CHAPTER V

AERIAL PHOTOCHARACTERISTICS

Airphoto interpretation has now become quite an important tool in various earth science investigations as the airphotos provide very reliable data in all studies pertaining to the surface features of the earth. In the fields of geology and geomorphology, the aerial photo-interpretation not only contributes to the accuracy of the results, but it also speeds up the investigation. It is now found quite possible for an individual or a small group of workers to cover larger areas in a small duration of time, since the airphotos provide a bird's-eye view of the vast amount of terrain data of the areas studied.

Stereoscopic investigation of airphotos, thus has become an essential procedure in geological and geomorphic studies in regions of complex changes. Himalaya is a typical example of such a terrain. Ray (1960) has rightly pointed out that many terrain features are polygenetic and the interpretation of the data depends largely on a thorough understanding of the principles and processes involved. In accomplishing this, airphotos are quite useful, and the various diagnostic elements like relative photographic tone, shape and size of images, texture, pattern of drainage, land-use and vegetation, and association of features as revealed by the photographs, help much in drawing proper inferences.

Earlier, the author (1968) had the opportunity to study the aerial photographs of a large area of Kumaon Himalaya at the Indian Photointerpretation Institute. This background therefore, adequately provided the basis for a detailed aerial photo-interpretation of the Kosi basin. The author also had access to the geological data, collected by Merh and his team of workers (1963 to 1972) who have investigated the lithostratigraphic and structural problems in the study area. It was therefore possible for the author to conduct extensive airphoto studies and then

correlate his inferences with the known geologic facts to establish correlation between morphologic characteristics and the geologic framework.

The photographs studied by the author include both the Earth Resources Technology Satellite-multi-spectral sensing (ERTS), and the conventional aerial photographs.

EARTH RESOURCES TECHNOLOGY SATELLITE PHOTOGRAPHS

Two types of ERTS photographs (simultaneously taken) - one with spectral wavelength of deeper penetration which picked up topographic details without vegetation, and the other with wavelength of shallower penetration showing the forest cover also, were available for study. In all, four photographs of 1:1 million scale, of the Kumaon Himalaya and the Gangetic alluvial plain, for both the wavelengths were studied.

On the ERTS photo showing vegetation details (Plate 23) it is easier to mark the broad regional geology (Plate 24). Water features like river courses, and the areas devoid of vegetation are recognised clearly on the photo by the shades of lighter tone. River courses are obvious when they cut through the forested foot-hills, but in the inner non-forested areas their courses are

PLATE 23

ERTS photo - Kumaon Himalaya and Gangetic plain showing forestation.

ERTS photo - Kumaon Himalaya & Gangetic plain (from two photos)

Regional geologic set up

1 Alluvial plain.
2 Siwalik foot-hills.
3 Lansdowne synform.
4 Dudhatoli synform.
4a Almora crystallines.
5 Nainital synform.
6 Central crystallines.
7 Baijnath synform.

N

0 25

Km.
(approx.)

somewhat indistinct. Sharp arcuate bends in the courses of the rivers Ramganga, Kosi and Gola, when they cut through the Siwaliks, (Fig. 2) are quite distinct on the photos. Each structural unit like the synforms of Landsdowne, Dudhatoli, Almora, Naini Tal and Baijnath can also be distinctly traced. The synformal structure is discernible by the alternate dark and light tone of the different stratigraphic horizons. The structures in the Siwalik foot-hill rocks are masked by the dense forests. The wavy erosional contact of the foot-hills with the piedmont alluvial plain (coalesced fans) is very typical, and the individual fans at the mouth of the rivers Kosi and Gola are clearly recognised by their shapes and lighter tone.

The ERTS photo of the same region - without any vegetation, does not clearly reveal the regional geologic structures (Plate 25). However, in the zones of Siwalik foot-hills, the anticlines west of Ramganga and east of Kosi rivers, can be recognised. These structural features are not seen in the previous photographs being masked by vegetation. The water features like the river courses and lakes show a dark shade, and even small lakes like Naini Tal and Bhim Tal, along the northern divide of Gola river are easily spotted. Individual river courses can be

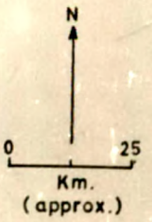
PLATE 25

ERTS photo - Kumaon Himalaya and Gangetic plain without vegetation.

ERTS photo-Kumaon Himalaya & Gangetic plain (from two photos)

Remote sensing (MSS)

Shows dark tone water features and topography without vegetation



completely traced. The topography is better depicted on this photo due to light and shade effect on the drainage divides.

CONVENTIONAL AERIAL PHOTOGRAPHS - UNCONTROLLED MOSAICS

The aerial photographs studied were taken by an Eagle IX Mark II camera of 15 cm (6") focal length, from two different altitudes i.e. 11600 and 5500 metres. The small scale 1:70,000 photos cover the entire basin areas and the photos of 1:33,000 scale cover areas of Siwalik foot-hills only. The quality of 1:70,000 scale photos was reasonably good while that of 1:33000 scale photos was excellent. Uncontrolled photomosaic of 1:70000 scale photos (Plate 26), and the same with annotated regional geology (Plate 27) were prepared. The uncontrolled mosaic of Kosi drainage, downstream from Basela was reproduced from 1:33000 photographs (Plate 28). This covers the river course mainly through Siwalik foot-hills and a fringe of Pre-Siwalik rocks. The annotated mosaic of this part shows the major morphogenetic units (Plate 29).

During the study of individual photographs under the mirror stereoscope, similar litho-associations and lineaments were frequently observed. During field checks

these were ~~checked and~~ verified and the inferences drawn were found to be reliable. As a consequence, photocharacteristics and guiding photo-expressions for each lithostratigraphic zone and tectonic lineament were formulated (Table 12), to provide 'Keys'. These 'Keys' with certain reservations, could be utilised to provide some basis of analogy and broad groups, reflecting the morphologic details vis-a-vis rock competency and erosional potential. However, these cannot be universally applied for predicting geology in unknown Himalayan areas, since the geologic and morphologic set-up considerably varies from one part to the other in the Himalayas.

Photocharacteristic on Uncontrolled Mosaics

A close examination of the uncontrolled photo-mosaic of the whole drainage basin of Kosi river (Plates 26 and 27) reveals the following tectonic lineaments and litho-associations.

1. Area Someshwar: A white toned linear patch along a tributary valley (Sim gad) with a bend near Someshwar and its further continuation in the ESE direction reveals a well defined tectonic lineament (North Almora fault). The strike ridges north of this lineament show NE-SW

PLATE 26

Kosi drainage basin - Uncontrolled aerial photomosaic

KOSI DRAINAGE BASIN

(uncontrolled aerial photomosaic)

PLATE. 26

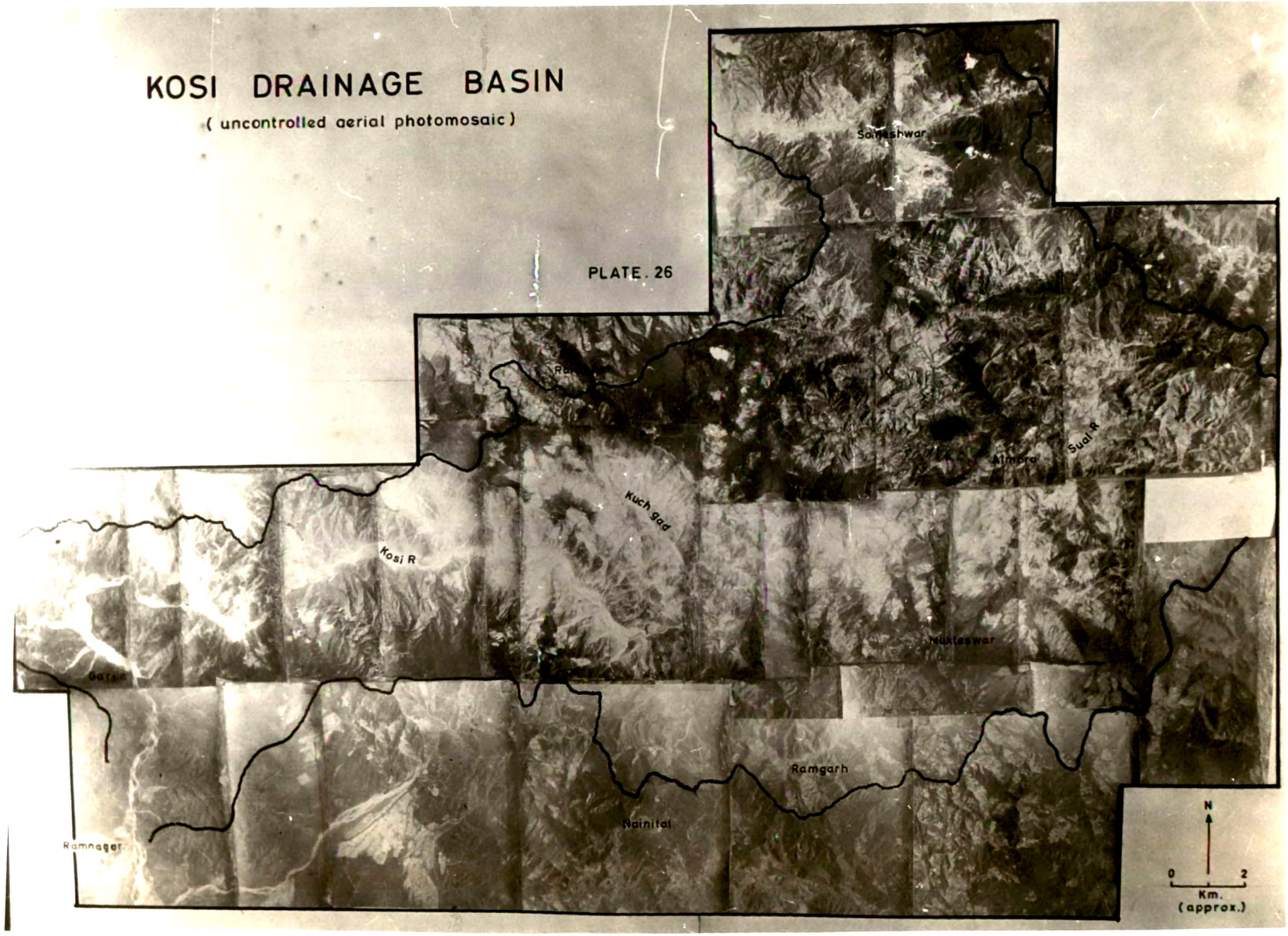


PLATE 27

Kosi drainage basin - Uncontrolled aerial photo-mosaic Geology.

KOSI DRAINAGE BASIN

(uncontrolled aerial photomosaic)

Geology

L E G E N D

Alluvium

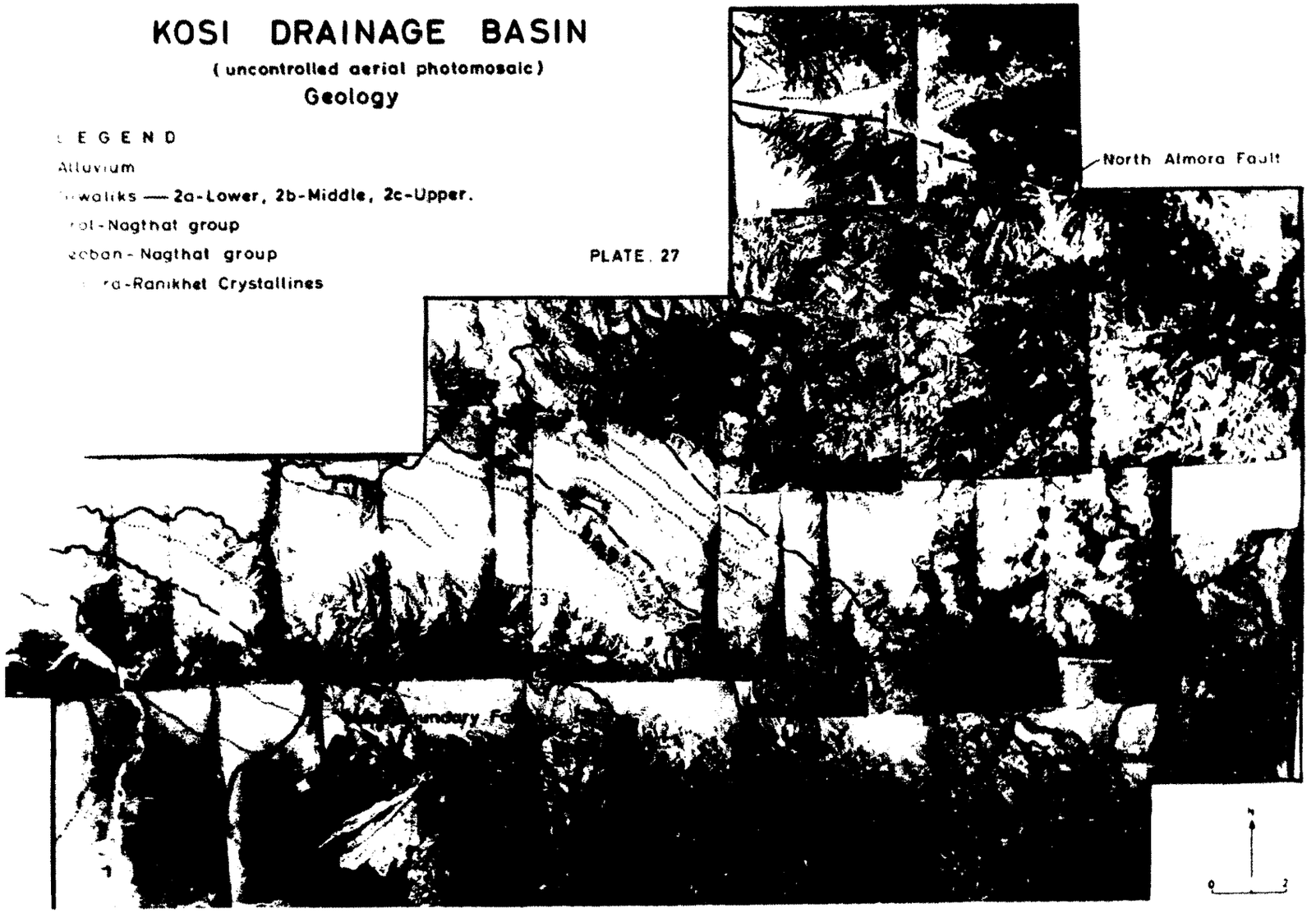
...walikis — 2a-Lower, 2b-Middle, 2c-Upper.

...ol-Nagthat group

...eoban - Nagthat group

...ra-Ranikhet Crystallines

PLATE. 27



trend, and the parallelism of ridges and valleys is indicative of metasedimentary strata. The major drainage divides south of this alignment trend WNW-ESE.

2. Area Almora-Mukteswar: To the south of this North Almora tectonic lineament, in the region upto Almora, the ridges are oriented in WNW-ESE direction and show following lithologic differentiation based on photo-expression:

(a) Zone of fine photo-texture and dark tone ridges (coarse gneisses).
(b) Zone of alternate light and dark tone thin bands (gneisses with quartzite bands)
(c) Zone of fine photo-texture and dark tone ridges (coarse gneisses).
(d) A narrow light tone zone, devoid of vegetation (crushed rocks, mainly schists).
(e) A zone of alternate light and dark tone thin bands (gneisses with quartzites).

There is thus, on either side of a narrow light tone, zone with identical expression on both sides of the photographs, which is indicative of a broad fold structure. The zone of alternate dark and light tone thin bands is suggestive of layers of hard metasediments. Isolated ridges north and

northwest of Almora (within gneisses locally known as Kalimat and Dyolikhet ridges) are arcuate in shape and stand out prominently in topography.

In the area south of Almora, upto Mukteswar the ridge trend becomes NW-SE.

3. Area SW of Ranikhet-Mukteswar: The characteristic photo-expression in this zone is the alignment of parallel strike ridges in NW-SE direction, marked by a topographic high and a sudden parallelism of small drainage channels on the upper steep slopes. This zone comprises a different lithology than the rocks of the Almora-Mukteswar area, and indicates hard sedimentary strata. On the mosaic, the junction between these two litho-associations is not as clearly expressed as is done by the North Almora fault. The sudden starting of strike ridges is the only indication of a dislocation, viz (South Almora thrust).

In this zone, further west, the parallelism of major ridges continue. A prominent ridge forms the right bank divide of Kuch gad, with light tone areas on both sides. Area further west is dark toned due to forestation. The photo-expression is indicative of the metasediments forming the ridges.

The Kosi river, before its bend through the foot-hills, follows a northwesterly course for a long distance, and during this a tributary joins it in the same alignment. All the drainage from the northern divide terminates also along this alignment. All this indicates a well defined tectonic trace (Main Boundary fault) and strike ridges to its south lose appreciable heights.

4. Areas S of Kosi-bend: It is a forested area and the geological details are masked to some extent. The ridges are closely spaced, parallel, and show a NW-SE trend revealing a sedimentary sequence of mainly sandstones.

The uncontrolled photomosaic of Kosi river downstream from Basela being of larger scale and good quality, reveals a clearer expression of lithologic variations and river deposits (Plates 28 and 29). The Main Boundary fault is well defined. The drainage from the northern Pre-Siwaliks gets suddenly reduced and terminate along or follow this tectonic trace. Within the Siwaliks, the rocks south of Garjia form very sharp and crested ridges in contrast to the ridges north of it. These crested ridges belong to Middle Siwaliks and consi

PLATE 29

Kosi drainage - Downstream from Basela
uncontrolled aerial photomosaic
Morphogenetic units.

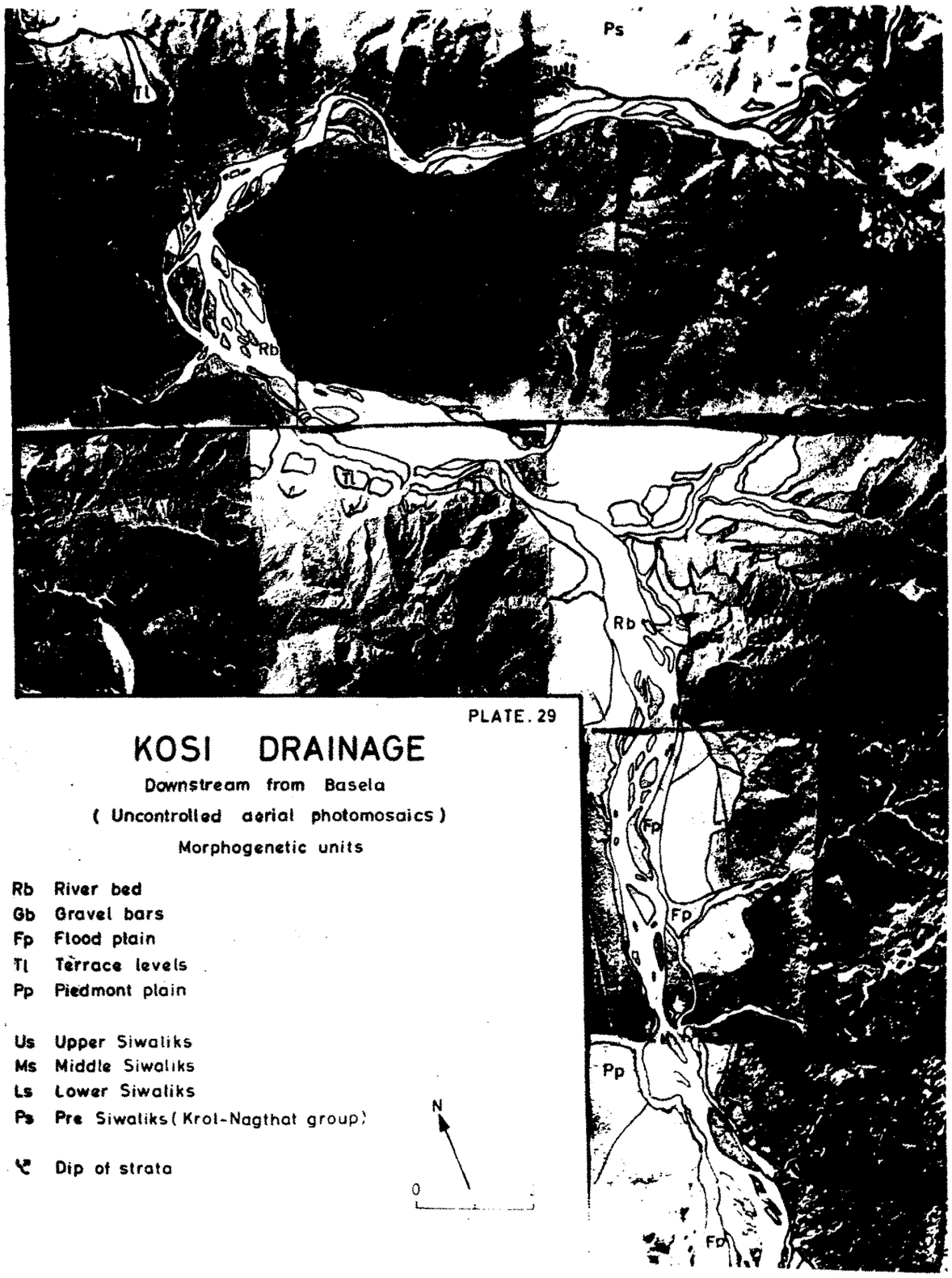


PLATE. 29

KOSI DRAINAGE

Downstream from Basela

(Uncontrolled aerial photomosaics)

Morphogenetic units

Rb River bed
Gb Gravel bars
Fp Flood plain
Tl Terrace levels
Pp Piedmont plain

Us Upper Siwaliks
Ms Middle Siwaliks
Ls Lower Siwaliks
Ps Pre Siwaliks (Krol-Nagthat group)

Dip of strata

N

0

The river has deposited a number of terrace along its course.

Stereoscopic Study

Vaidyanadhan (1973) in his 'Index to seventy aerial stereopairs illustrating the physiographic features of India', has mentioned features like antiforms, synforms, thrusts, faults controlling drainage, fracture lines, ridge and valley topography, hogbacks, dendritic drainage, river terraces, channel bars, landslides etc., in other parts of the Lesser Himalaya. Many of these features have been recorded in the study area also by the present author and they have been annotated on the stereopairs.

The author has prepared representative annotated stereopairs (Plates 30 to 36) pertaining to each zone of litho-association and for different terrace deposits. These stereopairs can be viewed with an ordinary lens-type pocket stereoscope.

The terrace deposits occur at different elevations (referred to as levels). On aerial photos, these are observed as distinct steps one below the other. Their surfaces are flat and show a tight grey tone, separated

from the next level by a nearly vertical face (terrace slope). These vertical faces are seen as medium to dark grey sharp lines on the photo. Five to seven terraces are observed at various sections in the down-stream portion of Kosi. Besides these, the other river deposits include the flood-plains, gravel bars, and dry beds. The dry river bed are the white, flood plain are of light grey tone, and the gravel bar show medium to dark grey tone due to riverine vegetation.

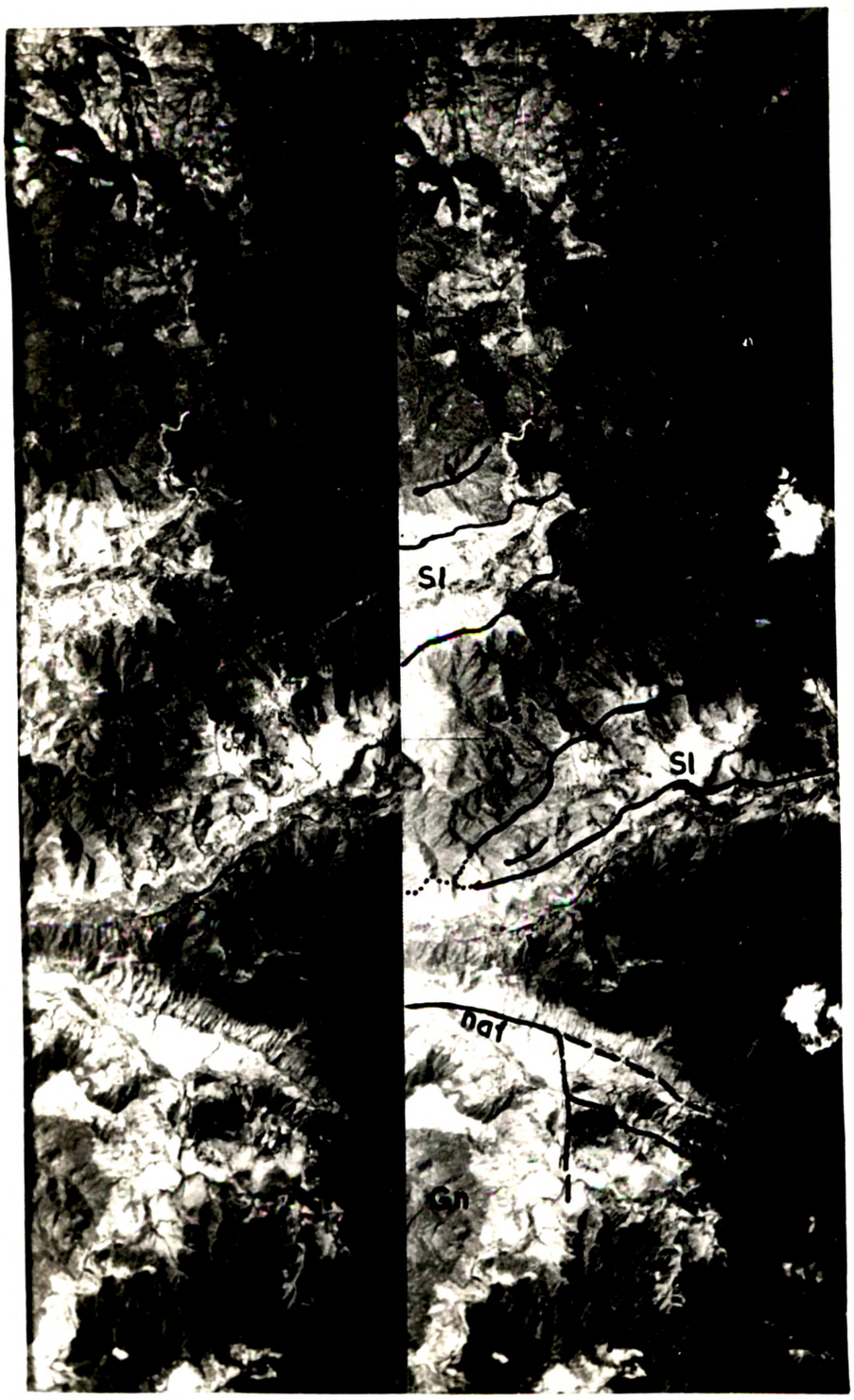
As compared to mosaics, the stereoscopic examination of the individual aerial photos gives wealth of information. Due to vertical exaggeration, the geological and structural details in particular, become quite distinct which in the field studies are likely to be overlooked.

Estimation of dips was done using the 'Slope Conversion Chart' of Ray (1960).

PLATE 30

Stereoscopic pair - Zone of Nagthat-Deoban metasediments.

Stereoscopic pair : Zone of Nagthat – Deoban metasediments.



Qs mainly schists

Q quartzites an slates

Lst limestones - (compact)

Gn gneisses

naf north Almora fault

Sl mainly slates

0 2

Km. (approx)

strike ridges of quartzites, limestone forming low broken ridge and clear expression of the fault.

PLATE 31

Stereoscopic pair - Zone of Almora Crystallines.

PLATE. 31

Stereoscopic pair : Zone of Almora Crystallines

Cs crumpled schists
Gnc compact gneisses
Gnq gneisses with quartzite bands
synformal axis

N

0 2

Km.
(approx)

subdued topography, compact gneisses stand out as sharp crested strike ridges and crumpled schists form low undulating ground; river entrenched

PLATE 32

Stereoscopic pair - Zone of Krol-Nagthat metasediments.

Stereoscopic pair : Zone of Krol ~ Nagthat metasediments.

Gn gneisses
Ph phyllonite
Q quartzite
Sl Slates
sat south Almora thrust
F fault
T Terrace

0
Km. (approx)

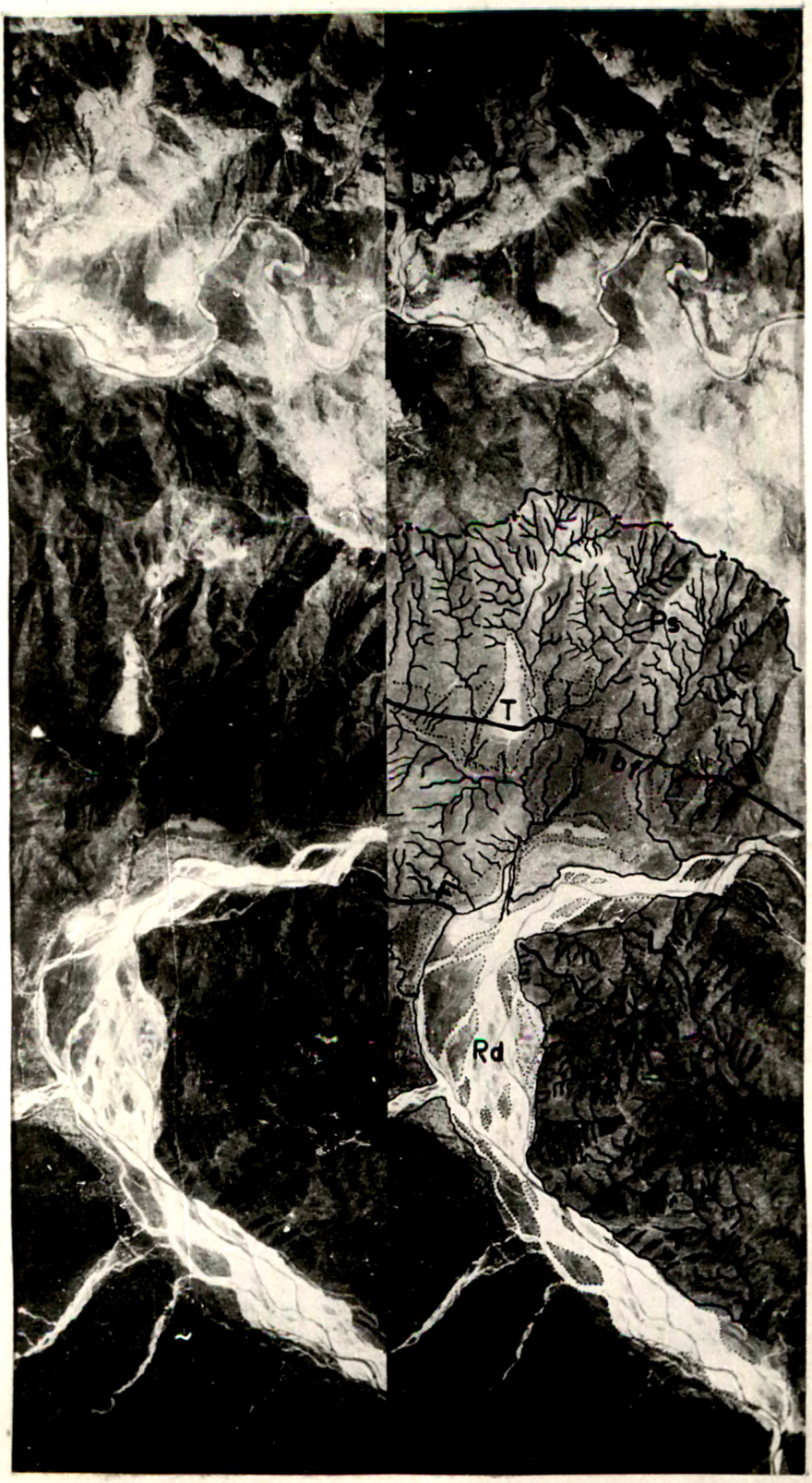
High relief strike ridges of quartzites, high density parallel drainage on the scarp slope, thrust contact inferred by stratigraphic reasoning. Five terrace levels near the confluence

PLATE 33

Stereoscopic pair - Siwalik sediments.

PLATE.33

Stereoscopic pair : Zone of Siwalik sediments



Ps Pre siwaliks

Ls Lower Siwalik

Us Upper Siwalik

mbf Main Boundary fault

F fault

T terrace

Rd river deposits

0 2

Km.
(approx)

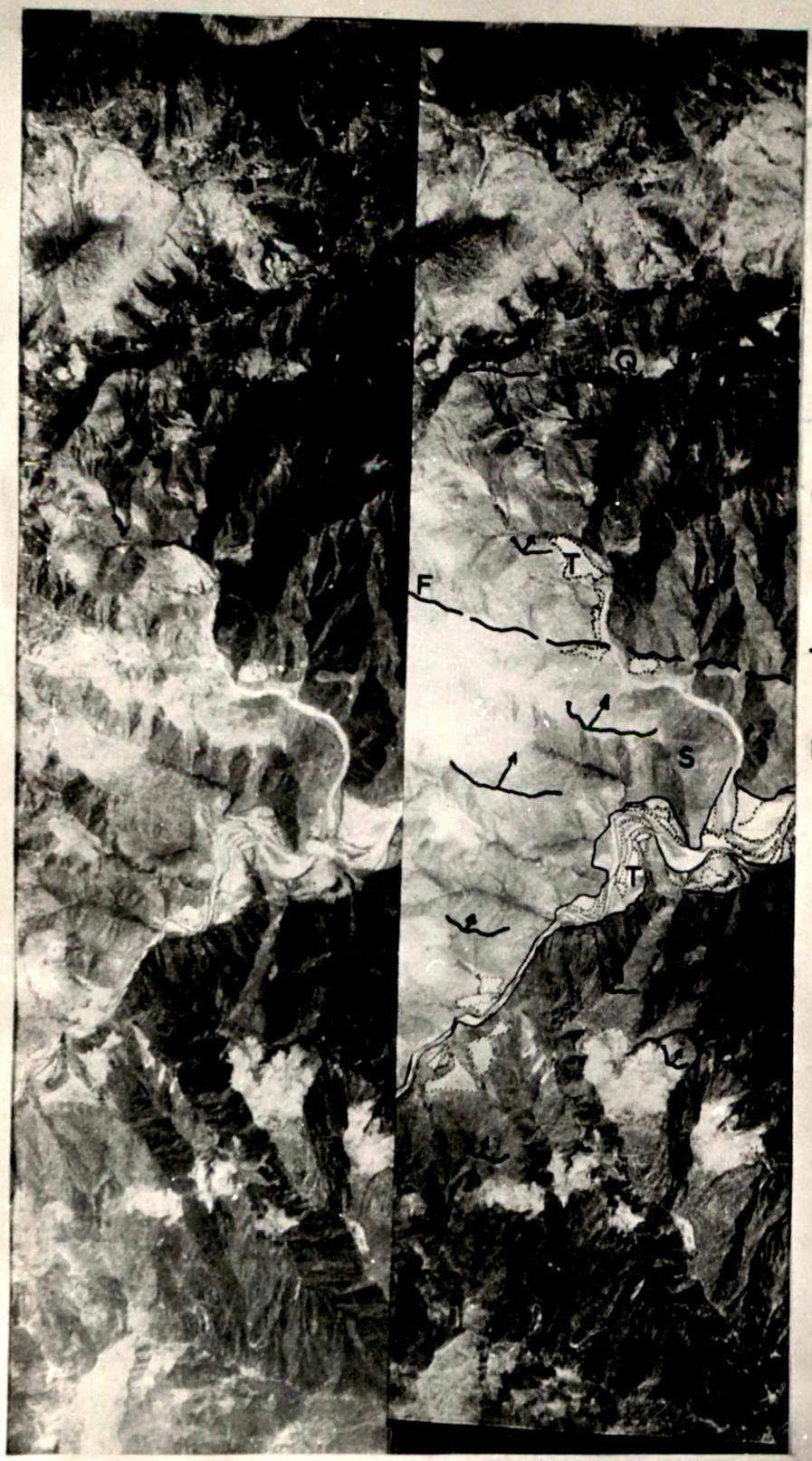
Low hill ridges, sharply crested, asymmetric, with regular dip slopes and forested. Wide river bed and terrace deposits.

PLATE 34

Stereosopic pair - River terraces
Krol' zone

PLATE. 34

Stereoscopic pair : River terraces
Krol Zone



Q Mainly quartzites

S Shales and quartzites

T Terraces

F Fault

N

0 2

Km.

(approx)

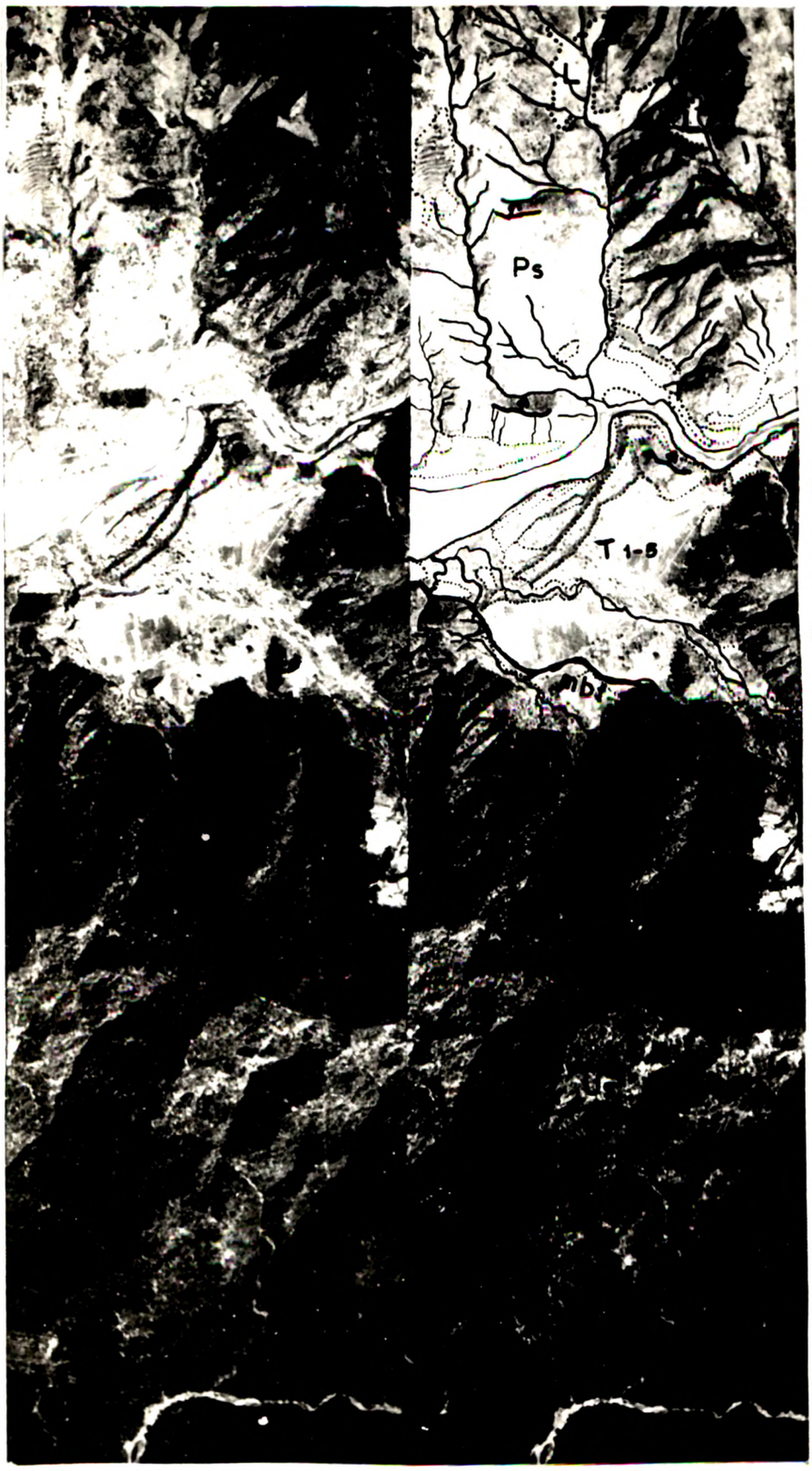
River cuts across the regional strike. Seven terraces along the left bank. Regular dip-slopes in shales and quartzites. Massive quartzite ridges sharply crested and having high relative relief and stream frequency.

PLATE 35

Stereoscopic pair - River terraces
Krol and Siwalik zone

Stereoscopic pair : River terraces

Krol and Siwalik Zones



Ps Pre siwaliks

Ls Lower siwaliks

Us Upper siwaliks

mbf Main Boundary fault

T Terraces

L Land slide area

N

0 1

Km.
(approx)

Five terrace levels to the north of Main Boundary fault.
Regular dip slopes in crested asymmetrical Siwalik strike ridges

PLATE 36

Stereoscopic pair - River terraces
Siwalik zone.

Stereoscopic pair : River terraces
Siwalik zone

Ps Pre siwaliks
Ls Lower siwaliks
Us Upper siwaliks

mbf Main Boundary fault

T terraces

Rb river deposit (flood plain, gravel bar)

L landslide area

N

0 1

Km (approx)

Four terraces along the left bank of river, south of the Main Boundary fault. The oldest terrace occupies abrupt high position on the Siwalik strata