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Morphotectonic Evolution of Mahan Drainage System in Son Trough Region of Vindhyanchal - Baghelkhand South, Madhya Pradesh

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Abstract: *River Mahan, a major tributary of the Banas river in the Son system, cuts across Archaean granite-gneisses and Bijawar quartzites of lower Cuddapah system. The study area is marked by three phases of unconformities which indicates that the basin is tectonically highly disturbed as reflected by faulting, folding and upwarping of the lower Vindhyan system. Consequently the streams were also rejuvenated. The drainage pattern in the Mahan river catchment is mostly dendritic and in parts trellised and radial and are controlled by structure of the rocks rather than the regional dip. The Mahan valley was covered by Deccan Traps during Cretaceous period which was subsequently removed. Presence of residuals laterites at the surface of Rewa plateau indicate presence of earlier basaltic cover. The Deccan lavas probably obliterated the pre-existing drainage network and during Tertiary period, new drainage lines began to develop over the solidified basaltic cover and the Mahan river established its course over the lava covered surfaces. Thus, the morphotectonic evolution of the Mahan drainage system appears to be a superimposed one. The Mahan basin has a variety of lithologies including granite, gneisses, schist, phyllite, quartzite, limestone, conglomerate, clay and sandstone. These rocks, affected by morphogenetic processes and tectonics, have carved out varieties of morphological facets. Six geomorphic units have been identified in the basin viz. dissected upland, structural relief, buried pediplain, piedmont plain, ravinous zone and young alluvial zone.*

Introduction

The Mahan river basin, occupying about 573.76 km^2 geographical area, is enclosed between $24^0$02' N to $24^0$20' N latitude and $81^0$27' E to $81^0$55' E longitude within the Sidhi district of Madhya Pradesh (Fig.1). It is a part of Peninsular Foreland falling between alluvial stretch of Great Plains and the Deccan (Singh, 1971) that forms a distinct physiographic unit of Sidhi-Agori Upland of Vindhyanchal-Baghelkhand South. It gradually merges with Deogarh Upland in the south and with Son Trough in the north (Singh and Singh, 1971). The river Mahan arises at an elevation of 450 m and flows southwest for a distance of 46.77 km cutting across granite-gneisses of Archaeans, Bijawar quartzite of Lower Cuddapah System and joins the Banas river at the height of 255 m near Bhanwarsen Ghat hills of Khainjua ridge. The important

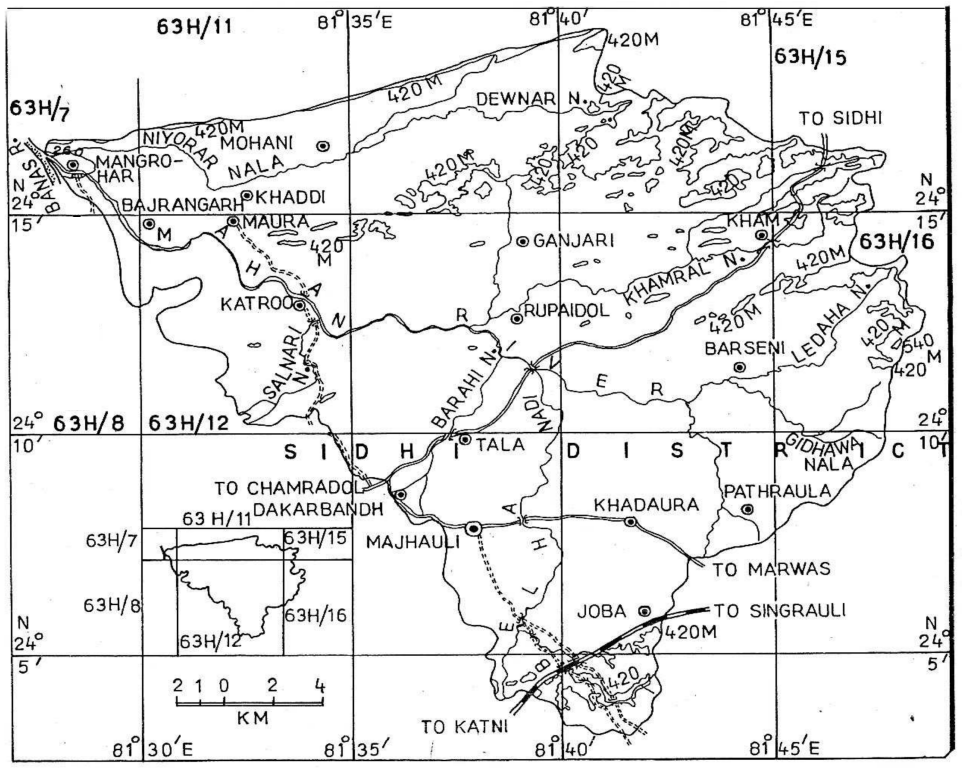

Figure 1. Index map of Mahan river basin

tributaries of the Mahan river are Niyorar, Salnari, Barahi, Gidhawa, Belha, Ledaha and Khamral. The study region, being located in the central part of the humid inesothermal (CW_g) climostatical region of India, enjoys sub-tropical monsoon climatic condition with hot-dry summer, good rainy season and cool-dry winters. The soils of the area, in general, are shallow to deep, non-calcareous, imperfect to moderately well drained and having moderate to low permeability. The climate and soils, as conditioned by structure and relief over a period of time, have played significant role in providing favourable conditions for growth of natural vegetation of deciduous type. Thus, the physical environment incorporating geological structure and geotectonics in collaboration with topo-function, climo-function, pedo-function and floro-function have given rise to a unique geomorphology of the Mahan river basin. In the present investigation, an attempt has been made to assimilate the physiographical, geomorphological, geological and structural evidences to dwell upon the morphotectonic evolution of the Mahan river valley.

The Mahan drainage basin

With an average annual rainfall of 1,089.7 mm the Mahan river basin is drained by a large number of small and seven big tributary streams like Niyorar, Salnari, Barahi, Gidhawa, Belha, Ledaha and Khamral (Fig. 2). The details of these major tributary streams regarding their area, length and order are as follows (Table 1):

The Mahan river emerges from the higher altitudes of Majhauli block at an elevation of 450 m and flows south-west for a distance of 46.77 km cutting across granite-gneisses of Archaeans and Bijawar quartzite before joining Banas river at an elevation of 255 m near

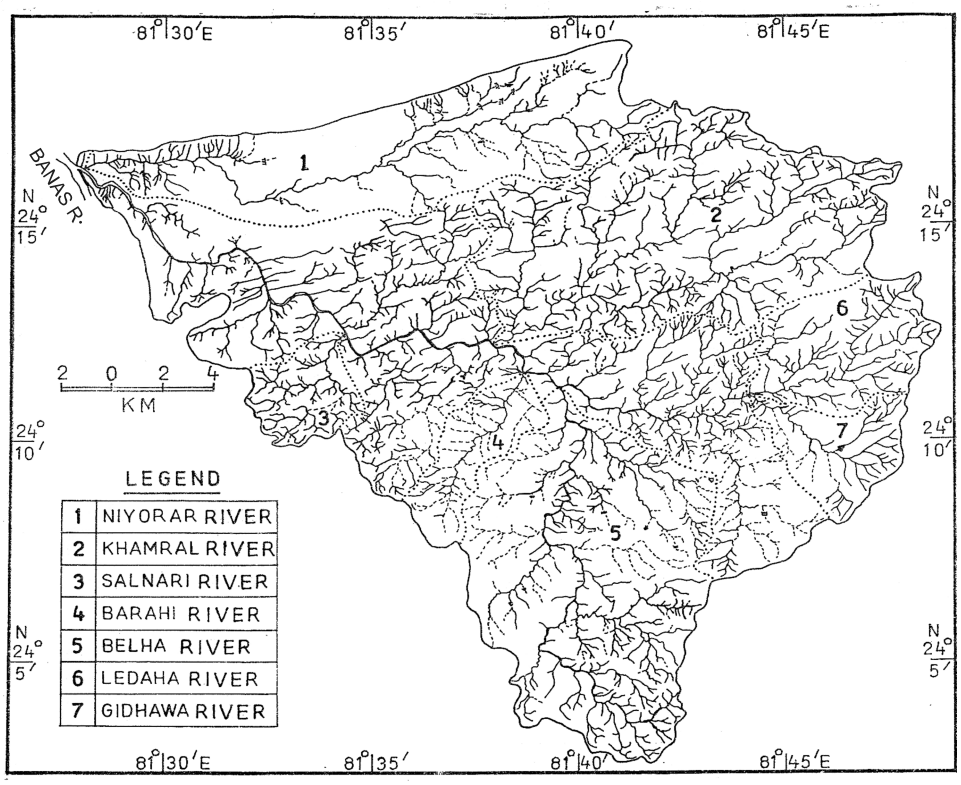

Figure 2. Drainage system of Mahan river basin

Bhanwarsen Ghat hills of Khainjua ridge. In fact, the Mahan is a major tributary stream of the Banas river which ultimately joins the Son river at Bhanwarsen Ghat (24°16'51" N, 81° 11'29" E).

Table 1. Major tributaries of Mahan river

S.no.	Basin	Area (in km²)	Length (in km)	Order
1.	Niyorar	88.31	29.60	4th order basin
2.	Salnari	28.65	4.55	4th order basin
3.	Barahi	34.65	6.30	4th order basin
4.	Gidhawa	42.50	6.40	4th order basin
5.	Belha	110.75	12.32	5th order basin
6.	Ledaha	34.23	7.40	5th order basin
7.	Khamral	126.28	15.32	6th order basin

After Maura locality, the Mahan river leaves the hilly tract and enters into the upland region where it is joined by a tributary known as Niyorar. Niyorar takes its primary sources from the hilly terrain of Chauphal reserve forest at an elevation of 530 m and flows north-west and west before it meets the Mahan river as its right bank tributary.

Besides aforesaid major tributaries, a number of lower order streams terminate their courses into Mahan river at different places and at different angles. All these tributaries of the Mahan river form angular pinnate to sub-parallel drainage pattern and serve as quick and efficient surface drainage.

On an average, the drainage pattern in the Mahan river catchment is mostly dendritic and in parts trellised and radial. The drainage pattern over Khainjua ranges is mostly trellised, particularly in the area underlain by the glauconitic beds and parts of the streams in northeast and southwest depending on the plunge of minor folds. The drainage in the catchment, other than Khainjua ranges, is of subsequent type indicated by the formation of deep valleys across the hard sandstone. The origin of most of the streams is comparatively on softer rocks. However, the pattern of drainage in the Mahan catchment is controlled

by the internal structure of the rocks rather than the regional dip. In Majhauli flat plain and at some places in intermontane valleys, the process of ravine formation is intensively active indicating the youthful nature of the streams which further suggests that drainage pattern has been established recently after the evolution of the Mahan drainage system with the greater Son drainage system.

Regional geology and structural set up

Geologically the study area is represented by Aryan, Precambrian, Purana and Archaean groups (Fig. 3). The Aryan group is represented by clay and sandstone of Mahadeva Series (Upper Gondwana System) and they range in age from Upper Carboniferous to Mesozoic. The Precambrian is represented by quartzite, limestone and conglomerate of basal stage of Lower Vindhyans. The rocks of Bijawar series of Lower Cuddapah system of Lower Proterozoic are represented by the Purana group. These rocks rest with unconformity, at some places on Dharwars and at other places on the gneisses and schists, and themselves underlie the Vindhyan system with an unconformity. The crystalline rocks, extremely contorted and faulted, largely intruded by plutonic intrusion and generally having a well-defined 'foliated structure' (Wadia, 1981) belong to Archaean Group that are 'azoic'.

On the line of systematic geological mapping done by the Geological Survey of India in the year 1952-53 and elaborated by the Directorate of Tube Wells and Ground Water Survey,

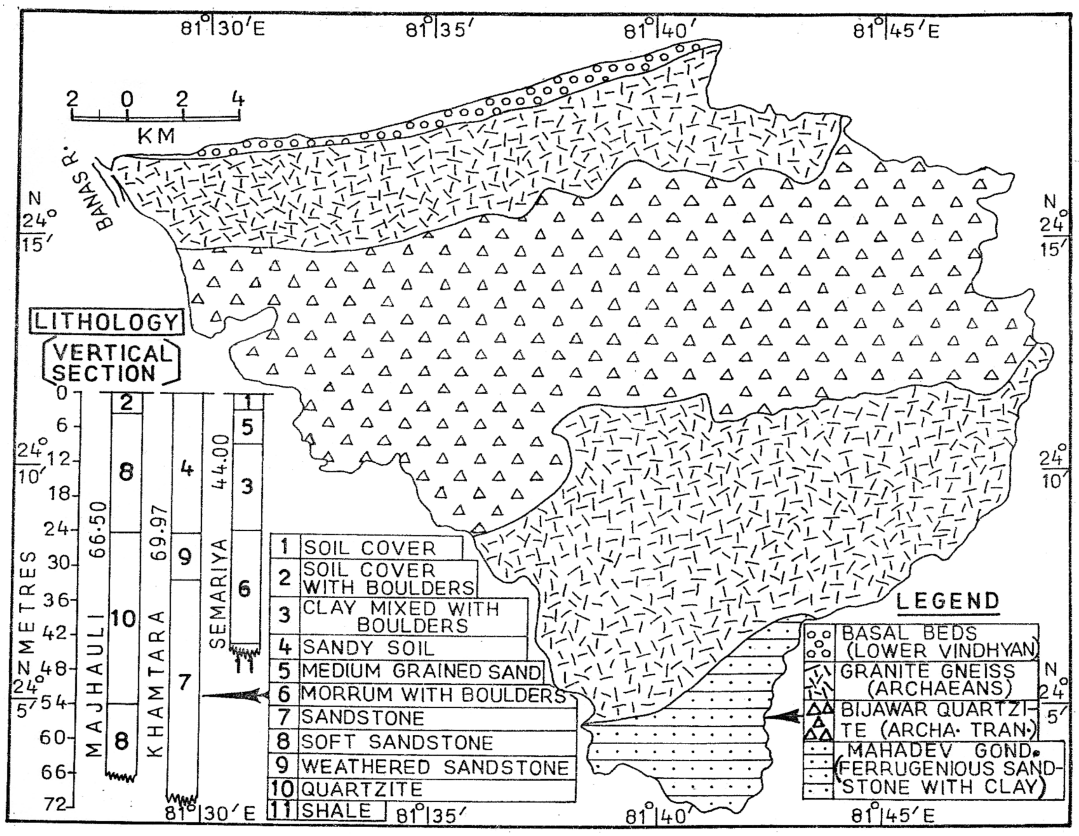

Figure 3. Geology of Mahan river basin

Table 2. Stratigraphy of Mahan river basin area

Group	Period	Name of formation	Lithology
Aryan Group (Mesozoic)	Upper Gondwana (Triassic to Jurassic)	Mahadeva Series	Clay and Sandstone
	U N C O N F O R M I T Y		
Pre-Cambrian	Lower Vindhyans	Basal Stage Conglomerate	Quartzite, Limestone and (Proterozoic)
	U N C O N F O R M I T Y		
Purana Group (Lower Proterozoic)	Cuddapah System (Lower Cuddapah)	Bijawar Series	Phyllite, Mica-schist, Talc-schist, Quarzite associated with Ferruginous matter
	U N C O N F O R M I T Y		
Archaean Group	Dharwars and Unclassified Crystalline		Granite, Granite-Gneisses, Basic Schists with later intrusives

Source: Report on Geohydrological Investigation in Majhauli and Sidhi Blocks of Sidhi District, M.P., 1972-73; Directorate of Tube Wells and Ground Water Survey, Bhopal (M.P.)

Bhopal, in the year 1972-73, an effort is made to deal with the present geological sequence of major geological formations found in the study region (Table 2).

The Mahan river basin has a variety of lithologies ranging from granite, granite-gneisses, schist with later intrusive, phyllite, mica-schist, talc-schist, quartzite associated with ferruginous matter, quartzite, limestone, conglomerate, clay and sandstone etc. over which Mahan river flows almost from southeast to northwest. These lithologies, after the age-old operation of the morphogenetic processes (since Archaean) punctuated by the tectonics of varied nature and intensity (resulting in buckling, tearing, transgression, intrusions, effusion etc.) have carved out varieties of morphological facets of different orders, wherein flat-topped plateau-like structures (over the rocks of Mahadeva series), knolls (over Archaean exposures) and typical plateau like structures (over the rocks of Bijawar series) are worth mentioning. These morphological facets of different orders reveal the fact of structural control in the landscape development in Mahan river basin.

The Dharwar rocks of the Archaean Group in the study area have complex geological structure. The general trend of Archaeans is in $N60^0E$ – $S60^0W$. The dips are due north with steep angles. Bijawar Formations are folded with general direction of fold axis in ENE–WSW that changes to E–W. Major joint directions in the rock formations are WNW to ESE, NW to SE, N to S, and ENE to WSW with low dips of about 5^0 towards south. Minor dislocations occur particularly in the bands of ferruginous material ranging from few mm to a few cms in thickness. Such minor dislocations in the Bijawar formations are indicators of possible faults. The dips of Lower Vindhyan formations range from 28^0 to 35^0 due north with a general strike direction. Joints are common and diagonal joints are seen in the section of Niyorar river. Apart from the major structures, a number of folds of small magnitude occurs in these formations. The rocks of Upper Gondwana System occupy the tectonic trough with faulted boundaries arranged along linear zones. In the Mahan river basin they are generally dipping with low angles of about 5^0 but show higher inclination near faults and intrusives.

Geomorphic setup of the area

Generally, the ridges and valleys, longitudinal hills and mini plains, bare rock expanses, sheltered alluvio-colluvial basins and rolling upland of dissected margins make the geomorphic set up of the area. The ridges are

Table 3. Geomorphic units and their characteristics of Mahan river basin

Geomorphic Units	General Characteristics
A. Dissected Upland	Characterised with steep scarps, deep gorges and narrow restricted rocky valleys prone to severe sheet erosion with some rills and gullies at periphery (mostly occupied by sandstone with clay in southern section of the Mahan river basin).
B. Structural Relief	Characterised with cuesta and escarpment topography with intervening lowland corridors created by differential erosion of gently tilted sedimentary rock structures. It is a broad irregular country of the Mahan river basin where scarps in the form of chain of low hillocks are occupied by hard porcellanitic formations and intermontane valleys are occupied by fragile and soft rocks like phyllite and schist.
C. Buried Pediplain	Surface of low relief of the Mahan river basin, broken by occasional residual hills and hillocks. The unit is the result of alluvio-colluvial deposition over a pediplain that existed before the onset of fluvial activity. In fact, this pediplain which was essentially a rock outcrop surface, was buried later by fluvial deposits over loaded by colluvial sediments from the neighbouring hilly ridges.
D. Piedmont Plain	Characterised with very gently rolling topography dissected by local streams in south-east part of the Mahan river basin. Isolated hillocks and tors are of common occurrence. Geomorhologically, the unit is the result of sediment deposits rolled down from the hill sides through running water action. The fringes of the upper back slopes are highly dissected.
E. Ravinous Zone	Badland topography along the side-slopes of the Mahan river and its tributary stream catchment especially of Belha river. The ravines are narrow in size and are controlled by the rectangular joint pattern that is characteristic of the underlying bed rock particularly where it is shallower and exposed. The zone consists of a highly intricate network of shallow to deep ravines which are 'V' shaped.
F. Young Alluvial Zone	Lowest landforms seen along the Niyorar-Mahan-Banas confluence zone. The unit is distinguished by the presence of point bars, lack of ravines and dark alluvial top soils.

low longitudinal type with gentle slopes especially along the river courses while the valleyside slopes are undulating. Basinal plains are level to flat, toe slopes are undulating and alluvial mid-fans have very gentle slopes while gullies and ravines represen the badland terrain. In fact, the soils of these gullied and ravined lands (specially the Mahan riverine tract and Belha river basin) are poor in nutrients, loose and friable, and crumble easily without protective cover of vegetation. The gullies and ravines become longer, deeper and wider as erosion increases with every successive rainfall. The process is still continued at an ever increasing speed. Hilly areas represent excessive relief features whereas peripheral lands have more or less dissected topography with complex slopes ranging from 3% to 10% having normal to excessive geomorphic features. On the basis of the aforesaid geomorphic features, six geomorphic units (Table 3) have been identified in the Mahan river basin.

Tectonic geomorphology

The study area is marked by three phases of unconformities between (i) Archaeans and Bijawar series of Lower Cuddapah system, (ii) Bijawar series of Lower Cuddapah system and basal stage of Lower Vindhyans, and (iii) basal stage of Lower Vindhyans and Mahadeva series of Upper Gondwana system (Table 2). This indicates that the Mahan river basin is highly disturbed tectonically as reflected by faulting, folding and upwarping of the rocks of the Lower Vindhyan system on the north and the Upper Gondwana system on the south.

The Dharwars and unclassified crystalline rock group of Archaeans is the oldest sedimentary strata of the Mahan river basin. The complex folding of rocks have obliterated nearly all traces of their sedimentary nature, and have given to them a thoroughly crystalline and schistose structure, hardly to be distinguished from the underlying gneisses and

schists (Wadia, 1981). Such nature of rocks (separated by important unconformities) in the area denotes at least two and possibly three great cycles representing periods of diastrophism, erosion and peneplanation (Heron, 1917). The closing of Dharwar period must have witnessed earth movements on extensive scale which folded the Dharwar sediments into complicated wrinkles. No such powerful crustal deformation of an equal degree seems to have occurred since than, not only in the Mahan river basin and its environs but in the Indian peninsula also (Wadia, 1981).

After Dharwar period a vast gap of time elapsed before the origin of Bijawars of Cuddapah system. During this period the area was cut down to the base level by a cycle of erosion. So it is on the deeply cut and denuded margins of the Dharwars that the basement strata of the Bijawar Series of Lower Cuddapah System rests. There is well marked angular unconformity between the Bijawars and the basal stage of Lower Vindhyans. This fact denotes that the Bijawars were already folded and disturbed and denuded before the deposition of the Lower Vindhyans in the area. Bijawars have also been faulted as is evident from the minor dislocations and their contact with the Lower Vindhyans in the study area.

The nature of Upper Vindhyan deposits (outside the study area specially in the north of the Son valley region) in general, shows very little structural displacement and have preserved almost their original horizontality of deposition (Agnihotri, 1986). But the Lower Vindhyans in the Mahan river basin show tectonic deformation by folding and faulting (Fig. 4). It means that a great crustal movement and epeirogenic activity occurred in the region before the sedimentation of Upper Vindhyans in the north of the Son valley (outside the present study region) which threw the basal stage Lower Vindhyans into folding and faulting as is evident from the Khainjua ridge of conglomeratic quartzites crossing through the Son valley near Bhanwarsen Ghat (dip: 80^0), near which the Mahan river terminates its courses into the Banas river and the Banas river into the Son river.

As regards the Gondwana system of the area, these are unique in formation. Its homogeneity from top to bottom, the fidelity with which it has preserved the history of land-surface of a large segment of the earth for such a vast measure of time, the peculiar mode of its deposition in slowly sinking faulted troughs in which the rivers of the Gondwana country poured their detritus and the preservation of valuable coal measure lying undisturbed among them, stamp these rocks with striking individuality among the geological systems of India. The rocks of Gondwana system occupy the tectonic trough with faulted boundaries arranged along linear zones (Wadia, 1981). They are generally dipping with low angles but show high inclination near faults and intrusive. During Upper Gondawana times, in late Triassic to early Jurassic, the sediments were affected by widespread folding and faulting (King, 1962). Crookshank refers to the steep folding of the Upper gondwana rocks at

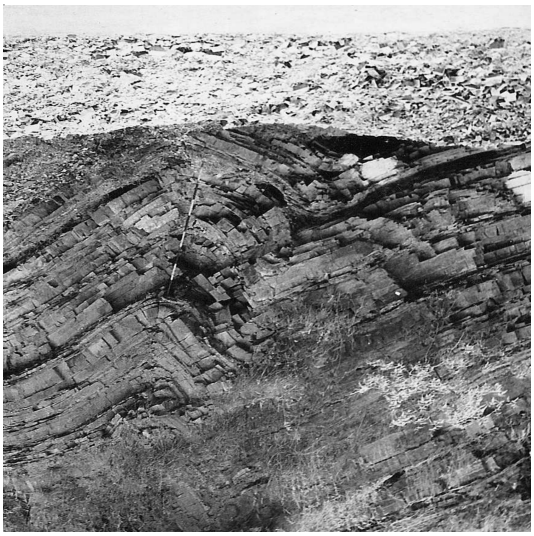

Figure 4. Folding of Lower Vindhyans (Khainjua ridge) at Dembha

many places (Dixey, 1970). But mostly the vertical faulting did not disturb the original horizontal stratification of the deposits (of the Mahan river basin lying especially along the southern sides of the Son valley) beyond imparting to them minor warping or slight tilt from one direction to the other while it made for their preservation, during all the subsequent ages (Wadia, 1981).

It is assumed that prior to the eruption of the Decan trap, the whole study area had once more been reduced to a lower peneplain in late Mesozoic era. By this time the compressional forces, which severally disturbed the northwestern and southeastern marginal zones of the Vindhyan basin, went into action and upwarped the region lying in between the Aravalli and the Narmada-Son, and consequently the streams were rejuvenated (Dube, 1965-67).

It is also to be pointed out that the central part of extensive Son valley (the part of which is the Mahan valley) received basalt cover of Deccan trap during Cretaceous period which buried the pre-existing relief. Later, continued denudation processes removed the lava cover, the records of which are absent in the Mahan river basin but laterites in Ram Nagar area of Satna district, Rampur Naikin area of Sidhi district and over some residuals standing at the surface of Rewa plateau still speak of the earlier cover of basalt (Agnihotri, 1986). This phase of lava cover and its removal at later stage has been responsible for the peculiar nature of the Mahan river valley.

Stratigraphy and alluvio-colluvial sequences

Alluvio-colluvial plain sequences are basically the lowest landforms seen along the Mahan river valley. These plain sequences are well identified as (i) alluvio-colluvial plain sequence and (ii) alluvial sub-system. The alluvio-colluvial plain sequence is further identified as (a) broad isolated inter-hill mini-plain, and (b) alluvio-colluvial fan. The elevation of the alluvio-colluvial plain sequence ranges from 270 m to 290 m having less than 1% regular slope gradient exhibiting normal to sub-normal relief features with slight erosion. Depending upon the micro-topographic differences broad inter-hill mini-plains are identified as upper convex slopes, mid concave slopes, gentle slopes and very gentle slopes. Similarly, the alluvio-colluvial fan is well identified as mid-fan (undulating), fan base (dissected) and depressed fan base (undissected).

The alluvial sub-system is spread up along the Mahan river. The elevation ranges from 255 m to 270 m which exhibits a micro relief ranging from sub-normal to normal and excessive. Average slope gradient of the entire area is in the order of less than 1% except severely eroded ravinous area. On the basis of topo-differences and relief this alluvial sub-sequence is well identified as very gently sloping low ridges along the Mahan river course, nearly levelled to flat basinal plain, very gently sloping laminar alluvial plain, very gently sloping alluvial mid-fan, undulating toe slopes, ravines, ravines and peripheral lands and peripheral lands.

Geomorphic evolution

The Mahan river emerges from the higher altitudes (450 m) near Dalapipar locality of Majhauli block and, cutting across the structures of granite-gneisses of Archaeans and Bijawar quartzite for the length of 46.77 km. It joins the Banas river at an elevation of 255 m. The Banas river after originating from Deogarh Upland near Mantoliya locality at the altitute of 384 m ($23^0$32'50" N, $82^0$02'46" E) runs almost in northwest direction and after a km of the confluence with the Mahan, it terminates its course into the Son river at Dembha site near Bhanwarsen Ghat ($24^0$16'51" N, $81^0$11'29" E). The Son river rises from Son Kunda near Son Bachharwar village, southeast of Pendra town in Bilaspur district

and flows north and northwest. Later on, it turns abruptly to the east and northeast and flows almost parallel to the Kaimur escarpment to ultimately join the river Ganga near Patna in Bihar state. Thus, the Mahan drainage system is a part of greater Son drainage system and for the purpose of discussion of its morphotectonic evolution, it cannot be singled out from its adjoining area, i.e. from the Son river catchment, because any tectonic event or morphogenetic process does not affect a small area only but leaves its imprints on a greater area.

A cursory glance over the drainage (Fig. 2), geology (Fig. 3), and morphology (Fig. 5) of the study region denotes the fact that the Mahan drainage basin is a part of greater structural-cum-erosional trough of the Son basin. As a distinct physiographic unit it represents diversified terrain characteristics exemplified by knolls mostly favoured to Archaean exposures, hills, ridges over different geological complex, spurs, intermontane valleys, alternating basins and gorges topography, flat and broad valleys over the 300 –380 m granite-gneissic surface, springs and rocky knobs, rills, gullies and ravines, cut-off ridges, inselbergs, imposing scarps in different parts, straight course of some rivers for considerable distances, parallel course of some tributaries to major streams, deep to very deep river valleys, right angled confluence of minor streams with major streams, development of radial and trellis drainage patterns in certain areas, vertical river banks and stony bed of rivers, etc. Such type of terrain characteristics

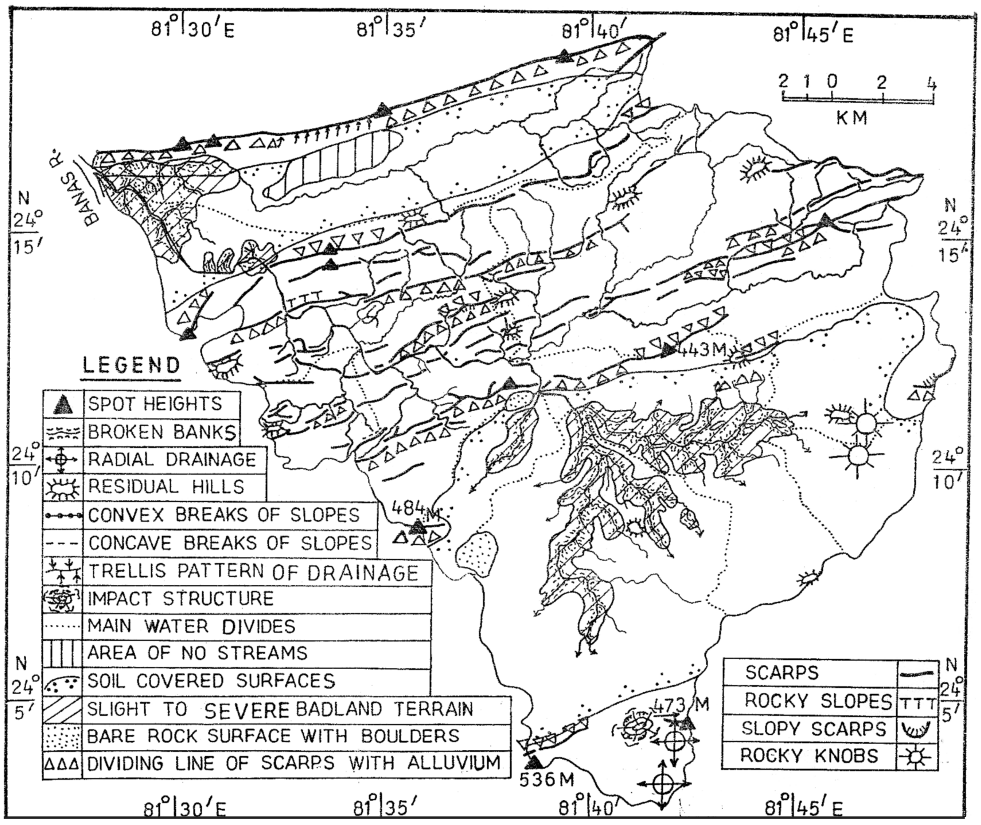

Figure 5. Morphological map of Mahan river basin

and nature of the rivers of the Mahan river basin, in association with the greater Son drainage system, clearly speaks that geomorphic evolution of the Mahan drainage system is controlled and affected, to a great extent, by tectonic movements and the lithology and structure of all the major rock groups like Archaean metamorphics, the mixed sedimentaries with igneous intrusions, Bijawars, Lower Vindhyans and Upper Gondwanas.

It may be argued that the Deccan lava during Cretaceous period covered the extensive part of the Son valley including Mahan basin and consequently buried and obliterated the pre-existing drainage network. It may be pointed out that all the reliefs (viz. Khainjua ridges and Kaimur escarpment) were buried under thick lava sheet. With the initiation of sub-aerial conditions during Tertiary period, new drainage lines began to develop over the solidified basaltic cover (Singh and Agnihotri, 1988) and the Mahan river (like other major tributaries of the Banas, Gopad and Son) developed its present course through several stages. The lava cover might have been soon removed through continued but gradual denudational processes. Once the Mahan (like other tributaries of the Son system) established its course over the lava covered surfaces, it continued to erode its valley over the buried structures and thus, its valley became superimposed over the Khainjua ridges and the pre-existing structures of the Archaeans, Bijawars, Lower Vindhyans and the Upper Gondwanas. Thus, the morphotectonic evolution of the Mahan drainage system appears to be a superimposed one.

Discussion

As has been stated earlier, the Mahan river valley for the purpose of discussion of its morphotectonic evolution, cannot be singled out from the greater Son valley. So it is important to point out a few of the outstanding characteristics of the Son drainage system (Uddin and Agnihotri, 1995) with reference to the Mahan river system. These are:

- With reference to the topographical map (63H), the entire Son catchment shows that after taking its source from Amarkantak hills (Maikal range), Son pursues an average north to northwest course through Pendra and Sohagpur, falls from about 579 m east of Pendra to about 442 m near Sohagpur and takes an abrupt turn towards north-east just after meeting Mahanadi (near Kundra) and then flows close and parallel to the Kaimur range following the strike direction. The closeness and parallelism of the Son to the Kaimur range indicate a close relationship between the origin of the Kaimur and the Son.
- The drainage pattern of the Son that developed on the north (left) bank of the river (after taking northeast trend) is quite different from that on the south (right) bank. The Son and its head tributary Mahanadi, both are confined by a high fault scarp on the north and not even a single river of large magnitude joins it from north. A few streams like Patparaha, Marhawal, Nagaura, Ghunghuri, Narkuin, Rehi, Kurheri etc. that carry the drainage of the Kaimur scarp (southern face), though have a very short span of length and low kinetic energy, cut across the sand stone Khainjua ridges of Semri series of the Lower Vindhyans and traverse narrow gorges across one or more steep sided highly resistant strike ridges, just as the Son itself does. But to the south of the Son river, a number of large streams like Banas, Gopad, Bijul, Rihand, Kanhar and North Koel, etc. join the Son river as right bank tributaries. Thus, the Son has much extensive catchment extending up to the catchment of Mahanadi (Singh and Singh, 1971). These right bank tributaries of the Son flow almost parallel from south to north and cut

across all physical obstacles–the Archaeans, Dharwarians (Bijawars), Gondwanas and Decan traps.

- The youthful nature of the streams joining the Son from both directions, left and right bank, denotes that the drainage pattern of these streams has been established recently (Dutt, 1968).
- Kaimur scarp rising abruptly like a steep wall from the base of the Son trough runs almost uninterruptedly throughout its length. The scarp is neither breached by any stream of importance from north to south or vice-versa nor bear traces of any former streams across the range (Dube, 1965-67). Only a narrow water gap, rather a furrow of flat surface, has been formed on weak structure by subsequent stream named Adh Nala which has dissected the Kaimur into two parallel ranges. Thus, the characteristics of the Kaimur ranges indicate its recent origin.
- In contrast to Kaimur highlands, Khainjua ridges extending on the both sides of the Son valley are characterised by numerous narrow gorges and passes. Even the tributaries like the Mahan river have cut across the physical obstacles at Chakridal, Bakwa, Barka and Tat Pahars, and have presented a scenery of dissected terrain with narrow passes and valleys (Fig. 6).
- It is interesting that the Khainjua ridges composed of quartzitic sandstone of Basal stage of Semri series, have been cut straight across by SW-NE flowing Son at two places. The first near Kusuma (Deolond: $24^0$12' N, $81^0$17' E) where a wide zone of crushed breccia and mylonitised rock at the contact of the Semri quartzite (Lower Vindhyan) and the Archaean gneisses lie at the depth of 45 m (Lakshmanan, 1972), and the second near Bhanwarsen Ghat at Dembha just after where Mahan meets north flowing Banas (Fig.7). Hence, at both the places the Son after cutting straight across the Vindhyan Basal conglomerate continues along its foot on the other side.
- The major course of the Son river has been strongly influenced by the post-trap warping of this region. All major faults are located to the south of the Son valley and only minor faults are seen in the vicinity of the Son valley (Singh and Agnihotri, 1988). The faults are parallel and runs east to northeast.

Keeping the above facts and features of the entire Son valley that include the present study region of the Mahan river valley, the nature of Kaimur scarp and Khainjua ridges in mind, the evolution of the present course of the Son drainage system as well as the Mahan drainage system may be assumed only by one way, that it is superimposed. This is because some facts and evidences can only be explained when the idea of superimposition of the greater Son drainage system as well as the Mahan drainage system is conceived. These include the closeness and parallelism of the Son to Kaimur ranges, joining of a number of south-north flowing larger streams to the Son from the south, the absence of any significant stream to the north of the Son but forming of narrow gorges across highly resistant strike ridges by them fairly steep slope of southern slopes of Kaimur scarp (facing the Son) in comparison to northern slopes (facing the Tons and its tributary streams), undisturbed and horizontal strata of Kaimur scarps but breaching and cutting across the highly disturbed, folded and warped Khainjua ridges of Lower Vindhyans by the Son and its tributaries like Gopad and Banas and its tributary stream Mahan and occurrence of laterites and basaltic outliers beyond the Kaimur scarps, etc.

Due to such superimposition and active down cutting by the Son and its tributaries (Banas, Mahan, Gopad etc.), a unique topography of narrow gorges cut-across the ridges emerged in the entire Son valley. This

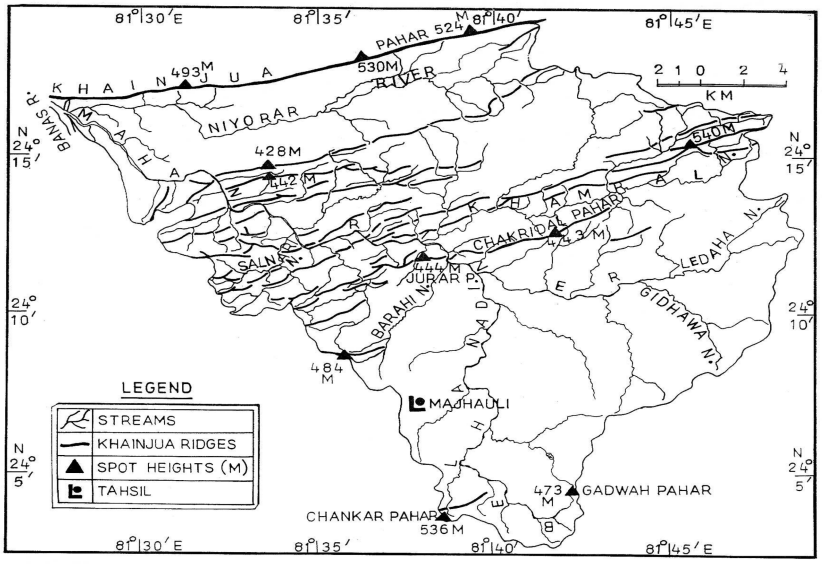

Figure 6. Superimposition of Mahan drainage system

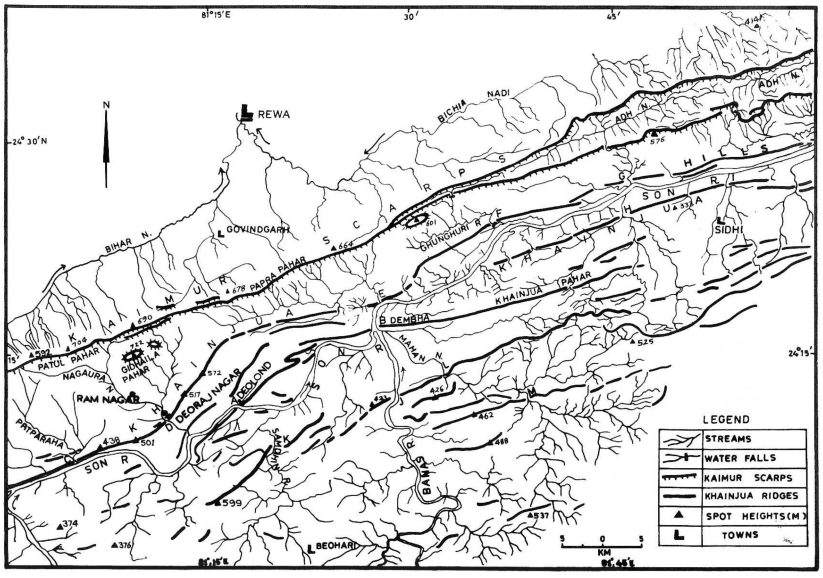

Figure 7. Superimposition of Son drainage system

suggests that the streams adjusted themselves with the lithology of the area where they existed. Kaimur scarp is an additional important factor in determining the present course of the Son drainage system. In fact the Kaimur scarp was formerly submerged by Deccan lava flow but with the removal of basalt, Kaimur began to reappear. Initially higher than the Khainjua ridges, Kaimur scarp confines Son valley to its present course and served as an active line of water divide between the Son drainage system and the Tons drainage system.

Conclusion

In essence, it may be concluded on the basis of discussion by taking in reference the entire

Son valley alongwith the Kaimur and Khainjua scarps, the evolution of the Mahan drainage system is a superimposed drainage system that emerged with the greater Son drainage system in Central India.

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