3.1. Research planning:

Prior to visiting the field area the existing literature surveyed such as reports of Geological survey of India, Dept. of Science and technology, ONGC and recent research papers published in different journals and seminars etc to prepare a complete field work programme. To identify the early environmental change through historical period, some existing relevant historical records have been taken from different literatures. Both manual observation and technical application has been used for the study area. The whole methodology is divided into three main parts namely (a) Literature survey and research planning, (b) field work for sample collection, (c) thin/ thick section making and microscopy and image analysis. For the present study some samples of sedimentary rocks were collected from selected parts of Southern Athramura hill, southern Baromura hill and Gajalia. Toposheets, satellite images and GPS has been used for locating the sampling stations on geo-referenced satellite images and mapping.

There are different sources for data collection. Some of the important and essential Source of Data collections are:

- Secondary data from GSI, DST and ONGC
- Primary data from field investigation
- Research papers from various reviewed journals and books
- Data collected from some old maps

The present study area has not much explored before, due to this very rare authentic data was found in the area. There are some problems which are realized during field study:

i. This area has not properly surveyed previously.

ii. Lacking of sufficient relevant literatures on environmental changes of this area.

iii. Communication lines are not well connected all this parts of the study area.

iv. Literatures of microstructural evidences are not found of this area.

3.2. Fieldwork and sampling:

Both manual observation and technical applications have been adopted during field work to find out geomorphic features and present status in the study area. Sediment characters and bedding
patterns were also studied in the field. Samples were collected from different parts of Southern Atharamura, Southern Baromura hill and Gogalia ridge. The field work is directed towards

a. Generation of data for understanding the present geomorphic features of the study area
b. Collection of sediment samples from selected sampling points
c. Field mapping of different sediment bedding zones
d. Measurement of dip angle of the sediment bedding
e. GPS will be used for locating the sampling points.

Plate 3.1. Field survey of the study area

Plate 3.2. Technique of Sample collection of the study area
Plate 3.3. Dip angle measurement and data plotting during field survey

For assessing the early depositional environmental condition changes through geological past, this work has been divided into three important methodological parts, i. sampling from different layers ii. thin section making and imaging and iii. analysis. Some of the samples have been selected for laboratory testing.

As it is stated earlier that evidences of environmental dynamics in temporal scale is preserved in the early depositions, each and every layer should be studied properly. Moreover environmental changes occur within a wide area, not in a small sector. Thus for in-depth assessment a wide area should be taken for field work. In that case the whole study area is divided into some geo-physical domains on the basis of research objective. Then from each domain some sampling points can be selected. It is not necessary that number of sample points should be always the same in every domains; it depends on the area and geo-physical / environmental nature of the domain. Very commonly five methods of sampling are used in the present study:

a. Wide area sample collection of some particular formation or depositional structure (Fig.3.1).
b. Sampling of some specific geological periods like Late Quaternary, Early Quaternary, Tertiary etc (Fig.3.2).
c. Collection of sample in wide area up to fixed depth from the surface.
d. Collection of all the samples in some selected area from surface to the maximum depth.
e. In case of experimental work on imaging or structural assessment sample / samples can be collected within very small area.
It is important that microstructure study for landform evolution assessment should be both qualitative and quantitative. Otherwise detection of past environmental changes is not possible. Not only good samples help to prove the hypothesis, but also large amount of sample help for establish the view of the researcher.

Fig 3.1. Some examples of raw samples collected based on specific formation (Dupitila) from South Tripura District, Tripura.

Fig 3.2. Conceptual model of sample collection from different formations based on specific geological period from selected seven sample stations.
3.3. Laboratory work & Thin Section making:

3.3.1. Laboratory work:

Laboratory works are most important in this study. Lab works are directed towards:

a. Selection of samples for final testing:

b. Thin section making:

c. Micrograph and digital imaging

d. Image analysis

e. Preparation of different models (like 2D and 3D visualizing)

f. Assessment

Thin sections are prepared in the microstructure laboratory. The basic equipments for thin section making used:

a. Core cutting and grinding machine

b. Polishing and lapping machine

c. High resolution microscope

d. Electric connection for 440v motors.

e. Water connection and enough supply of water

f. Sharpener/knife and geological hammer

g. Dissection table, a large wood table can be used

h. Petrographic glass slides, cover and cotton and other accessories.

i. Epoxy, alternatively araldite can be used.

j. Electric warmer, is used for drying the samples.

If the sediment samples are too fragile and not suitable for thin section, acetylene can be used for making the samples solid.
3.3.2. Thin section making

Thin section making is one of the most essential tasks in microstructure study. Early studies like Brewer (1976), Bale and Schmidt (1984), Katz and Thompson (1985), Wong et al. (1986), Jacquin and Adler (1987), Hansen and Skjeltrop (1988), van der Meer (1987, 1993, 1996), van der Meer and Laban (1990), Menzies and Maltman (1992), Vernon (2004), Mamtani et al. (2007) Cashman et al. (2007) were consulted during preparatory planning. Some recent works on sediment thin section making, like Cocquyt and Israe (2004) and Rohrig and Schar (2006) have also consulted during laboratory preparation. Very common materials like a small tile saw, glass stick and petrographic glass slide were used for preparing thin sections in the laboratory. Core cutting and grinding machine were used for initial grinding and polishing and lapping machine was used for making thin section. Resin and hardener (araldite) were used in 1:1 ratio for making.
thin sections. 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 samples under wet condition. An electric warmer was used for drying the samples in mild temperature (25°C) and then finally those were prepared for sectioning. Again epoxy and hardener were used in 2:1 ratio before making the thin sections. An ordinary sharp edged small stainless steel knife blade was used for making sections and removing the coating from those sediment layers. Microphotography was done by digital optical microscopic (10X eye piece and 20X objective lens), and high resolution fixed digital canon camera. For image analysis micro processing software was used.

3.4. Imaging and data analysis:

Both reflective and transmitted lights were used for microscopy. The prepared thin sections were analyzed by digital method for which following equipments used:

a. Microscope with standard magnification and fixed digital camera
b. Desk top PC with microstructure analyzing software
c. Colour printer

Digital operations were directed towards (i) digital image making of sediment sections (ii) visibility testing in RGB combination for understanding reflectivity of mineral compositions and (iii) making various models for assessing the geometric significances at micrometer scale. The entire digital operations have been done through the integration of different image processing software.

![Fig 3.3.Flow chart showing methodology of microstructure analysis](image-url)
Image processing is significant part in microstructure research, which has been continuously advancing on the scientific platform of the experimental contributions. Microstructure software was used for analyzing the smaller grain particles in different micro level scale. Image processing is another important part in microstructural research. Cooper (1998) Lachniet et al (1999) and Lachniet et al (2001) Dey et al (2009) etc were consulted by these authors during digital operation. The present image analysis was directed towards quartz grain arrangements by maximum possible maximum brightness-contrast (µ-C) method and microfabric mapping. In a very recent work Dey et al (2011a) attempted to visualize the quartz grains of the selected sample on the basis of brightness and contrast which is considered as the most important parameter in visualizing as these are very important for analyzing the reflectance or transmission capacity of any object. In case of a normal multi-spectrum image best visibility can be observed at 50% brightness and contrast. It is called normal visualizing condition. In this experiment both brightness and contrast were increased up to maximum possible level (µ=100% and C=70%) for detecting the maximum light transmitting objects or quartz particle under microscope and their distribution pattern in the thin sections.

Bi-directional Reflectance Distribution Function (BRDF) images are prepared within RGB buffer. Finally physical characters of the depositions, temporal change of microstructure patterns and their significances, change of source zone etc are analyzed for assessing the Tertiary-Quaternary landform evolution in this area. The surface microfabric mapping is another most important analytical part of the samples which referring characteristic of depositions /rocks and the sequential change of depositional pattern. Images were prepared within RGB combination. Dey et al (2011a) and Dey et al (2011b) presented a similar type of microfabric mappings within RGB combination where red (60% to 90% or more transmission) indicates high transmitted minerals like quartz, silica etc, green (35% to 59% transmission) indicates sand, clay sand, silica etc and blue (35% less transmission) represents dark grey / blue clay, lignite etc. In this work same transmission scale was followed in microfabric mapping.

Dey. et al (2009a) used reflectance variance measurement under optical microscope for assessing typical microstructures of sedimentary depositions. In another very recent work the same research team experimented on Bi-Directional Reflectance Variance Function (BRDF) model (Fig 3.4) for assessing the crystalline mineral surface conditions in sediment thin section (Dey et al, 2010).
Fig 3.4. BRDF model for assessing the crystalline mineral surface conditions in sediment thin section

References:


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