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SEDIMENT COMPOSITION OF THE THAKURAN RIVER BASIN OF THE SUNDERBANS

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Abstract: Thakuran River sediments are typical estuarine. Lithogenic constituents are dominant with about 85-90% in bulk and biogenic components constitute the rest (10-15%). Quartz, feldspars, mica, lithic fragments and some heavy minerals are the main terrigenous constituents. Secondary overgrowth of quartz with multiple rims of inclusions suggests their derivation from sedimentary rocks of different cycles of sedimentation. The heavy mineral assemblage in the sediments lead to conclude that the sediments have been derived from the acid igneous rocks of the Himalayas in the north and the metamorphic rocks of the Precambrian shields of the west and north-west of Bengal Basin. Benthic foraminiferal assemblage indicates a shallow water, moderate to low salinity environment of deposition.

Keywords: Lithogenic components; biogenic components; Heavy minerals; acid igneous minerals; metamorphic sources; sedimentary rocks; Thakuran River; Sunderbans.

1. INTRODUCTION

Thakuran drainage basin of the Sunderbans is characterised with the low-lying alluvial tropical coastal plains of the Ganges-Brahmaputra delta. The sediments of the many distinctive geomorphic zones like point bar, mid channel bar, marginal bar, natural levee etc are siliciclastic with sand-silt-clay as the chief constituents. The sand is characteristically terrigenous in nature and mainly composed of quartz with pockets of heavy mineral concentration [1]. Quartz grains from the sediment deeper than 0.5 m in trench sections often show yellowish brown surficial tint. Biogenic and terrigenous or detrital components constitute the common coarser fraction of the sandy materials. Quartz, feldspar, muscovite, biotite etc constitute the terrigenous materials, contributing about 40% to 80% of the total coarse fraction. Total heavy mineral concentration combining biotite, muscovite, amphiboles, pyroxenes, epidote-zoisites is moderately high. Heavy minerals like rutile, monazite, zircon, garnet, opaques etc are considerably less in all the collected samples. Biogenic materials are very few in the clayey silt samples, whereas these are abundant in the sand and silty-sand types of sediments. The non-detrital fraction includes skeletal grains of gastropods and bivalves or their fragments and calcareous concretions of possible algal origin. Benthic foraminifers with some pteropods, crinoidal stems and echinoid spines occur only as a very small part in the coarser fraction of the sandy materials.

A systematic study of both lithogenic and biogenic content of the sediments of the Thakuran River might possibly help for assessing the impact of the estuarine environment. Laboratory work concerning sediment properties consisted of mineralogical and granulometric analyses of the collected samples. Mineralogical studies of both heavy and light fractions were done. The heavy minerals were separated from the lights by heavy liquid (bromoform) separation method [2]. Grain-slides and impregnated sediment sections were studied under the petrological and high power binocular microscope to identify the minerals and their textural properties.

2. Lithogenic and Biogenic Components

The siliciclastic sandy, silty sand and clayey silt sediments of the Sunderbans show some mineralogical variations from landward to seaward stretch of the river as well as from one geomorphic zone to another. Primarily, both lithogenic (85-90%) and biogenic (10-15%) components constitute the mineralogical composition of the sediments.

Among the lithogenic components light mineral fractions constitute between 96 and 99% of the sediments, whereas, the heavy minerals (specific gravity > 2.9) constitute only 0.5 to 3.7%. The light mineral fraction is composed chiefly of quartz, feldspars of microcline, orthoclase and sodic plagioclase varieties, muscovite and lithic fragments of schistose, semi-schistose (phyllitic), cherty and quartzitic rocks (Fig. 1). The heavy minerals, in the decreasing order of abundance, are magnetite, garnet of white and pink varieties, hornblende, epidote-zoisite, biotite, chlorite, kyanite, sphene and zircon (Fig. 2).

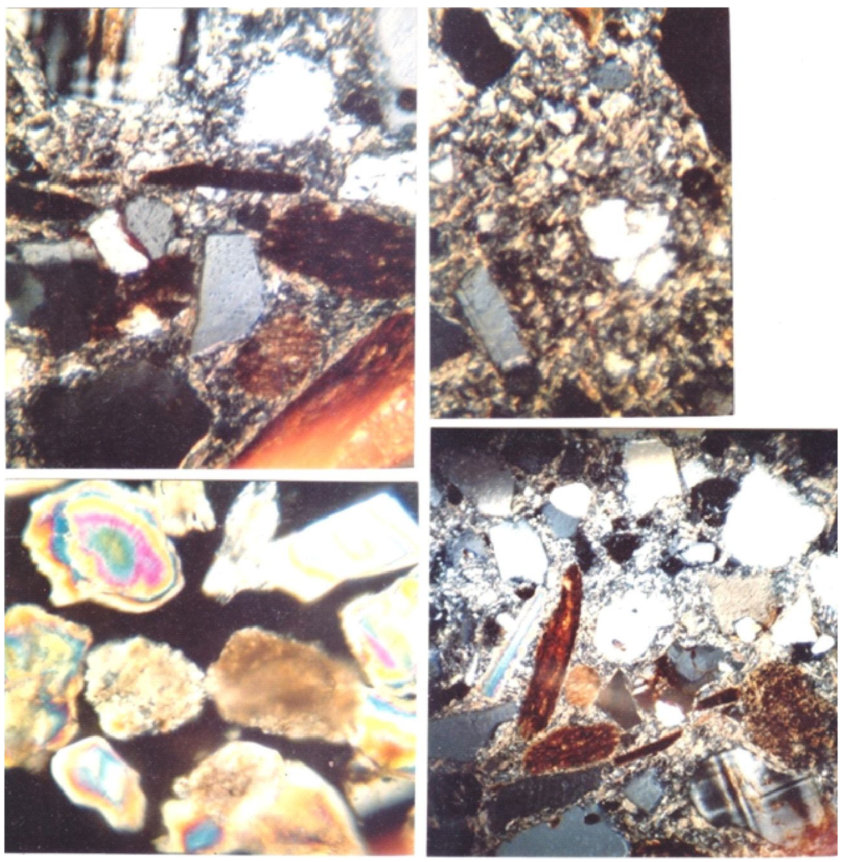


Fig 1 (Clockwise from lower left)

- Loose grains mounted in glass slides. Grains of quartz, feldspar and rock fragments show colour zoning because of greater thickness. Magnification : X 10
- Thin section of impregnated grains between crossed nicols. Grains of microcline (cross-hatched), orthoclase, quartz, schistose rock fragment, biotite (dark brown) and opaques are seen. Magnification : X 10
- Thin section of impregnated grains. Composites quartz grains, orthoclase (grey coloured) opaques are present. Magnification : X 10
- Thin section of impregnated grains between crossed nicols. Grains of quartz, rock fragments, biotite (elongated brown) muscovite (elongated bluish green), orthoclase are seen. Note the subangular to subround nature of grains. Magnification : X 10

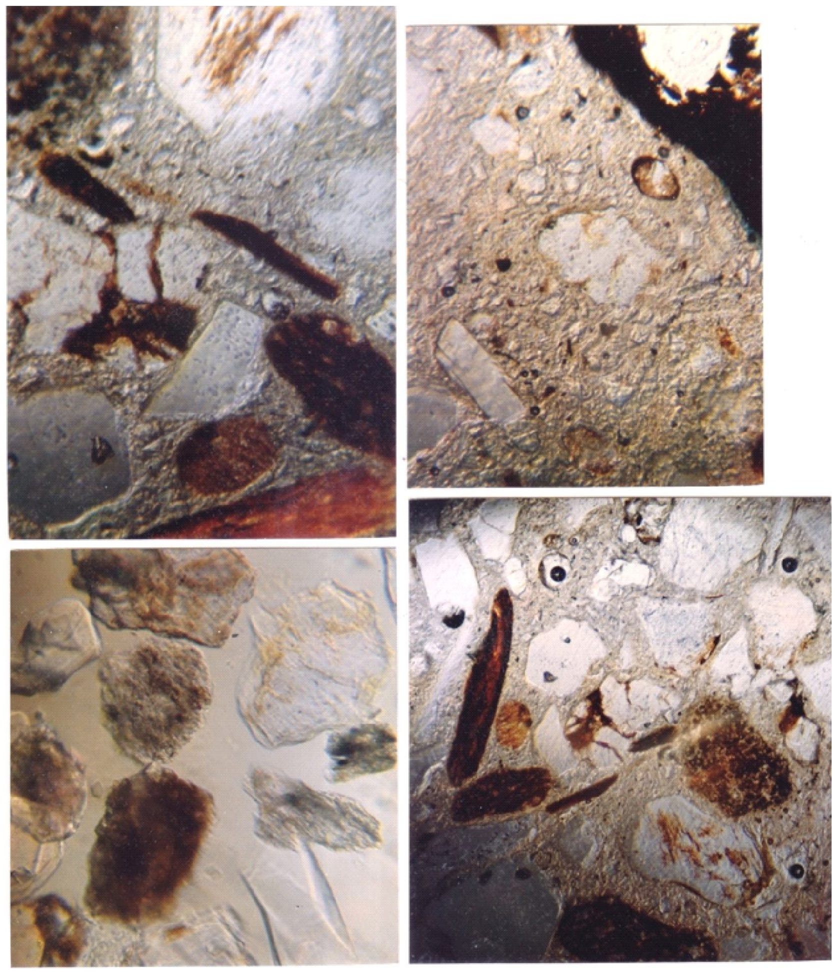
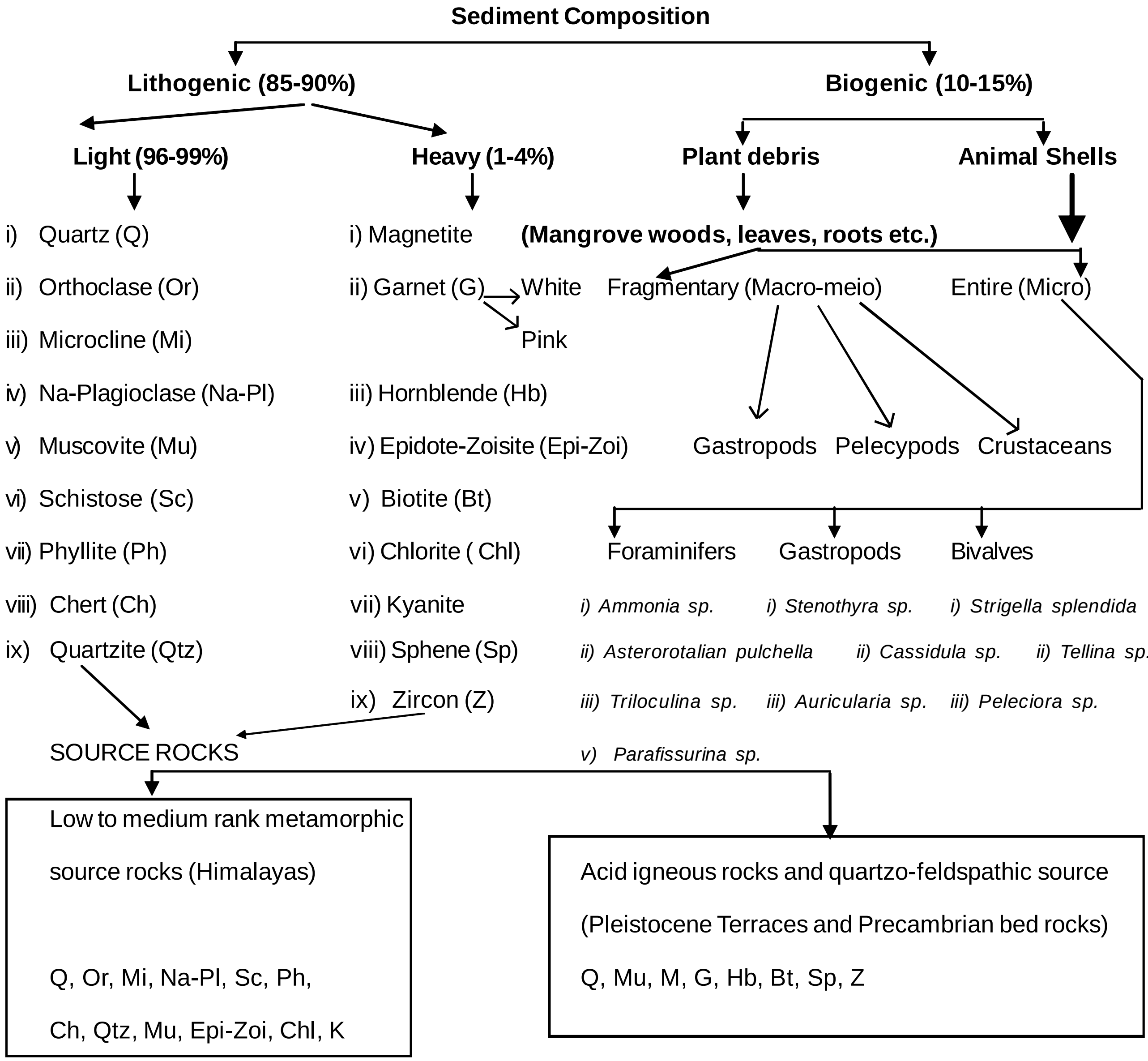


Fig 2 (Clockwise from lower left)

- Loose grains mounted in glass slide. Grains of feldspar, epidote-zoisite, chlorite, sphene and kyanite are present. Magnification : X 10
- Thin section of impregnated grains between crossed nicols. Section shows euhedral feldspar, quartz and biotite. Magnification : X 10
- Thin section of impregnated grains. Section shows several grains of orthoclase, few quartz, biotite and sphene. Magnification : X 10
- Thin section of impregnated grains. Grains of orthoclase, quartz, biotite, chlorite and hornblende are present. Magnification : X 10

The biogenic fraction of sediments is composed of both animals and plant bodies. Fragmentary macrobenthic and meiobenthic fauna as well as the entire shells of microbenthic fauna (Table 1) are important among the biogenic fractions. All these shells are made up of $CaCO_3$ and are susceptible to bioerosion. Entire shells of microbenthic bivalves, gastropods and foraminifers are quite common. The fragmentary animal shells are chiefly of macrobenthic and meiobenthic bivalves, gastropods and crustaceans. The assemblage of foraminifers like *Elphidium* sp, *Ammonia* sp, *Asterorotalian pulchella*, *Triloculina* sp and *Parafissurina* sp indicates a shallow water, moderate to low salinity environment [3].

Table 1. Components of sediment composition of the estuarine river sediments of the Sunderbans and the probable source rocks



Fresh and decomposed fragments of mangrove trunks, leaves, roots and pneumatophores are inevitably present in the sediments in variable proportions. These plant debris are generally greater in sediments in proximity to the mangrove forests. Thus the river bank and point bar samples contain great abundance of plant debris. This is well evidenced in trench sections where huge mangrove woods constitute a major component of large-scale planar tabular cross-beds. The deeper samples of mudflats associated with point bars and mid channel bars also reveal high content of humus material because of decomposition of mangrove litters.

3. Source Rock of River Sediments

The sediments of the Thakuran River are primarily derived from the sedimentary and metasedimentary rocks of the Himalayas in the north through the primary drainage systems of the Ganges and the Brahmaputra rivers. Furthermore, the sediments fed by the Pleistocene Terraces flanking the delta on all sides and the acid igneous bedrocks of the Precambrian shields of the north-west and west have significant role in the delta formation.

The association of light and heavy minerals namely quartz, sodic plagioclase, muscovite, biotite, garnet, hornblende, kyanite, epidote-zoisite, magnetite, phyllitic and quartzite rock fragments indicates a low to medium rank metamorphic source rocks of the Himalayas (Table 1). The presence of quartz, K-feldspers as microcline and orthoclase, magnetite, muscovite, biotite, hornblende, sphene and zircon (Figs 1 & 2) in the sediments refers to an acid igneous source [4] related to the Pleistocene terraces and the Precambrian shields (Table 1). The detrital quartz occurs both as single and composite grains (Polycrystalline quartz). Secondary overgrowth in quartz grains with two to three rims of inclusions suggests their derivation from sedimentary rocks of two to three cycles of sedimentation.

4. Conclusions

Mineralogically both lithogenic (85-90%) and biogenic (10-15%) components constitutes the sediments of the different geomorphic bodies of the Thakuran River. The light fractions are chiefly composed of quartz, feldspar of various types, and a few rock fragments. The detrital quartz occurs both as single and composite grains (polycrystalline quartz). Secondary overgrowth in quartz grains with two or three rims of inclusions suggest their derivation from sedimentary rocks of two to three cycles of sedimentation. Heavy minerals constitute 0.5 to 3.7%. The heavy mineral content refers to both acid igneous and metamorphic sources. The acid igneous minerals are derived chiefly from the Himalayas in the north and metamorphic mineral assemblage speaks of their derivation from the Precambrian shields of the west and northwest of the Bengal basin.

Mineral suits including both light and heavy fractions have been examined to infer the acid igneous and metamorphic provenance. The assemblage of heavy minerals refers to a major Himalayan source derivation of the sediments together with contributions from the Precambrian terrains and Pleistocene Terraces.

Mechanical fragmentation of both gastropods and bivalves indicates nearshore coastal marine environment with high energy conditions. Presence of benthic foraminiferal assemblages with comparatively smaller sizes suggest a eurihaline shallow marine environment as well as huge influx of freshwater from the Hooghly estuary in the eastern boundary of the Sunderbans. Higher population density and species diversity of the foraminifers indicate a relatively slow rate of sedimentation.

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