To My Grandparents

Abstract

The present study deals with assessment of the textural, mineralogical and geochemical characteristics of the suspended, bed load, overbank and floodplain sediments of the Brahmaputra River in Assam and six of its major tributaries. Within the 891 km study area along with six major tributaries (the Subansiri, the Jiabharali, the Pagladia , the Burhidihing , the Dikhow and the Kulsi) , the understanding of the geochemical characteristics of the river sediments was carried by integrating four objectives:

1. To study the role of riverine control on riverine selective deposition, differential transport and distribution of various grain sizes of the Brahmaputra River and its tributaries.

2. To study the role of floodplain storage in controlling the chemical weathering of sediments.

3. To study the distribution and characteristics of riverine carbon.

4. To study the control of tributaries in maintaining the nutrient and sediment budget of the river Brahmaputra.

The first objective was worked out by studying the grain size analysis of the Brahmaputra River and its tributaries and assessment of the geologic significance of such parameters as skewness and kurtosis by taking representative samples. In this study we found that the tributaries play a significant role in downstream changes in textural characteristics of the Brahmaputra River sediment. Analyses of standard deviation and skewness values along the course of the Brahmaputra reveal that standard deviation values of channel sediment samples indicate a poor to very poor sorting, normal for a fluvial environment, and that skewness is symmetrical to slightly posi-

tive. In the vicinity of the banks standard deviation has lower values due to the disappearance of coarser elements, but sorting still remains in the "very poor" domain. Rivers originating from the Himalayan orogenic belt region are characterised by the predominance of fine sand and very fine sand whereas the south bank tributaries bring much coarser sediments than the Himalayan rivers and are characterized by the high content of coarse- and medium-grained sand. Percentage silt-clay increases from bedload to bank to floodplain sediments. This may be due to the deposition of the finer fraction during floods and further weathering of the deposited sediments over time. The textural parameters clearly indicate the importance of source area in textural characteristics of sediments of tributaries.

The second objective of studying the role of floodplain storage in controlling the chemical weathering of sediments and to elucidate weathering conditions in the river basins was carried out through mineralogical and geochemical analysis of the river sediments. We collected and analysed sediments from different environmental classes in the Brahmaputra catchment (5 locations in the mainstream and 6 of its major tributaries before the confluence with the mainstream). Sedimentary facies were grouped as suspended, channel bed, overbank and floodplain deposits. Mineralogy of the sediment samples have been studied using X-ray diffraction technique (XRD. Major and minor oxides in sediment samples were determined using X-ray fluorescence (XRF) and inductively coupled plasma-atomic emission spectrophotometer (ICP-AES) respectively. In our study, presence of hornblende, plagioclase, chlorite and orthoclase in downstream locations indicate the lesser intensity of chemical weathering in the mainstream. We found that the amount of Kaonilite increases from Pasighat to Dhubri, while smectite and vermiculite decrease and illite remains stable. Illite and chlorite are higher in Brahmaputra than the Ganges (60% vs 42% and 17% vs 7% respectively), which may be due to the dominance of Himalayan tributaries in the Brahmaputra. Himalayan tributaries contain more micaceous minerals (with dominant biotite) south bank tributaries. More Illite in the north bank tributaries indicate more physical weathering and Himalayan uplift, whereas more smectite in the south bank tributaries are associated with more chemical weathering. From the geochemical data we found that in the Brahmaputra only the mobile elements are depleted in the channel and overbank sediments indicating low chemi-

cal weathering in the source area. In the suspended sediments, the major and trace elements show a conservative behaviour (unlike most rivers which show a downstream decrease). In the A-CN-K ternary plots (showing the weathering trends) the Brahmaputra samples plot near to the granite-graniodiorite line (average upper continental crust composition) indicating very less chemical weathering in the source area (in the cold and dry Tibetan plains). The tributaries showed more chemical alteration and weathering compared to the Brahmaputra. In the South bank tributaries all the samples plot away from the plagioclase-K-feldspar line which indicates that they have undergone intense chemical weathering compared to the north bank tributaries.

The third objective was to study the distribution and characteristics of riverine carbon. In order to explore the composition characteristics and distribution pattern of organic carbon (OC) in river sediments, we analysed OC content sediments and soils from the channel, suspended ,banks and floodplain of the Brahmaputra river (at 5 locations from upstream to downstream) and its tributaries rivers (before the confluence with the mainstream). The organic C content (%OC) in the sediments of the Brahmaputra ranged from 0.01 to 0.04% , 0.08 to 0.53% , 0.08 to 0.20% and 0.20 to 0.82% in channel, overbank ,floodplain and suspended sediments ,respectively. The POC as well as LOI (Loss on ignition) displayed inverse relationship with SPM in the Brahmaputra River i.e. elevated concentrations of POC associated with low SPM and depleted concentrations of POC with high SPM at the sampling stations were seen. Uniform OC content suggest strong hydrodynamic conditions during transport (also suggested by the poorly sorted sediments). The relatively low OC concentrations found in overbank and floodplain sediments compared to the POC at the catchment scale suggest that erosion and sediment transport processes lead to C losses to the Brahmaputra River during transport in the Assam Plains. The organic content in the north bank tributaries (originating from the Himalayas) was found to be higher than the south bank tributaries originating in the Indo-Burma ranges and the Shillong plateau. The TOC content in the north bank tributaries ranged from 0.01 to 0.1%, 0.11 to 1.85%, 0.24 to 1.98% and 0.3 to 1% in channel, overbank, floodplain and suspended sediments respectively. The TOC content in the south bank tributaries ranged from 0.0 to 0.08%, 0.0 to 0.3% and 0.03 to 0.5%

in channel, overbank and floodplain sediments respectively.

The fourth objective was to study the control of tributaries in maintaining the nutrient and sediment budget of the river Brahmaputra. To carry out this objective, the Brahmaputra mainstream as well as the Himalayan tributaries of the Brahmaputra River that join from the north (the Subansiri, the Jiabharali and the Pagladia) and south bank tributaries (the Burhidihing, the Dikhow and the Kopili) were studied in terms sediment chemistry and associated particulate flux, and individual elemental contribution from each tributary into the Brahmaputra basin. Sediment discharge estimates are calculated to determine each tributary's contribution to the suspended load of the entire river system. The instantaneous suspended sediment loads during the monsoon season are used to estimate the annual suspended sediment load for the system. In the Brahmaputra river load increased downstream and was probably due to tributary contribution and high bank erosion. Bank material of the Brahmaputra are mostly composed of dominant fine sand and silt with clay being less than 5% as recorded in our study. It was observed that the elemental and particulate flux for north bank tributaries was more than the south bank tributaries - flux in the Subansiri River was found to be highest among the tributaries. With the dam under construction in this river, the effect on suspended flux on the Brahmaputra needs to be further investigated after the completion of the dam.

In conclusion, the significant findings for the whole study are presented as follows:

1. The textural parameters clearly indicate the importance of source area in textural characteristics of sediments of the tributaries while grainsize.

2. The north bank tributaries are characterised with high sediment fluxes and periods of physical weathering and Himalayan uplift, whereas the south bank tributaries is associated with more chemical weathering.

3. The Brahmaputra samples indicated very less chemical weathering in the source area. The tributaries showed more chemical alteration and weathering compared to the Brahmaputra.

4. Bank material of the Brahmaputra are mostly composed of dominant fine sand and silt with clay being less than 5% as found in our study which may explain the unstable banks and extensive erosion in the basin.

5. It was observed that the elemental and particulate flux for north bank tributaries was more than the south bank tributaries - flux in the Subansiri River was found to be highest among the tributaries.

The parameters analysed and discussed under this study is probably the first attempt to study the textural, mineralogical and geochemical characteristics of the Brahmaputra and its tributaries in detail in the Assam part of the river. This study provides some basic information that we need to plan and manage any water resource program and would be helpful for overcoming water management issues made critical by deterioration of river water and sediment quality.