A NOTE ON THE SEDIMENTOLOGICAL STUDY OF GOMTI RIVER, UTTAR PRADESH, INDIA

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ABSTRACT

Sedimentological study of point bars and natural levees of Gomti river has been made. Along the river channel two well-defined raised terraces are recognized. Main type of bedding in the point bar and natural levee sediments is small ripple cross-bedding. Climbing ripples, horizontal lamination (both high-energy and low-energy), and large scale cross-bedding are also present. Scour and fill structure, erosional channels, concentration of molluscan shells in pockets and few escaping traces of molluscs are the other important features. Sediment is silty fine sand, and extremely rich in mica.

Sand and silt fractions are composed mainly of quartz, mica, plagioclase, alkali feldspars and minor amounts of heavy minerals. Clay fraction shows Illite as the main mineral with sub-ordinate amount of kaolinite, chlorite and montmorillonite; together with some quartz and feldspars. In Gomti sediments chlorite as clay mineral is unstable.

INTRODUCTION

Study of modern sediments, their depositional environments, and processes of sedimentation may lead to a better under-standing of sedimentary sequences in ancient rocks. An important geological depositional environment is fluvial environment. The alluvial tract of Indo-gangetic plain offers an unique opportunity for the study of fluvial sedimentation processes, and deposits of fluvial sediments in vertical and lateral sequences.

A research project has been initiated at the Department of Geology, Lucknow University. For the study of fluvial processes, especially the river deposits of the alluvium, study of Gomti river sediments has been first undertaken. Main reasons for the selection of Gomti river were the simplicity of the river and the approachable tract through which it flows.

The purpose of this paper is to provide some preliminary data on the sedimentary structures, grain size and mineralogy of the sediments of natural levees and point bar deposits of the Gomti river.

AREA OF INVESTIGATION AND METHODS OF STUDY

Indo-gangetic plain constitutes a vast alluvial plain between Peninsular India and the Himalayas. Since the uplift of the Himalayas this region has been filled up by sediments brought by rivers originating mainly in the Himalayas. Few rivers bring material from peninsular rocks as well. The major river in this area is the Ganga to which most other rivers are tributaries. Gomti river is also a tributary of the Ganga. River Gomti originates in the thickly vegetated alluvial tract of district Pilibhit, Uttar Pradesh and flows down to

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Udiyar Ghat, district Ghazipur, where it meets the River Ganga. Throughout its length Gomti flows through the alluvial sediments.

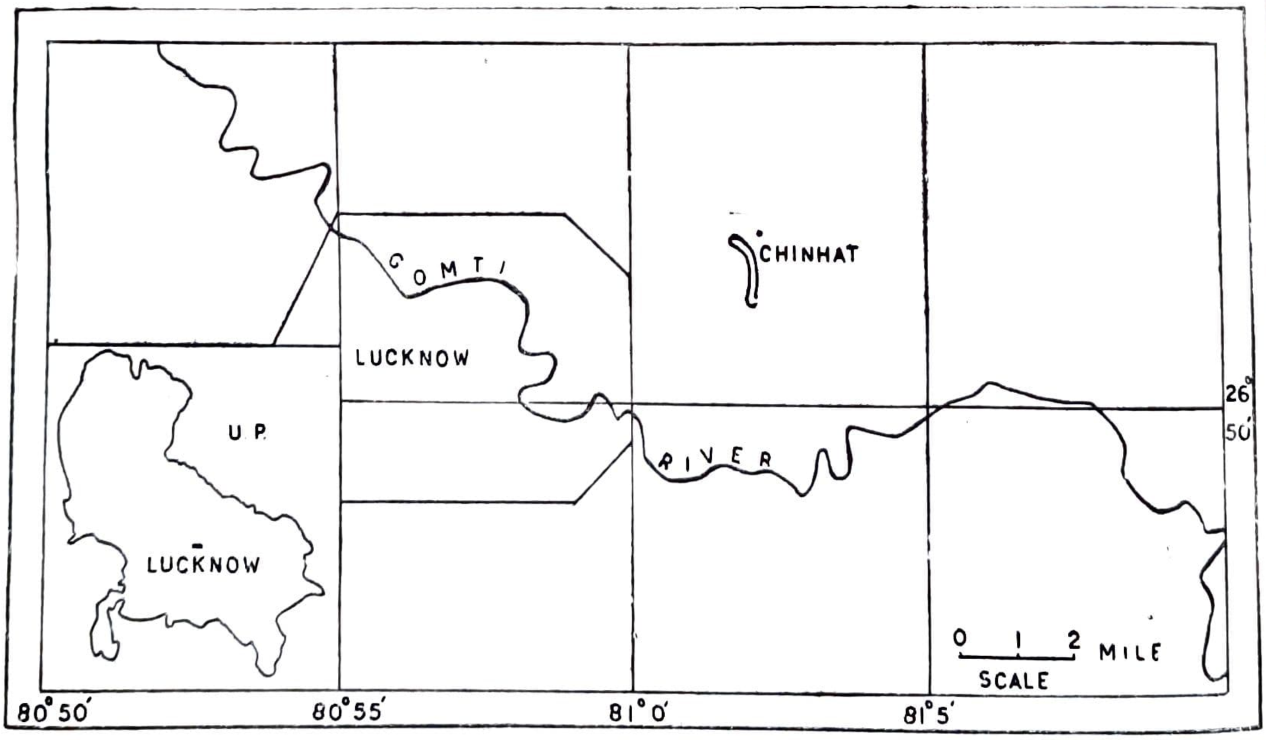
About 50 km long tract of Gomti river, in the vicinity of Lucknow, has been invest gated in detail (see location map, Text-fig. 1). The main aim of the study was to investigate the sand deposits on the point bars and naturally levees. On some of the point bars 1-2 m thick sand deposit may originate during a single flood phase. Generally, thickness of these deposits during a single flood phase is less than 1 metre.

On the point bars 50 cm or even deeper trenches were dug in order to see the primary sedimentary structures. On several point bars large sections upto a depth of 1-2 m were available, since it is quarried in large amounts. Due to high content of mica in the sediments of Gomti river, sedimentary features were clearly visible. It was not found necessary to make relief casts and lacquer peels.

Detailed notes and photographs of all the sedimentary features were made. Sediment samples were collected from each locality for grain size analysis and mineralogical studies.

Grain size analysis was carried out by sieving a dried 100 gm sand sample for 15 minutes. Following sets of sieves were used—B.S.T. Sieves No. 52, 72, 100, 120, 150, 200, and 240.

Silt and clay fractions of several samples were separated by sedimentation in Atterberg cylinders. Mineral identification was done by making x-ray diffraction diagrams of oriented samples of silt and clay fractions.



Text-fig. 1. Location map.

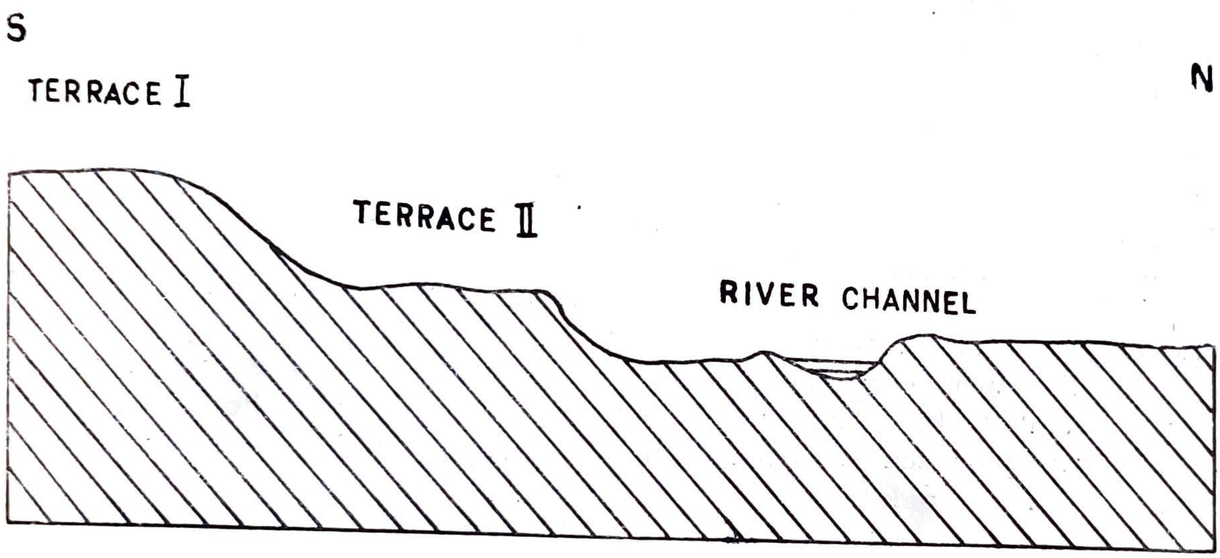
GENERAL FEATURES

In the vicinity of Lucknow, the channel of Gomti river shows well developed meanders. Natural levees are moderately developed on the channel sides. Flood basin is vastly extended Gomti river, like other rivers of this region suffers from annual floods during the months of

August-October. It is during these months of flood, sediment is deposited on natural levee, and point bars.

A striking feature along the Gomti river is development of raised river terraces. There are, at least, two elevated, well-marked terraces. These two terraces were observed all along the area of investigation. At points they are well-developed and well exposed; at the other points they are rather obliterated. A good example is offered by the location of Lucknow township itself. The locality Chowk is situated on the highest terrace; whereas the historical Imambara is located on the lower terrace. Then comes the river channel with its well developed Levees (Text-fig. 2; Pl. 2, fig. 4).

It is difficult to assign definite age to these terraces. However, we feel that movements in Pleistocene and later have helped in the formation of these terraces.



Text-fig. 2. An idealized section across Gomti river showing two well developed terraces on the southern bank. Locality—Lucknow.

PRIMARY SEDIMENTARY STRUCTURES IN POINT BARS AND NATURAL LEVEES

Detailed study of point bar and natural levees sections revealed a variety of sedimentary features. Main emphasis was laid on the study of bedding. Following are the important bedding types observed in these deposits:

(a) *Small ripple cross-beading*

This is the most common bedding in almost all the sections, and may constitute upto 80-90% of the section. Small ripple cross-bedding is produced due to migration of small ripples, and cross-laminae are the preserved foreset laminae of the small ripples. The process of ripple migration and generation of cross-bedding has been discussed by REINECK (1961) and ALLEN (1963, 1968).

Foreset laminae are well seen due to accumulation of mica flakes. Cross-bedded units are invariably trough-shaped (Pl. 1, fig 1).

(b) *Climbing ripples*

Locally, thick sequences of climbing ripples were found upto 50 cm (Pl. 1, fig. 2). Climbing ripples originate due to migration and simultaneous upbuilding of ripples. All the climbing ripples observed were of the type—ripple laminae-in-drift (McKEE, 1965).

Genetically, climbing ripples are closely related to small ripple cross-bedding. Climbing ripples are formed when suspended load/bed load ratio is very high; thus, much sediments are available from suspension resulting into upward growth of ripples. McKee (1965, 1966), Jopling and Walker (1968) have discussed the genesis and importance of climbing ripples.

(c) *Horizontal bedding*

Bedding made up of parallel beds was commonly found in sets 50 cm thick (Pl. 1, fig. 3). At places, sets of horizontal beds are only 1-2 cm thick, and interbedded with small ripple cross-bedding. Some of them were clearly generated in higher flow regime (Simons *et al.* 1965). It evidenced by the erosional contact between ripple bedded units and overlying horizontal beds.

In other cases, horizontal beds were formed at lower energy conditions, as a result of deposition from suspension due to sudden decrease in velocity and competency of the river flow (cf. Reineck & Singh, 1971).

(d) *Large scale cross-bedding*

It is rather seldom recorded and only solitary, which suggests its formation from local 'micro-deltas' and lee-faces. McKee (1957) and Jopling (1963) have discussed the generation of cross-bedded units due to migration of 'micro-deltas'.

Associated with these bedding types are small and large erosional channels, scour and fill structures. Locally, in sandy deposits mud galls were abundant.

Organic matter, coaly matter, wood-pieces and molluscan shells are generally found accumulated into pockets (Pl. 2, fig. 6). Sometimes, fluvial sorting resulted into accumulation of gastropods and lamellibranchs in different pockets. A few escaping traces of molluscs were also recorded.

Locally, small scale penecontemporaneous features were also observed. They were most likely produced as a result of expulsion of water from the rapidly deposited fluvial sediments (Pl. 2, fig. 5). On most of the natural levees sand deposits were overlain by a mud layer of variable thickness (upto 10-15 cm). The mud layer exhibited mottled structure produced most probably due to desiccation process and chemical reactions during drying. On point bars, this mud layer is either absent or only few mm thick.

GRAIN SIZE

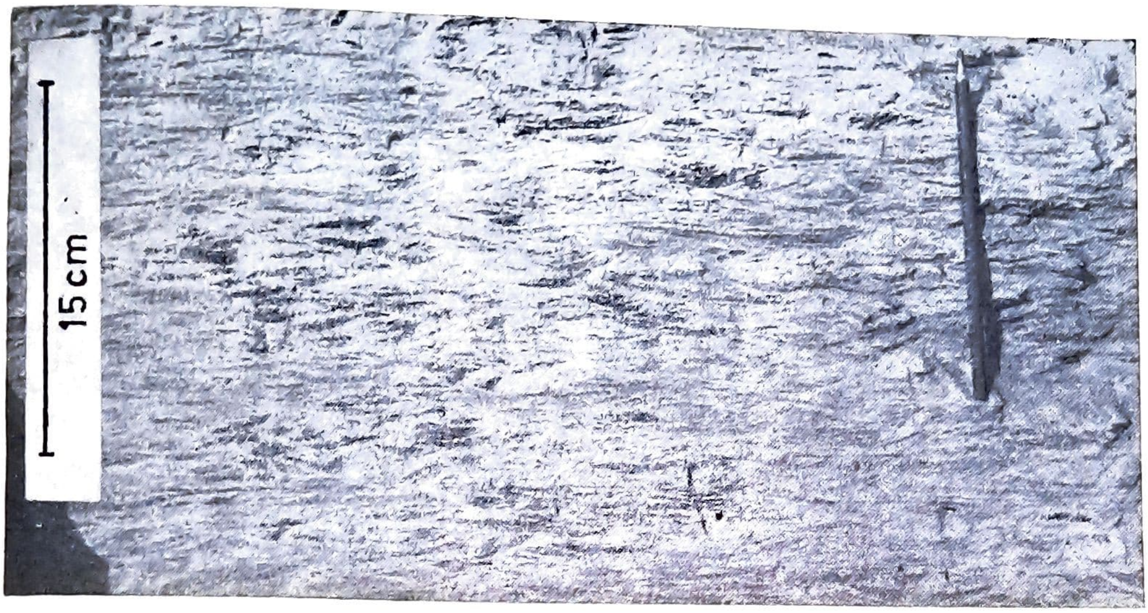
Grain size analysis of 12 samples showed that sediment is silty fine sand. Median varied from 0.056 mm to 0.160 mm. The average median is 0.10 mm. The average sorting coefficient is 1.24. For this rather small tract of river, no regional variations in grain size parameters can be suggested. Detailed work on regional variation in grain size parameters is under progress.

MINERALOGY

Only some preliminary mineralogical data is presented here.

Sand fraction is composed of mainly quartz, mica (both biotite and muscovite), and minor amounts of heavy minerals. Coarser sand fractions are composed entirely of mica flakes.

X-ray study of silt fraction showed quartz to be the dominant mineral, with appreciable amounts of plagioclases and alkali-felspars. Small amounts of mica are also present.



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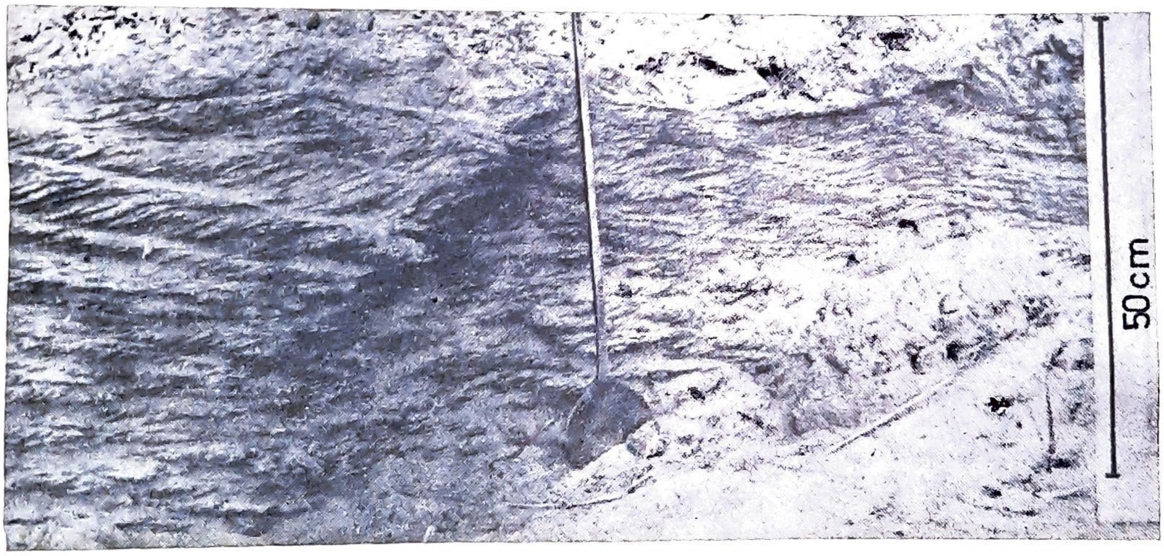

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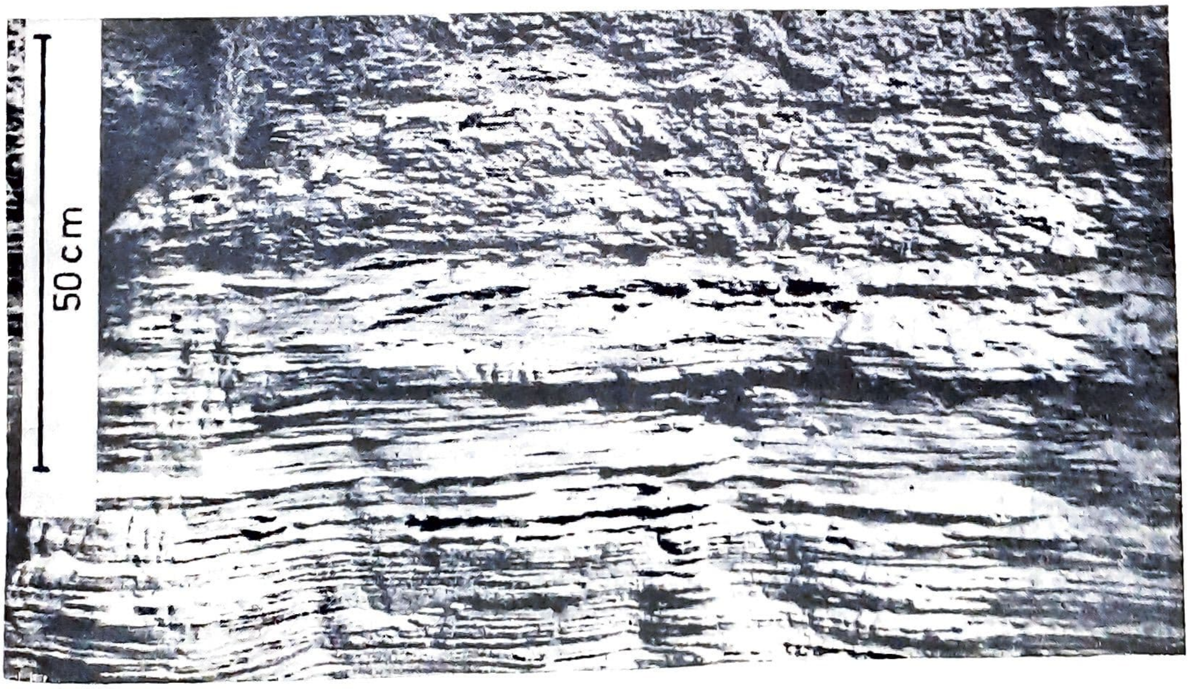

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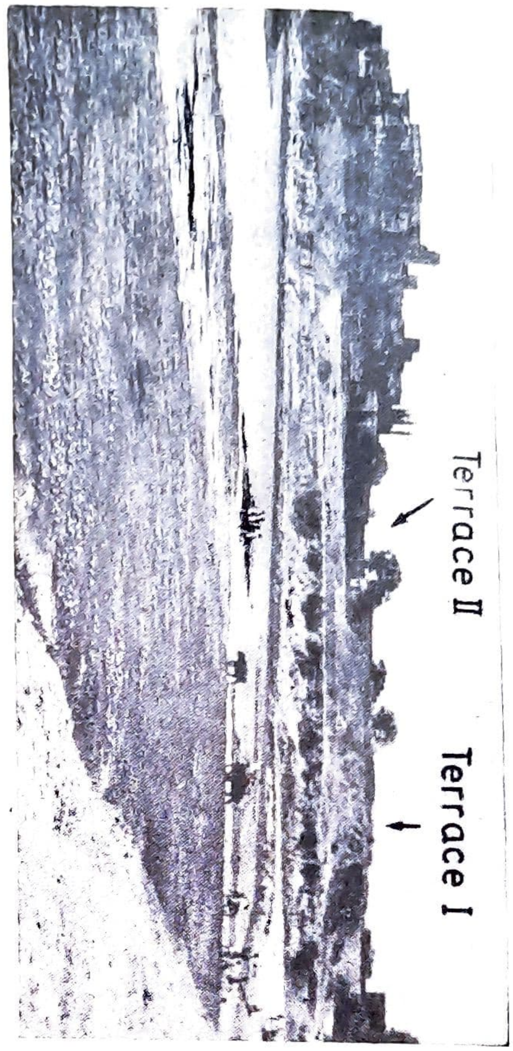

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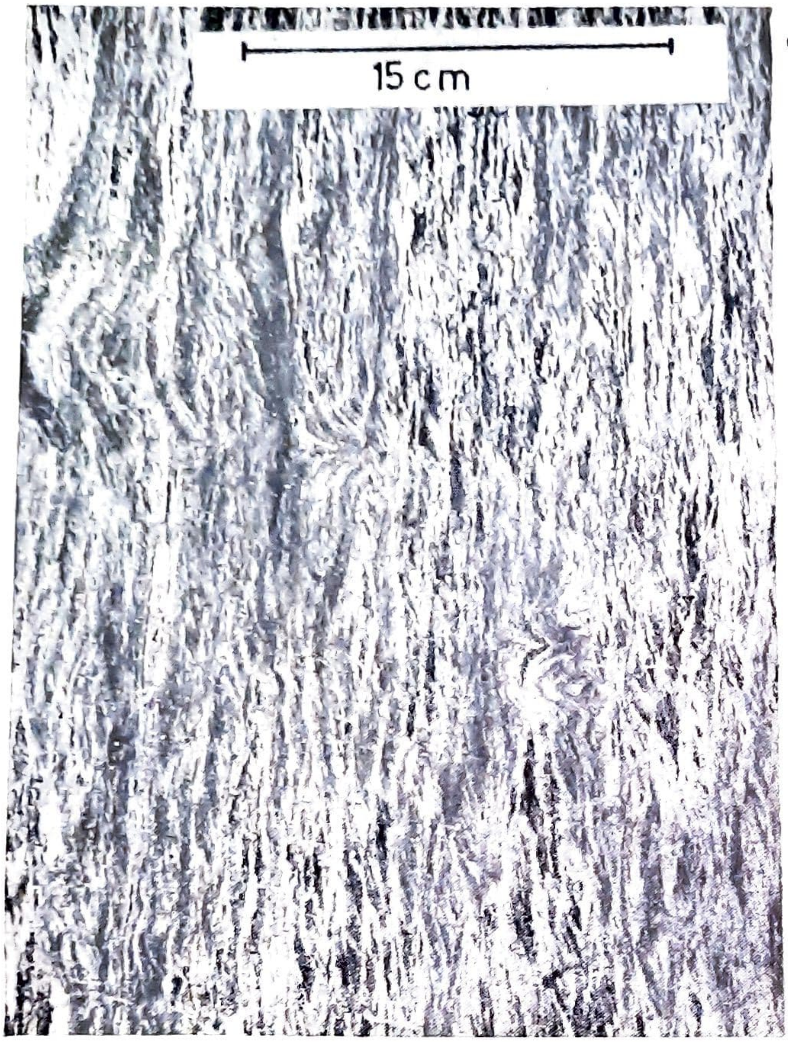

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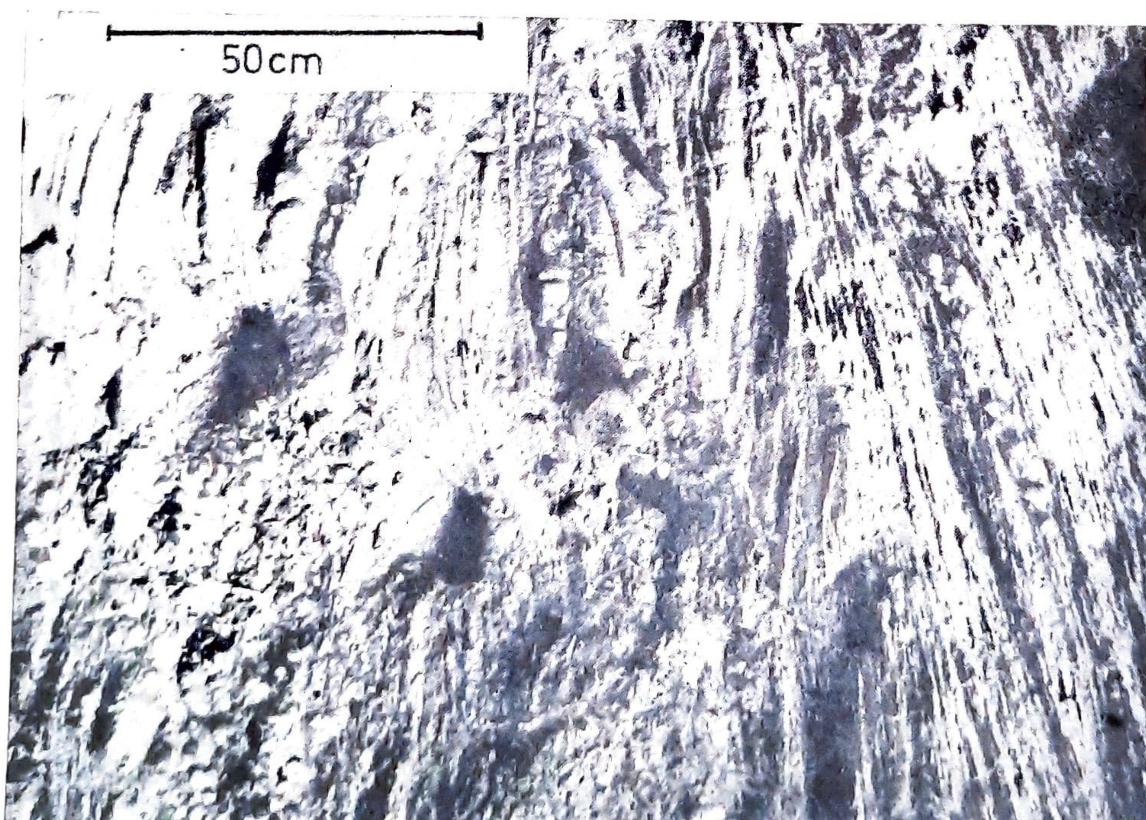

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X-ray identification of clay fraction exhibited illite as the most abundant mineral, together with some kaolinite. Minor amounts of chlorite and montmorillonite are also present. In Gomti sediments chlorite as clay mineral seems to be rather poorly crystalline and unstable. Samples heated only upto 200°C for 1 hour showed disappearance of chlorite peak at 14°A, which generally persists even after 1 hour heating at 550°C (Brown, 1961).

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EXPLANATION OF PLATES

Plate 1

1. Small ripple cross-bedding. Individual units are festoon-shaped. Direction of flow from right to left.
2. Climbing ripples of ripple laminae-in-drift type. Note the pseudobeds dipping in the upstream direction. Direction of flow from right to left.
3. Horizontal bedding. Lower part of the section shows well-developed parallel beds. In the upper part of the photo small ripple bedding is developed.

Plate 2

4. Photograph showing two terraces near Salempur. On the cut-side of the river both terraces are visible.
5. Penecontemporaneous deformation features developed in a ripple bedded sequence. These features were formed, most probably, due to expulsion of water after deposition.
6. Concentration of molluscan shells (mainly gastropods) as pockets in a channel fill deposits.