PART I: GENERAL MORPHOLOGY OF THE AREA
Knowledge of physiography of a region is a prerequisite to any aspect of study in geography. Apart from the purely geomorphological aspect, physiography greatly influences the natural resources of an area. It not only influences the availability of resources directly and indirectly, but it determines the mode of exploitation and development planning in a region. According to Sharma (1974-75) "the land surface is the area where human life is lived, even the minute details of land configuration have important bearings upon the settlement of human population, their movement and through this, it has indirect but deep effects on all resources. It comes to be reckoned within the socio-economic life of the region, and its effect appears tangibly in the landuse patterns."

Land configuration is the outcome of various factors. Davis (1899) expressed it in short as the outcome of structure, process and stage. In other words, the basic constituents of topography, i.e. lithology and structure, the process it has undergone and finally the stage of the cycle of erosion in which the region exists frame the surface features.

The river basin is demarcated on two sides by prominent water-divides namely the hard Vindhyan Kaimurs in the north and by dissected Trap country of Maikal range in the south-western margin. The water-divide in the southern part, is the area of high relief and the two river basins the Rihand
sub-basin of Son and Hasdeo (of Mahanadi catchment) have come in close contact through intense dissection of Deogarh hill area. The eastern part of the Son basin in M.P. is demarcated by Kanhar river basin which is a tributary of Son river and the area lies in Bihar and Uttar Pradesh states.

The physiography of the Son river basin is very interesting. It is a part of the old landmass of Peninsular India. The physiography exhibits the imprints of changes in its long geologic history. The area is characterised by the geomorphic features like cuestas, mesas, buttes, entrenched meanders, gorges and broad open valleys, representing a multicyclic landscape.

Wadia (1949) while discussing the nature of landforms of Peninsular India states, "In the Peninsula, the mountains are mostly of the 'relict' type, i.e. they are not mountains in the true sense of the term, but are mere outstanding portions of the old plateau of the peninsula that have escaped, for one reason or the another, the weathering of ages that has cut out all the surrounding parts of the land".

Broadly speaking, the scenery exhibits all the typical characteristics of dissected ancient plateau.

Geology and differential erosion of the rocks of varying resistance determine the surface features of the area. Quartzites, granites, sandstones, porcellanites etc. are the harder rocks which form bold topography, like hills and ridges, whereas soft rocks dominate the low level country and plains. These
factors have developed a ridge and valley type of topography in the region. The inclination of strata has determined the nature of landforms to a great extent. Flat topped hills or ridges surrounded by steep scarps of horizontal strata can be seen in the Vindhyan and Gondwana countries. Straight and continuous sharp crested ridges and escarpments are supported by tilted beds. The original slope of the land and the drainage normally conform with the dip direction. The mode of weathering and erosion differs greatly depending on the dip, structure, permeability, climate, vegetative cover etc. and thus directly and indirectly govern the formation of micro landforms. The study of these micro features cannot be made in detail due to the large extent of the area. The area can be divided into three physiographic divisions (Fig. 4.1).

I THE KAIMUR SCARP

II THE RIVER VALLEYS SOUTH OF KAIMURS
   (a) THE SON VALLEY
   (b) MAHANADI VALLEY

III HIGH RELIEF AREA OF MIDDLE AND SOUTH WESTERN SON BASIN

IV SOUTHERN LOW LYING PLAINS

I. THE KAIMUR SCARP

The Kaimur hills trending ENE-WSW direction, form the northern boundary of the Son river basin. It is the water divide between the Son river basin in south and the Tons river basin in north. Its extent is about 480 Km from Sasaram in the east (in Bihar) to Katangi (Jabalpur) in the west. The
average height is 615 m.

Geologically the scarp is mainly composed of quartzitic sandstones of Upper Vindhyan. The rocks dip forming a gentle slope towards north, whereas the southern part facing Son valley is in the form of a scarp. It seems to be an erosional scarp but many workers (Mallet 1868, Oldham 1901, Choubey 1985 etc.) suggest the role of faulting in the formation of this scarp. It may be possible that the fault scarp has been modified by the process of denudation. This scarp rises abruptly from the Son trough. To the north of the confluence of Gopad and the Son, the Kaimur comes very close to the Son river and nearly touches the valley. The height of the scarp decreases from west to east. This is a continuous flat topped hill range and is not breached at any place by any significant stream throughout its length. The drainage seen in regional perspective indicate that the rivers flowed towards north (Fig. 4.3). Absence of any windgap in the Kaimurs and the continuous unbreached nature of the scarp is noteworthy. It seems that if any windgap were there it must have been present over the Trap cover which once covered the whole area including the Kaimurs. The signs of post Trap drainage in this area have been removed by denudational agents. The erosion may have been done by the Son and its tributaries when it flowed across the Deccan Trap covered Kaimurs. When the Traps were removed the hard Vindhyan were exposed and the drainage was superimposed over the Vindhyan topography. However the hard Kaimur ridge could not be breached and the drainage adopted itself parallel to the strike of the Kaimur ridge. Thus the
Kaimurs emerged into a waterdivide between the two river systems of Tons and Son rivers. Some pioneer workers have also expressed similar views regarding the evolution of the area. Oldham (1901) expressed the possibility of superimposition from a higher surface and that the country was levelled into a gently undulating surface before the present course of the Son was evolved. Auden (1949), Ahmad (1966) also discussed the Deccan Trap extension towards the north over the Kaimurs. Rao (1965) found Deccan Trap outliers 9 miles south of the NE flow of Son after it takes a turn towards NE. In Lakshmanan's (1969) views, "The presence of lateritic and bauxitic outliers and also pieces of chalcedony definitely derived from Traps point to the former trap extenton over the Kaimur and Rewa plateau." He states that, "Kaimur is a erosional scarp which has retreated and a valley, a precursor to the present Son, was etched even before the Gondwanas were deposited."

The morphology of the Kaimurs is sometimes characterised by terraces. In case of soft rocks sandwiched between hard sandstone beds, the escarpment is divided into two distinct terraces. Some minor tributaries which flow across Kaimurs to join Son, do not follow the dip direction. Oldham (1901) accounts for the Kaimur's nature and to quote him, "It seems peculiar indeed that the Kaimur has always stood as a water parting divide during the long course of past geological history and it has never been crossed by any stream of great significance not withstanding the fact that the tributaries on its either side exhibit conspicuous features suggesting a long history of
denudational chronology in the region."

The continuity of the Kaimurs breaks slightly at two places. Firstly, SSW of Govindgarh (north of Jurmani village) where the 1500' contour is marked by a fingertip stream 'Marhawal' and joins Son from the north. At this place the continuity of the scarp is lost but it is resumed after about 2 miles. Secondly, NNE of Chorhat (north of Tikat village) where Adhnadi crosses the Kaimur scarp and the sharpness of the scarp is lost.

II. THE RIVER VALLEY AREA PARALLEL TO THE KAIMURS

South of the Kaimur scarp and parallel to it are the lower Katni, Mahanadi and Son valleys aligned in a straight line. Upper reaches of these rivers are situated in approximately NW-SE direction. These lower valleys form a trough which is broad in the west and narrow in the east, from west of Katni to the confluence of Son and Rihand rivers in the east. This region is the eastern extent of Narmada-Son furrow (Spate, 1967). The area slopes gently towards east. The average height of the region varies between 300 to 450 m. The average slope rarely exceeds 6°.

The area has unconformities between Archeans and Bijawars which again unconformably lie below the Vindhyans. The rock types are limestones, shales, quartzitic sandstones and porcelanites. In this area Vindhyans and Gondwanas come into close contact (West 1962). The area is nearly a plain
with east-west trending hillocks alternating with broad valleys which are the outcome of differential erosion of hard and soft rocks present in the area.

The western part of the Mahanadi valley area is known as 'Murwara basin'. Mahanadi and its tributary Umrar nadi have flattened the area. However two dissected moderately high features towards NNE of Umaria are present.

Further east, the Son valley is made up of soft rocks of Khenjua stage. It is evident that the NNW'ly flow of upper Son is controlled by shear joints in the softer shales of porcellanite stage. The abrupt turn of the Son towards NE is mainly controlled by the softer Khenjua rocks. Apart from this the confluence of the more active Mahanadi is significant here. The Mahanadi joins the Son forming a confluence angle of 180° thus forming the Katni, Mahanadi line in continuation with the Narmada Son alignment. In this area the valleys are broad and open. The small east-west trending hillocks of harder porcellanites and sandstones are the characteristic features of the area. All the major tributaries of the Son join from south in this area thus forming a region of unilateral drainage pattern.

Incised meanders are developed west of the confluence of Surnin nadi which develops on the hard porcellanite and sandstones. Typical quartzite ridges are the characteristic feature of the area. The eastern part of the trough is very narrow between the Kaimur scarp in the north and Deosar hill
area in the south. The island of hard sandstone present at the confluence of Gopad and the nearness of the Kaimur to the river valley indicates that the rocks are harder and the effective erosion in this area has ceased.

This region has flat and fertile land which supports dense settlements, at places stilled with hillocks which display landforms like saddles and buttes.

III. HIGH RELIEF AREA OF MIDDLE AND SOUTHERN RIVER BASIN

This high relief area is spread over the whole of the middle Son river basin and covers a large area. In the west the water-divide trending in a NE-SW direction between Johilla and Mahanadi river basins serves as the western limits of this region. Towards the eastern side this region is broad and is close to the Son valley in the form of Deosar hills in the north and dissected. Deogarh hills in south which is adjacent to the Surguja basin.

This high relief area sustains the middle and mature valley areas of all the major rivers of the Son river basin.

The area comprises Archaeans granitic gneisses, Upper Vindhyans, Upper Gondwanas and Deccan Traps. Differential lithology and structure is an important factor enhancing the relief in the region.

The western part of this region is 'Jaisingnagar plateau'. This is occupied mostly by Gondwana sandstones which are very much dissected. The height of the hills exceeds 900 m at places.
Conduene sandstone forming a series of flat topped hills with Mesa & Butte.
The average slope varies between 6° to 8°. Meandering Johilla river descends from the Maikal range situated in the south and forms a gorge. Here the Johilla river gradually turns towards NNE from NNW direction and joins the Son. The Son valley area here is remarkably plain and merges with the northern plain valley area (number II of the physiographic division).

Further east lies the rugged plateau of 'Deogarh hill'. Its high relief distinguishes it with the adjacent areas. This highly dissected region gradually broadens towards the east. The average height ranges from 600 to 1200 m. The quarter inch topographic sheet 64 I covers this area. It is an area of very prominent relief and steep slopes as seen from the highly congested contours. Intervening steep sided gorges and ravines are the characteristic features. The whole area is occupied by broad flat topped hills and typical conical hills formed by weathering. The river valleys in this area are in late youth to early mature stage forming gorges and deep valleys showing high degree of dissection. The slope analysis also indicates high average slope in this area, the maximum average slope reaching up to 12° in Deogarh hill area and towards west in Chang Bhaker area it is more than 14°. The Deogarh hill is the waterdivide between Gopad and Hasdo rivers. Important peaks are Deogarh, Jatarsuka and a peak north of Piparkchar nadi (a tributary of Rerh river), and the respective heights are 1029 m, 1083 m, 1187 m.

The area comprises Archaeans, Upper Vindhyans, Upper Gondwana and Deccan Traps.
Most of the right hand tributaries of the Son river, i.e. Gopad, Banas, Keuai and Kunuk originate from these highlands and descent down dissecting this plateau. Hasdo which is a river of Mahanadi (Orissa) system originates a few kilometers NW of the source of Gopad, north of Sonhat village. The Rihand forms a narrow valley in this area.

The eastern part of the Deogarh hills i.e. the Tatapani area is also fragmented by prolonged erosion.

South of Deogarh hills are Korea hills which are drained by Hasdo and its tributaries. They form the southern limit of the Son river basin.

The area NW of Deogarh is known as Changbhakar, which is intensely dissected by Banas and Gopad's tributaries. The average slope rises up to 14° to 15°.

Dense vegetation and inaccessibility makes this high relief Deogarh hill area a sparsely populated one.

North of Deogarh hills and close to the Son valley lies an area of comparatively less average height and exhibit mature to old type of topography, known as 'Sonpar hills' or 'Deosar hills'. The extent of this area is from Gopad valley to Kanhar river in Sidhi district. Flat topped hills, knolls and debris cover are the characteristic features of the area. In Chatterjee's (1965) view, these hills are perhaps the remnants of an ancient mountain range of the type of the Aravallis, which existed in the earlier part of the Vindhyan times and
has an east-west trend parallel to the Son. Similar to the Kaimurs the northern side (facing Son valley) of the hills are gentle whereas the southern face usually forms scarps. Some small rivelets flow towards Son from these scarps, dipping towards north. The average height of the region is between 380 to 460 m. The average slope of the area varies between 8° to 12°. Geologically the area comprises granites, granitic gneisses, quartzites, sandstones and schists, with a complex structure. It has been eroded down to moderate relief with well developed rills, gulleys and deep valleys. The area is drained by higher order streams. Badland topography and the dense vegetative cover has limited the settlements. Agricultural activities are limited to the small fertile patches.

From the water divide between Gopad and Rihand in the NW to the Rihand river, lies a comparatively low and flat area of 'Singrauli basin'. The northern part of this basin is a plateau standing over the surrounding plains covered by Talchir sediments. The Barakar sediments project over the Talchir outcrops as scarp faces. Towards the north, the Gondwana sediments against Precambrian rocks which form a series of east-west trending prominent scarp ridge with steep slope towards south. This scarp has developed due to the fault between the Gondwanas and the older rocks. The Moher plateau has the step-like scarp faces towards south consisting of gently inclined sedimentary strata of varying resistance. The slope of the area is towards south-east. The height of the plateau is above 500 m. The average slope is 2° to 4°. The southern plain has a height of about 275 m.
The south western part is a hilly tract. The Rihand changes its north-westerly course towards north-east direction and joins Son. The low lying plain area is confined to the Rihand valley and its tributaries Mear and Kachin. The slope conditions and resistant rocks provide an excellent setting for the reservoir of Rihand dam.

The 'Maikal hills' constitute a highly dissected area in the southwestern part of the Deogarh hills. Many streams originate from this highland such as Son, Narmada, Mahanadi and some streams of the Godavari system. Maikal range is the watershed between drainage systems of Arabian sea and Bay of Bengal. This table land is Trappian country. The peaks rise well above 1000 m. e.g. the peak near Bahmangarh (1127 m), Rupaipahar (1099 m) etc. The average slope is 15.6° in this area which is maximum in the Son river basin, and it gradually decreases in the surrounding areas. The southern encroachment which is very dissected and is in the form of fragmented hills and ridges is known as ALA RANGE. It is parallel to the main high continuous range in NW-SE direction. "Amarkantak plateau constitutes the physiographic hub of central India, as from here ranges run in different directions - the Maikal towards southwest, the Bhandari towards northwest continuing westwards as Vindhyan range" (Sharma 1974-75). Terraced topography is a characteristic feature of the Trap country and is present in the scarp facing the Son river basin. The north-western part of the range is breached by the Johilla river. The incised meanders and deep gorges indicate rejuvenation in the area. Small rivulets form rapids and small waterfalls, for example
Bakan Nadi waterfall (30 m), and Bhaisa Nadi waterfall (28 m).

These hills of volcanic rocks have rich deposits of bauxite in lateritic zones (Fig. 8.2).

The southern most part of this region is 'Basania Basin'. It is a flat country which is drained by Johilla river. The Basania basin is divided into two parts by a range trending NW-SE. The maximum height of the range is evidenced in Rupaipahar (1000 m), and is the water-divide between Johilla and Narmada river basins. Southern Basania basin is drained by Narmada river. This flat country supports ample cultivation in the area.

**SOUTHERN LOW LYING AREAS**

Two areas of similar relief are there in SSW and SSE parts of the Son river basin. These are 'Sohagpur' and 'Sarguja' Basins. Korea hills is situated in between and separates the two.

The 'Sohagpur basin' is situated to the north of Maikal ranges. This flat country is surrounded by high relief area in all directions. In the NW dissected Jaisinghnagar plateau, Deogahd hills at the northern margin, and Korea hills in the east form the boundary. The continuity of this flat region is broken by residual hills or monadnocks. The average height varies between 375 m to 525 m. The height of the basin increases towards north. The average slope is 2° to 6° the area is mainly occupied by soft Lower Gondwanas. Granitic
gneisses, metamorphics and Deccan Traps are also present in small pockets. The landforms are controlled by the lithological contrasts of different formations, for example, Barakars and Talchirs form low plains, Traps form high areas and dolerite dykes form rugged hills.

Several streams originate in the high Trappean region in the south and join Son. This area is drained by rivers, Kewai, Kunuk, which are right-hand tributaries of Son and Tipan joins the trunk stream from left. The Son meanders in its plain in this area. Upper Gondwana high altitude areas only have thick forest cover and the rest of the area has dense settlements.

'Surguja basin' is also a plain and low relief area, mainly occupied by Archaean and coal bearing Lower Gondwana rocks. The flatness of the basin is interrupted by monadnocks and residual hills of Upper Gondwana or quartzitic rocks. This flat region is also surrounded by high relief areas. In the west by Korea hills, in the north by Deogarh hills and the south-eastern part it is demarcated by high pat country. In the south-west, the Hasdo and its tributaries are actively eroding the area, which in due course of time may capture Ranh river by headward erosion as visualised by Fermor (1914). Thus the possibility of change in the scenery in near future is there.

The area is drained by Rihand and its tributaries. The average slope is $8^\circ$ to $10^\circ$. 
PART II :: MAJOR DRAINAGE TRENDS
River valleys in the Son drainage basin are morphologically established in a typical way. The Son river originates from the high Maikal plateau and flows down in a NNW direction. It takes a sudden ENE turn on softer olive shales of Khenjua stage in Markandeyghat area. This ENE line of the valley is extended by Mahanadi valley in the west and by Katni river valley further west. This ENE valley line is situated parallel and close to the south of Kaimur scarp.

On a regional scale it is noteworthy that on both sides of the waterdivide, the Kaimurs, the direction of the major tributaries is generally SE to NW. This is true for both Son and Tons drainage systems, situated in the south and north of the waterdivide respectively (Fig. 4.3). The direction of drainage indicates a former flow in SE to NW direction across Kaimur. Oldham (1901) states, "In the Vindhyan period and at the time when the mountain chain still existed, the course of the drainage must have been northwards from the mountains across the plain of deposition in which Vindhyan system was being deposited". Study of palaeocurrents made by Laxmanan (1969) also supports this view. Absence of any windgap and the continuity of the scarp throughout its length which is not breached by any major stream is noteworthy. By detailed study in this respect, it is concluded that the Kaimur was once covered by Traps and all signs of previous drainage have been washed away by the process of denudation and the Son drainage has been superimposed over the relicts of Vindhyan topography.
Conical hill capping resistant sandstones
Deccan Trap outliers, presence of chalcedony and study of erosion surfaces support this view.

There are eight major tributaries of Son in the study area, of which five are right hand tributaries namely, Banas, Gopal, Rihand, Keval and Kunuk. The three tributaries which join Son from left are Mahanadi, Johulla and Tapan. All these left bank tributaries join Son while it flows in NNW direction. No tributary of significance joins the Son from left in the section in which it flows to the ENE direction (Fig. 4.2).

Another important feature about the drainage is the NNW flow of all the rivers of the Son and the tributaries and their change in flow towards NNE direction. This point is discussed while describing the evolution of the drainage.

I. UNILATERAL DRAINAGE

The Son river basin is a typical example of unilateral drainage. Such a large drainage system does not have any tributary of significance from one side i.e. from north. All the major tributaries come and join the Son river from the south. The waterdivide, the Kaimurs, between Tons and Son rivers is very close to the Son river in the north. These hills have rocks dipping in northern direction with a gentle slope towards north. The Kaimur range forms a scarp facing south, towards Son river. The drainage in the area is mostly consequent in nature. The major rivers which originate from Kaimur hills flow towards north following the regional dip direction to join Tons river system. Only small tributaries
come down to join Son. These are Adh Aadi, Marhawal nadi etc. These tributaries show deep dissection in their flow. All the major tributary rivers, Mahanadi, Johilla, Banas, Gopad, Rihand and Tipan flow approximately in a northerly direction except Keuai and Kunuk which flow in south-west and westerly directions respectively, to join the Son river.

Three reasons which seem to be important regarding the unilateral pattern of drainage in the area are, firstly high altitude and gentle dip slope towards north of Kaimur hills, secondly a general south to north slope of the area south of Son river, thirdly the superimposed nature of topography in the area. The evolution of the drainage provides further explanation.

EVOLUTION OF THE DRAINAGE

The drainage in the area has been evolved over the Traps. After the removal of Traps the drainage was superimposed over the relict topography of Vindhyans probably following the ancient drainage lines. The prominent imprints of the post Trap drainage have been erased from the scene by the complete removal of the Traps from the lower Son valley area. But the presence of chalcedony and cherts and Trap outliers near the Son valley south of Son's ENE flow confirm this view.

The turn of the Son from NW to ENE direction which follows the softer Khenjua shales is noteworthy. The possibility of the impact of Dextral movement along the fault rather
Meanders of Lower Riand river.
a series of faults (Das and Patel, 1984) cannot be overlooked.

The Son river is one of the oldest rivers of India. It traverses through one of the oldest land mass of the Indian sub-continent having a complex geological history. Evolution of the drainage is dealt in detail while discussing the denudation chronology of the area.

LITHOLOGICAL AND STRUCTURAL CONTROL

Characteristics of lithology, mainly resistance of rocks and structural influences discussed earlier in this chapter, indicate that the drainage is not altogether unrelated to these factors but Son and its tributaries often ignore structural control. The study area is a part of the old landmass of eastern plateaux of Indian Peninsula. The process of denudation has molded the landscape and the initial controls of structure and lithology appear ineffective. This does not mean that the landforms are devoid of these influences. Lithological groups control the drainage by the internal structure of rocks, i.e. hardness, permeability specific gravity etc. Impact of joints and fractures, faults is noteworthy. These influence the drainage and in turn the whole landscape. The drainage normally follows the dip direction in the area except N of Son and it is mostly consequent in nature.

It seems that no major fault controls the course of the Son river. Mallet (1869), Auden (1933), Oldham (1901) and many recent workers support this view. The views of Meddlicott
and Blandford are noteworthy... along the whole Son valley there is little or no faulting in the zone of disturbance but at the Son-Narmada watershed one or two minor faults occur at the close to the boundary, the ENE strike being remarkably steady. Throughout... The Son's course is rather controlled by shear joints of softer shales of Deorajnagar Formations (Porcellanite), trending in NW-SE direction, while its NNW flow. On the other hand the flow controlled by softer olive shales of Kheinjua stage and the Son takes a ENE bend (Rao, 1967). Although the impact of dextral movement cannot be overruled. The fault reported by Gupta (1983) along porce-
llanite bed, faulting in limestone bed (Laxmanan 1969) and other tensional forces (Fig. 1.1) that were active must have some bearing over the ENE bend of the Son river. The structural influence can be seen on the courses of almost all major tributaries Banas, Gopad and Rihand which is discussed earlier. To a certain extent Johilla and Mahanadi also indicate the same trend. Banas follows the contact between Upper Gondwana and Upper Vindhyan and flows to north direction. This is marked after it flows in NNW direction a few miles after the fault (Fig. 1.1).

According to Gupta (1983), the narrow belt of lowlying valley tract between the Kaimur in the north and the highlands in the south, is frequented by a series of faults. An identical view is expressed by Das and Patel (1984). Although no fault of any great significance has been noticed on either side of the valley, the conspicuous parallelism of streams on
either side of the Kaimur does show the existence of a weak zone. One cannot therefore rule out the possibility of existence of a deep-seated weak zone in this area, but it is yet to be confirmed.

After the ENE bend of the Son river, it flows across the ENE-WSW trending Deolond quartzite ridges at Kusma (24°11' 50" - 81°17'30"") and at Demba approximately 36 Kms downstream. Shear joints in the Basal quartzites in Deolond ridge area and the highly jointed nature of the Basal quartzite resulted in a plane of weakness in these ridges and is responsible for the river cutting across the quartzite ridges. Former workers have expressed the view so far that the Son's course is superimposed over the quartzite ridges. But it seems to be more authentic that the river has adopted the course of some former drainage line. Gupta (op. cit.) has pointed out the remnant of an ancient river, a dry valley, while studying the Bansagar Complex in the quartzite ridge area.

Waterfalls, rapids, incised meanders are the features controlled by the change in the rock resistance to a major extent. Whereas structure has molded these features at places e.g. waterfall over Gopad river between Dole and Rehi villages caused by an oblique fault (Garlapuri 1969).

The bold topography, such as ridges, scarps etc. are formed by quartzites and hard sandstones and the valleys, plains are occupied of phyllites, gneisses and other softer rocks. Drainage density in the area is also enhanced by softer
rocks in the river basin. Thus it is concluded that the lithology and structure do have considerable bearing over the evolution of drainage in the study area.

WATERSHED CHARACTERISTICS AND RIVER PIRACY

The river basin has well demarcated water divides on all sides. Some characteristics of the rivers and lithology are peculiar owing to the boldness of the water divides around and within the river basin (between sub-basins): (i) the active lower order streams which are intensively eroding the area, (ii) occurrence of hard and soft rocks in close association and its influence upon the water divides, (iii) the affect of structure, i.e. weak zones in the area.

The water divides between the sub-basin are losing their identity at several places. Under these circumstances river piracy or capture is not uncommon. Some pioneer workers have also reported the past river piracies and have studied the areas where capture can occur in future. In the vicinity of Kaimurs, the river Adh flowing from west to east which joins Narkuni (a small tributary of Son from north) is captured by Narkuni which was flowing in an easterly direction prior to the capture (Shrivastava, 1973). Another example is quoted by Oldham near Kushmahar village (18°4′ E 24°17′ N). As he states "here a tributary of the Gajnas nala, which joins the Son near Bhelki, flows in a gap which is larger than its size proving itself to be a misfit. It has encroached on the drainage area of the Bana."

Fermor (1914) studied the topography of Korea hills in detail. Korea hills are the southern part of the Deogarh hills which form the waterdivide between Son, Rerh (Rihand) and Hasdo (tributary of Mahanadi river) rivers. According to Fermor the Hasdo and its tributaries flow at a higher level than Son and Rerh rivers and Hasdo and its tributaries are comparatively eroding at a faster rate, thus they can be head Son or Rerh river in future by headward erosion.

Tributaries of Keuain nadi and Goini nadi originate from a ridge within one mile of each other in Deosar hill area. This is a dissected area and the Kewain flows at a comparatively low level. Goini is much active and in future by headward and differential erosion if it extends its flow towards Kewain, it can be captured by the Kewain nadi.

THE GEOMORPHIC PECULIARITIES

Every drainage basin has its own characteristics. Some of these characteristics may be interesting and peculiar to that particular area. In the Son river basin a few characteristics are very interesting:

RIGHT ANGLE TURN OF SON RIVER: The abrupt turn of Son river from NNW to ENE direction is conspicuous. It is said that softer Kheinjua olive shales are responsible for this turn. The confluence and pressure of more active Mahanadi from west is also noteworthy. But the impact of the tensional forces which have been discussed earlier, seems to be more authentic
Gorge on which the keying of Saseagar dam is being done.
reason causing the turn.

CONTRAST IN TOPOGRAPHY: The area north of the Son river's ENE flow has a sequence of subsequent streams which flow opposite to the dip direction. These small streams show recent erosive action on the southern surface of Kaimur scarp and join the Son. Whereas in contrast to these streams are the well developed valleys of the tributaries to the south of the Son river valley. The tributary streams to the north are not significant, that is why the Son drainage is said to be a unilateral drainage pattern.

MISFIT STREAMS: One of the examples of misfit streams is present in north of Deorajnagar. A very small tributary flows from north to join Son to the south, flowing across a continuous ridge through a wide gap and breaks the continuity of the ridge which is a misfit for the large water gap.

YAZOO TYPE OF STREAMS: The trunk stream develops natural levees and the tributaries are compelled to flow parallel to it to considerable distances till it gets a favourable site of confluence. Some examples of this type of streams are noticed near Chorhat and Sihawal.

RECEDING CONFLUENCES: Confluences of Son-Gopad, Son-Banas, Mahanadi-Bhader are reported to be receding (Shrivastava, 1973).

LAYOUT OF THE LITHOLOGY IN THE RIVER BASIN: It is interesting to note that the layout of the lithological groups are in east-
west trends. From north to south along any longitude, a number of lithologies occur. On the other hand, along latitudes, mostly, only one or two lithologies are met with. Only the Vindhyana (Kaimur) have ENE-WSW trend and the rest follow E-W trend. It may be noted that all the major ridges follow approximately same E-W trend. Major faults reported in the area also follow the same trend.

DRAINAGE PATTERNS

According to Zernitz (1932) "the patterns which streams form are determined by inequalities of surface slope and inequalities of rock resistance. This being true, it is evident that drainage patterns may reflect original slope and original structure or the successive episodes by which the surface has been modified, including uplift, depression, tilting, warping, folding, faulting, and jointing, as well as deposition by the sea, glaciers, volcanoes, winds and rivers. A single drainage pattern may be the result of one or of several of these factors". The following types of drainage patterns have been found in the Son river basin: Dendritic, sub-dendritic, sub-parallel, pinnate, radial, trellis, annular, rectangular. Mostly 'dendritic' and 'sub dendritic' drainage pattern occur in the area. Other patterns cover small areas and are only of local importance.

1. DENDRITIC DRAINAGE PATTERN

The streams in this pattern are inequent in nature. The irregular branching in all directions and the joining of
the tributaries with the main streams at all angles are the characteristic features of dendritic pattern. Areas of similar rock resistance have this type of drainage pattern. Son river basin has mainly the sub-dendritic and dendritic type of drainage pattern. Possibly mature to old stage landscape is the reason for this drainage pattern because the area has a variety of rocks and resistance too is not uniform. Dendritic pattern indicates lack of lithological control. The rivers are approaching to a graded stage and the initial inequalities of the lithology no longer has a bearing over the drainage pattern (Fig. 4.4-A).

2. PINNATE DRAINAGE PATTERN

This pattern resembles the dendritic, but in this type of pattern, the control of slope element is more and the streams are consequent in nature. "These acute-angled joinings with the rather evenly spaced and parallel tributaries form a pattern so much like that of a feather that it might approximately be called pinnate" (Zernitz 1932). A vast area of pinnate drainage pattern is the south-western part of the river basin, where streams flow down from the Maikal hills occupied by Deccan Traps. Lameta beds and the Gondwana rocks form the down slope areas. The Barua nadi and its tributaries which flow down from the water divide between Johilla and Son rivers, to the Son valley, form pinnate drainage pattern. Tributaries Tipan river also forms this type of drainage pattern (Fig. 4.4-B).
3. SUB-PARALLEL DRAINAGE PATTERN

The tributaries in this pattern are nearly parallel to the main stream. Parallelism is the dominating feature. The river basin has this type of drainage pattern in small areas. An example is in Rihand valley, near Rihand reservoir area (Fig. 4.4-C).

4. TRELLED DRAINAGE PATTERN

"The essential characteristic of trellised drainage is the presence of secondary tributaries parallel to the master stream or other stream into which the primary tributaries enter ... the trellis pattern implies a lattice effect which the elongated parallel secondary tributaries furnish". The pattern has subsequent streams connected by resequents or obsequents. The development occurs where the edges of formations varying in resistance outcrop in parallel belts. This type of drainage patterns is found in Rihand valley area. The Basania nadi and tributaries along with other tributaries of Rihand form this pattern (Fig. 4.4-D).

5. RADIAL PATTERN

When the streams radiate from a central area normally in all directions down a hill it is radial pattern. The streams are consequent in nature. A few examples of radial drainage pattern can be seen in the vicinity of Chataonda village. Tributaries of Neur nadi and Goini nadi also form this pattern (Fig. 4.4-E).
6. ANNULAR DRAINAGE

"... is ring like in pattern. It is subsequent in origin and associated with maturely dissected dome or basin structures". An example of this type of drainage is present in Tapar river basin which is a flat area with residual hills. The pattern is near Piparia village SE of Venkatnagar (Fig. 4.4-F).

7. RECTANGULAR DRAINAGE

Right-angled bends in the streams and tributaries joining at right angles form this type of pattern. The role of structure is prominent because this pattern is controlled by right-angled jointing or faulting of rocks. The Gopad river NNW of Ramgarh takes at least five right angled turns and the tributaries join the trunk stream at right angles. The area is occupied by Upper Gondwana rocks groups (Fig. 4.4-G).

SUPERIMPOSITION OF SON

As discussed earlier in this chapter, Son drainage is superimposed over the present scene as the Deccan Trap cover have been removed. The Traps covered the whole area in Tertiary. The gradual denudation of lava rocks has occurred and the Son river has been superimposed over the relict topography.