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THE PLANATION SURFACES AND THE DEVELOPMENT OF DRAINAGE OF MAHARASHTRA PLATEAU

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ABSTRACT : The present day drainage network, with major streams having NW-SE trend, and the remenants of the apparent planation surfaces do not show a logical accord. The highest remenants of the planation surfaces are not exactly in the soure region of the east flowing rivers but further east. An attempt is made in this paper to trace the development of the drainage and explain the occurrence and the locational anamoly of the planation surface. The hypothesis is that most of the planation surfaces, mainly those found bg high level plateaus, were developed prior to a period when the drainage attanined the NW-SE trend probably as a result of fractures which developed in association with the Western Ghat faulting activity.

The trend surface analysis was used to establish the surfaces at different levels. It was through this exercise that the existence of a ' central ridge ' in NS direction, roughly coinciding 73^0 40′ E meridian could be established. The occurrence of central ridge with marginal variatious in the details of altitude in each trend surface map helped in building a sequence of possible drainage development over the Maharashtra Plateau.

Introduction

A careful study of the existing drainage pattern over the Maharashtra plateau clearly indicates the existence of W-E segments associated with the main rivers closer to their source region. The two distinct directional components of the main rivers and the topographic differences in these parts lead one to believe that these two could not have been developed through a continuous cyclic development. The WE-components of the rivers are always associated with broad valleys and graded profiles almost up to their source, whereas the N-W SE components are essentially bordered by the escarpments abutted by extensive surfaces around 2500′.

The polycyclic nature of the landscape of Maharashtra plateau has been explained by Dikshit (1970). The surface around 4500′, which includes high level plateaus like Mahabaleshwar- Raireshwar, could be considered as the oldest possible surface within the Deccan trap region. This surface could be identified in north by a number of peaks over 4000' around Harishchandragad areas, though these are not as extensive as the plateau of Mahabaleshwar. Apart from this the surfaces around 3400' (Bhimashankar), 2700′ (Kanhur), 2500′ (Saswad-Peth-Parner), and 2100′ (Ahmednagar) have been mentioned by Dikshit (1970).

An attempt has been made in this paper to build the sequence of the development of planation surfaces and consider the probable development of drainage of this region.

The Data base-and Techniques

For the present exercise the area between 18^0 and 19^{0}' 30′N parallel and 73^0 & 75^0 E meridian was taken. The altimetric values were obtained from one inch tpoographic maps of SOI for each grid size of one square minute. The surfaces which could be identified with the help of altimetric frequency graphs, are 2700' (Kanhur); 2500' (Saswad-Peth-Parner) and 2100' (Ahmednagar). The higher surfaces like that around 3400' (Bhimashankar) and 4500 ' (Raire shwar-Harischanaragad) are not distinctly revealed by altimetric frequency graphs due to the restricted areal extent of these surfaces. However, these surfaces figure out prominently in the superimposed profiles and their existence is undoubtedly proved.

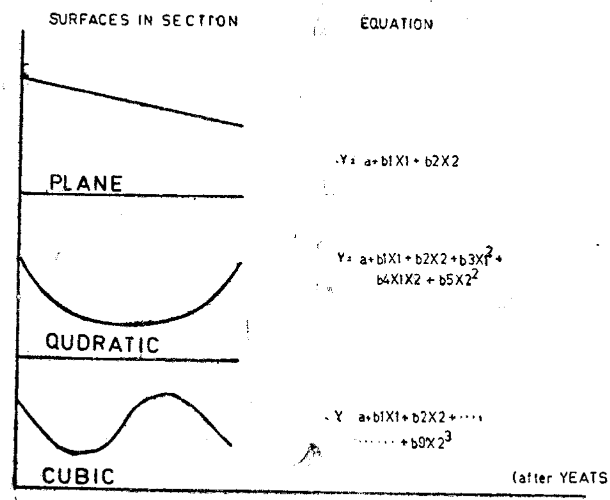

Fig 1

Considering the distribution of the higher level surfaces, confined to western margin of the plateau, and the peculiar distribution of the peaks rising over 4000' was thought that the trend surface analysis could be applied to the altimetrie frequency data.

The trend surface analysis is applied to altimetric frequency data to reconstruct the initial relief conditions. The work of Chorley and Haggett (1965) could be considered as probably the earliest attempt of its application in geography. The work of King (1969) and Doornkamp (1972) can be cited as the other important papers wherein trend surface analysis has been used to explain the earlier conditions.

The trend surface analysis is basically a multiple regression model dealing with three variables. with dependent variable (Y) being height and the explanatory variables being the northings (X_2) and easting (X_1) of the grid used.

The equation $Y = a + b_1X_1 + b_2X_2$ obtains a plane surface with unidirectional slope. The quadratic surface can be obtained by using the equation
$y = a + b_1X_1 + b_2X_2 + b_3X^2_1 + b_4X_1X_2 + b_5X_2^2$
This surface essentially develops a ridge or valley like surface (Fig. 1). The higher degree surfaces can be obtained by using higher powers of explanatory variables X_1 and X_2 and the general form of the equation can be stated as follows :
$y = a + b_1X_1 + b_2X_2 + b_3X_1^2. + b_4X_1X_2 + b_5X^2_2 + ... + b_n X_2^p$

A programme for the trend surface teahnique was prepared and initially a simple plane surface and a quadratic surface were computed for the western part

Table I

exponential powel of vauiables		%explained variance	number of regression coefficients
x_1	x_2		
4	10	37	41
6	10	40	55
8	10	41	63
10	10	44	65

of the area using values more than 4000' As the percentage of explained variance was too low and the possibility of one single surface at this level extending thus far is too low it was thought necessary to have a programme for a higher degree polynomial. For higher degree polynomials the data base was increased by adding values between 3000' and 4000'.

From the distribution of peaks rising to 4000' within the study area, five major valleys were identified such as Nira-Mula-Indrayani Kukadi and Pushpavati. Considering their West-East orientation in the western part and the N-S spacing, the explanatory varible was raised to the 10th power. The programme was then run for the 4th, 6th, 8th and 10th power of X_1 variable (Eastings). The following table records the percentage of variance, explained at each stage alongwith the number of regression coefficients.

Results

The computed surfaces have been shown In fig. 3. The North-South orientation of the higher peaks (over 4000') is found to have been continuously controlling the distribution of altitudinal values computed for each surface. These peaks have always been responsible for developing a ridge like feature roughly coinciding with 73° 40 ' E meridian with a major Col in the present Indrayani valley. The maximum value of coefficient of multiple correlation reached is 0.6624 in case of 10 th Degree polynomial. The low percentage of explained variance (43.88%) may be considered as a result of complex nature of the distribution of altimetric frequency values.

The consistent occurrence of ' Central ridge ' on all the trend surface maps almost in the vicinity of the major 4000' peaks, to the east of present Ghat escarpment, suggests the occurrence of a ridge in the prefaulting period. This gives a clue to reconstruct the probable sequence of drainage development.

Drainage Development

It has been suggested by Dikshit (1970) that the pretrappean drainage on the Maharashtra plateau was flowing westward with probably eastern ghats as the divide. The erruption of the lava was a major event which disturbed the overall pattern of drainage existing in pre-trappean period. considering the higher frequency of the dykes in the Western part o the plateau it may be assumed that the centre of erruptive activity was somewhere between 73° and 74° E. It is interesting to note that ' central ridge, ' repeateatedly occurring on every trend surface map, lies more or less in the same region.

The probable sequence of the events associated with the Deccan trap formation and western ghat faulting has been shown in fig. 2. With reference to the decreasing thickness of the basalt in the eastern part of the plateau the westward slope of pre-trappean surface can be visualized. Fig. 2a shows such surface over which the existing drainage was flowing westward. The errupt.

ive activity of the late Cretaceous and early Tertiary in the western part of this surface, caused a continual outpouring of lava. This continued, with intervals, for a long period till the Deccan Trap. country finally came into existence. Thus a newly built basaltic plateau, with a 'central ridge' was developed over which new drainage lines were initiated. These streams flowing in either directions from the central ridge were

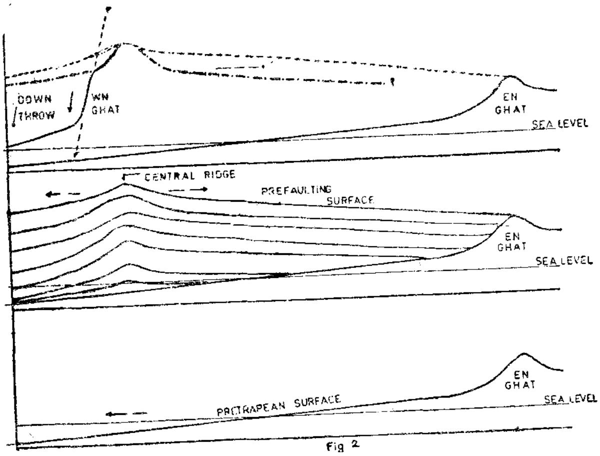

Fig 2

disturbed by the later event of the Western Ghats formation. The Western Ghats, identified as the edge of the plateau overlooking the escarpment on their west originated as a result of a series of longitudinal faults with their original location to the west of the 'central ridge.' This explains why the high peaks of the Maharashtra plateau are not necessarily along the ghat escarpment.

The Sequence of Drainage Development

Fig. 4 presents schematically a sequence of the development of drainage lines. Starting with the due W-E drainage lines on either side of the central ridge, the successive changes in the orientation of drainage lines have been shown in fig. 4a-b, c, d, e, f. The rivers on the eastern side of the central ridge, having a easterly flow at least in the source region, are associated with major low cols in the Western Ghats. Pavana, Pushpavati, Kukadi, Bhima, Indrayani, Mula, Karha and Nira are the eight major east flowing rivers. On the western side a number of rivers have been assumed. No river has been named or no attempt has been made to identify them with present Konkan rivers. This is mainly for the reason that the probability of same rivers to continue to exist over a down thrown portion is considered too low.

Over a period of time, even before faulting, a number of cols developed in the central ridge by the headward erosion of these rivers. The next major event was the faulting itself. The origin of the ghats could not possibly be associated with a single event, it must be in fact a chain of events. Moreover the exact location of the fault line is also a point of debate, though it could be said with certainty that it was to the west of the 'central ridge'. It has already been mentioned that the major peaks of the plateau are not located along the ghat escarpment. As a result of faulting giving rise to Western Ghat formation the basins of the west flowing rivers underwent a down throw of several hundred meters and only part of their source region was left at higher altitudes (Fg. 4b).

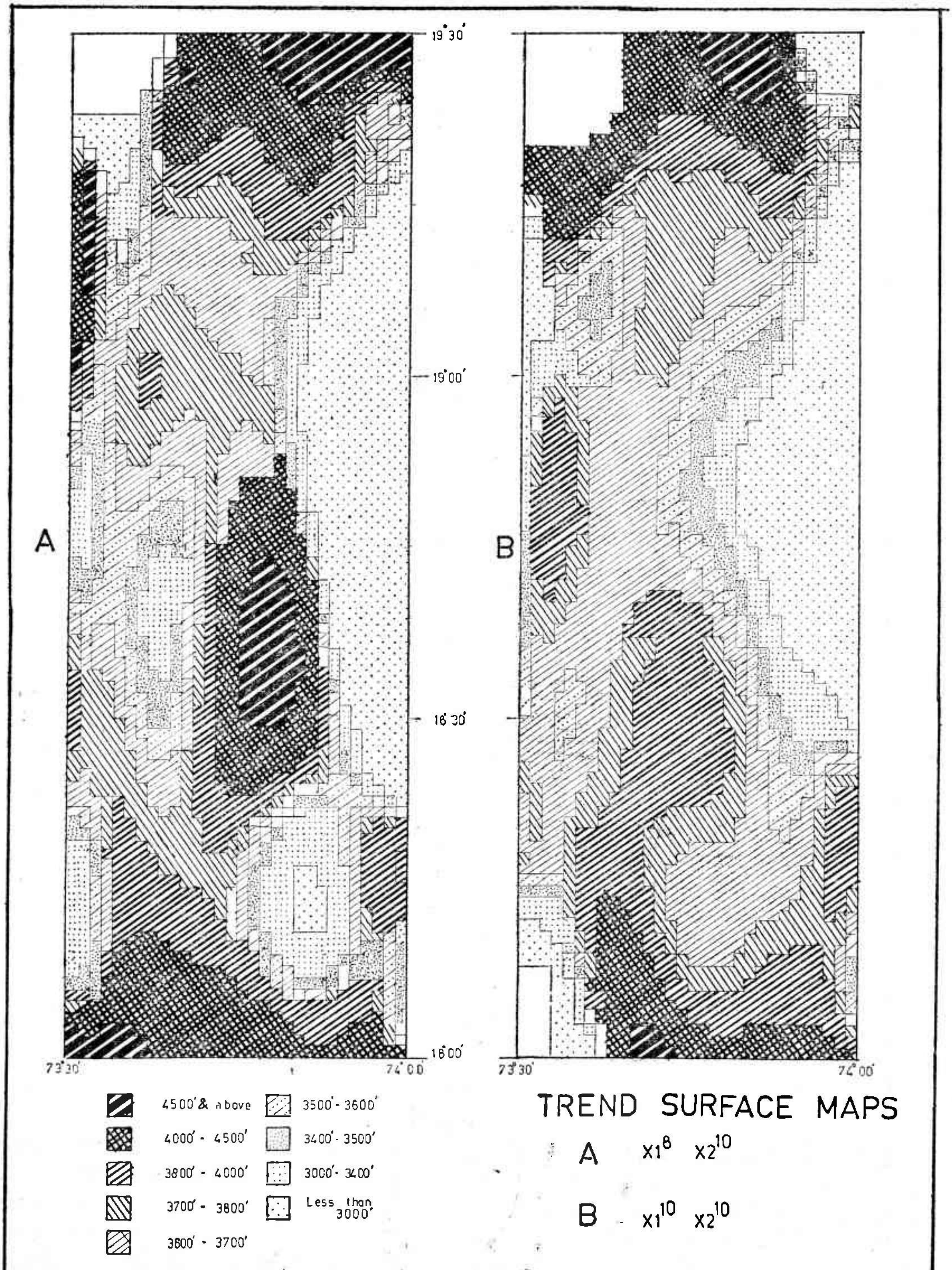
19°30'
19°00'
16°30'
16°00'
A
B
73°30'
74°00'
73°30'
74°00'
4500' & above
4000' - 4500'
3800' - 4000'
3700' - 3800'
3600' - 3700'
3500' - 3600'
3400' - 3500'
3000' - 3400'
Less than 3000'
TREND SURFACE MAPS
A x1^8 x2^10
B x1^10 x2^10

Fig. 3

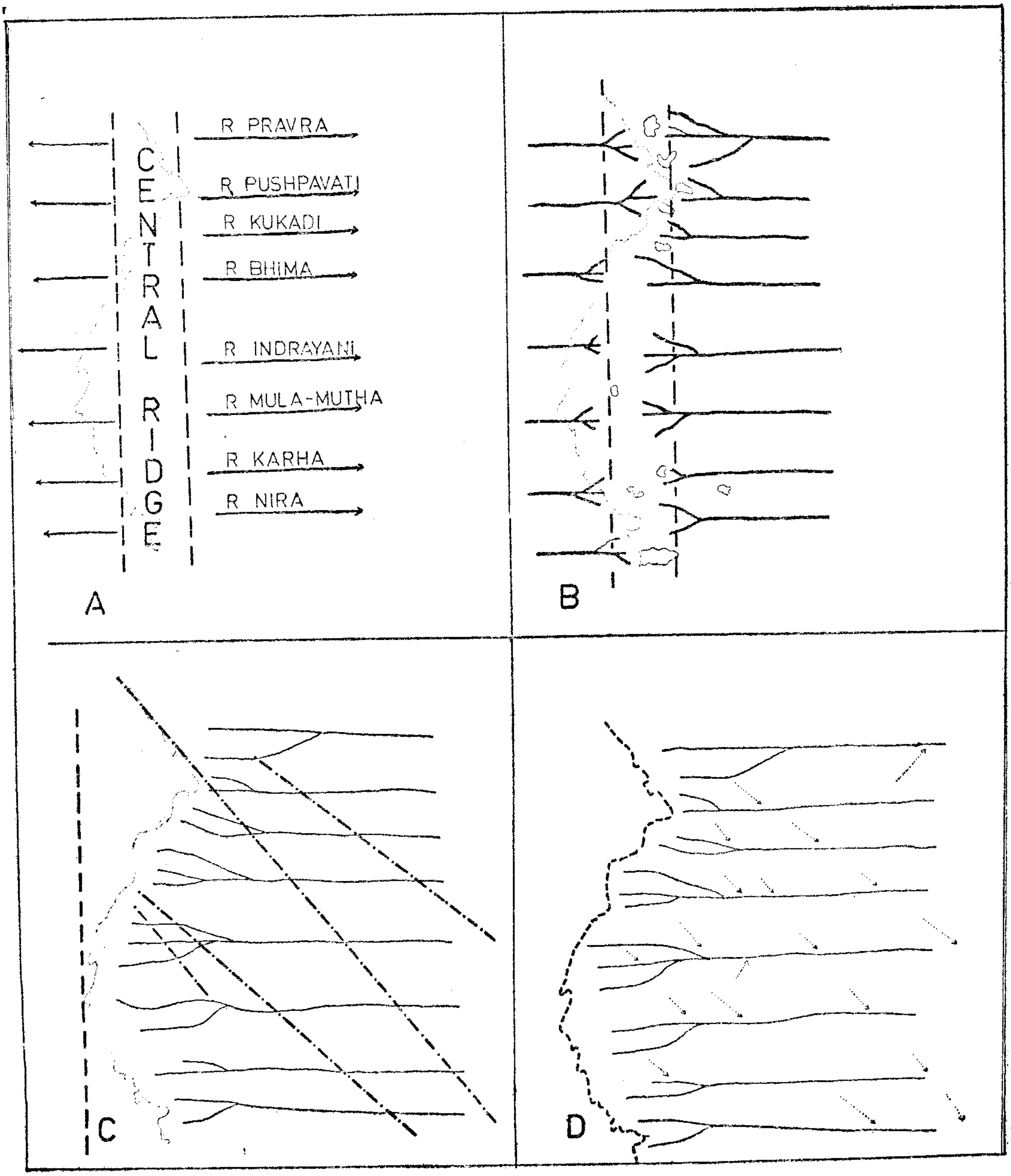

Fig. 4

It is contended that prior to the faulting these existed at surface around 4500' with valley floors reaching as low as 3500' (or even less). A number of fractures and minor faults in NW-SE direction also developed, over the plateau region concurrently the major north-south fault. The lineaments of these minor faults can be easily traced from the satellite imageries.

The newly developed main fracture zones have been shown in fig. 4c. These fracture zones were responsible for the diversion and change in the course of the rivers, through the capture. The small streams which

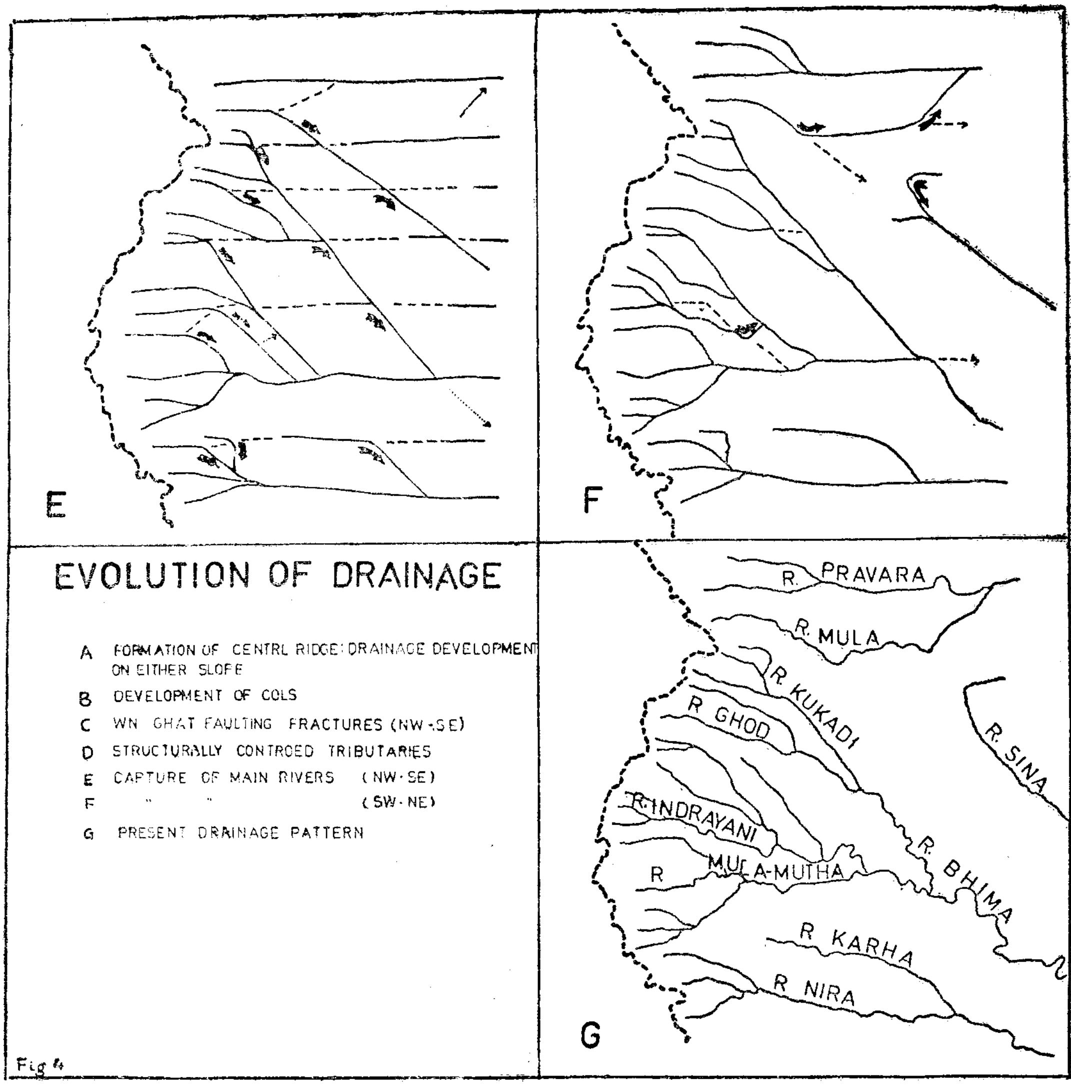

Fig. 4

devloped along these fractures have beene shown in fig. 4c. These newly developed tributaries, following the structural guide lines were responsible for diverting the waters of main rives. The most important fracture zone was occupied by the Kukadi-Ghod and Bhima rivers. It is interesting to note that the north western continuation of this fracture line coincides with present ghat scarp beyond river Pravara.

It can be seen in fig. 4 that river Pravara is still maintaining its original West-East course. The main derangements is to the south of Pravara which lies beyond the main fracture zone. The development of minor fracture and capture by tributary streams resulted in diverting Mula (a tributary of Pravara), Meena (initially tributary of Kukadi), Bhima, Indrayani, Kanand and Shivaganga to southeast. Later the minor fracture lines giving rise to small tributaries in NE-SW direction diverted Pushpavati to Pravara and Indrayani to Bhima (fig. 4).

The major changes which might have

occurred after this can be listed as follows :

1. Mula (Of Pravara) originally diverted in SE direction was recaptured by lower Pushpavati flowing into Pravara.

2. Upper Pushpavati along with Mandvi was diverted to the Kukadi.

3. A part of Pushpavati, left over portion of Kukadi and old Bhima developed into a stream roughiy coinciding present Sina.

The last map in the series shows the present day pattern of the rivers alongwith the major surfaces. It is interesting to note that the 2500' surface, the most extensive and well maintained, has the scarp almost parallel to the rivers bordering them.

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