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Development Of Drainage Pattern In Denwa Watershed Madhya Pradesh, Central India

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ABSTRACT –

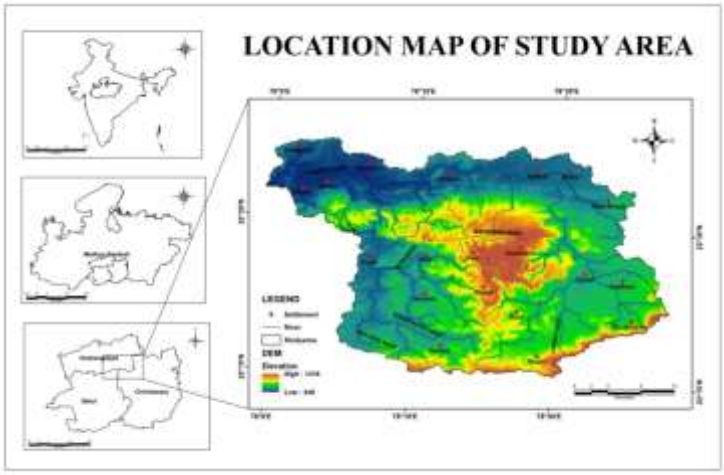
Drainage arrangement denotes to the specific organization, spatial decoration of principal watercourse and its branches form conjugately. Lithology, geological structure and geomorphic account perform vital role in drainage designs development. Existent study is an assessment of possible structural and topographic appliance on drainage pattern of Denwa watershed, central India. Study area includes part of Satpura range extending from 22°15′25"N to 22°37′52"N latitude and 77°59′26"E to 78°31′36"E longitude with 1997 sq.km. area. Plateau and hills of Satpura manifests the topography. Different drainage configurations are deciphered and processed from Survey of India Topographical maps (55 J/2, 3, 6, 7, 10 & 11) on 1:50,000 scale and superimposed on Geological Maps. There five kinds of drainage arrangements (dendritic, radial, rectangular, parallel, and herringbone) are dominant. Streams are commonly superimposed on present-day youthful topography of exhumed Gondwana formation from Deccan Trap terrain.

Keywords:

INTRODUCTION –

Denwa watershed is found as a valley of Satpura Range in Hoshangabad district of Madhya Pradesh. Pachmarhi which is the famous tourist heritage of Central India traced at the centre of this watershed. It is the one and only hill station of Madhya Pradesh. The study area lies within geographic coordinates of 22°15′25"N to 22°37′52"N latitude and 77°59′26"E to 78°31′36"E longitude. The area of enquiry is 1997 sq. km. It forms the eastern part of Satpura Range encompassing the Southern part of Madhya Pradesh. Dhupgarh is the highest peak of the area with 1352 metre in height. Topography is displayed by tableland and hills of Satpura. The plateau is mostly dissected, traversed in all directions by narrow deep ravines, hollowed out by stream action.

The area of investigation belongs to the Survey of India topographic maps (55 J/2, 3, 6, 7, 10 & 11). Here the rocks fit to Gondwana Supergroup. The lithology embraces friable, coarse grained, thickly bedded and almost horizontal sandstones presenting shallow marine deposition. They opulent in iron, often conglomeratic and show numerous sedimentary structures like cross bedding, current bedding and voidal concretions. This part is intruded by several basaltic dykes allied with Deccan Trap.



After ending of Deccan volcanism the zone was advanced to experience domal upliftment supported by drainage characteristics and presence of numerous waterfalls (near about 84 waterfalls), various morphometric structures such as cuesta, mesa, butte, inselbergs etc are characteristics of homoclinal structures, promotes polycyclic evolution of landforms. The average rainfall is 125-175 cm. The vegetation is tropical deciduous type.

OBJECTIVES –

The contemporary paper is an attempt to make a comprehensive document on drainage pattern analysis and its development in Denwa watershed of Madhya Pradesh. Main intentions of the study are as follows –

- Assessment of probable geological control on drainage.
- Discuss various drainage patterns, stream courses, peculiar changes in flow direction, headward erosion, stream piracy and anomalous drainage with reference to structural lineaments.
- Find evidence to support the explanation for evolution of drainage patterns.

DATABASE AND METHODOLOGY –

Different drainage configurations are deciphered and processed. They are primarily obtained from the Survey of India Topographical maps (55 J/2, 3, 6, 7, 10 & 11) on 1:50,000 scale and superimposed on Geological Maps. Indian Remote Sensing Satellite Resourcesat-1 LISS-III Geo-coded FCC data of October 2011 are also used in this regard. These imageries have been visually interpreted after making necessary ground inspection.

GEOLOGY –

Geological study is very essential in terms of drainage evaluation of any region. Being a part of the vast Satpura-Gondwana Basin Pachmarhi Hills has legislature of almost all major geological formations of India which ranges in between the age from Archaean metamorphic to recent alluvium. Bulk of Satpura succession was deposited as mega half graben bounded by basin margin fault controlled subsidence which regimes with intervening tectonically static periods. Also subsidence rate varied across the basin resulting in an asymmetric basin fill with thickness increasing towards north (Chakraborty & Ghosh; 2005).

The study area is being a part of Satpura hill range trending in E-W to ENE-WSW. The highest elevation is 1352 m above msl in Dhupgarh hill of Pachmarhi range where as the lowest elevation is 460 m above msl in west central part. Lithological units that compose geology of the area mainly expose rocks of Gondwana Supergroup and Deccan Trap Supergroup. The major geological formation is of Upper Carboniferous to Early Cretaceous, familiar as Gondwana Supergroup. On the other hand, Deccan Trap belongs to Upper Cretaceous to Palaeocene age.

Lower Gondwana group has been divided into three formations namely Barren Measure, Raniganj and Bijori formation. Apart from Barren Measure, lithology of Lower Gondwana comprises of thick, massive sandstone with dominance of grits containing abundant feldspar and intermittent lenticels of clay and shale. It is also categorized by absence of conglomerate and ferruginous flakes. The sandstones belonging to Raniganj formation cover a major area at southern portion and as a little patch in west. In some parts of south, south-west and west of the area Bijori formation is predominant. This formation restrains intercalated sequence of sandstone, clays and shales. Bijori clays are more shaly and micaceous.

On the other side, Upper Gondwana has been divided into four formations namely Pachmarhi, Denwa, Bagra and Jabalpur. The Pachmarhi formation is exposed in central and maximum northern part of the area, forming high hills with steep scarps and gorges. Pachmarhi formation is represented by coarse grained sandstone with occasional conglomerate and clay bands. The presence of conglomerate along with ferruginous partings and lack of fossils distinguish Pachmarhi from underlying formations.

Pachmarhi rocks are overlain by Denwa formation, which is exposed as a band in the northern most part of study area. Denwa formation comprises sandstone, variegated clay and conglomerate. These rocks also show low dip (~5◦) towards north. Denwa formation is overlain by conglomerate and clay of Bagra formation. It occurs as outliers in some patches of north-western part of the area under investigation.

Deccan Traps lies over the rocks of Gondwana in a scattered form as small residual patches of previous cycle from south-eastern part to north-western encompassing a central tract. This central tract of basaltic flows is designated by Amarkantak group. Numerous sills and dykes of basalt/ dolerite intrude Bijori surface. Dykes are mainly trending in E-W to ENE-WSW direction. Current bedding, cross bedding & voidal concretions is very common sedimentary structure of this region.

DRAINAGE PATTERN –

Drainage pattern means ‘form’ (geometrical forms) of drainage structures and spatial arrangement of streams in a specific zone or province. Drainage network pattern denote to “the particular plan of design that the individual stream courses collectively form” (Thornbury 1954). Drainage forms are indomitable by lithology, geological structure, topography, relief and geomorphic history of the area.

Climatic environments also attribute to plentiful arrangements of drainage forms. Variety of drainage pattern differs from place to place due to various endogenetic forces which influence landforms. And as a final point, evaluation of drainage pattern also helps in detecting stage of the cycle of erosion. Dendritic drainage is outlined all over the basin as a very common feature. At certain places rectangular

pattern has also been witnessed. On domal structures trellis and radial types of drainage patterns observed. In the eastern parts deranged drainage is very common and remarkable. A large number of water bodies in this region also testify deranged drainage pattern.

The following types of drainage patterns have been recognized in Denwa Basin.

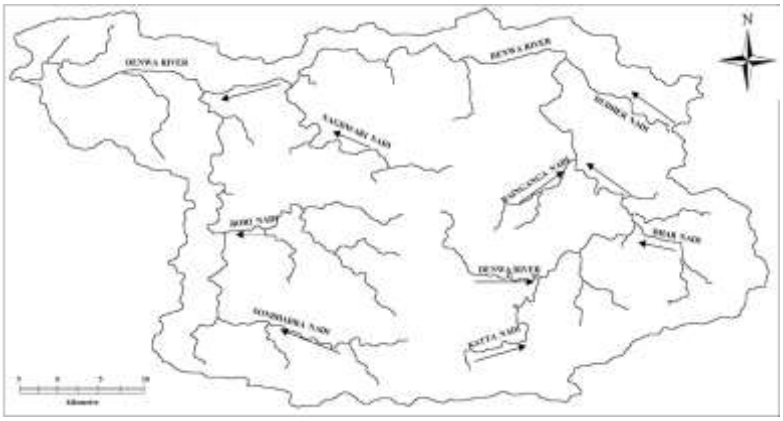


Fig.2: Major Streams of Denwa Watershed

DENDRITIC PATTERN –

The major regulatory aspect for advancement of this shape is initial land slope. It is characterized by irregular bifurcation of streams in several directions at any angle although commonly at significantly less than a right angle. These types of drainage configuration largely mature upon rocks of identical resistance and indicate a prominent lack of structural control. Dendritic drainage is outlining on massive sandstone of Gondwana formation. The Deccan Trap flows are more or less flat or have only a slight gradient towards north. Thus common flow course of the main rivers is also towards north. To some magnitude, on Deccan Traps, development of drainage pattern is also influenced by the resistance of rocks. Due to disclosure of different flows along the fissures and joints of basalt, small rivulets have engraved their valleys. (Fig.3 & 4).

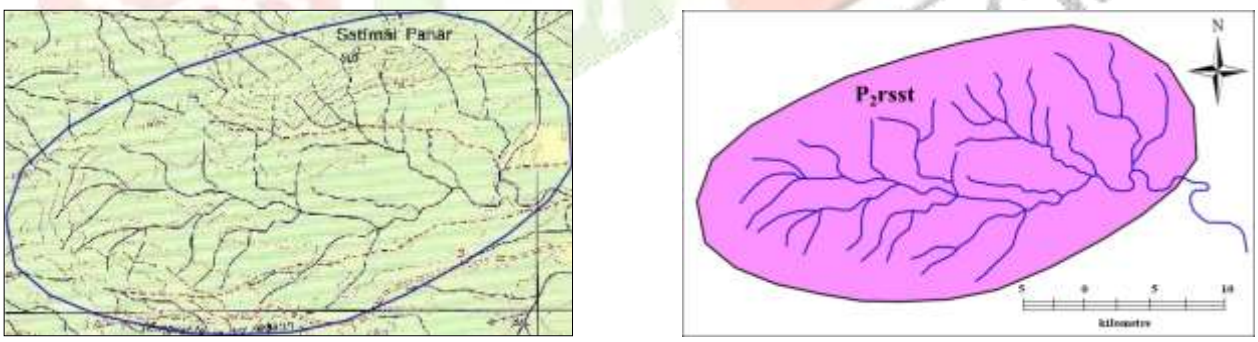


Fig.3: Dendritic pattern advanced on massive Raniganj Sandstone of Late Permian age.

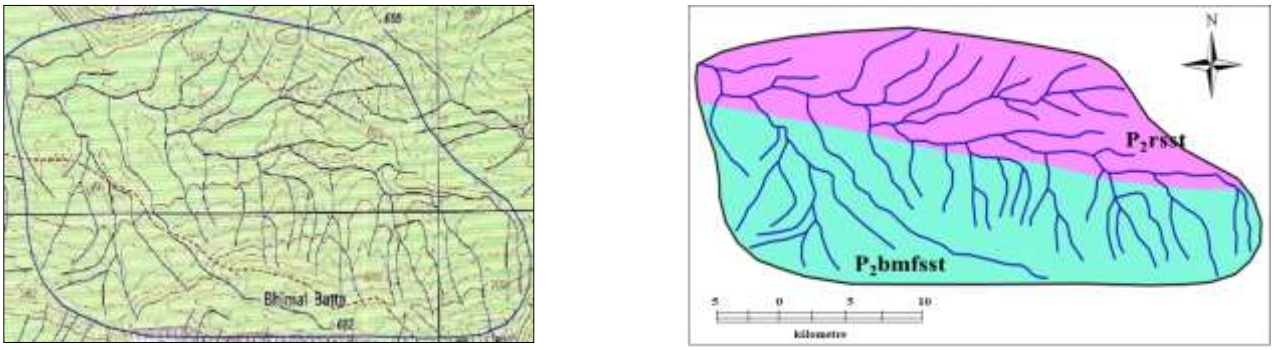


Fig.4: Dendritic pattern developed on Raniganj sandstone & Barren Measure.

PARALLEL PATTERN –

A parallel decoration of streams and their tributaries represent to parallel course or almost parallel to one another, and are regularly spaced out. It is symbolic of an area of evident and constant gradient. It is shown from drainage map of the study area that parallel pattern is detected in middle part of the watershed where rock formation belongs to upper Gondwana. The most supportive aspect for improvement of parallel shape is the general slope from SE to NW. All the streams go downhill the slope in parallel lines. In most situations they drift along the joints or cracks. (Fig. 5, 6, 7 & 8)

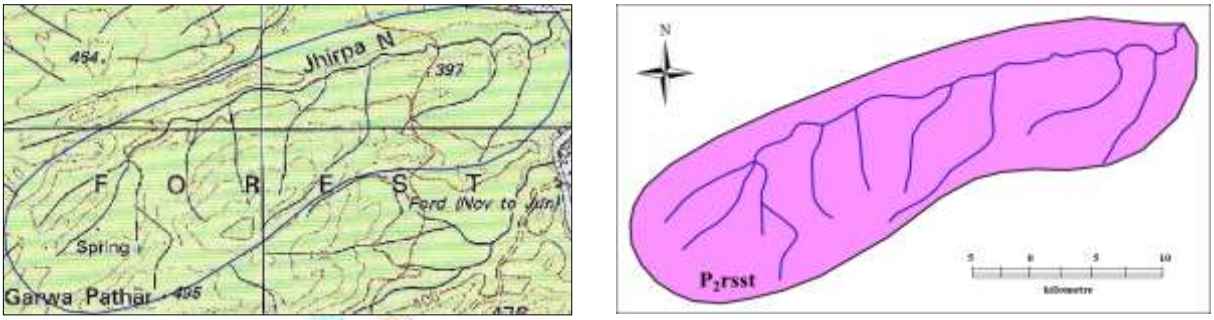


Fig.5: Parallel pattern develops on terrain with uniformly resistant strata of Raniganj Sandstone.

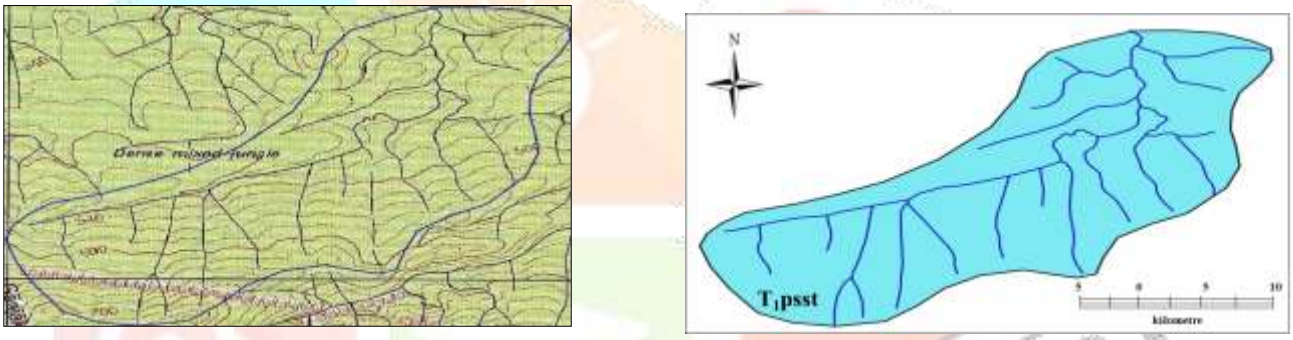


Fig.6: Parallel pattern developed on Pachmarhi sandstone due to uniform resistant strata marked by regional slope towards north.

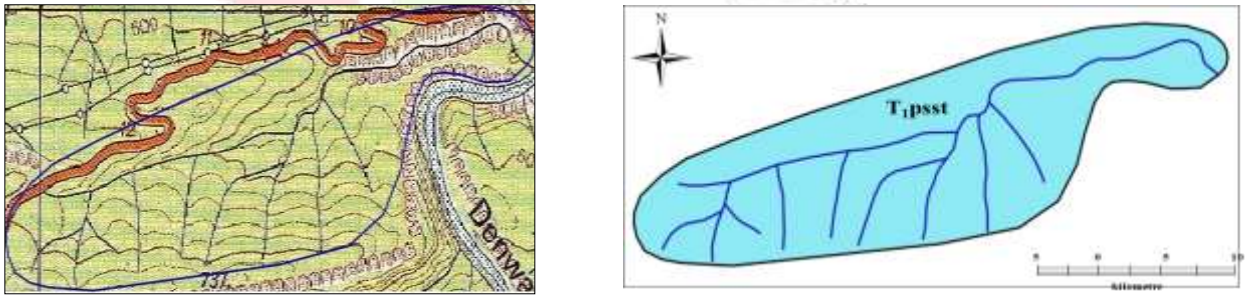


Fig.7: Parallel pattern expanded on Pachmarhi sandstone due to development of parallel vertical joints.

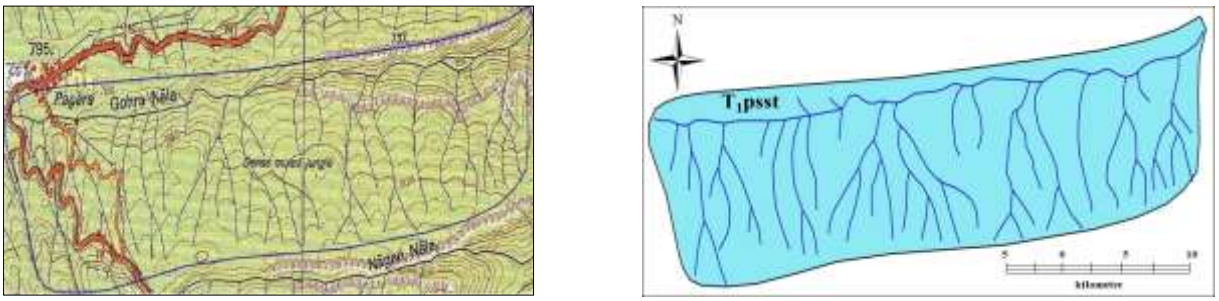


Fig.8: Parallel pattern expanded on this area of Pachmarhi Sandstone due to structural control exerted by a series of closely spaced faults.

RADIAL PATTERN –

Radial drainage configuration, also known as centrifugal pattern is fashioned by theose watercourses which deviate from a central elevated point in all directions. It is noticeable that dome structures, volcanic cones, batholiths and laccoliths, residual hills, small tablelands, mesas and buttes, and isolated uplands favour the evolution of perfect radial pattern (Fig.9). The streams emerge at the central point of the before mentioned reliefs and channel down the slopes in all directions, since the channels are monitored by local slopes and eventually become consequent streams. These streams be similar to the spokes of a wheel or the radii of a circle.

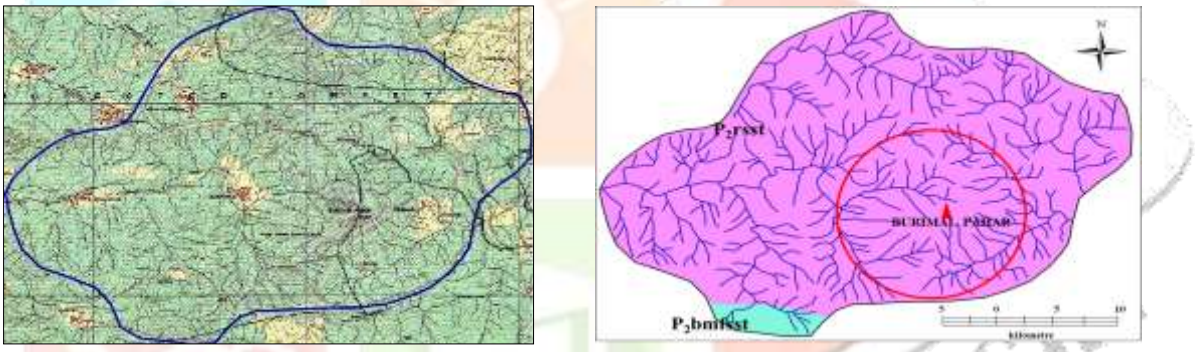


Fig.9: Radial Pattern evoluted on Raniganj Sandstone surrounding an isolated conical hill named Burimal Pahar of 1092 metre elevation.

HERRINGBONE PATTERN –

Herringbone form, also known as rib pattern (like the rib of human beings), predominantly developed in mountainous areas where board valleys are fringed by parallel ridges heaving steep hillside slopes. The longitudinal consequent streams as master streams, are progressive in the longitudinal parallel valleys while tributaries, as lateral consequents, after originating from hill slopes of adjoining parallel ridges connect longitudinal consequent almost in right angle. Paths of the tributaries are straightened out because of slope factor and little distance between ridges and longitudinal consequent occupying valleys. Hence the tributaries are not endorsed to adapt sinuous course and join their master stream at acute angles (Fig. 10, 11 & 12).

Herringbone pattern is emergent at the interface areas of Deccan trap formation and Gondwana surface where resistant rock of Deccan formation afford steep slope for lateral consequents and relatively non-resistant Gondwana sandstone provide longitudinal valley for master stream.

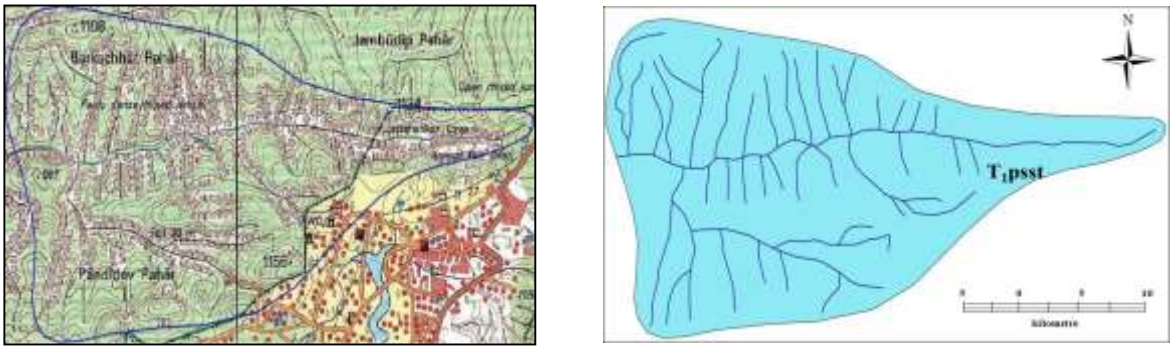


Fig.10: Closely spaced elongated scarps development due to intense valley incision by local streams on Pachmarhi Sandstone becomes helpful for the arrangement of rib like drainage pattern in this area.

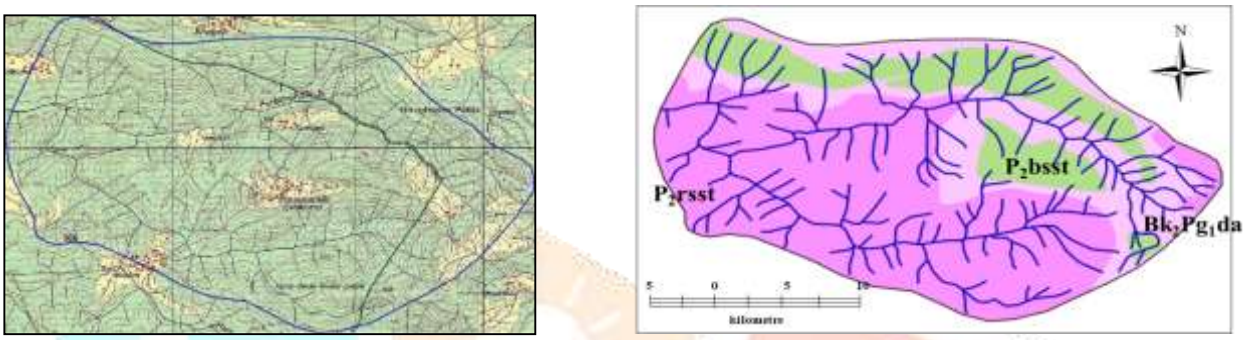


Fig.11: This pattern is advanced on alternate strata of soft rock (Raniganj and Bijori Sandstone) and hard rock (Basalt). Thus basalt provide steep slope for tributaries and sandstone afford longitudinal valley for master stream.

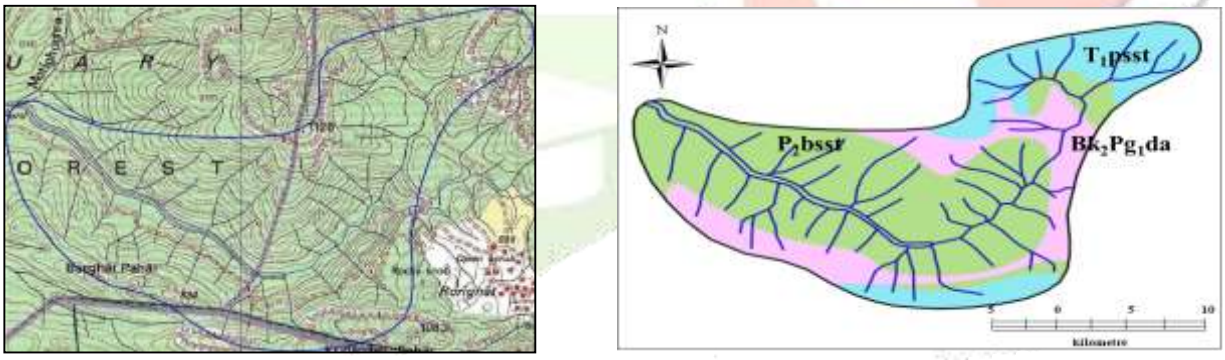


Fig.12: Developed on hard rock of Basalt and comparative soft rock of Bijori and Pachmarhi Sandstone.

RECTANGULAR PATTERN –

In this context both the principal stream and its tributaries exhibit right angle bends. The convergence angle is unwavering by the faults lines of rocks in rectangular array. Rectangular pattern is enumerated by widely spaced tributaries. This decoration is generally advanced in those sections where rock joints form rectangular shape. The rocks are weathered and eroded along the interfaces of joints, fractures and faults and thus surface runoff accumulates in such long and narrow clefts (ensuing as of weathering and erosion) and sketches numerous small rills. These rills are further extended in length and width and became channel. With the march of time a network of streams is established wherein watercourses track the outlines of

weakness (joints and fractures). Tributaries intersect their dominant stream almost at right angles to engrave a rectangular drainage pattern (Fig. 13).

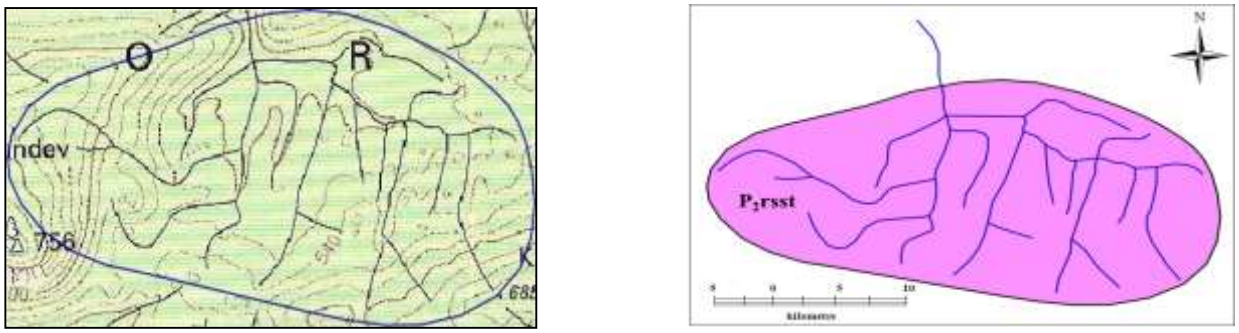


Fig.13: Controlled by joints and faults the rectangular pattern advanced in this area on Raniganj Sandstone of Late Permian age.

ANGULATE PATTERN –

Angulate drainage is a modification of rectangular drainage and proceeds where joints or faults join each other at acute or obtuse angles rather than at right angles.

ANOMALOUS DRAINAGE –

Anomalous drainage bucks structural controls, flowing across geological and topographic units. Anomalous character is unrestricted where the main stream flows across a hilly terrain and after a short distance adopts an easier route. The Denwa River itself unveils about 65.18 km length on hilly terrain upto Matkuli and after that near about 67.56 km distance travel on relative plain area of low relief before its confluence with Tawa River.

EVOLUTION OF DRAINAGE PATTERN –

Some important reasons to inspect chronological evolution of drainage pattern are–

the presence of Bijori scarp in the south of Pachmarhi sandstone, streams flowing parallel to the direction of faults maintaining straight courses, lithological boundary of the Pachmarhi sandstone with the Bijori presents a sudden convexity, Linear alignment of waterfalls, Lines joining radial drainage pattern being parallel to the fault trace and the Interrelationship study of morphometric parameters which shows anomalous correlation in some cases. The chronological sequence in the evolution of drainage pattern which provides some insight into several quite complex features has been elucidated under four phases as follows-

PHASE I-

In the first stage initially the rectangular shaped drainage pattern was developed in the area which was controlled by North to South and East to West trending joint sets as in the study area towards north at the contact of Pachmarhi Sandstone with Denwa Clays this drainage is replicated in trellis pattern which is evidenced by the existence of rectangular drainage pattern as relict feature at some places, the peaks and ridges of the most elevated parts in sandstone presenting the Rectangular top with the sides running North to South and East to West, like Chauragarh, the Ridge running North to South like Dhupgarh and East to West like Jambudip and the extension of rectangular pattern on the Pachmarhi mesa has not been affected by other drainage patterns.

PHASE II-

The second phase was followed by the advancement of streams running South-East to North-West which led to the onset of angulate drainage. The angulate drainage subsequently modified by erosion and movement of Pachmarhi block towards south.

PHASE III-

In third Phase the improvement of angulate drainage is verified by the adjoining of North-South and East-West streams against rectangular drainage. In this phase the Angular contacts of the rectangular drainage become more acute which developed angular drainage pattern at places. The presence of rectangular drainage is found as relict in the areas of angular drainage and total elimination of the former in area where the latter has assumed eminence. The development of angulate pattern is regarded to be the result of joining of strike slip fault and joints.

PHASE IV-

In the fourth Phase the evolution of drainage on Pre-trap surface was completely stopped by Deccan volcanism (65 million years). Cessation of Deccan volcanism (40 million years) marks the beginning of post-trap drainage evolution. Due to uncapping of Deccan trap overburden, the area underwent domal upliftment and intensified erosion rate. In this phase the occurrence of radial pattern in some area may be consequential of the above incidence which is found on some sorts of isolated conical hills, like Burimal Pahar.The Dendritic drainage pattern is now developing on massive sandstone of Gondwana formation. Parallel and herringbone pattern is emergent at the interface areas of Deccan trap formation and Gondwana surface where hard rock of Deccan formation provide steep slope for lateral consequents and comparatively non-resistant Gondwana sandstone afford longitudinal valley for master stream.

The indications of structural control on drainage system are discussed with reference to various drainage outlines, straight courses of streams, sudden change in flow direction, head ward erosion resulting into scarp retreat, stream piracy and anomalous drainage. Observation of satellite imageries indicates presence of several lineaments. These lineaments are presented by straight courses of streams and modified drainage.

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