International Research Journal of Environmental Sciences ISSN 2319–1414
Vol. **6(11),** 16-22, November **(2017)** *Int. Res. J. Environmental Sci.*

Mineralogical composition and spatial variation of suspended sediments in a 2nd order channel of the Brahmaputra River in Majuli, Assam, India

Suman Saikia* and Jayanta Jivan Laskar
Department of Geological Sciences, Gauhati University, Guwahati, Assam, India
sumansaikia1991@gmail.com

Available online at: www.isca.in, www.isca.me
Received 28th August 2017, revised 9th November 2017, accepted 20th November 2017

Abstract

The Brahmaputra River flows across Assam in a braided pattern with large discharge and heavy sediment load. The present study investigates the post-monsoon mineralogical variations in the suspended load in a 2nd order channel of the Brahmaputra River in Majuli, Assam. The channel flows along the southern bank of Majuli. Representative suspended sediment samples were collected from different locations and depths along the 2nd order channel, which were subsequently subjected to laboratory analysis for the determination of amount of suspended load as well as their mineralogical content. The suspended load varies from 0.337 gm/l to 1.77 gm/l. X-ray Diffraction analysis of the sediments indicate the presence of quartz, chlorite, chamosite, strontianite, sanidine, orthoclase, tourmaline, albite, oligoclase, augite, hornblende, biotite, muscovite, enstatite, epidote calcite, dolomite, hematite, goethite, gypsum, garnet, apatite, tourmaline, zircon, silimanite, kyanite, rutile, zoisite, clinozoisite and glauconite. The clay minerals varieties found are illite, montmorillonite and chlorite. A decrease in the amount of suspended load is observed from upstream towards the downstream part of the channel due to drop in stream power and change in flow direction of the 2nd order channel in its downstream portion. No clear segregation of minerals is observed along the course of the river channel.

Keywords: Brahmaputra River, Sedimentation, Suspended sediment, Mineralogy.

Introduction

Large Rivers constitute the main pathways of solutes and suspended particles from the continents to the oceans[1]. As such, the study of sediment load carried by rivers and canals has been the subject of intensive research for centuries, due to its importance in the regulation of river and canal systems[2]. These studies also greatly assist in study of sediment characteristics for example sediment types, nature of movement, amount of sediment present and to solve various problems related to sedimentation.

The Brahmaputra river of South Asia is the fourth largest river in the world in terms of annual discharge[3]. The average discharge is approximately 20,000m^3/s[4] and has an average annual sediment load of about 735 million metric tonnes[5]. In Assam, the river displays a braided pattern with large discharge and heavy sediment load and active lateral migration[6]. Another conspicuous feature of the Brahmaputra River is the presence of large alluvial islands of which several are more than a century old and inhabited as well[7]. One such island is Majuli, which is located in the upper reach of the Brahmaputra valley in the Majuli District of Assam. This island has been recognized as the largest riverine island in the world. It has a population of 0.16 million people and is the seat of many Vaishnavite spiritual center's called 'Satras'[7].

The present study investigates the post-monsoon mineralogical variations in the suspended load in a 2nd order channel of the Brahmaputra River which flows along the southern bank of Majuli in the Majuli District of Assam. This portion of the area is not affected by sediment supply from any other source except the Brahmaputra River.

Location of the study area: The study area is situated in the southern part of Majuli between latitude 26°54'18.19'' and 26°57'56.42''N and longitude 94°08'47.56'' and 94°17'26.14'' E (Figure-1). The approximate length of the channel is 13 km.

Methodology

Field investigations in the river channel were carried out immediately after the recession of floods with the help of a mechanized boat. During the course of field investigation, representative suspended-load samples were collected from different locations and depths by means of a customized suspended sample sampler of capacity 1 litre. The location coordinates were recorded with the help of a hand-held GPS receiver (Garmin e-Trex). The water+sediment samples were carefully collected in labeled polypropylene bottles for laboratory analysis.

In the laboratory, the collected water + sediment samples was left undisturbed and allowed to settle down for one week. At the end of a week, the overlying water from the settling vessels containing the sediment + water mixture was carefully decanted off, without allowing any of the contained sediments to drain off with the water. The remaining portion of the sediment +

water mixture was subsequently passed through a filter paper to separate the remaining portion of water from the sediments. The suspended sediments in the filter paper is oven dried at 80°C for 24 hour, weight of each sample was measured and stored in air-tight plastic bags for further laboratory investigations.

The next step involved the preparation of oriented slide mounts of the sediments for XRD (X-Ray Diffraction) analysis. This was accomplished by mixing a small portion of the sediments with distilled water on an oriented glass slide and allowing them to settle by gravity and dry under room temperature. The resulting mixture after almost 24 hours formed a thin and uniform coating on the slide once the water evaporates off.

The mineralogical composition of the suspended sediments was determined by X ray diffraction analysis on a Rigaku TTRAX-III X-ray Diffractometer at the Indian Institute of Technology, Guwahati. The operational parameters of the system was set as follows:

Instrument Operating Voltage – 9 KW, Cuk alpha radiation (θ = 1.54A°), and 2 θ: 2 to 40°

Diffraction occurs for each angle of incidence which satisfies Bragg's equation which states $n\lambda = 2d\sin\theta$, where n is a whole number, λ= the X-ray wavelength, d = the distance between planes of atoms and θ is the angle of incidence. The various constituent minerals were identified from calculated 2θ and 'd' values and the relative intensities from standard ASTM Powder Diffraction Data File[8]. Clay minerals were identified from standard chart for oriented sample[9].

Results and discussion

Table-1 shows the amount of suspended sediment (in gm.) per liter of water, at various locations of the study area.

Table-1: Table showing weight of suspended sediment at various locations.

Sampling location	Weight(gm.)
1	0.44746
2	1.123656
3	0.42665
4	0.55001
5	1.76578
6	1.18672
7	0.45584
8	0.36956
9	0.39722
10	0.36649
11	0.62668
12	0.33665
13	0.61518
14	1.055

The total suspended load at various location ranges between 0.337 gm/l and 1.77 gm/l. The spatial variation of suspended load along the river channel is shown in Figure-2.

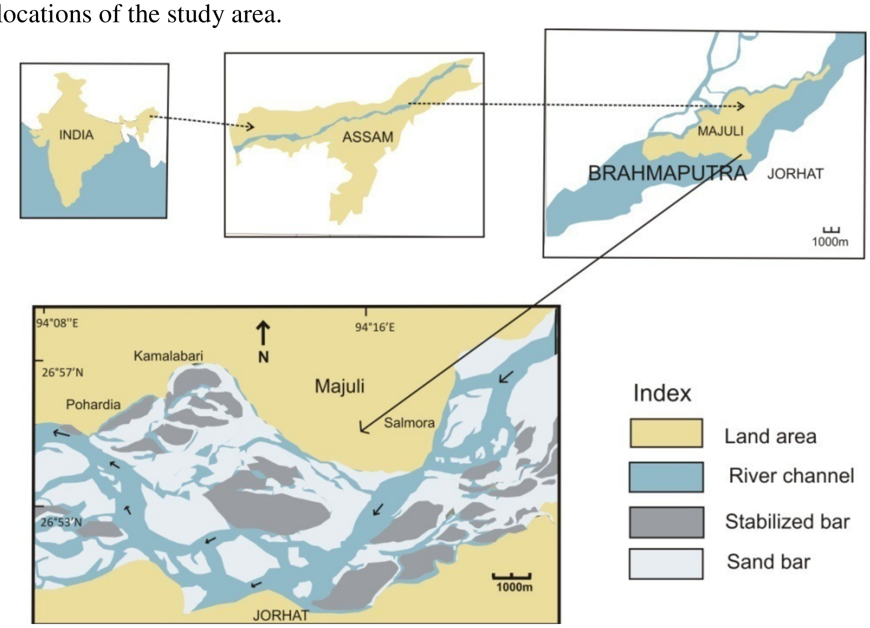


Figure-1: Location map of the study area.

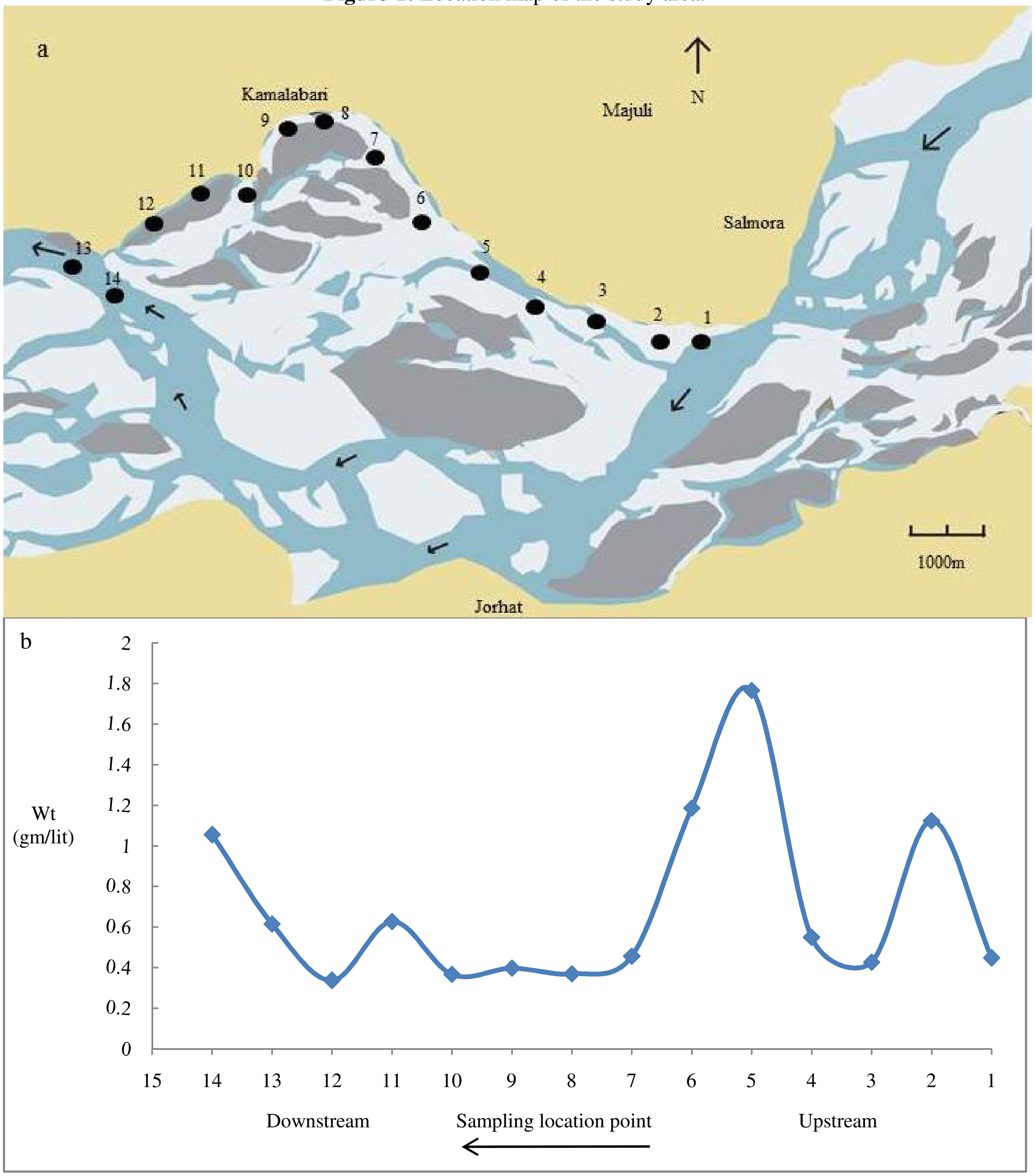
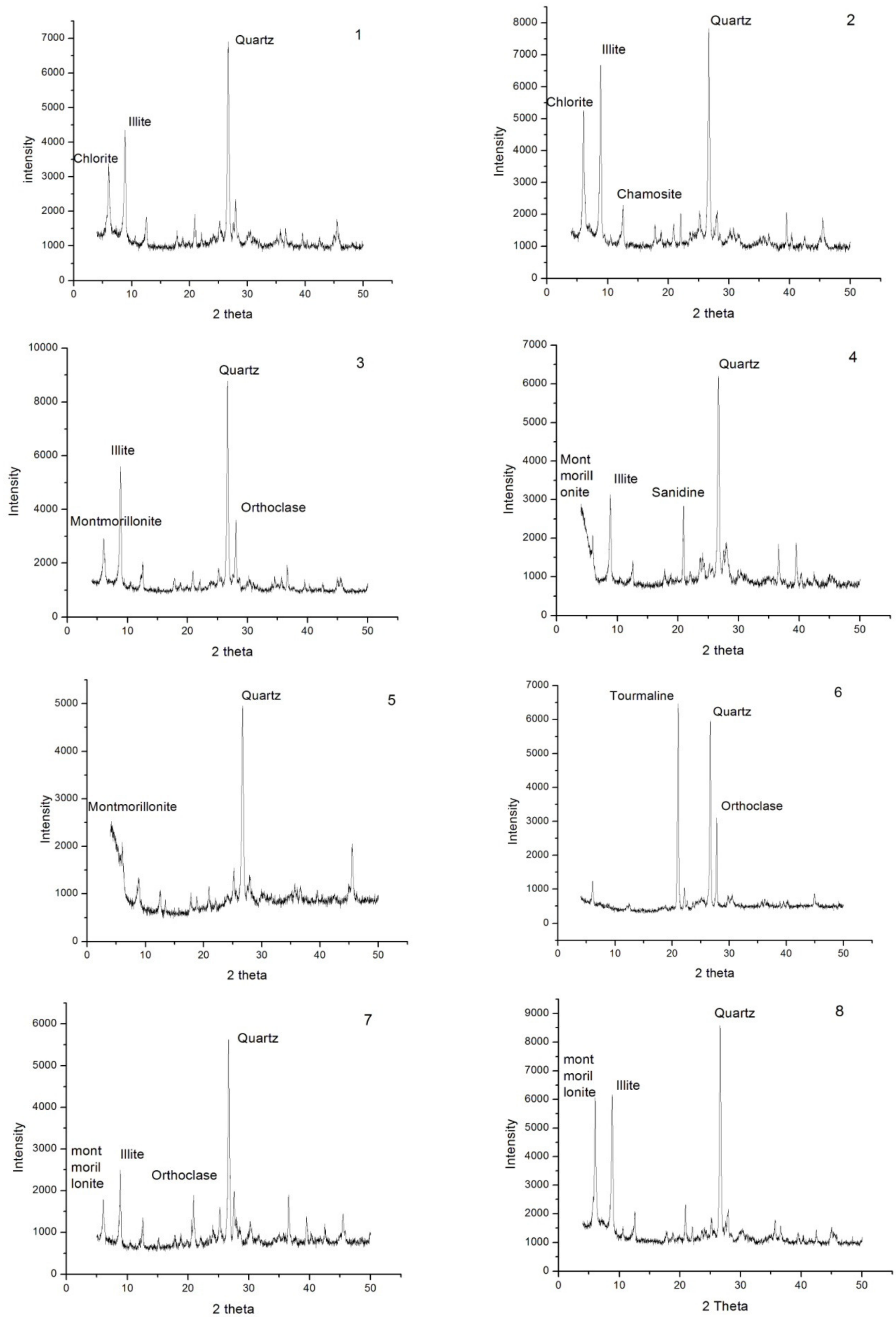


Figure-2: (a) Sampling location point marked on the map, (b) Graph showing spatial variation of suspended sediment load at different locations in the study area.

The graphical plot of amount of suspended sediment at various locations indicates greater amount of suspended sediment load (up to location 6) in the upstream part of the channel. The suspended load decreases downstream beyond sample location no.6. This might be caused due to loss of stream power because of change in the course of the river channel around this location. Further beyond, the suspended sediment load again shows an increasing trend near the confluence of the 2nd order channel with the main channel of the Brahmaputra River.

The x-ray diffractograms of oriented suspended load were examined to identify their mineralogical content (Figure-3). The various parameters determined during the study were 2θ, "d" spacing and relative intensity.


1
Quartz
Illite
Chlorite
intensity
2 theta
2
Quartz
Illite
Chlorite
Chamosite
Intensity
2 theta
3
Quartz
Illite
Montmorillonite
Orthoclase
Intensity
2 theta
4
Quartz
Mont
morill
onite
Illite
Sanidine
Intensity
2 theta
5
Quartz
Montmorillonite
Intensity
2 theta
6
Tourmaline
Quartz
Orthoclase
Intensity
2 theta
7
Quartz
mont
moril
lonite
Illite
Orthoclase
Intensity
2 theta
8
Quartz
mont
moril
lonite
Illite
Intensity
2 Theta

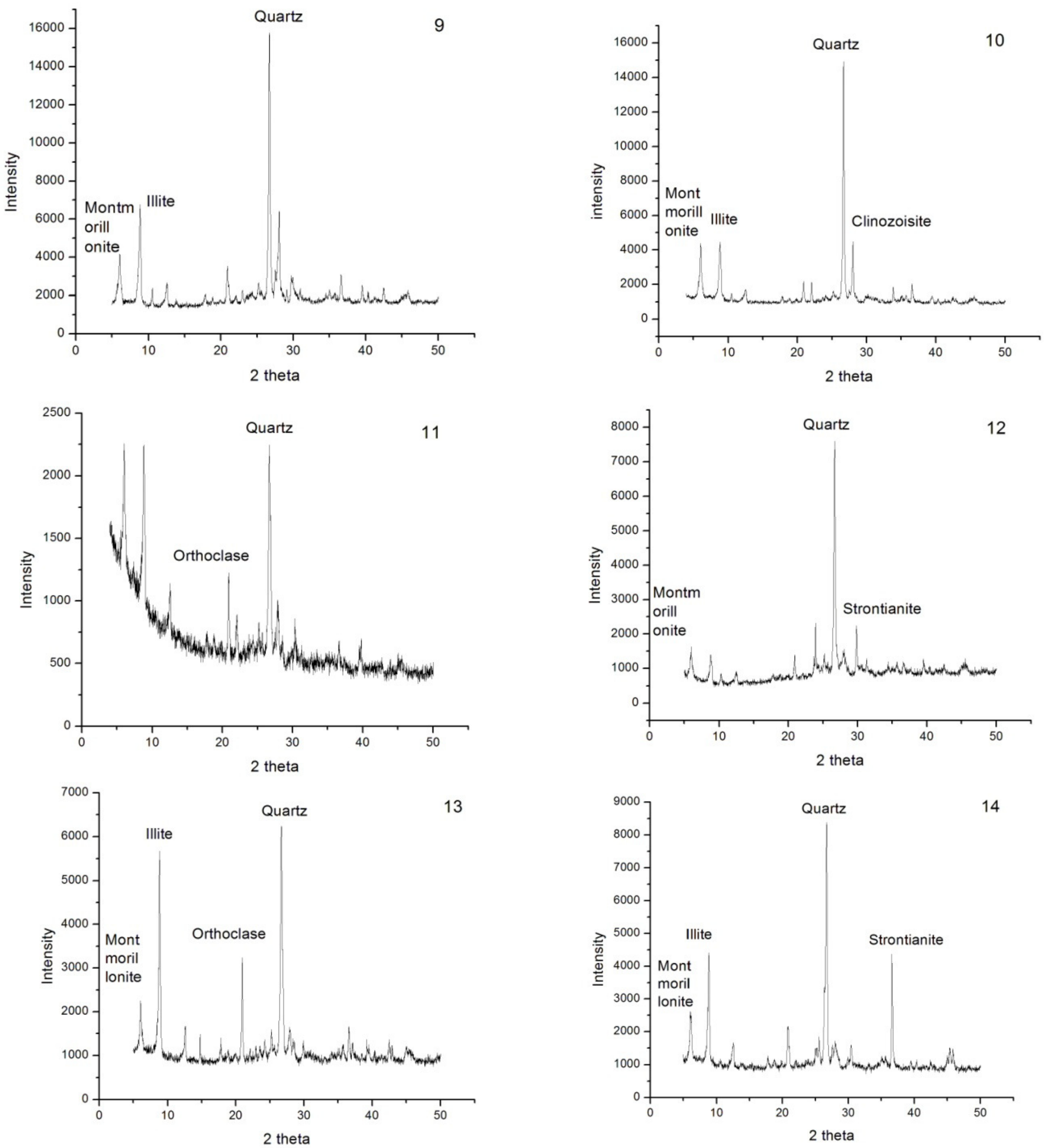


Figure-3: X-Ray Diffractograms of suspended sediment samples.

The most frequent and prominent peaks in the diffractograms are shown by quartz, illite and montmorillonite. Chlorite, Chamosite, Strontianite, Sanidine, Orthoclase, Tourmaline also show prominent peaks in some samples. Quartz is identified by a prominent peak at 26.66° 2θ, 3.343 A° d value and relative intensity of 100. Montmorillonite shows peaks between 5.89° and 6.80° 2θ. Illite shows peaks at approximately 8.8°, 17.7° and 26.75° 2θ. Chlorite shows peaks at approximately 6.3° 2θ. Chamosite shows reflection at 12.56° 2θ and 7.05A° d value. Orthoclase peak occurs at 28.06° 2θ, 3.18 A° d value and a relative intensity of 42. Strontianite shows 36.60° 2θ, 2.45 A° d value and a relative intensity of 40. Besides these minerals, minor peaks observed in the diffractograms indicate the presence of Albite, Oligoclase, Augite, Hornblende, Biotite, Muscovite, Enstatite, Epidote Calcite, Dolomite, Hematite, Goethite, Gypsum, Garnet, Apatite, Tourmaline, Zircon, Silimanite, Kyanite, Rutile, Zoisite, Clinozoisite and Glauconite. The clay mineral varieties found are Illite, Montmorillonite and Chlorite.

The spatial distribution of mineralogical assemblage found at various sampling locations is shown in Table-2 and Figure-4.

Figure-4 depicts the spatial variation of the mineral assemblage along the course of the river.

Table-2: Tabulated data of mineralogical composition of various analyzed suspended load sediments.

Sample no	Albite	Anaclime	Apatite	Augite	Biotite	Calcite	Chamosite	Chlorite	Clinozoisite	Dolomite	Enstatite	Epidote	Hematite	Garnet	Goethite	Glauconite	Hornblende	Illite	Illmenite	Kyanite	Montmorillonite	Muscovite	Oigoclase	Orthoclase	Quartz	Rutile	Sanidine	Sillimanite	Sphene	Staurolite	Strontianite	Tourmaline	Tremolite	Zircon	Zoisite
1	●	●			●		●	●	●	●							●	●				●	●		●						●	●			
2	●		●				●	●						●			●	●	●	●	●	●			●						●		●		●
3					●				●		●				●			●			●	●		●	●						●				
4	●		●				●					●						●			●	●			●		●					●			
5	●				●						●							●			●				●	●					●				●
6	●				●			●			●										●		●	●	●						●	●			
7					●		●									●		●			●			●	●		●		●			●	●		
8	●		●															●			●			●	●			●			●				●
9	●				●				●				●			●		●			●	●			●		●						●		
10						●			●	●			●					●			●				●						●	●		●	
11	●			●	●		●														●			●	●					●					
12	●			●	●		●	●													●			●	●					●	●				●
13	●					●	●	●										●			●	●	●	●	●	●		●			●	●			
14	●										●				●			●			●			●	●			●				●			

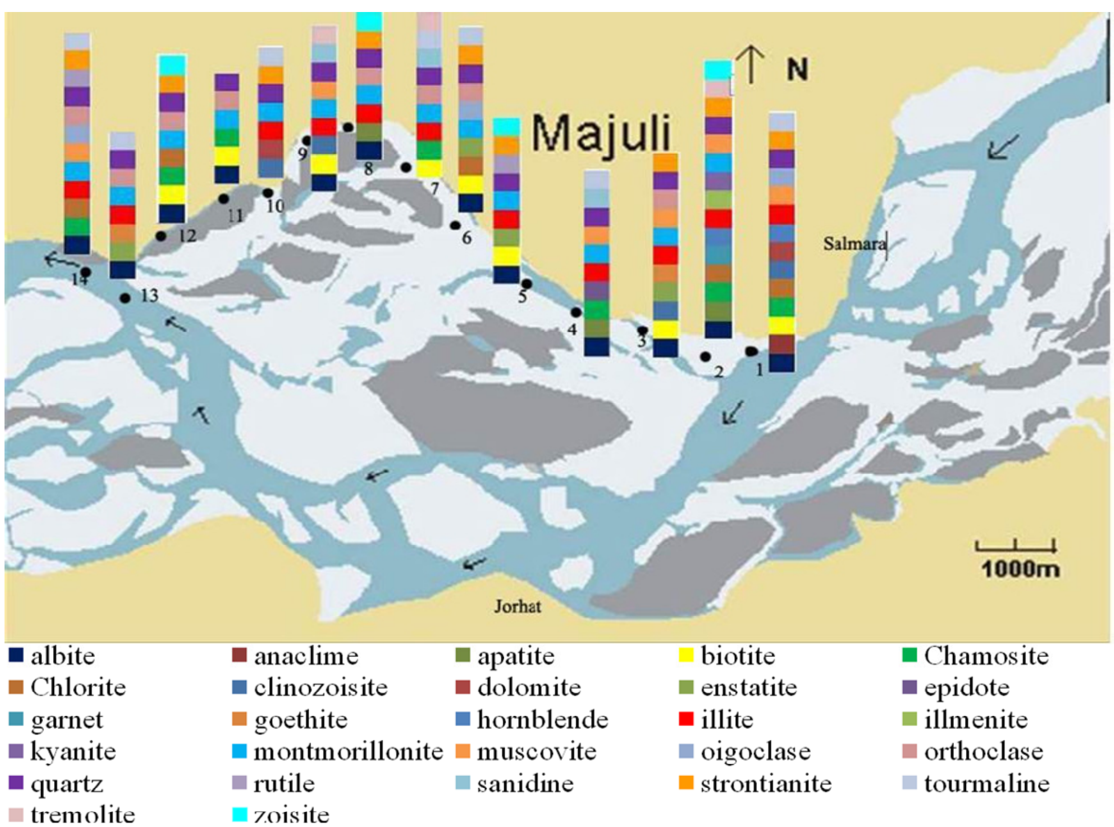


Figure-4: Schematic diagram of the study area showing sample location (black dot) and the associated mineral assemblage.

Table-2 and Figure-4 indicate that there is no distinct indication of lateral segregation of various mineral fractions in the suspended load along the course of the river channel. Quartz, albite, illite, montmorillonite, chlorite, strontianite show consistent occurrence in all locations. Hornblende, garnet and kyanite occur only in upstream portion of the study area, whereas hematite, rutile, sillimanite and calcite are restricted to the downstream portion.

Conclusion

The study reveals that the suspended load in the 2nd order channel of the Brahmaputra river near Majuli ranges between 0.337 gm/l to 1.77 gm/l. The suspended load is high in the upstream portion of the channel, and decreases in the downstream portion. This is probably due to drop in the stream power due to change in the flow direction of the 2nd order channel in its downstream portion.

XRD analysis of suspended sediment indicate that the suspended sediment contain quartz, chamosite, strontianite, sanidine, orthoclase and tourmaline. Other minerals identified in the x-ray diffractograms are albite, oligoclase, augite, hornblende, biotite, muscovite, enstatite, epidote calcite, dolomite, hematite, goethite, gypsum, garnet, apatite, tourmaline, zircon, silimanite, kyanite, rutile, zoisite, clinozoisite and glauconite. The clay minerals present are illite, montmorillonite and chlorite. No systematic variation in the mineral distribution could be identified along the course of the river channel.

Acknowledgement

The authors thank the Head, Department of Geological Sciences, Gauhati University for the laboratory facilities. One of the authors (SS) would like to thank the University Grants Commission, New Delhi, for providing the necessary research fellowship under National Fellowship for Students of Other Backward Classes Programme. The authors would also like to thank Dr. S. Sarma, of Department of Physics, IIT Guwahati for providing the laboratory facilities for XRD analysis of the sediments. The equipment has been procured under DST FIST Grant SR/FST/PSII-020/2009 (Physics). A special thanks also goes to all who helped us during field-work and collection of suspended sediment.

References

1. Campodonico V.A., García M.G. and Pasquini A.I. (2016). The geochemical signature of suspended sediments in the Parana River basin: Implications for provenance, weathering and sedimentary recycling. *Catena*, 143, 201-214.

2. Acharya Anu (2011). Experimental study and numerical simulation of flow and sediment transport around a series of spur dikes. Dissertation thesis. The University Of Arizona UMI Number: 3454308, 192.

3. Mahanta C., Zaman A.M., Newaz S.M.S., Rahman S.M.M., Mazumdar T.K., Choudhury R., Borah P.J. and Saikia L. (2014). Physical Assessment of the Brahmaputra River Ecosystems for Life: A Bangladesh-India Initiative, Dialogue for Sustainable Management of Trans Boundary Water Regimes in South Asia. Ch- 2, IUCN 2014, 90.

4. Immerzeel W. (2008). Historical trends and future predictions of climate variability in the Brahmaputra basin. *International Journal of Climatology*, 28(2), 243-254.

5. Datta B. and Sing V.P. (2004). Hydrology. The Brahmaputra Basin Water Resources, Singh V.P., Sharma N., Shekhar C. and Ojha P., Kluwer Academic Publishers, Netherlands, 139-195.

6. Coleman J.M. (1969). Brahmaputra river channel processes and sedimentation. *Sedimentary Geology*, 3(2), 129-239.

7. Lahiri S.K. and Sinha R. (2014). Morphotectonic evolution of the Majuli Island in the Brahmaputra valley of Assam, India inferred from geomorphic and geophysical analysis. *Geomorphology*, 227, 101-111.

8. Lindholm Roy C. (1987). A Practical Approach to Sedimentology. Allen and Unwin, Inc, USA., 276.

9. Carroll D. (1970). Clay Minerals: A guide to their x-ray identification. *Geol. Society of America*, Boulder, Colorado. Spl., 126, 80.