CHAPTER - V

D R A I N A G E   C H A R A C T E R I S T I C S

METHODOLOGY OF ANALYSIS

LONGITUDINAL PROFILES

BASINWISE DESCRIPTION

MAIN OBSERVATIONS

DRAINAGE CHARACTERISTICS

INTRODUCTION

Drainage is an integral part of a landscape, and in any geomorphic study the analysis of drainage basins either as a single unit or as a group of basins has considerable relevance (King, 1971). A landscape is in a way, the sum total of drainage basins which provide convenient units into which the area could be sub-divided. Any landscape as it exists to-day constitutes the end-product of development of each individual drainage basins of which it is composed. Within each geomorphological region, the drainage basins have similar forms to each other, indicating that these basins are evolving in similar way to each other. Thus by analysing the development of each drainage basin, greater understanding of the landscape as a whole is achieved.

According to Zernitz (1932) "Patterns which streams form are determined by 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, wind, and rivers". Therefore as streams persist in a landscape they show the effect of a long geologic history as well as information on structure and surface conditions (Schumm, et. al. 1987).

The quantitative approach to the drainage basins owes its initiation to Horton (1945). A good number of subsequent workers, (Strahler, 1952, 1954, 1958, Chorley, 1957a, 1958a,b, Clarke, 1967, Dury, 1952, Gregory & Walling, 1973) has helped to build an elaborate methodology.

According to Schumm (1972), for analysis of drainage network, the factors like density, which also has a bearing on the permeability of the rocks, the amount of geological control on the drainage pattern and the integration and homogeneity of the pattern have to be considered. With the increasing awareness of the role played by the tectonic factor in drainage developments, the conventional approach made by early workers, is now generally being abandoned. Even in the case of structural control of drainage, a lot of new thinking has now been inducted, and the significance of the role played by various structural features like dips of strata, faults, fractures and joints etc. is now appreciated more.

Emphasizing the tectonic factor, Ollier (1981) has given a specific example of trellis pattern, and categorically stated that, "older nomenclatures should be discontinued, because it, builds into the nomenclature a presumed (and erroneous) time-sequence for the origin of the various streams. It was thought that a main stream flowed down an initial erosion surface cut across the strata, and this was called a consequent stream, being a consequence of the initial dip of the presumed erosion surface.

The strike streams were thought to be developed subsequently to the consequent streams, so were called subsequent streams. Once these had carved valleys, secondary streams would form on the new valley sides; those parallel to the consequent stream were called secondary consequent streams, so were called subsequent streams (once these had streams). In reality the whole of any land area must be drained, and run-off and initiation of drainage affect all parts of the land surface right from the beginning. No part of the land area awaits the establishment of main drainage before becoming drained itself, and subsequent is misleading, as well as being less descriptive than 'strike' valley. The early history of a drainage pattern may be difficult to work out, but the structural relationships are clear, so structural terms for drainage pattern description are to be preferred". Howard (1967) has also laid stress on the importance of drainage analysis in structural interpretation.

The present author could not agree more with these two workers, because in the present study, the drainage characteristics ideally reflect the tectonic features of the study area, and also reveal a lot about the successive events of the landscape evolution and the controlling factors. The area provides a good example of drainage diversity, and its close relationship with various factors of landscape evolution. Drainage characteristics point to strong evidences of a morphotectonic control.

The area is traversed by one major river Tapi, which originates far away beyond the Trappean Highlands. The remaining conspicuous rivers are seen starting their courses from the Great Escarpment in the east. The entire drainage of the study area, has been found to consist of (1) Lower portion of the Tapi river basin (2) Drainage basins of rivers, Mindola, Purna, Ambica, Auranga, Par, and Kolak (Fig.V.1)

METHODOLOGY OF ANALYSIS

Morphometric analyses of above stated seven river basins in the study area, was carried out to decipher and understand the various factors responsible for the development of the area's stream pattern. A perusal of the overall drainage pattern clearly shows that it has been controlled by structure. The slope of the ground has also influenced the drainage development in the upper segments. Keeping the structural factors therefore, in mind, the author studied the basins and analysed the important morphometric parameters of drainage evolution, and the variations in these paramters were correlated with the controlling factors.

To highlight the role played by the fracture pattern in the drainage development, the author has prepared lineament maps for each basins based exclusively on the stream patterns. The relevant rose diagrams for the lineaments have also been prepared to highlight the intensity of various fractures, a synoptic view of which is given in Table V.1.

Table V.1 Data for Lineament Orientation and Length based on Drainage basins

Azimuth Class		Tapi Basin Total No.	Tapi Basin Total length in km	Mindola Basin Total No.	Mindola Basin Total length in km	Purna Basin Total No.	Purna Basin Total length in km	Ambica Basin Total No.	Ambica Basin Total length in km	Auranga Basin Total No.	Auranga Basin Total length in km	Par Basin Total No.	Par Basin Total length in km	Kolak Basim Total No.	Kolak Basim Total length in km
0-10	NE	16	454	-	-	141	318.00	151	420.75	46	199.75	77	107.00	31	53.75
10-20		13	55.50	3	8.00	12	17.00	8	31.25	1	2.5	4	10.25	5	10.50
20-30		4	8.75	-	-	--	-	6	26.50	4	9.25	9	20.50	5	12.25
30-40		7	25.00	2	15.50	6	34.25	-	-	6	13.50	4	6.25	3	5.75
40-50		7	33.25	4	23.25	--	-	-	-	2	4.25	5	10.00	2	3.75
50-60		6	27.75	8	15.40	--	-	-	-	5	16.25	5	12.75	-	-
60-70		3	6.50	9	35.50	7	27.75	-	-	2	4.25	3	5.00	1	1.25
70-80		44	141.00	7	24.00	3	16.50	16	20.00	7	13.75	5	13.75	4	10.50
80-90		153	449.00	28	104.25	59	98.50	114	152.75	27	43.50	54	69.25	57	100.00
0-10	NW	23	99.25	8	23.25	7	24.75	54	49.50	16	10.00	25	56.00	22	44.00
10-20		64	244.50	3	11.00	-	-	1	1.75	7	10.00	4	12.26	4	15.50
20-30		53	219.75	-	-	-	-	-	-	4	13.75	1	1.75	2	2.50
30-40		13	58.50	9	33.50	4	13.00	19	48.00	7	21.25	4	7.75	3	6.50
40-50		7	24.50	4	14.50	-	-	14	46.00	5	18.75	7	14.75	1	1.25
50-60		11	30.50	-	-	-	-	6	28.50	2	9.75	8	14.00	3	7.50
60-70		-	-	2	7.25	5	25.25	-	-	1	5.75	3	9.50	-	-
70-80		-	-	-	-	5	14.75	-	-	-	-	1	7.00	1	2.25
80-90		16	41.50	9	43.25	53	92.40	72	45.50	21	42.50	15	32.50	-	-

The drainage characteristics have been investigated on Survey of India 1 : 50,000 scale Toposheets. The author has analysed each river basin separately, applying the Horton's law of Morphometry (Horton, 1945). He has calculated following parameters.

1. Stream order : The method outlined by Strahler (1957) has been followed for assigning the Stream Order. Each smallest finger tip tributaries are designed, first order. At the junction of any two first order streams, a channel of second order is formed and extends down to the point where it joins another second order channel where upon a stream of third order results and so forth.
2. Bifurcation Ratio : The ratio of number of streams of given order to the number of streams of the next higher order.
3. Stream Length : Total length of individual stream orders.
4. Basin Area : Area of the individual basin.
5. Maximum Basin Relief : The difference between the highest and lowest basin altitudes.
6. Drainage Density : It is the ratio of total channel segment lengths computed for all orders within a basin to the basin area as projected on the horizontal plane.
7. Stream Frequency : The number of streams per unit area.
8. Relief Ratio : A dimensionless number, defined as the ratio between total basin relief (elevation differences of lowest and highest points of a basin) and the longest dimension of the basin parallel to the principal drainage line (Schumm, 1956).

9. <u>Elongation Ratio</u> : The ratio between the diameter of a circle with the same area as the basin and the maximum length of the basin as measured for the relief ratio to indicate the shape of the basin (Schumm, 1956).

10. <u>Ruggedness Number</u> : This dimensionless number is the product of relief and the drainage density.

$$\text{Ruggedness} = \frac{\text{Drainage density} \times \text{relief}}{1000}$$

The details of the parameter values for the various basins are given in Table (V.2)

LONGITUDINAL PROFILES

The longitudinal profile of a stream is a graph of Distance versus Elevation and it is always useful in reading the past geomorphic and geologic records. According to Leopold et al. (1969), the factors controlling the stream profile can be considered to be a function of the several variables, viz. (i) discharge, (ii) load (delivered to channel), (iii) size of debris, (iv) flow of resistance, (v) velocity, (vi) width, (vii) depth and (viii) slope.

From the inter-relation of these variables is derived the relation of fall in elevation to the distance along the channel. The gradient of longitudinal profiles is also controlled by the lithology and structural variations. The characteristics of longitudinal profile of seven rivers of the study area, summarized in Table V.3 & Fig. V.2

BASINWISE DESCRIPTION

TAPI RIVER BASIN

Only the lower portion of this river basin which falls within the limits of the study area, has been analysed (Fig.V.3 & Table V.4). The river is supposed to flow along a fault, with the south portion having been uplifted. This fact is reflected in the drainage characteristics. From this point of view, the area to the north of the river is more interesting in terms of stream development. Portion to the south of the river shows a rather inhibited formation of stream channels. The longitudinal profile and its characteristics are already given in Table V.3 and Fig. V.2.

For the purposes of analysis, the author selected three sub-basins, from the northern part and three smaller sub-basins from the south.

Northern Sub-Basins (I,II,III)

Sub - basin I shows an elongated NNE-SSW trend, and covers an area of 106 sq.km. The pattern is sub-dendritic with more meanders along the courses of higher order streams, and most of them follow the same trend as that of the sub-basin. Sub-basin II is also elongated in the same direction as that of the Sub-

Table : V.3 Characteristics of the river's Longitudinal Profiles

Name of the Rivers	Length of the River in km.	Altitude in meter Max.	Min.	Nature of the Profile	Gradient	Remarks
Kolak	81.00	380	2	Concave with steep slope	0.0047	
Par	135	560	3	Concave with five breaks	0.0041	Several breaks in hilly terrain are due to N-S fracture with sharp break near to the coast.
Aurange	99.50	400	4	Concave with five breaks	0.0040	All of the breaks are in the hilly terrain.
Ambica	146.00	460	4	Concave with one break	0.0031	
Purna	174.50	480	5	Concave with five breaks	0.0027	Several breaks on the hilly terrain are due to N-S fractures /faults.
Mindola	120.50	120	2	Concave with five breaks	0.0010	Gentle slope due to the flow of river in alluvial portion.
Tapi	151.50	100	3	Genlte slope	0.00064	

TABLE V.4 Morphometric Parameters of the various Drainage Sub-basins of Tapi river based on Toposheet

Sub-Basins	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
I	1	308	3.71	128	0.41										
	2	83	5.19	60	0.72										
	3	16	3.20	27	1.69	144	106	11.62	2.29	3.90	0.77		11	15	0.24
	4	5	5.00	17	3.4										
	5	1		11	11.00										
II	1	1140	4.01	397	0.35										
	2	285	4.01	215	0.75										
	3	71	5.46	119	1.68	327	398	22.52	2.10	3.83	0.50		37	45	1.52
	4	13	2.60	42	3.23										
	5	5	5.00	26	5.26										
	6	1		36	36.00										
III	1	662	6.13	187	0.28										
	2	108	4.00	68	0.63										
	3	27	3.37	43	1.59	405	144	13.54	2.37	5.62	0.52		22	26	0.81
	4	8	2.70	17	2.13										
	5	3	3.00	18	6.00										
	6	1		11	11.00										
IV	1	140	4.52	64	0.46										
	2	31	3.10	42	1.35										
	3	10	2.50	12	1.20	223	77	9.90	1.82	2.42	0.83		10.5	12	0.19
	4	4	2.50	15	3.75										
	5	1		7	7.00										
V	1	120	4.29	45	0.38										
	2	28	3.11	25	0.89										
	3	9	4.50	14	1.55	235	41	7.23	2.27	3.90	0.60		11	12	0.10
	4	2	2.00	6	3.00										
	5	1		3	3.00										
VI	1	80	6.66	32	0.40										
	2	12	3.00	13	1.08										
	3	4	4.00	5	1.25	175	28	5.97	2.11	3.46	0.41		13.5	14.5	0.06
	4	1		9	9.00										

1 - Stream Order, 2 - Number of Streams, 3 - Bifurcation Ratio, 4 - Total length of Stream in Km, 5 - Average length of the Stream in km, 6 - Max basin relief in m, 7 - Total area of the drainage basin in sq.km. 8 - Diameter of the area equal to the area of basin in km, 9 - Drainage density, 10 - Stream Frequency, 11 - Elongation Ratio, 12 - Relief Ratio, 13 - Maximum length of the basin in km, 14 - Horizontal distance parallel to the main diameter line in km., 15 - Ruggedness number.

basin I. The northern and southern parts of this Sub-basin show two different drainage patterns. The northern part points to a joint trellis pattern, following two directions. NNW-SSE and E-W. Here, most of the lower and higher order streams are seen controlled by major joints and fractures. The southern part forms, sub-dendritic to dendritic drainage patterns, and is controlled mainly by a southerly slope. Sub-basin III falls within the highly jointed and fractured area on the northern side ~~part~~ of Tapi river. It covers 144 sq.km. The prominent drainage pattern is of joint trellis type controlled by the two sets of E-W and N-S joints. In the western part of the sub-basin these joints have given rise to a rectangular pattern.

From the study of overall morphometric parameters of all these sub-basins, it is obvious that the role of structural features has been quite prominent. The morphometric analysis shows Drainage Densities ranging from 2.10 to 2.37; and high Stream Frequency of 3.90 to 5.62; the Bifurcation Ratios vary from 2.66 to 6.13.

Of these Sub-basins, only the Sub-basin II does not show linear relationship when the Stream Order is plotted against the Number of Streams (Fig.V.4). This is indicative of the fact that the river has been structurally affected by a number of minor faults and fractures. None of these basins conform to the Horton's law, when Stream Order is plotted against Average Stream Lenghts (Fig. V.5). This deviation is more pronounced in the

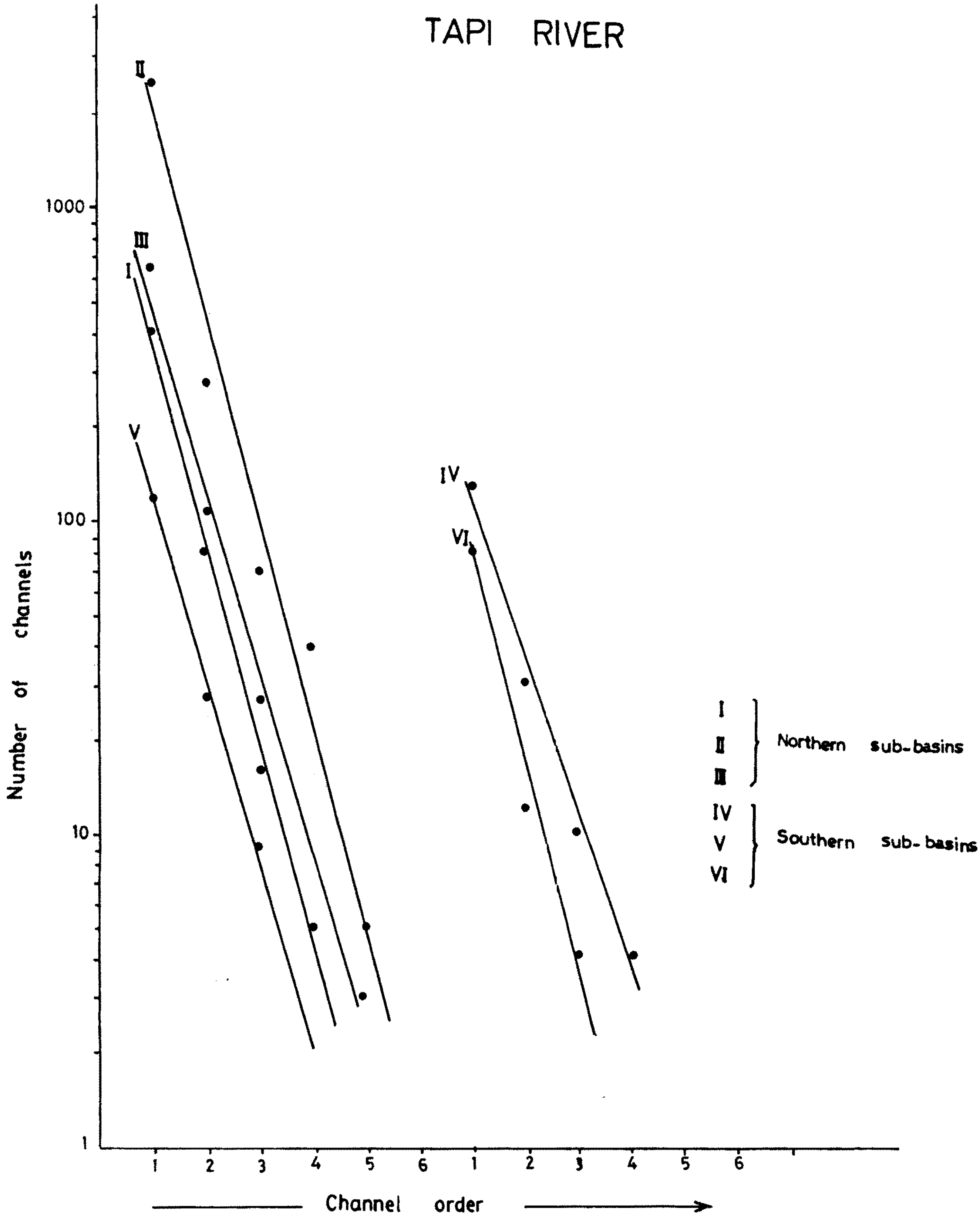

Fig: V.4 RELATION OF NUMBER OF CHANNELS TO CHANNEL ORDER

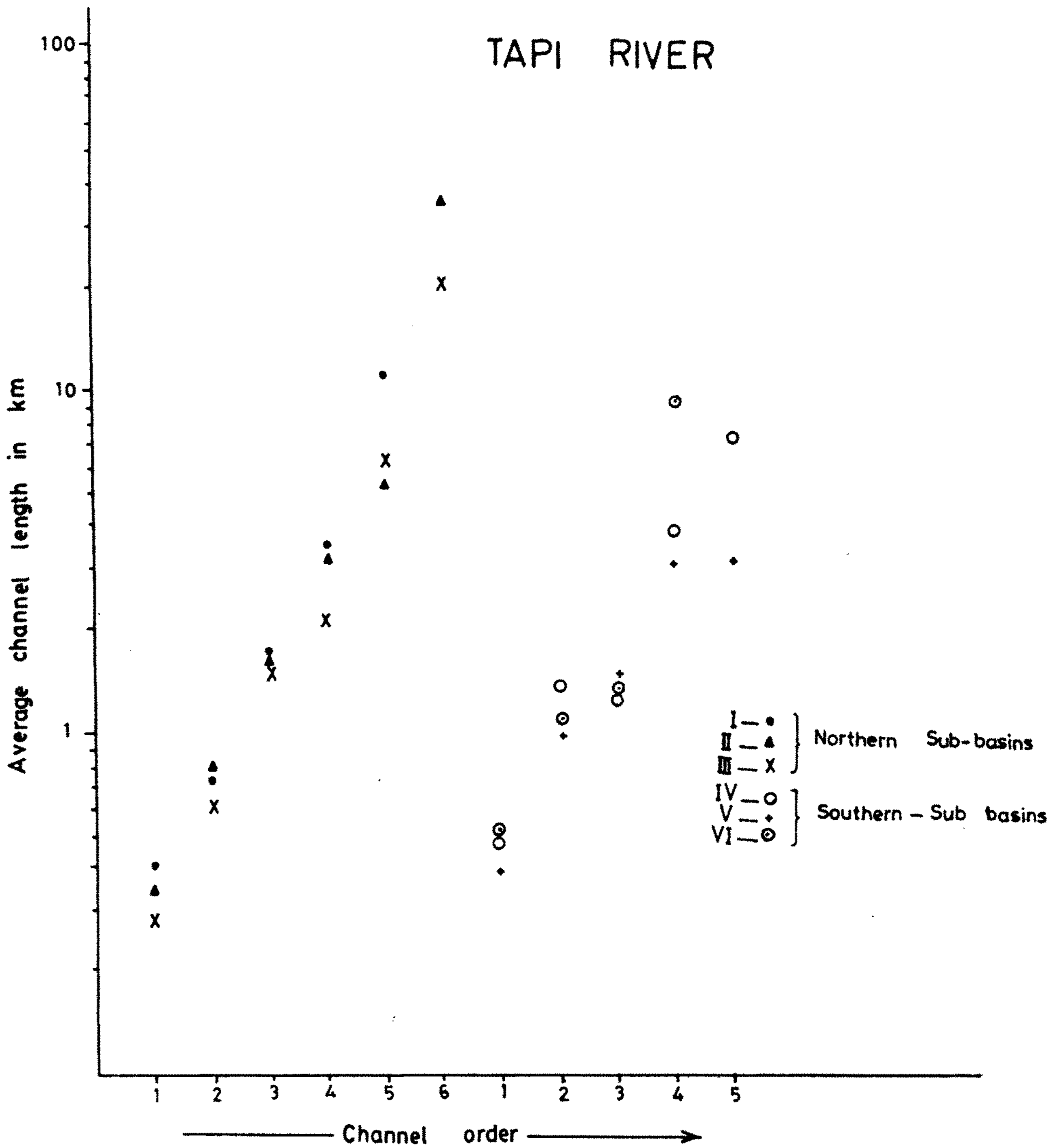

Fig: V.5 RELATION OF AVERAGE CHANNELS LENGTH TO CHANNEL ORDER higher order streams, and is on account of the influence of comparatively major fractures and joints.

Southern Sub- basins (IV,V,VI)

Since the southern block, has been uplifted, these sub-basins are comparatively small in all respects. Sub-basin IV is elongated in a N-S direction and shows a sub-dendritic pattern, flowing from south to north ~~work~~ (Fig. V.3). The total area coverd by the basin is 77 sq.km, with a maximum relief of 223 m. The morphometric analysis of this basin shows a low Drainage Density (1.82) and also a low Stream Frequency (2.42) as compared to the other basins (Table V.4). Here the role of the structure is less as compared to that of the basin slope. The relationship of the Stream Order to the Number of streams is linear (Fig.V.4). But it shows some deviation in the relationship of Stream Order versus Average Stream Lengths (Fig.V.5). The deviation is better seen in lower order streams (1st and 2nd orders), while the higher order streams show a sudden increase in their lengths. This is because of dominant role of slopes. Sub-basin V covers an area of 41 sq.km, and is elongated nearly parallel to the Sub-basin IV (Fig.V.3). Drainage pattern is dendritic with less meanders. Due to a smaller catchment area and a high relief, this basin shows a higher Drainage Density (2.27), and Stream Frequency (3.90) as compared to the previous sub-basin. The sub-basin shows a deviation in relationship between the Stream Order versus Average Stream Lengths (Fig.V.5), but it follows the Horton's law in respect of Stream Order versus Number of Streams (Fig.V.4). The distinctive character of Sub-basin VI is its straight, N-S direction. It covers an area of 28 sq.km. There is only one 4th order stream, which flows in a straight line from south to north, following a major N-S fracture. Analysis shows a very low value of Ruggedness (0.06) as compared to the other sub-basins, because of low relief. The plot of relationship of Stream Order against the Number of Streams and Average Stream Lengths are shown in (Figs. V.4 & V.5).

MINDOLA RIVER BASIN

The Mindola drainage basin elongated in the E-W direction is about 91 km long, (Fig.V.6), with a Bifurcation Ratio of 2 to 5.33. Most part of the river is flowing in the alluviul portions, and the drainage pattern is mainly dendritic to sub-dendritic. According to Verstappen (1983), this type of basin shows less influence of geological structure, and the streams of most orders are controlled by slopes. 4th order streams show a WNW-ESE trend with only a very few meanders. Overall Drainage Density values are higher in the hilly terrain as compared to those in the Uplands and Coastal plains. The main trunk of the river nearly follows E-W direction. Meanders in the Coastal plains point to a very low energy due to absence of gradient. The drainage pattern in the northern parts of this basin is controlled by a general southerly slope, a feature attributed to the uplifted southern block of Tapi. The longitudinal profile of the river shows a smooth concave curve without any break (Fig.V.2). The concavity of the profile is obviously more due to the decreasing gradient of the stream bed rather than due to increase in the discharge. The Stream Frequency (2.82), is dependent on the lithology, and as already mentioned, it is on account of the river flowing through a softer lithology. The river channel relationships with number and the Average Length of Channels are plotted in (Figs. V.7 & V.8).

PURNA RIVER BASIN

The Purna basin has an E-W direction with a wide eastern part, covering most of the Trappean Highlands. The drainage pattern shows much diversity within the basin, which is a reflection of the differences in the various geomorphological units, (Fig. V.9). In the hilly terrain near the Great Escarpment, the lower order streams flow down because of the steep slopes, while on the flat plateaus, they are controlled by the joints and fractures, mainly trending N-S. The drainage pattern is rectangular to sub-rectangular. Most of the 4th order streams have straight courses, and appear to flow along a set of N-S fractures. The higher order streams like 5th and 6th order show a number of meanders, but these meanders are on account of the streams flowing along intersecting sets of fractures. Towards the downstream, the patterns are dendritic to sub-rectangular, and most low orders are slope controlled. The main trunk of this river does not show any significant meandering, because of the decreased influence of N-S fractures as compared to the E-W ones. The Drainage Density to the south of the main trunk is less as compared that to the north. This is due to the

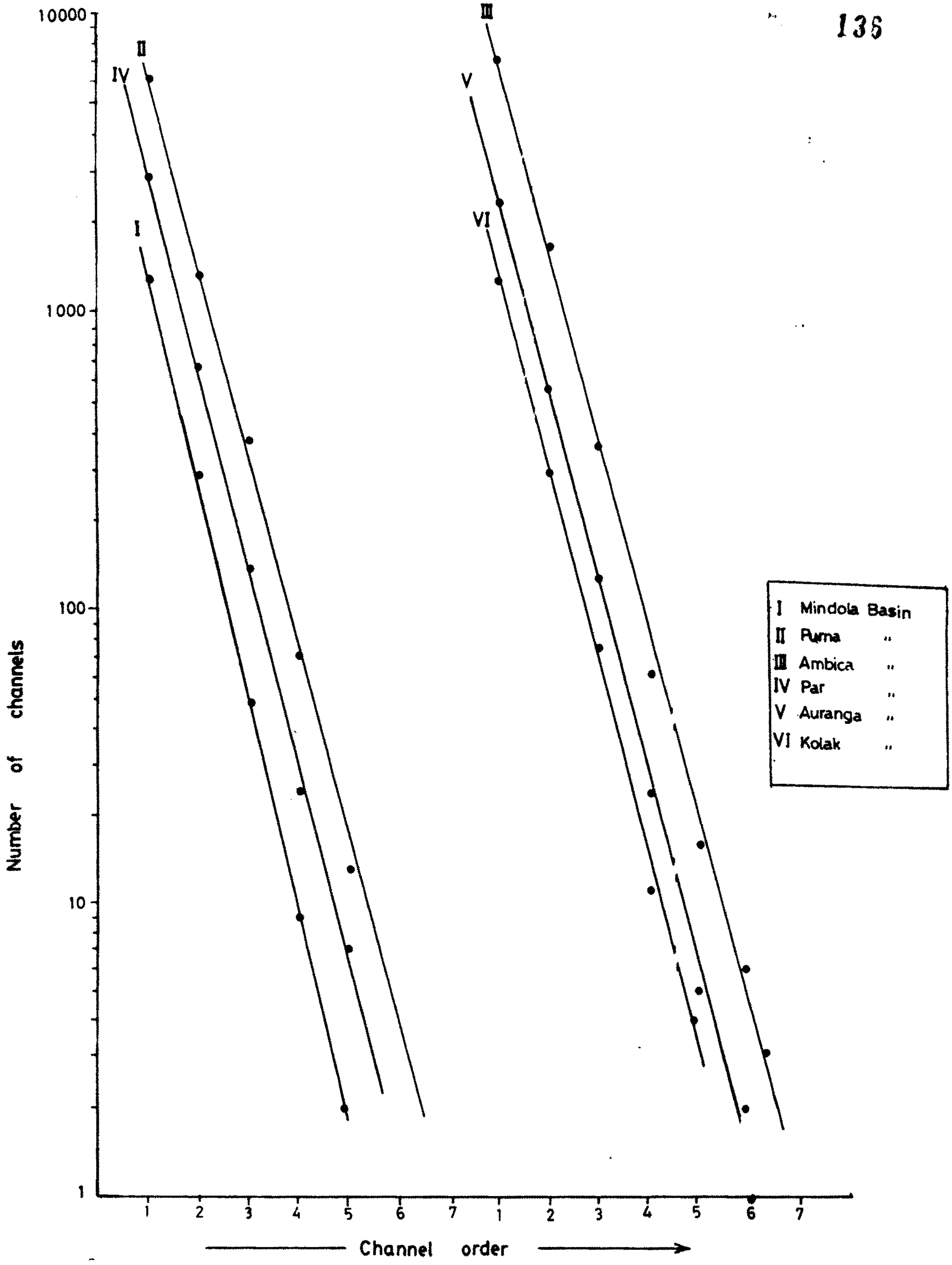

Fig: V.7 RELATION OF NUMBER OF CHANNELS TO CHANNEL ORDER

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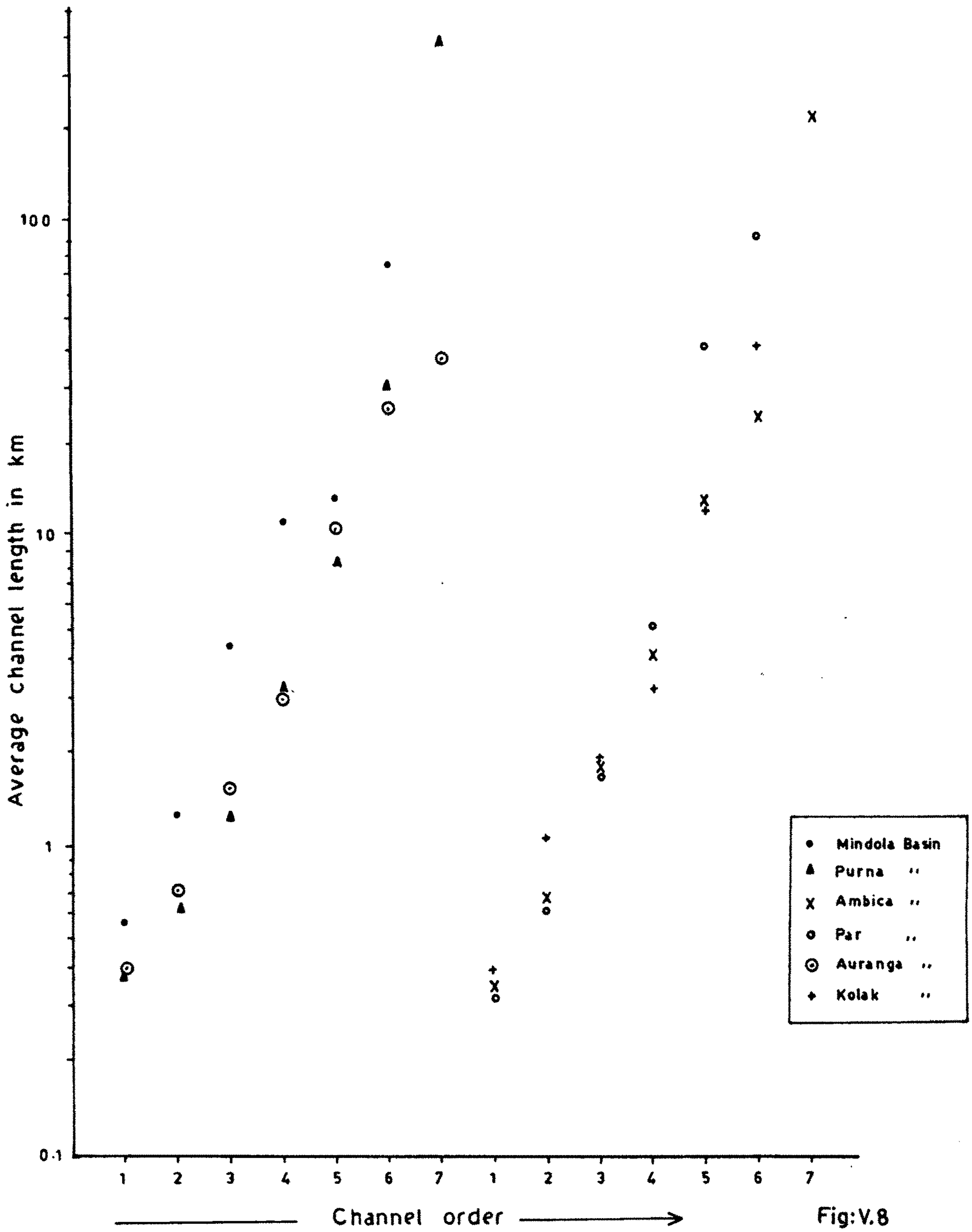

Fig: V.8

RELATION OF AVERAGE CHANNELS LENGTH TO CHANNEL ORDER fact that the Purna river is flowing along a major E-W fault with an uplifted southern block. Overall Drainage Density of this basin is (2.16) and the Bifurcation Ratio is between 3 to 5.57, pointing to a high ruggedness (2.89). Among all the basins in the study area, this basin is located along a zone of very steep slope, which has been found to comprise a fault zone. The plots of the order of the drainage channels against the numbers show a marked straight linear relationship (Fig. V.7). While the relation of the Average Length with Stream Order does not show such a linear relationship (Fig.V.8). This deviation is attributed to the small lengths of 1st and 2nd order channels along the N-S joints, which when joined as 3rd and 4th order channels suddenly increase in length. This is a typical case of structural control due to joints and fractures, wherein the erosional development is preferred along the planes of weakness, and the rock does not act in a strictly homogenous manner. The Stream Frequency is high (4.12), and shows again a conspicuous relationship with structure and lithology. It is flowing through a harder lithology of highly jointed trap.

The longitudinal profile of this river shows several breaks mainly in the hilly terrain (Fig. V.2). These breaks are because of major and minor N-S faults and fractures.

<u>AMBICA RIVER BASIN</u>

Among all the basins, this basin has streams of highest order viz. 8th, with three main tributaries, Ambica, Kaveri and

Khavera. The basin is elongated in the E-W direction which gently swings southward in eastern portion (Fig.V.10). The higher order streams like 4th and 5th order are controlled by fractures, and due to high density of intersecting fractures, they show numerous meanders along their courses

Drainage patterns in the extreme eastern part are of dendritic to sub-dendritic types due to steep slopes, while in the lower part of Trappean Highlands, the higher order streams flow along two major fractures (E-W and NE-SW). The analysis of morphometric parameters show Bifurcation Ratios between 2 to 5.72 and these values are high for 3rd, 4th and 5th orders, reflecting the structural control on these channels. Stream Frequency is quite high (3.53). The relationships between Channel Order v/s the Number of Channels and that v/s Average Length of the Channels are quite revealing. Whereas the former follows the law of Horton and shows a linear relationship with the number of channels, in the latter case, it does not do so (Figs.V.7 & V.8). This deviation is attributed to the higher order streams like 5th and 6th order channels flowing along the striking fractures which show a sudden increase in length and a large number of bends.

The longitudinal profile shows several breaks mostly in the higher elevations (Fig.V.2), wherever the river crosses fractures. But as compared to Purna river, the breaks in this river are not so well-defined, and some of them are attributed to lithological factors.

AURANGA RIVER BASIN

This basin is elongated in E-W direction and is characterised by two distinctly parallel 5th order channels, separated by a nearly ENE-WSW linear ridge (Fig. V.11). The lower order streams like 1st and 2nd orders are slope controlled, though some of them do flow along joints and minor fractures. The higher order channels follow major fractures, and the intersection of the two main fracture directions has given rise to zig-zag courses to these channels. The drainage pattern is mainly sub-dendritic to directional trellis. Drainage Density is 2.23 and Bifurcation Ratio is between 2 to 5.25; Stream Frequency is high, (4.30). All these point to the prominent role of structure. The relationship of the Stream Order versus the Number of Streams follows the Hortons law, but it does not show such a linear relationship with the Average Stream Lengths. (Figs.V.7 & V.8). Such a discreperсy in the low order streams, according to Chansarkar (1974), obviously points to a structural control of the small low order streams, as he found that in areas of fractured rocks, when the first order streams unite and become second order within their own catchment, they attain a higher Stream Frequency and Density, whereas the second order streams attain lower Stream Frequency as well as low Density.

The longitudinal profile characteristics of this river are given in (Table. V.3). The profile is marked by five nearly identical breaks (Fig.V.2); most of the breaks fall within the Trappean Highlands, and are seen located just at the junction of two higher order channels.

PAR RIVER BASIN

This basin covers an area of 1112 sq.km. with a maximum elevation of 1142 m (Fig.V.12). The two main tributaries of the river are Nar and Par, which originate from the Treappean Highlands beyond the limit of the study area. The river shows a typically zig-zag course. The trunk stream as well as the two tributary channels, in their upper portions follow numerous bends and curves, a fact essentially pointing to their flowing along numerous intersecting joints and fractures. The zig-zag course is controlled by two sets of fractures, N-S (NNE-SSW) and E-W (ENE-WSW) and their main trunk flowing in a ENE-WSW direction. Linear ridges separate the tributaries. The lower order streams are of sub -trellis to dendritic pattern, and the higher order streams like 4th, 5th and 6th orders, show several curves and bends on account of high density of intersecting fractures. The Stream Frequency is 3.30, and Bifurcation Ratio varies from 3.43 to 7, which is quite high. High values of Stream Frequency and Bifurcation Ratio as well as a linear elongated basin trend, is typical of control exercised by structural lineaments (Vestappen, 1983). The relationship of Stream Order versus Number of Streams and Average Stream Lengths is plotted in (Figs.

V.7 & V.8). This relationship follows the Horton's law in the former, while it deviates in the latter case. This deviation is seen in higher order streams and it is again on account of the influence of N-S fractures in ~~the~~ the lower portion of the basin.

The longitudinal profile also emphasizes the influence of fractures by showing breaks in lower part of the curve (Fig.V.2). The profile also shows several breaks in the hilly terrain. A distinct break is seen at 21 km from the source of river at the junction of two 4th order channels, which is evidently due to a major NNE-SSW fracture.

KOLAK RIVER BASIN

This basin is located in the extreme south of the study area, having an areal extent of 533 sq.km. (Fig. V.13). In this basin the effect of N-S fracture is more prominent, and this is reflected in courses of the tributaries of this river, especially in the lower part of the basin. Here the 5th order streams are seen flowing in SE direction. However, the higher order streams are showing several bends and curves along their courses. The drainage patterns are observed to change from hilly terrains towards the coastal plains. They are mainly of sub-trellis type in the east but become sub-dendritic to dendritic in the west. Drainage Density is 1.71 and the Bifurcation Ratio ranges from 2.75 to 6.73, and showing higher value of Elongation Ratio (0.51). This is on account of the two main fracture directions.

The linear relationship of the Stream Order to the Number of Stream follows the Horton's law, while it deviates in the case of Stream Order versus Average Stream Lengths (Figs.V.7 & V.8). This deviation has been attributed to the length of higher order streams like 5th and 6th order.

The longitudinal profile of this basin is marked by prominent breaks, and a sudden rise in gradient towards the Trappean Highlands (Fig.V.2).

MAIN OBSERVATIONS

The morphometry of the various drainage basins of the study area, brings out the dominant role of fractures and joints. This is obvious from the very fact that in most basins the Average Stream Lengths when plotted against Stream Order, deviate from the linear relationship. The other parameters also are supportive of the above fact.

In the higher elevations, quite a few low order streams are slope controlled, but this is restricted to steeply sloping areas. On the other hand, low order streams flowing on plateaus or gently sloping ground, at most places follow joints and fractures. Other important factors in drainage development are those of (i) the near horizontality of basaltic rocks, (ii) lithological variations and related response to erosion and (iii) spacing, density, and magnitude of the various sets of fractures.

Higher order streams are, by and large, fracture-controlled and their zig-zag courses point to their flowing along more than one sets of intersecting joints. The trunk streams are following major structural lineaments, viz. Tapi and Purna rivers.