amounts of silt. The colors of the sediments vary from bluish gray, steel gray and reddish brown. The reddish brown color is observed in the sediments of upstream direction. The reddish brown colours of the sediments indicate their derivation from the Pleistocene clay formation. The reddish brown colors of the sediments also represent their deposition in oxidizing environment. At few locations burrows and rootlets have been observed. The massive clay facies deposited in swampy or lacustrine environment during winter at low energy conditions (Miall, 1985: Roy et al., 2001).


Figure 3: Photograph showing Fm facies at Char Kalibari

**Parallel Laminated Sandstone (Sh):** The parallel laminated sand is mainly composed of fine to very fine sand with minor amounts (20%) of silt. The color of comprising rocks range from brownish grey to reddish brown. The constituent minerals are principally quartz, feldspar and mica. The facies sharply lies above the Sp facies at the opposite bank of the Zainul Abedin Park. The parallel laminated sand (Sh) facies might have deposited in tidal environment in the lower flow regimes (Harms et al. 1982).

**Figure 4:** Photograph showing different rocks and bioturbation at the left bank of the Old Brahmaputra River, Mymensingh.

**Planar Cross Stratified Sandstone (Sp):** Planar cross stratified sandstone (Sp) facies is exposed at the basal part of the lithocolumn on the left bank of the Old Brahmaputra river, opposite side of the Zainul Abedin Park, Mymensingh (Figure 5). The sandstone is micaceous in nature, both biotite and muscovite are present. The colors of the sandstone vary from whitish gray to grayish brown. Ferruginous materials like limonites and goethites are present in the succession. Fine grained sand with minor amounts of medium grained sand and silt constitute this facies. The deposition of small scale planar cross-bedded (Sp) facies has been attributed to current migration of linear ripple whereas large scale planar cross-bedding is produced both by linear (two dimensional) mega ripple and sand waves or migration of three dimensional medium subaqueous dunes (Ashley, 1990).

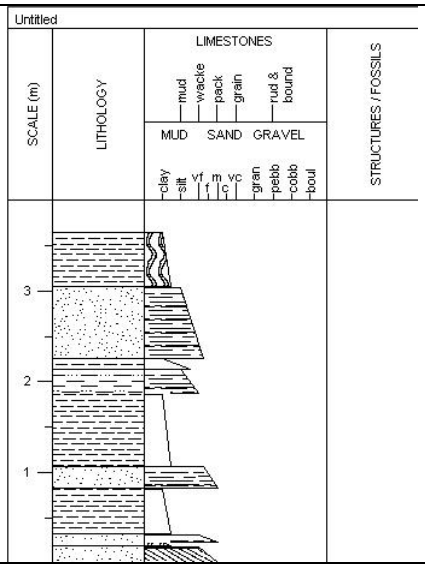
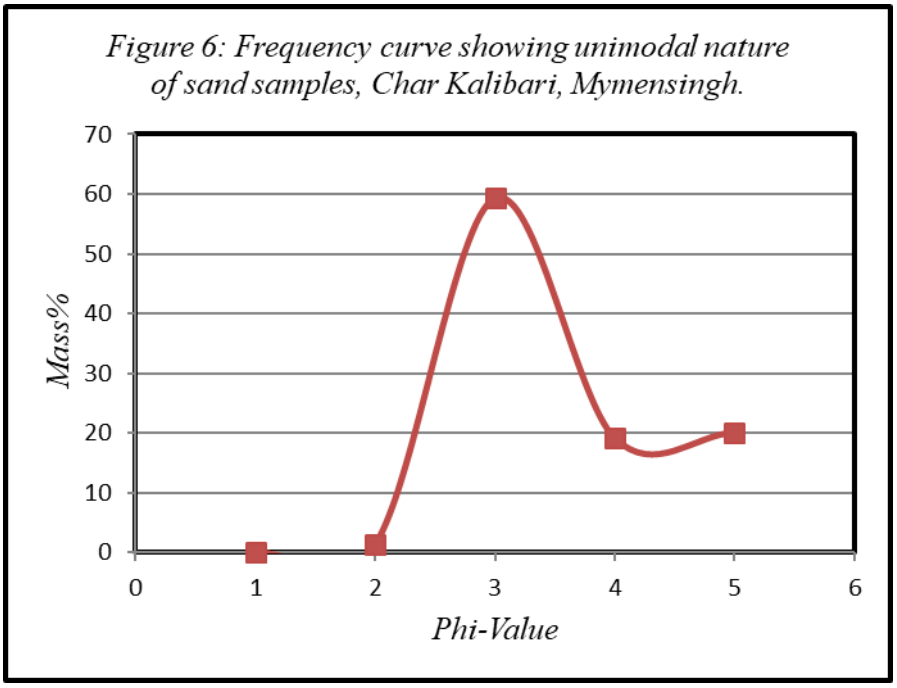


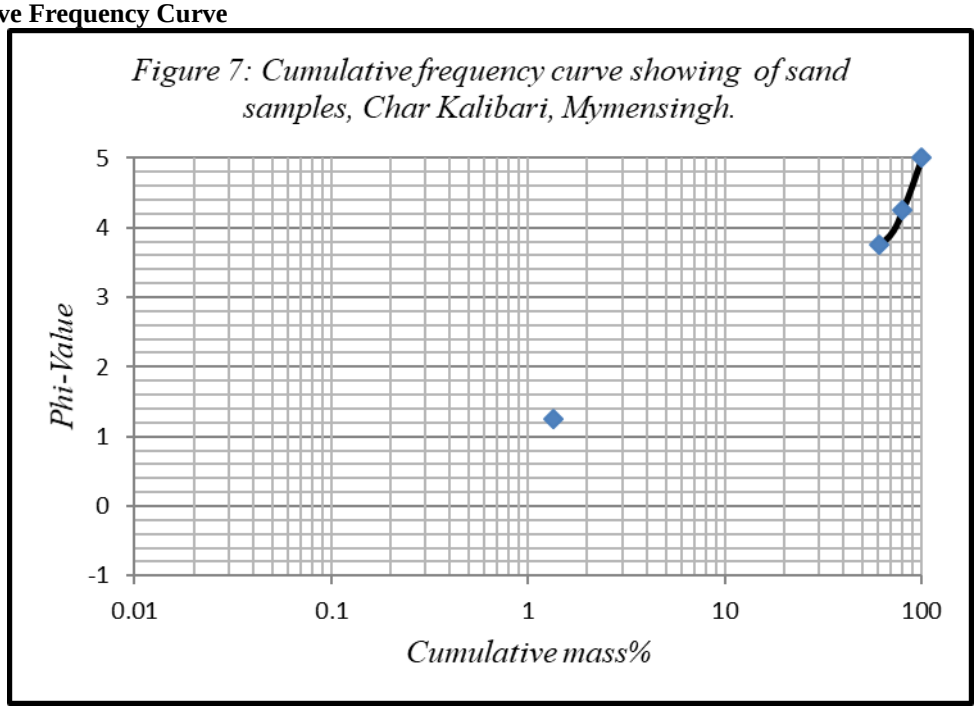

**Figure 5:** Litholog at the left bank of the Old Brahmaputra River, Mymensingh.

**Frequency Curve**




For all of the examined sand samples of the Old Brahmaputra River the frequency curves are constructed where the frequency of different size classes are plotted along the y-axis and the phi sizes are plotted along the x-axis. The samples have a single peak indicating unimodal source of the sediments.

**Cumulative Frequency Curve**




The cumulative-frequency curves are drawn (Fig. 7). It reveals that the major portions of the sediments are transported by saltation population. The dominant saltation population depends upon various hydrodynamic factors such as current velocity, water depth and nature of depositional slope. Traction population closely related to the turbulence of the transporting medium. Suspension population is an indication of the distribution of fine-grained sediments (especially clay) and low energy condition of the transporting agents. The sediments, which are carried by suspension, might have deposited during winter seasons at low energy conditions while the water depths decrease.

The average percentage of traction population is 0.09%, of saltation population is 83.87% and suspension population is 16.38% (Table 1).

**Table 1:** Showing the traction, saltation and suspension population on the analyzed sand samples of the Old Brahmaputra River, Mymensingh (in weight percent).

| Sample No. | Traction | Saltation | Suspension |
|---|---|---|---|
| S-1 | 0.1 | 60.613 | 39.287 |
| S-5 | 0.04 | 93.275 | 6.685 |
| S-6 | 0.112 | 88.276 | 11.612 |
| S-7 | 0.176 | 90.705 | 8.943 |
| S-8 | 0.04 | 86.487 | 13.696 |
| Average | 0.0936 | 83.8712 | 16.0446 |

**Graphic Mean (Mz)**

The graphic mean values of sand samples range from 3.41φ to 3.50φ. The mean size is slightly decreasing in the downstream direction of the sediments of Mymensingh. The graphic mean size of all the samples is very fine sand. The uniform size of the sand samples indicates that they derived from the same source.

**Table 2:** Graphic measure values of the analyzed samples of the Old Brahmaputra River, Mymensingh.

| Graphic measures | S-1 | S-5 | S-6 | S-7 | S-8 |
|---|---|---|---|---|---|
| C | 1.10 | 1.90 | 2.15 | 2.05 | 1.95 |
| $M_d$ | 3.60 | 3.50 | 3.55 | 3.55 | 3.60 |
| $M_o$ | 3.80 | 3.80 | 3.80 | 3.75 | 3.80 |
| $M_z$ | 3.50 | 3.42 | 3.48 | 3.47 | 3.46 |
| $\sigma_1$ | 0.84 | 0.49 | 0.39 | 0.41 | 0.41 |
| $SK_I$ | -0.17 | -0.37. | -0.30 | -0.28 | -0.45 |
| $K_G$ | 1.50 | 2.20 | 1.78 | 1.32 | 1.50 |
| $SO_S$ | 1.38 | 1.08 | 0.87 | 0.81 | 0.83 |
| $\alpha_S$ | -0.45 | -0.75 | -0.36 | -0.29 | -0.35 |

**Inclusive Graphic Standard Deviation ($\sigma_1$)**

Standard deviation is an environment sensitive textural parameter. Sorting of sediments reflects the velocity of the transporting medium, energy of waves, turbulence of water, depth of the basin and the rate of sedimentation (Saha et al. 2019). The inclusive graphic standard deviation of the analyzed samples range from 0.39φ to 0.84φ (Table 2) indicating well sorted to moderately sorted nature of sediments. The beach sediments are characterized by well sorting nature.

**Inclusive Graphic Skewness ($SK_I$)**

The mean value of inclusive graphic skewness ($SK_I$) is -0.31 ϕ while the numerical values range from -0.45ϕ to -0.17ϕ. The strongly coarse skewed nature of the deposits is indicative of supply of finer sediments from tributaries of the Old Brahmaputra River.

**Graphic Kurtosis ($K_G$)**

All the analyzed samples of the field area are leptokurtic as the magnitudes of graphic kurtosis is more than 1. The leptokurtic nature of the deposits in the study area suggests that the sediments have achieved good sorting in the high-energy condition of the fluvial environment at the time of deposition. The leptokurtic samples are better sorted at central portions of the tail (Saha et al. 2017).

**Depositional Environment Through Scatter Plots**

The plot of graphic kurtosis Vs inclusive graphic skewness of the sand samples of Old Brahmaputra River (Fig. 8) indicates the deposition of the sediments in the riverine environment.

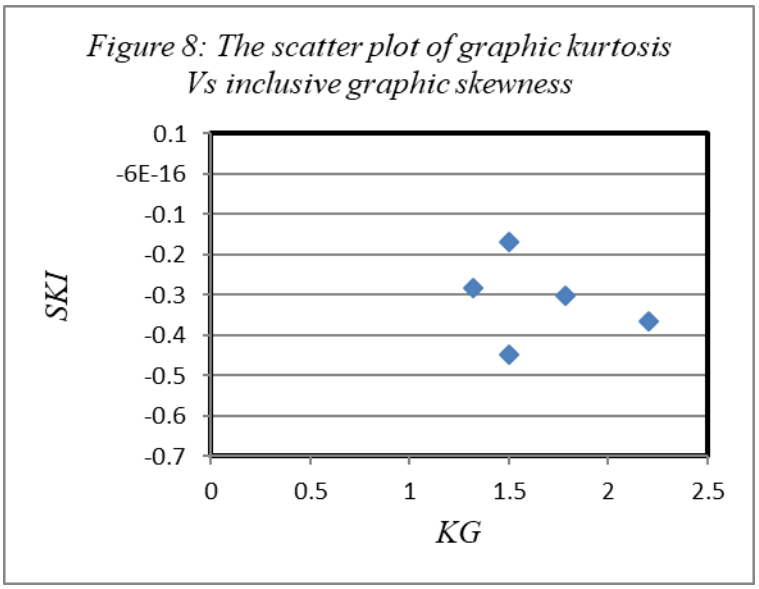



*Figure 8: The scatter plot of graphic kurtosis Vs inclusive graphic skewness*

The scatter plot of the simple sorting measure versus simple skewness measure (Friedman, 1967) has shown that the investigated sediments were deposited in two environments—60% of the samples were deposited in beach environment while 40% of samples were deposited in river environment (Fig. 9). The study reveals that the sediments might have deposited the Holocene marine transgression in the Bengal Basin (Afroza et al. 2009: Roy et al. 2004).

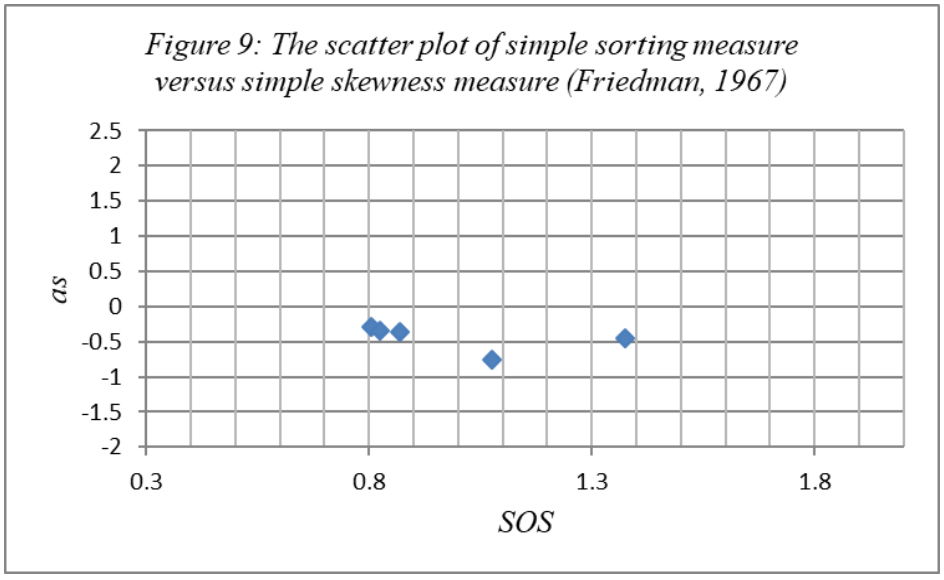



*Figure 9: The scatter plot of simple sorting measure versus simple skewness measure (Friedman, 1967)*

## IV. Conclusion

The present study reveals that Fm, Sh and Sp facies constitute the lithological succession of the study area. The finer massive clay sediments (Fm) were deposited in the shallow lacustrine environment during the winter at low energy conditions. The parallel laminated sand (Sh) facies might have deposited in tidal environment in the lower flow regime. The deposition of small scale planar cross-bedded (Sp) facies has been attributed to current migration of linear ripple whereas large scale planar cross-bedding is produced both by linear (two dimensional) mega ripple and sand waves or migration of three dimensional medium subaqueous dunes. The repetitive sedimentary column shows the evolutional history of the sedimentary basin. This resulted due to transgression and regression of the sea during the Holocene period. The graphic mean size of all the samples is very fine sand. The uniform size of the sand samples indicates that they derived from the same source. Most of the sediments are carried by saltation. The well sorted nature of the sediments is indicative of beach environment. The scatter plots show that the sediments were deposited in river and beach environments, which actually indicative of tidal nature of the Old Brahmaputra River. Further research works can be conducted to study mineralogy and age of the sediments.

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