EVOLUTION OF THE SON DRAINAGE

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(Communicated by W. D. West, F.N.A.)

(*Received* 9 *July* 1970)

A geological study of the western portion of the Son valley, where the Son takes an abrupt E.N.E. bend from its northerly course, has led the author to conclude that the present drainage of the area was superposed from a Deccan Trap cover, and the course of the Son river has been controlled by lithology and not by any major faulting. It is also concluded that there is a Pre-Trappean erosion surface at about 1600′, as originally pointed out by R. D. Oldham. The drainage appears to have originated on the Deccan Traps which were later denuded away, exposing the underlying older formations. By a process of differential and headward erosion, all the northward flowing tributaries were finally captured to form the Son river.

INTRODUCTION

Since the work of Oldham *et al.* (1901), describing the evolution of the various geomorphic features on a regional perspective, no serious attempt seems to have been made to study the geomorphology of the Rewa plateau or the Son valley region. In an article published in 1962, Ahmad postulated the significance of faulting in the formation of the Kaimur scarp. While discussing the Son's course, Rao (1965) stated that joints might have played a major role in the formation of the gorges across the Basal quartzite ridge (of the Semri series) and also in controlling the drainage of the area. As a result of the work hitherto done by the author, some tentative suggestions are given regarding the evolution of the drainage course of the rivers Son (*Swarnamukhi*) and Tons (*Tamasa*). It is admitted that the hypothesis presented herein is not conclusive and its validity is being tested. Nevertheless, the author believes that this aspect of the origin of the drainage merits consideration

GEOLOGY OF THE AREA

An area of 620 square miles falling under long. 80° 55′ and 81° 30′ and lat. 24° 0′ and 24° 15′ was geologically mapped (Fig. 1) on the one inch to a mile topo sheets 63 D/16, 63 H/4 and 63 H/8. As a result of this field work, the author proposes the following sequence for the area:

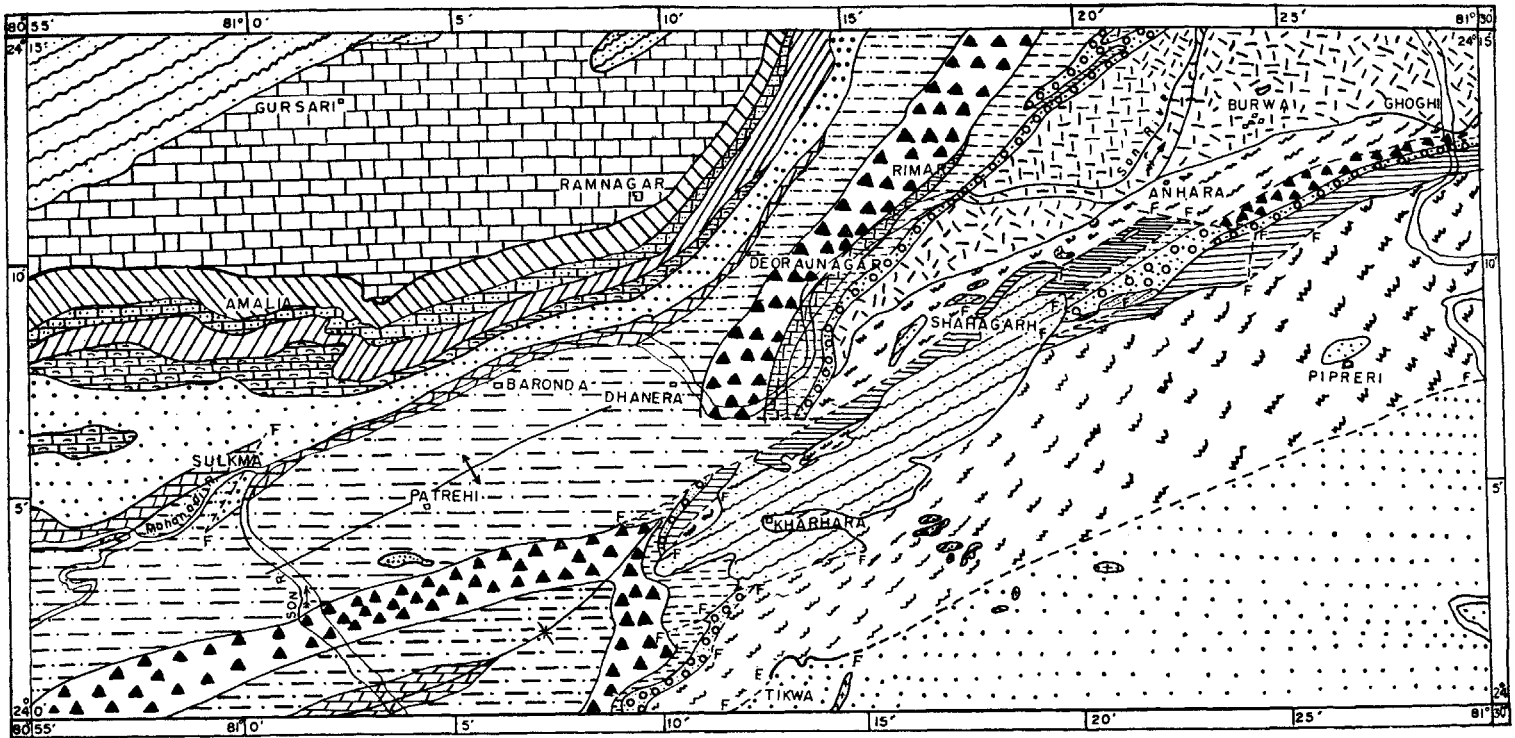
	Deccan Trap—Dolerites and basalts	
	Gondwana (Supra-Barakars)—Sandstones and clays	
	Upper Vindhyan (Kaimur series)—Quartzites	
Lower Vindhyan	Semri series	4. Rohtas stage—Limestones 3. Kheinjua stage—Shales, limestones and sandstones 2. Porcellanite stage—Silicified tuffs, shales and sandstones 1. Basal stage—Conglomeratic sandstone, shale and Kajrahat limestone
	Red Shale series	Upper-Sandstone Middle—Shale Lower—Conglomeratic sandstone
	Granites and associated instrusives Bijawars—altered tuffs and flows, quartzites and limestones	

(———) indicates unconformity.

Major Drainage Trends

The most important physiographic feature in eastern Madhya Pradesh is the great Kaimur escarpment. This forms the watershed or divide for two of the major rivers of peninsular India, the Son on the south and Tons on the north (Fig. 2). It is found that the Kaimur scarp extends from Sassaram (in Bihar) on the east to the source of the Mahanadi (beyond the confluence of the Son and Mahanadi on the west). Throughout its length of 300 miles and throughout its continuation into the Narmada valley it is not breached at any point by any stream flowing northwards. With a few minor exceptions no stream flows from the north to join the Son river. Everywhere the scarp rises to a height of 500 to 1000 feet above the low ground at its foot and though the height of the crest varies from place to place through undulations of the strata or the varying amount of strata removed by denudation, there is nowhere a deep cut gap or easy passage from the north to the south of the Kaimur range. This unique feature of the absence of any gorge or wind gap across the Kaimur scarp indicates that no stream of considerable size ever flowed due north across the scarp.

GEOLOGY OF PART OF THE SON VALLEY IN THE SATNA AND SHAHDOL DISTRICTS



LEGEND

- DECCAN TRAP INTRUSIVE
- GONDWANA–SUPRA-BARAKAR
- Unconformity
- Upper Vindhyan — LOWER KAIMUR QUARTZITE
- Unconformity
- ROHTAS STAGE—LIMESTONE
- LOWER VINDHYANS — KHEINJUA STAGE — BLACK SHALE
- LIMESTONE
- GLAUCONITIC BEDS
- LIMESTONE
- SANDSTONE AND SHALES
- LIMESTONE
- OLIVE SHALES
- BASAL STAGE — PORCELLANITE STAGE
- KAJRAHAT LIMESTONE
- SHALE
- CONGLOMERATIC QUARTZITE
- Unconformity
- RED SHALE SERIES(?)
- Angular Unconformity
- GRANITE AND GNEISSES
- BIJAWARS

- ANTICLINAL FOLD AXIS
- SYNCLINAL FOLD AXIS
- F---F FAULT

FIG. 1.

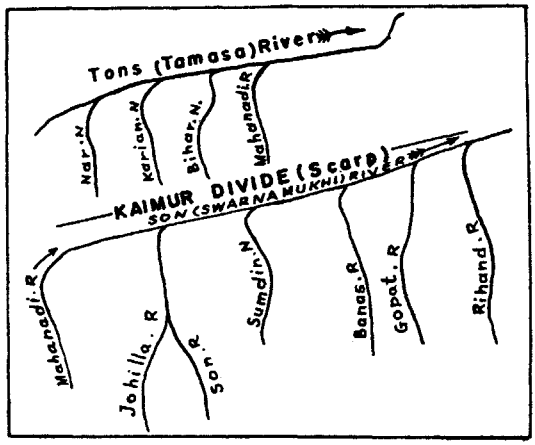


FIG. 2. Sketch map showing the major drainage trends

A study of the physiographic map will reveal that the drainage trends of the tributaries of the Son and the Tons on either side of the Kaimur divide are towards the north (Fig. 2). All the important tributaries of the Son river to the south of the Kaimur scarp with a few trivial exceptions have a northerly or NNWly course till their confluence with the Son. Some small *nullahs* from the south of the Kaimur scarp, however, are found to cut across the sandstone ridges of the Kheinjua stage of the Semri series and flow south into the Son. These are the small obsequants over the southern flank of the Kaimur range. Similarly, some of the tributaries of the Tons to the north of the Kaimur scarp before continuing their northerly or NNWly course are found to flow ENE, presumably tracing a soft shale band between the Kaimur and Rewa series. The Son before receiving many of its tributaries is no larger than any of the major streams draining into it like the Banas, Mahanadi, Rihand, etc.

LITHOLOGICAL CONTROL OF THE SON'S COURSE

It is significant that although all the major tributaries of the Son come up to the foot of the Kaimur scarp to join the Son, not a single stream cuts across the scarp. It appears that structure or lithology of the Bijawar, Red Shale series or the Semri series do not have any bearing or control on the northerly course of these streams.

The Basal quartzite ridge of the Semri series has been cut down producing gorges at a few places like Deolond, Dembha, etc. The presence of gorges in the Basal quartzites of the Semri series and the wind gap at Kushmahar (Oldham *et al.* 1901) and the total absence of any of them in the Kaimur scarp to the north is note-worthy.

Over a greater part of its course the Son flows through the soft Kheinjua rocks of the Lower Vindhyans and no major fault seems to control or to have controlled its course.

Absence of Major (boundary) Faults in the Son Valley

In the Son valley faults are more common to the south within the Gondwanas. Though major faults are common, fault of the nature and size of a great boundary fault is nowhere seen and no such fault seems to have controlled the course of the Son river.

None of the pioneer workers in the Son valley has pointed out the existence of major faults in the Son valley (Mallet 1869; Oldham *et al.* 1901; and Auden 1933 & 1972). Medlicott and Blanford (1879) have thought that 'along the whole Son valley there is little or no faulting in the zone of disturbance, but at the Son-Narbada watershed one or two more faults occur at and close to the boundary, the ENE strike being remarkably steady throughout'. This view is expressed in all the successive editions of the '*Manual of the Geology of India*' (Medlicott and Blanford 1879; Oldham 1893 and Pascoe 1959).

Ahmad (1962), however, finds difficulty in explaining the origin of the Vindhyan (Kaimur) scrap in the Son valley without invoking the help of intense faulting where in reality no such intense or major faulting is recognisable. Rao (1965), on the other hand ascribes the credit of bringing out large-scale faulting to Dr. West. In explaining the origin of the Kaimur scarp Ahmad overlooks lithological control, and seems to overemphasize the part faults play in the formation of scarps. According to Ahmad (1962), "epeirogeny initiated the formation of the Vindhyan plateau, but very soon after a narrow belt of country that may extend for 15–20 kms. south of the Vindhyan scarp was subjected to strong tensional forces, which resulted in a number of step faults and further uplifted the area into a tableland. Extensive fracturing and jointing as also local folding in the Vindhyan formations accompanied this faulting. The rocks involved were thereby completely shattered and became extremely prone to rapid erosion and denudation. This has resulted in the scrap which conforms neither to the definition of a 'Fault Scrap' nor of a 'Fault-line Scarp'."

Unilateral Drainage of the Area

The great strike valley of the Son is bounded to the north by the Kaimur scarp and is flanked to the south by the Gondwana plateau with Deccan Trap outpourings. The Son and most of its tributaries originate from the high Amarkantak plateau which is the eastern termination of the Satpura ranges. The Amarkantak plateau rises to an elevation of 3698′ and forms an important topographical feature in eastern Madhya Pradesh. Leaving the plateau in a northerly direction the streams pass through coal-bearing Lower Gondwana terrain composed of shales and sandstones. Along the course of the river the Lower Gondwana is sporadically capped by small patches of Deccan Trap. A few miles north of lat. 22° the river enters the Upper Gondwana country of soft sandstones and clays and flows in the north-northwesterly direction. It crosses a narrow belt of crystalline granites and Bijawars south of lat. 23° and then passes into the Lower Vindhyan terrain of softer formations. It is here on the softer

Lower Vindhyans to the south of the Kaimur scrap that it changes its course from the N.N.W. to E.N.E. The Son near the bend is found to actually follow a limestone band of the Kheinjua stage. For almost the rest of the course it more or less maintains this direction till it merges with the Ganges

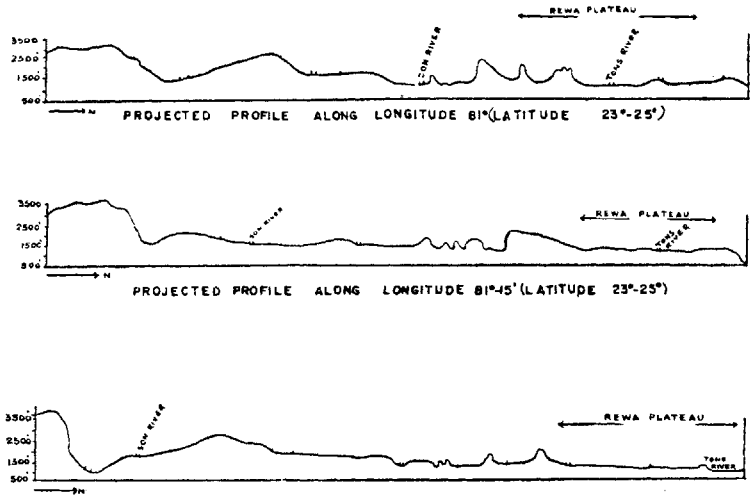


FIG. 3. Projected profile along longitude 81°–30°

As already pointed out, throughout its length the Son receives no tributary of any importance from the north. Although Oldham *et al.* (1901) drew attention to the unilateral drainage, they did not ascribe any reasons for it. This, the present author feels, was due to the higher altitude occupied by the eastern termination of the Satpuras and a general north-northwesterly slope.

REVERSAL OF DRAINAGE AND UPLIFT OF THE SATPURAS

If the drainage history of the area is considered, according to Oldham (1901), '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 the Vindhyan System was deposited.' This finds support in the study of the palaeocurrents made by the author (under publication).

It is generally believed that during Upper Gondwana time the drainage was to the south, the fluviatile or riverine Upper Gondwanas were deposited in faulted troughs and Vindhyans also appear to have contributed much detritus. In the present area of study it was found difficult to study the current direction in the Gondwanas, since they are largely covered up by alluvial deposits. It is suggested here that a palaeo-current study of the Gondwanas will be worth undertaking in not only proving the drainage direction, but also in finding out whether the present limit of the Gondwanas

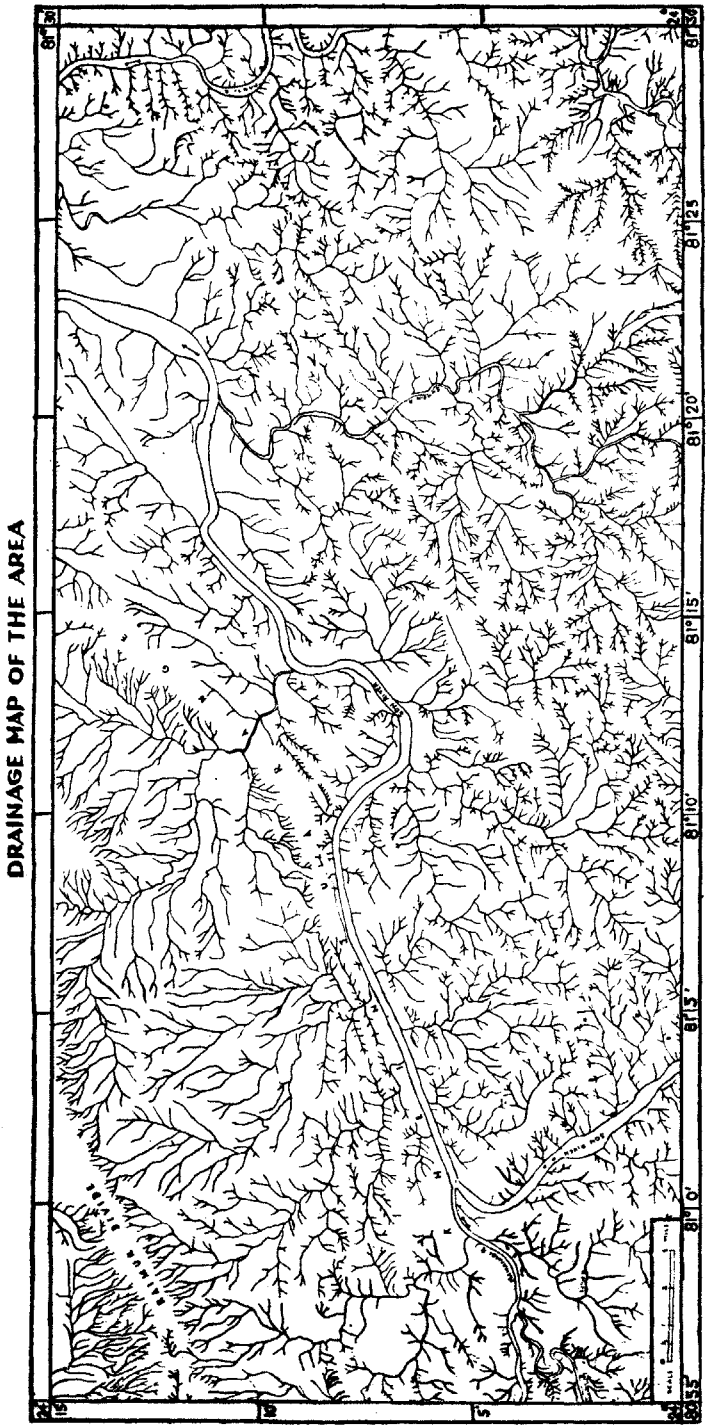


FIG. 4.

represents the original limit. But the present drainage trend to the north originating from the Deccan Trap shows that the trend might have been reversed. At the same time no evidence of an antecedent drainage is seen indicating gradual uplift of the Satpuras. This, in other words, helps in fixing the date of the uplift of the Satpuras in this region. The descent of the Son and its tributaries from the Amarkantak plateau is more or less steep and abrupt.

Pre-Gondwana Topography

In the course of the work a few outliers of Upper Gondwanas at Nipania have been noticed and at Patrehi, roughly three miles to the south of the Son river, where it takes an easterly bend from its northerly course, and also at Papreri and Tikwa. The Gondwanas show a distinctly faulted contact with the older rocks. This peculiar feature of the extension of the Gondwana sediments to the north of the faulted contact was explained by Vredenburg (Oldham *et al.* 1901) as being due to the rate of deposition in the Gondwana basin exceeding the rate of subsidence along the faulted margin.

This shows that the Kaimur scarp is an erosion scarp which had retreated more or less to its present position and a valley, a precursor to the present Son, was etched even before the Gondwanas were deposited.

Extension of Deccan Trap over the Area

Auden (1949) points out the significance of the highly titaniferous bauxitic laterite on the Rohtas plateau as also the numerous outliers of the Deccan Trap that exist between Rohtas and Ambikapur and thinks that 'the Deccan Traps at one time covered Vindhyans and Archaeans alike in this region at least as far east as longitude 85°. This is 190 miles beyond the main existing outcrop'. Recent workers on laterite and bauxite, like Roy Chowdhury (1958), Roy Chowdhury *et al.* (1966), concur with the suggestion of Fox (1936) that the outliers of laterite in these areas represent the actual original extent of the Trap spread. Pascoe (1963) states that the Deccan Trap 'once extended far northward into Bundelkhand and eastwards past Lohardaga to the Raniganj coalfield'. While discussing the coal deposits of Mirzapur and Singrauli in U.P., Coulson (1939) has shown a number of Deccan Trap outliers at Ubri, at Manhari on both sides (east and west) of the Rihand river, etc. (*refer map of Coulson*). Roughly nine miles to the south from the northerly to the easterly bend of the Son river, small outliers of Deccan Trap have been reported at Baturaba by Rao (1967). Quite recently Ahmad (1966) also had discussed the possible former extent of the Deccan Trap over the Kaimur plateau.

Furthermore, the author for the first time has noticed numerous dykes (and a sill) intruded into the Gondwana sediments in the vicinity of Beohari, while they are also seen abundantly exposed in the Katni-Singrauli railway-cutting. Deccan Trap flows also occur a few miles to the south of Beohari and at Patna. The possibility that these intrusives may be the feeders of the flows cannot be ruled out. West (1959) has moreover shown that the trap flows in some cases have travelled up to a distance of 83 miles or more.

Considering the above evidence there appears to be a strong probability for the flows originally to have spread over the whole area.

Pre-Trappean Erosion Surface

Oldham *et al.* (1901) regard the Son river gorges in the Basal quartzite to have been formed by superimposition from a higher surface level, with which view the present author agrees. According to Oldham, the country was reduced to the level of a gently undulating peneplain with a gradual drop in height from west to east before the present course of the Son river was evolved. It can as well be argued whether the superimposition could not be from the Gondwanas which might have extended to the north from their present limit. West (1962) has pointed out that though it is possible for the Gondwanas to have been deposited over the Vindhyans to the north of the Narmada and Son valleys and later completely denuded away, there is no evidence however to suggest this. Gondwana sediments are nowhere found to intervene between the outliers of Trap and Vindhyans to the north of the above two valleys.

A significant geomorphic feature of the area is the Pre-Trappean erosion surface. All over the Son valley this peneplain can be recognized by the uniformity of summit levels at about 1600′ above M.S.L. By studying the summit heights over the sandstone and quartzite ridges of the Kheinjua and Basal stages of the Semri series, the Bijawar quartzite ridges and the Kaimurs, Oldham recognized the erosion surface to be at 1600′. There has been difficulty in reconstructing the Pre-Trappean profile, since systematic mapping (on the scale of one inch to a mile) by the Geological Survey of India of the southern portion of the area (forming part of the Amarkantak plateau, covered by Gondwanas and Traps) is still under progress and also the level of the contact of the Traps with the older rocks is not known.

If the accordance of summit levels of the sandstone ridges of the Kheinjua and Basal stages is considered, they agree well with the 1600′ surface of Oldham. Similarly an even crest is seen distinctly in the Kheinjua quartzite ridge overlooking the Son-Mahanadi junction. These conclusively suggest the existence of a peneplain at about 1600′. However, some of the spot heights over the Kaimurs are more than 2200′ in the area covered by the author opposite the easterly bend of the Son; but this level gradually drops to 1600′ about 30 miles to the east, and it persists further east, especially in the areas to the east of Sidhi where the ridges of the Lower Vindhyans, Bijawars and Kaimurs are all found to occur at more or less the same height.

Now the question arises whether the traps covered only up to the Kaimur scarp or covered the whole area. There are no ways of finding out the original thickness of the trap cover over these rocks. The presence of lateritic and bauxitic outliers and also pieces of chalcedony definitely derived from traps point out to the former trap spread over the Kaimur and Rewa plateaux. The incongruity in the heights shown by the Kaimur scarp in the area of study with the 1600′ erosion surface is explained by Oldham *et al.* (1901) as follows: 'The Kaimur range being broader and more plateau-like than the narrow range of the basal quartzite ridge has probably been lowered in a lesser degree of denudation and the present difference in elevation—739 feet—is more than the difference at the commencement of the last period of uplift. From this we see that the Kaimur scarp must then have been in existence but the highest points probably did not rise more than 500 feet above the level of the Son valley, while depressions must have descended nearly to its level. Instead of a continiuous barrier

there must have been consequently a series of low hills with broad, open easily traversed gaps between them'.

When the eruption of the traps leading to the complete burial of the area ceased, gradual uplift appears to have taken place probably during early Tertiary times. The drainage as we see it at present was initiated over the Deccan Trap. With the gradual removal and denudation of the traps the mature topography formed before the eruption of the Traps was resurrected.

Discussion

The northerly drainage trend of the tributaries of the Son and the Tons and also the presence of gorges cut by these rivers in the Basal quartzite of the Lower Vindhyans and their total absence in the Kaimur scarp has already been pointed out. The pattern of the flow of the Son river where it is flowing ENE between Dhanera and Anhara across different stratigraphic horizons and more particularly its crossing the Kajrahat limestone band of the Semri series thrice is an indication of superimposition from a surface above (Vaidyanadhan—personal communication). Oldham *et al.* (1901) regarded the gorges in the Basal quartzite to have been formed by superimposition. It may not be irrelevant to recall the view of Oldham *et al.* (1901) here according to whom 'the course of Son was fixed at a time when the form of the surface was determined by different conditions to those now it is dependent on, and has been superimposed on the present surface features'.

According to the evidence in the western portion of the Son valley, the Kaimur scrap retreated more or less to its present position prior to the deposition of the Gondwanas thereby exposing the underlying softer Lower Vindhyan formations composed largely of calcareous and argillaceous sediments. It is also shown that the course of the Son river is not controlled by any major faults. It can reasonably be conjectured that the Deccan Traps once spread over the entire area, and the drainage as seen at present in the Amarkantak plateau was initiated on the Deccan Traps.

The only remaining possibility is that denudation of the traps probably helped by some faults near the mouth of the Son river (confluence with the Ganges), exposed the contact of the hard resisting Kaimur quartzite with the undelrying softer Lower Vindhyans. Because of the differential erosion along the contact, the Lower Vindhyans were freely exposed and eroded at a faster rate with the result that the streams and *nullahs* which were flowing over the (Deccan Trap) Kaimur scarp to the north were split up into two drainage system with the Kaimur scarp forming the divide.

As the contact was gradually being etched out, the northward flowing tributaries were diverted from a northerly to an easterly course by a process of headward erosion, with the scarp bound them to the north. The absence of any wind gap or gorge across the present Kaimur scarp can be explained as due to the original drainage having been superposed over the Deccan Traps which subsequently were denuded away. Thus by a process of headward erosion and diversion of drainage all the northward flowing tributaries were captured to form the great Son river.

Study of Plate 32 of the National Atlas Organization (Nagpur Plate, Physical) by Vaidyanadhan (personal communication) has led him to conclude that 'the Son river could have been superposed over the Sohagpur Basin (around 1600 feet above M.S.L.) and the first and second order streams in the uppermost reaches of the river should have been diverted into it comparatively recently.

It is quite possible that the Johilla river over Maikala range could have once flowed into Narmada or more possibly Umrar before captured by headward erosion of one of the tributaries of the Son'. Unlike the Narmada or Tapti Valley, the Son does not show much alluvial development. Ahmad (1962) draws attention to the presence of alluvium over the plateau to the north of the Son river. To quote Ahmad (1962): 'Then again, an extensive area near Chaura, above the tableland is covered by recent alluvium that may range from three to five metres in thickness. The drainage from this area too runs northwards and is not part of the Son system. The alluvium has now been cut throguh by a comparatively small stream and Vindhyan rocks are exposed underneath.' Although the author differs with the interpretation given by Ahmad for the above, this is significant in this context to show that streams flowed to the north and deposited the alluvium.

Acknowledgements

The author is indebted to Prof. W. D. West for guidance, facilities provided and for critically going through the manuscript. Thanks are also due to Dr R. Vaidyanadhan for suggestions, comments, and for going through the manuscript.

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