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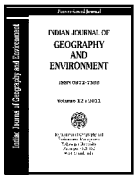

Microscale Observations by Digital Imaging for Physical Analysis of a Lake Deposition Sample : an Experimental Study

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A B S T R A C T

Micrographic studies are considered as one of the important tools for analysis of physical characteristics of sediment depositions. Recent development of digital technology plays very important role for analysis of physico-cheminal and mineralogical compositions of the sediment depositions. In this study the present author attempted to analysis some physical characteristics of late Holocene lake deposition by digital imaging and image processing. For that purpose Rudrasagar lake of Tripura was selected for field work and sample collection. In the sedimentology laboratory a section was prepared from the collected sample for micro-photography under reflected light. Image analysis at micro level was done by multi-processing techniques with several sophisticated image processing software.

1. Introduction:

From early 20th century sedimentological researches in earth-sciences has been considered as an important pillar for assessing the landform development history and present geo-physical status. During the middle part of the last century Hansen's (1959) study on lake sediment characters highlighted chemical, physical and ecological status of lakes. Ryder and Pesendorfer (1989), and Wetzel (1990) analysed the different classes of sediment suspended (turbidity) in natural lakes. With the development of techniques of microscopy, petromicrography started to be considered as a scientifically fascinating subject of profound practical importance (Radlinski *et al,* 2005). In the mid 70s of the last century Brewer (1976) studied soil fabric at micro level which was very remarkable for the initial growth of systematic studies. From the early 80s, methodological approaches in micrography have become more experimental. Inventions of sophisticated scientific tools in the 70s, 80s and 90s played important role in the experimental works of microscopic sedimentology. Uses of SEM and optical microscopy, molecular adsorption, SAXS and SANS resulted some excellent research output in petrographic image analysis (PIA) which was reflected by some remarkable works of Bale and Schmidt (1984), Katz

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and Thompson (1985), Wong *et al* (1986), Jacquin and Adler (1987) and Hansen and Skjeltrop (1988). Apart from those, some other contemporary works by van der Meer (1987, 1993 and 1996), van der Meer and Laban (1990), Menzies and Maltman (1992) discussed the evidences of genesis and deformation. Over the last 20-25 years, especially from the middle of 90s, the method of digital microscopy has become very popular in sedimentological studies. In the year 1996 Bryant and Davidson attempted a micromorphological study by image analysis on old cultivated soils. Later Cooper (1998) also observed the usefulness of digital image analysis in sediment studies. Vernon (2004) presented a general outline on practical approach of igneous, sedimentary and metamorphic rock microstructure. Meanwhile some experiments on lake sediment thin section making by Cocquyt and Israe (2004) and Rohrig Schar (2006) resulted remarkable advancement in sediment microstructure research especially in Limnology. Recent development of digital technology has attracted many scholars in microphotography and digital imaging researches. As a result of that sedimentological studies are now directed towards more in depth analysis and received more attention in applied sciences. The research team in the which the present authors are working also involved in the studies of microstructural evidences landform evolution in Tripura (Dey et al, 2008) and paleo-coastal parts Bengal basins Dey et al (2009a) and Dey et al, (2009b). Considering the recent trends, the present authors decided to perform an experiment on micrography and digital imaging for physical analysis of late Holocene deposition Rudrasagar lake area (23°30' N to 23°31'08 N latitude, 91°18'45 E to 91°20'00 E longitude) of Tripura, India. The basic objective of this study is directed towards micro to nano scale analysis.

2. Sampling and section making:

The sediment sample used in this study was collected from 0.49m depth from the lake bottom for micrography. In the recent works the present authors experimented on thick sections in case of very fragile samples which proved very useful for microstructure and micro-architecture studies (Dey et al, 2010; Debbarma et al 2010). In this study these authors also decided to work with thick section instead of thin sections because the lake sediments are very soft and not suitable for thin section making. Some very common materials like a core cutting and grinding machine, lapping and polishing machine, small tile saw, steel knife, sample plate, petrographic glass slides etc were used for preparing the sections in the laboratory. A coating of liquid wax, mixed with transparent synthetic gum, was used for cutting and making the primary blocks from very soft or easily breakable sediment sample under wet condition. An

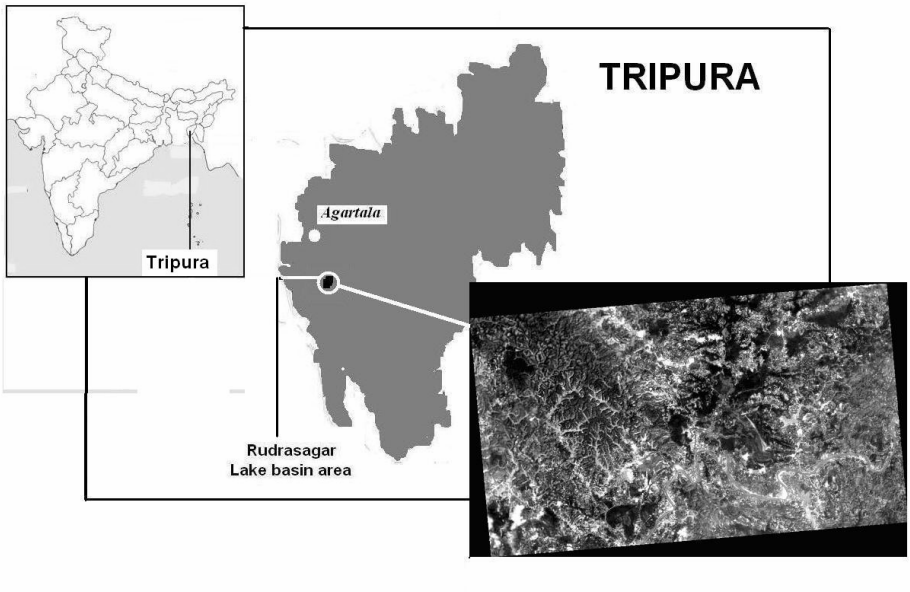

Figure-1: Location and environ of the sampling site Rudrasagar Lake of Tripura, India

electric warmer was used for drying the sample in very mild temperature (25ºC) and then finally it was prepared for sectioning. An ordinary sharp edged small stainless steel knife blade was used for making sections and removing the coating from the sediment layer. Actually one perfect flat surface of 30 μm thick section was needed for this experiment to use the sections as objects of reflectance or 'reflectors' (figure-2a).

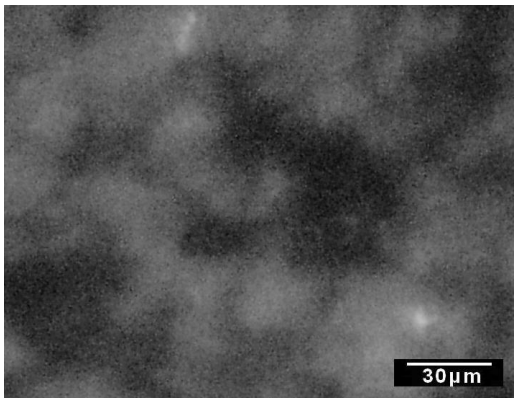

Figure-2 : Microphotograph of the thick section for digital operation

Digital imaging:

Digital microphotography of the prepared thick section was done for interpretation of the sediment characters. In this section the present authors concentrated on developing multi-processing technique for digital imaging and image analysis (Figure-3). Multi-processing operation is actually the integration different operational tools or software for a complete analysis. In this research total three software were used. Systematic observation shows that this sample is consist of three types of minerals like yellow fine sand, silica and gypsum. The DN values of the different compositions were studied carefully within RGB combination to understand the visibility characters of different minerals. "Contrast slicing" operation was done for identifying highest and lowest DN values and their corresponding minerals of high and low reflecting characters. In the contrast slicing method different brightness and contrast level was tested to identify the highest (silica) and lowest (gypsum) DN values representing minerals of the sample.

3. Results and Discussion:

Observation through the different bands shows that light coloured minerals are very prominent within

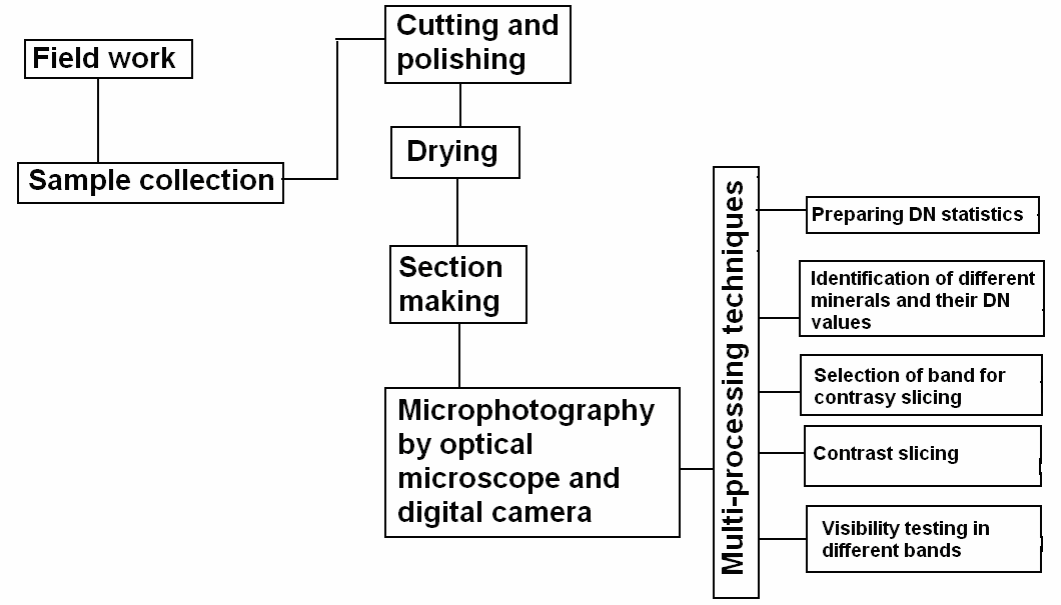

Figure-3: Outline of methodology: sampling, image making and multi-processing technique for image analysis

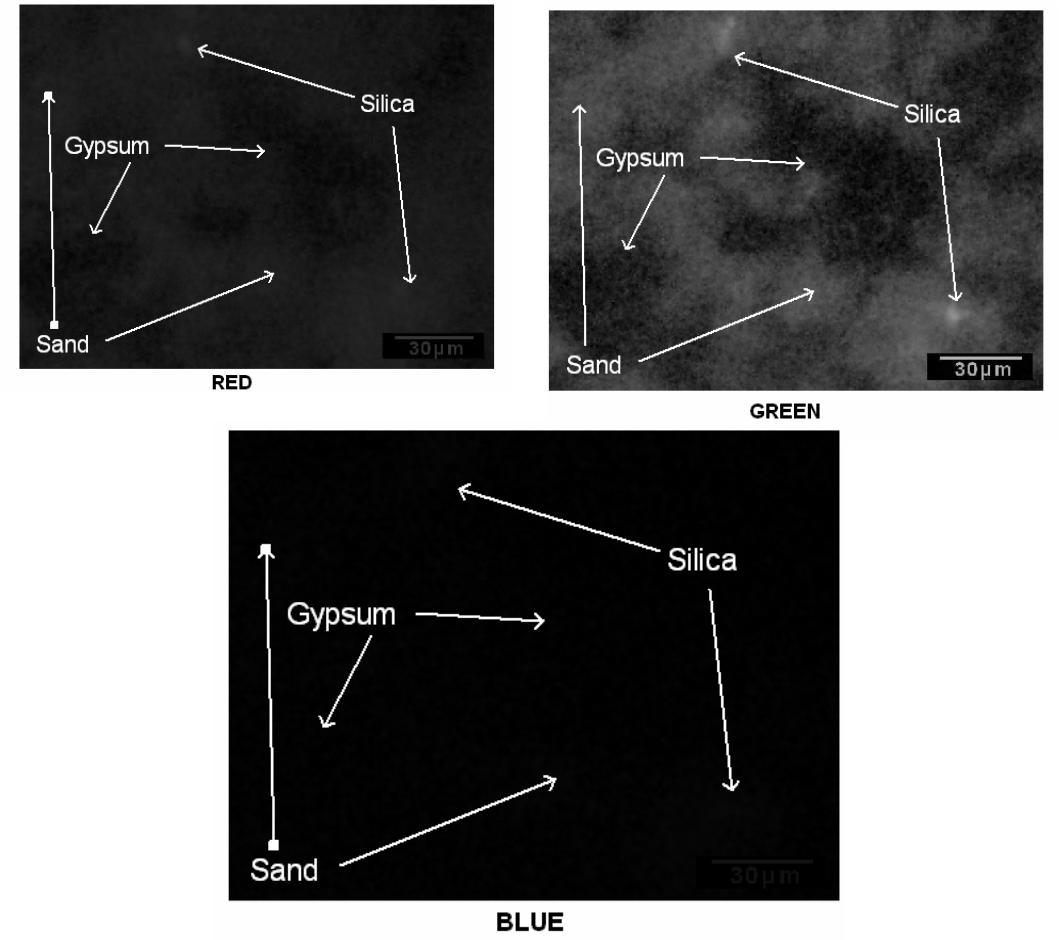

Figure-4 : Visibility of different minerals in different spectral resolutions (R,G, B)

0.6-0.7μm wavelength and high contrast level or in red band. In the selected sample section two light coloured minerals namely silica and yellowish fine sand are identified. In the prepared digital form silica is represented by 135-225 DN values and yellowish fine sand is represented by 85-134 DN values (figure-4). It is interesting that dark coloured minerals are not properly visible in this band. Within 0.5-0.6μm wavelength dark coloured mineral like gypsum is very perfectly visible. In blue band (0.4-0.5 μm wavelength) since the contrast is very low individual minerals are not clearly visible and it is very difficult to identify those minerals.

Considering the observations in R,G and B bands, R band was selected for slicing operation due to its greater extension of DN values (figure-5a). Moreover a total visibility of the different minerals of the image is found in Red band which is better than other bands. Contrast slicing was done in the selected band by the present authors to identify the maximum DN value and minimum DN value and their corresponding minerals. Silica is maximum visible within brightness-contrast level of 20%-90% and gypsum is maximum visible within brightness-contrast level of 47%-86% (figure-5b and 5c).

4. Conclusion:

All scientific interests have some future application values. Physical analysis in sedimentological researches also provided many excellent developments in applied science which made interested scientific thinkers to concentrate in that topic. Methodologically digital imaging for analysis of the sediment layers is not new to the earth

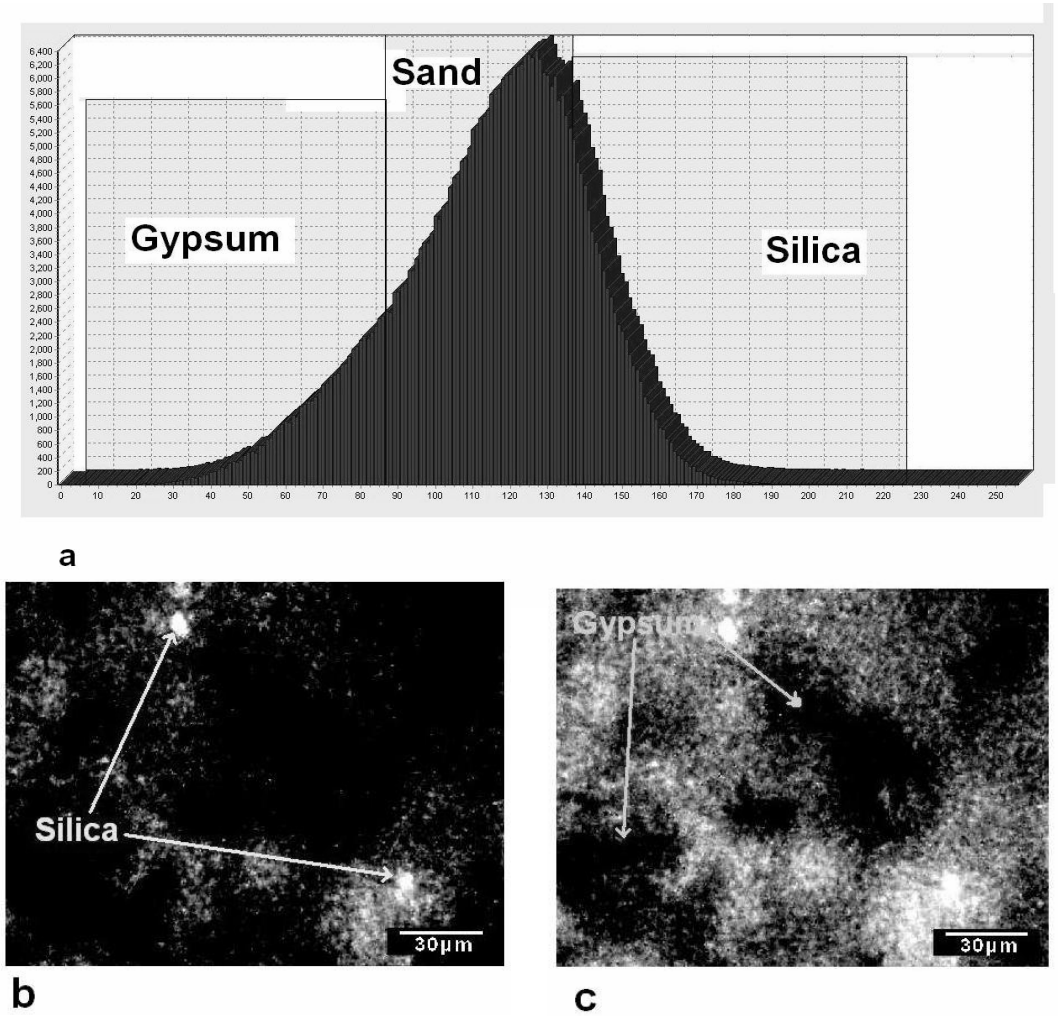

Figure-5 : corresponding values of different minerals in R band (a) and slicing operation to identify silica and gypsum the same band (b and c).

scientists and it has been developed massively by multi-dimensional approaches over the last 20-30 years. In this study the present authors attempted to apply multi-processing techniques for maximum utilization of the merits of some image processing tools (software). The digital parameters like DN values, reflectivity, visibility ranges within different wavelengths (RGB combination) etc are used for understanding the physical quality of the different minerals because the digital parameters are influenced by some physical features like colour, roughness etc. Although the multi-processing experiment is little time consuming but finally it results a satisfactory level of observation of the sediment deposition. Still some further methodological addition is needed for a future version of advancement in sedimentological studies.

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