CHAPTER X

Geomorphological Mapping

GEOMORPHOLOGICAL MAPPING OF THE MAYURBHANJ UPLAND

Geomorphology as a scientific discipline aims at describing and explaining the landforms on the surface of the earth. Before the end of the Second World War the description of a landform or a group of landforms and their explanation was done mostly through written reports without any visual representation with symbols. As such, comparison between work done in different countries of the world was extremely difficult particularly because of the absence of a precisely defined terminology (Fairbridge, 1968). The first geomorphological map of some use though was published as early as 1914 by S. Passarge, it is surprising that no other map of some help to geomorphological explanation was published before the end of the Second World War. Then demand came from different scientific bodies of agronomists, engineers, planners and others for more precise landform maps and the geomorphologists got interested in preparing maps with convenient and understandable symbols to illustrate their otherwise descriptive reports. The main purpose of geomorphological maps is the graphic representation of the landforms of an area indicating the explanation of its causes of formation so that its landforms may be compared with landforms of other areas and also used for planning of the area for landuse and other purposes.

At the beginning of the second half of the present century researches were carried out on geomorphological mapping systems in various European countries like France (Tricart, 1965), Poland (Klimaszewski, 1963) and the U.S.S.R. (Baszenina, 1960). But the legends for representation of different landforms as prepared by them differ so much from one another that it was felt necessary to form a Commission for standardisation of the legends. It was mainly for this purpose that the Sub-Commission on Geomorphological Mapping was formed at the meeting of the International Geographical Union held at Stockholm in 1960. But the geomorphic features as well as their various causes of evolution vary so widely from place to place that it has not been possible so far to standardise the legends prepared by the geomorphologists of different countries. Here follows a brief description of the methods followed by some of the pioneering countries in the field of geomorphological mapping :

Polish Legend :

The geomorphological maps produced in early fifties by the Geomorphological Survey of Poland are probably the most attrative and the easiest to read of any existing set of maps. The Poles were among the first to realize the great potential of geomorphological mapping in the field of applied geography. Since the beginning of the fifties the Geomorphological Section in the Division of Geography, Polish Academy of Sciences kept close contact with the Regional Planners in order to produce geomorphological maps for facilitating planned development of various parts of their country. The most interesting feature of the Polish maps is that the colours used in the maps make it possible to distinguish three periods : Neogene (Late Tertiary), Pleistocene and Holocene and also three slope values. Prominent features like ridges, summits etc., are shown in black. The erosional and depositional forms of Pleistocene are shown in orange and green respectively while those of Holocene are shown in red and blue respectively. The problems with Polish maps is that they do not give any structural or lithologic information and,as a result,the origin of such features remain unknown in most cases ; moreover, they become useless when reproduced in black and white.

Russian Legend :

The Russian maps are mostly produced at scales from 1:25,000 to 1:50,000. They are much more elaborate than those of French or Polish. More than 500 forms are included in the Russian legend for geomorphological mapping. The items are divided into two major groups : single forms and Families of forms. Single forms include features like volcanic cones, individual erosional features of glacial erosion such as matterhorns, cirque, arete, nunatack etc., depositional features of glacial origin like eskers, moraines, etc. These are shown by symbols whose colours indicate the origin. The families of forms are represented by a wide variety of shades while the pattern in which the colour is printed indicated the ages of these forms. The symbols in colour are printed on such colours that indicate family of forms. Superimposition of one colour on another sometimes makes the map confusing, though bright and colourful. Moreover, they do not represent any slope data which is a serious drawback no doubt.

French Legend :

In December 1962, an International Symposium was held in Strasbourg (which was incidentally attended by the present author who was then working on geomorphology under the guidance of Professor Jean Tricart, Directeur, Centre de Geographie Appliquee, Universite de Strasbourg) in order to standardise the geomorphological map legend prepared by different countries of the world. Prof. Tricart presented at the Conference a legend containing 265 symbols and six pages of explanatory text along with five sample maps : two at 1:25,000. Tricart used colours for representing lithology and symbols for different landforms which were overprinted on lithologic colours. The colours of the symbols indicate the age of the forms. The maps were quite satisfactory but confusions arose because of the contrasting colours of the lithology and symbols which were superimposed, often giving rise to altogether different colours.

Other Legends :

In addition to the above legends there are several others

Such as Czechoslovakian, Belgian, Canadian etc. But as has already been stated, standardisation of these legends proposed and used by different scientific institutions of different countries have not yet been done.

Detailed discussions of these legends will not be of much use at this stage. All of them have some merits which deserve recognition ; but the author is of the opinion that the Polish legend, though attractive and easier to read, is not as systematic as the French legend. Besides, the French legend has been designed to cover more explanatory depiction than the Polish or any other legend. It is for this reason and more so owing to the simple character in depicting a varieties of complex landforms that the author has adopted the French legend in his present geomorphological mapping of the Mayurbhanj Upland. The choice of the area for this purpose has been discussed earlier in Chapter I.

Geomorphological Mapping Of The Jamuna Basin Around Gurguria :

In the first place, an attempt was made to map a small area in considerable details around a conveniently selected village, Gurguria (21°53'N, 86°15'E) located in the Jamuna Nala basin in the west-central part of the Mayurbhanj Upland. It covers an area of about 14 km^2 on the Jamuna Nala, a tributary to the Khairi river. The preliminary choice of the place was due to the observation that the area contained a variety of geomorphic features of interest such as a rim-like ridge composed of basalt which almost surrounds the study area, dykes forming parallel ridges, foot-hill zones of convex slope made up of talus deposits, and undulating plains with lateritic uplands and small isolated hillocks along with a river valley passing through them. In addition to these the area contained one of the largest villages which fact made it more interesting and attractive than some other similar areas having similar geomorphic environment. Moreover, the area lies on the main route, rather the most developed and frequently used route, in the area which links Jashipur, the most important township on the western side, with Nawana, the centrally located village in the interior of the Upland, giving an additional advantage to the study of the area.

Methodology :

The area to be mapped was first located on the Topographical Map (No.73K/5) prepared by the Survey of India. An outline map was prepared on which the boundary and alignment of streams were marked. Plane Table, Prismatic Compass, Abney's Level, Esray Compass, Chain and Tape were used in the survey work. During ground traverse the pre-plotted features were checked and re-adjustments were made wherever necessary.

Next, the location and extent of various topographical features having geomorphic significance as surveyed during field traverse were plotted on the map. The following topographical features were identified in the area which are geomorphologically significant. (1) Basaltic Rim, (2) Colluvial Zone, (3) Dissected Older Alluvium, (4) Lateritic Upland, (5) Dyke Ridges, (6) Alluvial Flats (Fig. 10.1)

Construction of the Geomorphological Map :

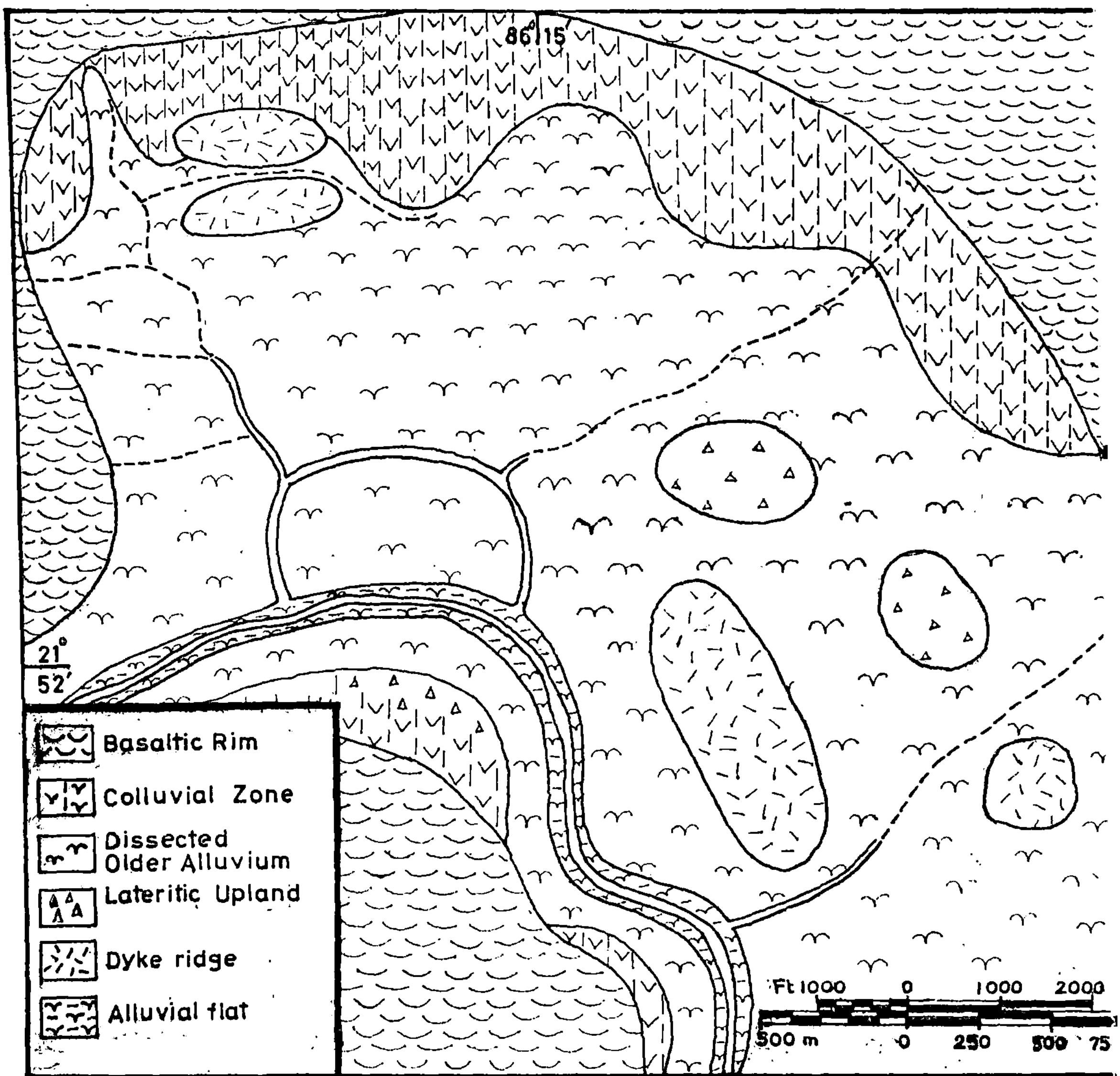
The topographical units thus identified were then studied considering their geomorphic significance such as relation to the underlying structure and lithology, nature of top soil, slope, geomorphic process or processes operating in the area etc. On the basis of the above information, necessary inferences were drawn regarding the nature of the landform features and their probable mode of origin. The geomorphological units were recognised accordingly and proper symbols were selected following Tricart and others. The geomorphological map was then prepared using those selected symbols on a scale 1:25,000.

The following relationships were established before identifying the geomorphological units for the selection of appropriate symbols :

TABLE XIX

Geomorphological Units

Topographical Unit	Structure/ Lithology	Soil Cover	Process	Geomorphological Unit
1. Surrounding Hill Range	Basalt (Top Band of Volcanics)	Thin	-	Basaltic Rim.
2. Foot-hill Zone	Coarse colluvium derived from basaltic rim	Coarse	Gravity transfer, Mass wasting	Colluvial Zone
3. Undulating Plains	Older Alluvium and Slope wash deposits	Coarse to medium older alluvium	Fluvial channel and sheet wash erosion	Dissected Older Alluvium
4. Isolated Hillocks	Laterite on decomposed basalt	Ferrugenous with concretion nodules	Sheet wash & chemical weathering	Lateritic Upland
5. Linear Ridges	Dolerite dykes	Bare rock	Fluvial erosion	Dyke ridges
6. River Valleys	Alluvium on basalt base rock	Fine alluvium with other fluvial deposits	Fluvial deposition	Alluvial Flats



Geomorphological Map of the Gurguria Area

Analysis of the Geomorphological Units Revealed By the Map :

An analysis of the nature of the geomorphological units identified and mapped in the area is given below :

1. **Basaltic Rim** : The Hill Range forms a rim around the area like a boundary wall. It is almost continuous except where the Jamuna Nala enters and again where it leaves the mapped area. Smaller channels have dissected the northern section of it. The rim is made up of basaltic rocks belonging to the Top Band of Volcanics as stated by Iyengar (1964). The slope is usually above 25°. The lower part is covered by dense forest while the top surface often shows exposure of barren rocks disintegrated into blocks.

2. **Colluvial Zone** : This is a zone of transition between the hills and the plains. It has a gentle, moderately convex to straight slope separating the hills from the plains. It is not a continuous zone because small streams have dissected it at several places. The width is also variable. The top soil consists of ferrugenous materials of coarser character derived from the adjacent hill-stopes associated with fragments of basalt derived from the same sources. The top soil is of lateritic nature and granules and nodules are also quite common. This zone of accumulation owes its origin to the transfer of the weathered materials mainly under the force of gravity from the adjacent steep-sided hills. In fact, the talus deposits have covered the original bed-rock surface at the foot-hill zone and gradual

weathering and soil creep have further modified the initial steepness of these scree or talus slopes. The angle of slope varies from 15° to 25°.

3. Dissected Older Alluvium : This covers the major part of the mapped area. The Jamuna Nala, a tributary to the Khairi river is the major line controlling the alignment of this feature. Minor tongue-like extensions are found to run upward across the foot-hill zone following the course of the small tributaries of the Jamuna Nala. The surface of the plain is undulating in nature, the slope angle never exceeding 10° and lying mostly between 2° and 7°. The plain slopes down towards the Jamuna Nala and also towards the minor tributaries which dissect this zone in several segments. Initially the zone of the plains must have been a degradational feature carved out of the basaltic surface made up of "Top Band of Volcanics". At present the plain is composed of alluvium of Pleistocene age which peeps through a thin veneer of recent alluvium. The materials in general are of coarse to medium texture but the recent alluvium is of finer texture. The surface as a whole represents an aggradational plain of fluvial origin.

4. Lateritic Upland : Two small isolated hillocks of somewhat domal form and gentle but slightly convex slope have been mapped in the area. The surface is lateritic in character which has developed on decomposed basalt. The top soil is dominated by lateritic granules and nodules with ferrugenous concretions. Channel formation is minimum in the area

because of the coarse texture of the soil. As a result, sheet wash plays a dominant role in moulding the topography of the area. At the same time lack of vegetation allows soil creep and granules and nodules are found scattered all over the adjacent peripheral plain. The surface slope varies from 10° to 15°. The location of the hillocks on the micro-interfluves of the small tributaries of the Jamuna Nala points to their denudational origin.

5. Dyke Ridges : A few dykes, composed of dolerite, are found in the northern and eastern part of the area. Because of their greater resistance to weathering, these intrusive bodies have become prominent topographic features rising abruptly above the adjacent plain. The angle of inclination of the surface of dykes exceeds 50° while that of the disintegrated materials deposited at the foot of the dykes reaches upto 20°. Block disintegration is a common process shaping the form of the dykes. Linear joints are prominent in some parts where the action of running water has widened the gap between two parts of the dyke, initially separated by the normal process of block disintegration, forming a narrow strip of fluvial deposits in between. This process of fluvial action is mainly during the monsoons. The surface of the dykes is without any vegetation. This favours rapid block disintegration by insolation and consequent retreat of the zone of contact between the dyke and its deposits at the foot.

6. Alluvial Flats : The stream channels found in the mapped area consist of mostly non-perennial streams with the exception of the

Jamuna Nala, which is the only perennial stream. This stream describes a full meander in the area. The outer concava bank displays the typical vertical bank that rises to even 15 feet (4.6 m) above the bed of the river. The valley width is variable, ranging between 15 and 40 feet (4.6 and 12.2mm). Mapping was done during the pre-monsoon period when the river was obviously not at the bankful stage and a major part of the bed was dry with the channel winding through it. The bed was strewn with all kinds of deposits varying in size from granules to pebbles, cobbles and boulders of angular to sub-rounded shape which gives an indication of the fluctuating nature of discharge of the stream during the various seasons of the year.

The non-perennial streams of the area, after emerging from the surrounding hills, either get lost in the plains or join the Jamuna Nala. During the time of observation the valleys of these streams were either dry or displayed a chain of disconnected stagnant pools of water. A particular valley running from the north to the south through the western part of the area and joining the Jamuna Nala showed marked incision over the alluvial flat.

Some gullies have formed in the area especially in the upper course of some of the non-perennial streams where the headward extension of the channels have eaten up a part of the undulating lateritic upland. The process is most active during the rains. Detailed measurement of one of such areas was done with the help of Prismatic

Compass, chain and tape, and Abney's Level. The sides of gullies are observed to be almost vertical and channels winding at places. Granules and nodules derived from the surrounding lateritic blocks are found concentrated at the bottom of the channels which are, however, deeply infested with highly poisonous snakes like Cobras etc.

Man's Adaption to the Geomorphic Features :

Geomorphological characteristics play a dominant role in determining the nature of human activities and landuse pattern in the area. The Basaltic Rim, because of the rugged rock exposure, lack of flat land and thin soil cover, discourage landuse of any sort. The Colluvial Zone has been mostly left to its initial forest cover, and the local people rely a great deal on its products. The Dyke Ridges being rocky, hardly have any soil cover and so cultivation is practically impossible. Some huts, however, are constructed on the dykes where people live in order to extract forest produce from the nearby forests. This is done with the purpose of saving more useful land for uses other than settlement. The Lateritic Upland is also used mainly for settlement because of the same reason. The village has grown up on it and the alluvial areas around it have been kept for agricultural purpose. Nothing except some vegetables can grow on these lateritic uplands, that too with much effort. The Dissected Older Alluvium is seasonally cultivated to produce only one crop a year as it is moderaltly flattish and somewhat not too infertile, but has a limited supply of water for irrigation.

In this area simple terraces are cut on the sloping ground with small embankments at the edges to prevent run-off and check soil erosion from the individual terraces. Maximum utilisation made by the agrarian population of the area is of the Alluvial Flats which are made up of newer alluvium where water for agriculture is available and the soil cover is also thick and fertile so as to yield rich crops with minimum effort.

Preparation Of The Geomorphological Map Of The Whole Upland

Introduction :

The map around the village Gurguria on the Jamuna Nala was based on the information collected by field work only. This was possible because the area was a small one and every part of it was accessible. On the other hand, the Upland as a whole was too big to be covered by field survey. Moreover, many parts of it were inaccessible because of the absence of any hospitable route, very dense forest cover and also because of the large number of ferocious animals like tigers, bears and elephants. As such, an altogether different approach, different from what was done for the small selected area discussed earlier, was made while preparing the geomorphological map of the whole area.

Methodology :

At first the area was traversed along the main routes, and landform characteristics were observed. The important and prominent features, which were accessible, were first identified and their structure and lithology noted and recorded. Inaccessible features having similar appearance and also other inaccessible but prominent features were observed from a distance and logical inferences drawn regarding their characteristics, both topographic and geologic. The features thus identified, were then plotted on an outline map of the Upland drawn on a scale 1:500,000. This map was then superimposed on maps of geology and slope as well as on physiographic diagram one after another. This helped in collecting the necessary information on the basis of which appropriate symbols were chosen and plotted on the map.

Construction of the Geomorphological Map and its Use in Explaining the Geomorphology of the Upland :

Altogether 13 symbols were selected on the basis of a combination of factors like landform types, lithology and structure, slope, relief etc. Here follows a brief description of the features recognised through an analytical study of the map prepared.(Fig.10.2

I. High Plateau :

1. High Plateau of Ferrugenous Shale : This occupies a contiguous area on the east-central part of the Upland where the elevation varies from 2500 ft (762 m) to 3500 ft (1067 m), the slope

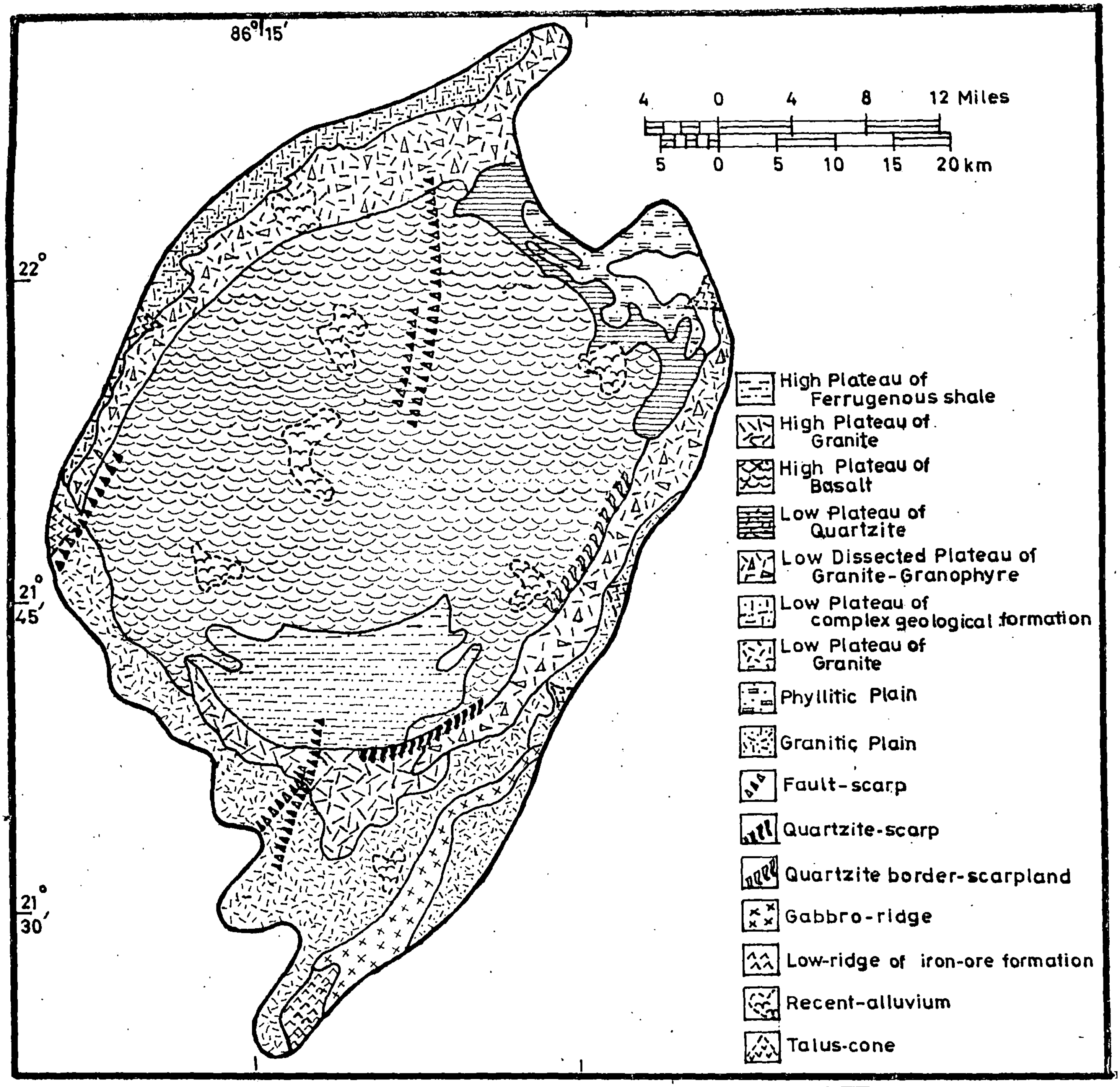
varies from 5 to 10 per cent and at places above that value. It occupies the southern part of the basal band of volcanics which is bound by the basal band of quartzites in the south and the middle band of quartzites in the north. The general slope of the land is steeper on the southeast and gentler on the north.

2. High Plateau of Granite : It occurs only in the southern half of the Upland intervened at places by fault scarps and quartzite scarps. The area is composed of Singbhum Granite which forms a plateau surface at an elevation of about 3000 ft (914 m). The terrain is a gently rolling upland with occassional granitic hillocks. The slope of the land varies usually from 5 to 10 per cent and only rarely exceeds that amount.

3. High Plateau of Basalt : This covers a large area in northern half of the Upland where the elevation is also around 3000 ft (914 m), and the slope varies like the previous case from 5 to 10 per cent. The surface is underlaid by Sill which has intruded through the top band of volcanics. The Sill incidentally occupies the central part of the basin structure and is exposed to the surface because of the erosion of the volcanics which now surround it.

II. Low Plateau :

4. Low Plateau of Quartzite : It occurs in a circular



Geomorphological Map of the Mayurbhanj Upland patch in the north-eastern part of the area where the predominating lithology is quartzite belonging to the "basal band". The slope is steep, mostly above 10 per cent. The elevation varies from 1000 ft (305 m) to 1500 ft (457 m). The terrain is often rugged because of the abrupt rise of the quartzitic rocks above the general level of the land.

5. Low Dissected Plateau of Granite-Granophyre : This occurs in the northern, eastern and western fringe areas where the general topography is usually low, below 1000 ft (305 m), in the north and east and below 2000 ft (610 m) in the west. The lithology is mostly of pyroxene granite-granophyre and the area invariably lies outside the basal band of quartzite. The slope however is variable, from below 5 per cent to above 10 per cent ; this is mainly because of the high amount of dissection of the terrain by the out-flowing streams.

6. Low Plateau of Complex Geological Formation : This occupies the north-western fringe of the Upland where the Singbhum granite, with some intrusives, form the main lithologic character. The relief is mostly below 2000 ft (610 m) and the slope is below 5 per cent.

III. Plain :

7. Phyllitic Plain : It occurs in the north-eastern part of the area and covers a considerable area where the slope value

is usually below 5 per cent and the landform is flattish in nature, made up mainly of phyllites. The elevation varies from 500 ft (152 m) to 1000 ft (305 m).

IV. Scarps :

8. Fault Scraps : These occur in several places and particularly along the Burhabalang River in the north-central part as well as along the Deo-I Nala in the southwestern part of the Upland. Several other smaller streams in the south are also guided by the faults which occur along their courses. The abnormally straight course of the streams usually indicate that they are controlled by high-angle faults.

9. Quartzite Scraps : These are found along the quartzite bands, particularly along the outermost one which is the basal band of quartzite and which forms the outer boundary of the basal band of volcanics. These scraps have in-facing dip slope and out-facing escarpment, the outer side being more prominent, which is usual for a basin structure like this.

10. Quartzite Border Scarpland : This is a prominent topographic feature in the eastern part of the Upland and is formed by the basal band of quartzites. It is not a single scarp but rather a zone of scarpland which rises abruptly from the Baripada Plains in the east and merges gradually with the central part of the Upland

As such, it looks very prominent when viewed from the east and quite subdued when viewed from the west. The slope is very steep and the whole area is covered by dense forest. It is flanked on the east by pyroxene granite-granophyre and on the west by the basal band of volcanics.

V. Minor Ridges :

11. Gabbro Ridge : This exists as a single feature in a linear segment in the southernmost ledge of the Upland. The slope exceeds 10 per cent. The feature has a sharp relief character although the general elevation is from 1000 ft (305 m) to 2000 ft (610 m). The feature is made up of Gabbro-Anorthosite which is much more resistant than the Romapahari granite that surrounds it. It is obviously result of differential erosion. The upper part of the feature is dissected to form three small hillocks in a linear fashion arranged in the north-northeast to south-southwest direction.

12. Low Ridges : These are formed on Iron Ore Formation of Badampahar and Gorumahisani. They occupy the southernmost end of the Upland where iron-ore formations have produced low ridges below the general elevation of 1000 ft (305 m). These ridges are sharp-crested but having low relative relief. The slope of the land in the surrounding area exceeds 10 per cent.

VI. Recent Formations :

13. Recent Alluvium : It is found along the stream courses in linear bands almost every where in the Upland. It consists all over of post-pleistocene deposits of fluvial origin. In higher elevations and particularly in the steeper sections where a sudden break of slope occurs, such as the zone adjacent to and on the inner side of the quartzite rims, the alluvial deposits of finer quality are often found to occur along with granules, pebbles and cobbles of various size and shape, and of heterogenous lithologic composition.

14. Talus Cones : These occur in the fringe areas only, particularly at the exits of the streams across the boundary of the Upland where there is a sudden drop of gradient. Coarse-grained unconsolidated sediments form the main lithologic character of the unit. The elevation varies from 1000 ft (305 m) along the eastern margin to 1500 ft (457 m) along the western margin.

Limitations of the Map :

In the present case the author prepared the geomorphological maps only in black and white in order to avoid complications in representing the various attributes of the geomorphological units. Obviously because of this, confusions concerning superimposition of different colours did not arise. But at the same time a great variety of information which could be represented in colours, could not be incorporated. In any case, following the Tricart School for geomorphological mapping an attempt was made to represent the various geomorphological units by different symbols which showed the landform characteristics, as well as their causes of origin. Other details such as the age of the features could not be incorporated. However, since the rocks in the area are all of the same pre-cambrian age (except the newer alluvium and the talus formations in the margin) the work became much easier and less complicated. In any case, the geomorphological map prepared in this way presented the basic information needed by not only a geomorphologist but also by a planner or an agronomist who is interested in deciding on the most useful way of utilising the information for the development of the area.