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THE GEOMORPHOLOGICAL FEATURES OF NAGPUR DISTRICT, MAHARASHTRA

R. M. POFALI, Nagpur

ABSTRACT : The geomrophological studies have been undertaken in the area of Nagpur district, Maharashtra with the help of aerial photographs, topographical maps and field investigations. The study has brought out various landscape features which have evolved from heterogeneous lithological formations and under many paleoclimatic successions. The study reveals that terrain comprises peneplained Precambrian basement which has witnessed intense folding, faulting, thrusting and sedimentation during Gondwana period and pouring of lava during the early Tertairy which has capped the older peneplain in the western part of the district. The formation of Gondwana landscape and its evolution indicates the successive climatic changes from humid through glaciation to arid. The geomorphic screening of the area has brought out three distinct terrain characteristics under the present landscape configuration viz. the trappean topography of the western part of the district, the folded and faulted area of the north and the plainland of the southeast remarkably formed out of alluvium dotted with Precambrian and Gondwana residual hillocks and ridges, alluvial terraces and rejuvenated valley floors.

Introduction

The Nagpur district is in the eastern part of Maharashtra State and located between 78°30′ to 79°30′ E longitude and 20°30′ to 21°45′ N latitude covering an area of about 9930 sq. km. The northern border merges with the district of Chhindwara, M. P., while Bhandara, Chandrapur, Wardha and Amravati districts of Maharashtra border its eastern, southern and western boundaries respectively.

The district enjoys a tropical monsoonic climate with the mean annual rainfall ranging between 100 and 130 cm. of which about 80% is received during June to September. The eastern part receives a rainfall of about 130 cm. which progressively decreases to 100 cm. in the west. The mean annual temperature ranges from 25°C to 27°C. The region experiences a hot summer with mild winter in most of the years.

The geological succession consists of quartzites, gneisses, schists and marbles of Precambrian age, shales and sandstones of Lower Gondwana age, basalt of the Tertiary period and recent Quaternary alluvium (Distt Gaztt. 1966).

The elevation of the district ranges from 150 to 600 metres above the mean sea level. About two third area of the district has an average elevation more tnan 300 meters above the mean sea level, while the remaining area lies below this elevation. The elevation of the district progressively decreases from north to south and also north to west. The general inclination of the terrain is from north to west as well as from north to southeast.

The district is drained by two river systems. The Wardha river flows along the extreme western border collecting 30% of the drainage water from the west, while the river Wainganga flows along the extreme eastern border collecting the major share of the drainage water (70%) from the eastern and south eastern portions of the district. The Wunna and Jam are the important westward flowing tributaries of the river Wardha while the Kanhan, Sur and Amb are the major eastward flowing tributaries of the river Wainganga (Fig 1).

Terrain Characteristics of the district

The landscape analysis carried out from the aerial photographs and supplemented with field observations reveals that the district has three well-marked geomorphic units which can be further divided into sub-units. The major geomorphic units differ from one another in respect of lithology, strucure and stage of evolution. They are mainly (i) Terrain made up of folded and faulted strata in the north (ii) Plainland of the southeast and (iii) Plateau land of the southwest and western parts. Each of these geomorphic units is the assemblage of a number of micro geomorphic sub-units having separate stages of evolution.

(i) The northern hilly terrain with folded and faulted strata

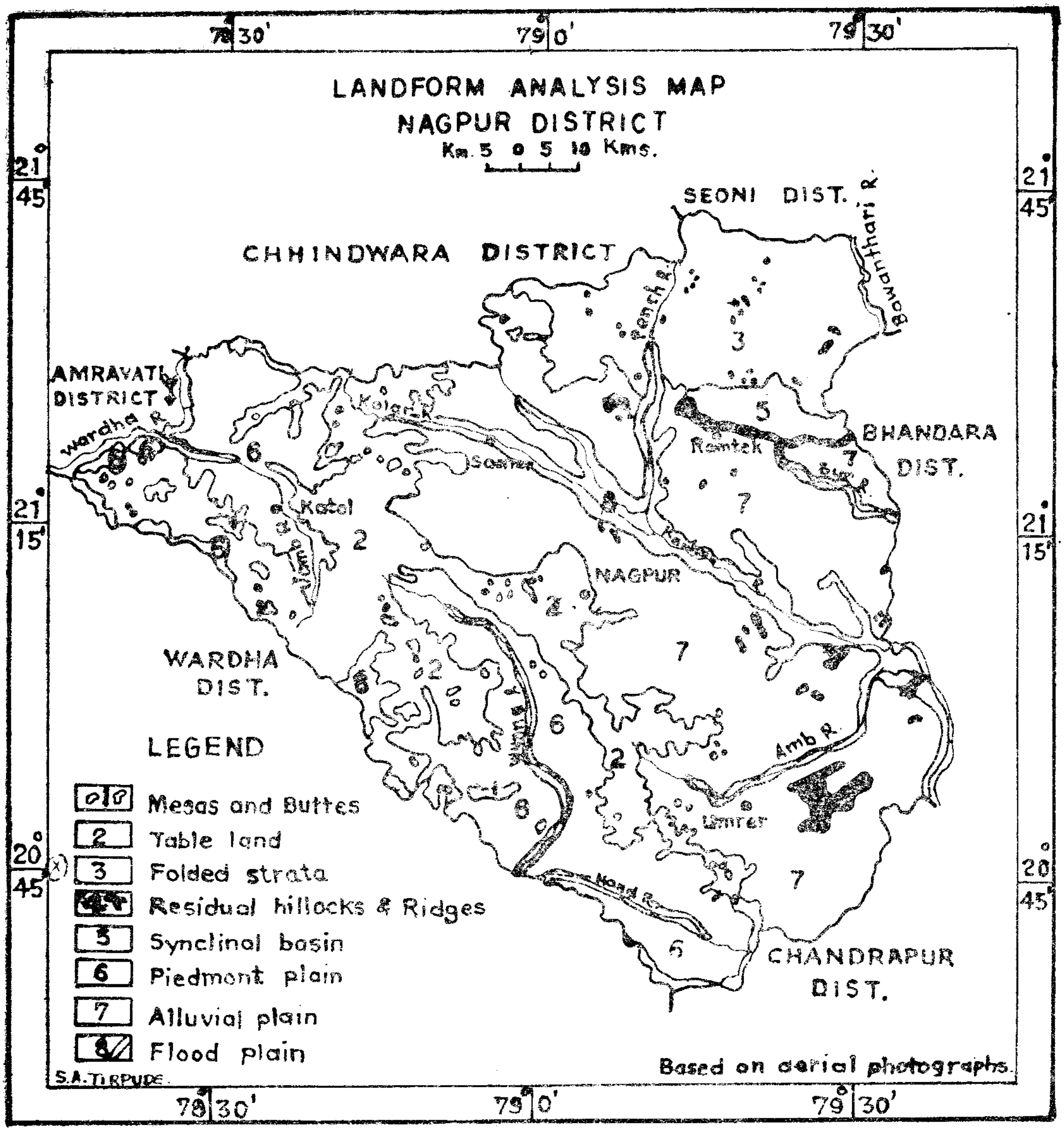
The northern part of the district located between 79°0′ to 79°30′ E longitude and 21°25′ to 21°45′ N latitude presents highly disintegrated and subdued topography on ancient crystalline rocks. This unit stands out prominently in the physical landscape of the district. The topographic evolution displays that the present configuration of the landscape is the result of age long denudation and cyclic implications. The bold ridges and hills are mainly the relicts of earlier mountain system which resisted the process of prolonged degradation. The area remains interesting both geologically and geomorphologically, as it shows unique sequences of Precambrian landscape worn out by age long denudation into sharp features within a relatively narrow range of relief i. e., 150 to 300 metres (Fig. 1).

The elevation of this unit ranges from 300 to 450 metres above the mean sea level with a number of resistant summit of accordant levels rising up to the height of 550 to 600 metres above the mean sea level. The general slope is from north to south while subsequent slopes exhibit complex pattern.

The strata display high degree of folding and faulting due to intense diastrophic activities during the Precambrian period and some disturbances in the form of regional tilting towards south at the close of late Tertiary or Pleistocene age. The folded structure shows steep dips towards south and strike generally E-W or WNW-ESE (Pascoe, 1965).

The rocks of the area belong to highly metamorphosed phase of the Sausar series of the Dharwar system of the Precambrian era. They are arranged in parallel bands and are intensively folded into an anticlinorium and a synclinorium of considerable complexity indicating severe tectonic movements. The major rock types of the area are schist, dolomite, calc-granulite, calc-gneiss, marble and quartzite. The quartzites being very resistant are mainly the ridge makers while the granite, gneiss, schist and marble are highly decomposed and disintegrated due to physicochemical weathering giving rise to the topographic features of low relief.

The folded and faulted strata are prominenltly seen on the aerial photographs well exposed to the north of Ramtek on Nagpur-Jabalpur Road and also in the transverse valley of the river pench (79°0′-79°15′ E and 21°28′-21°44′ N). In the northwestern sector, the ancient rocks of this unit were burried below a thin capping of lava but are now exposed in the form of subdued hillocks along the course of the river Kanhan due to erosion. A number of faults as well as shear zones are remarkably opened due to renewed erosion by the tributaries of the rivers Pench, Kanhan, and Bawanthari (Fig.2).



The rivers Bawanthari and Kanhan exhibit their influence in the area through their tributaries. The river Bawanthari flows along the northeastern border of the district and the river Kanhan along the western border of this sub-unit. Therefore, Pench the main tributary of the Kanhan, is the only river which dominates the drainage characteristics of the area. The river Pench flows transverse to the regional structure and its course is mainly governed by the dip of the formation. Its bed is rocky and is bounded by steep interlocking ridges producing a number of gorges all along its course through the hilly terrain. It is joined by many subsequent streams excavating valleys in the weaker formations. The interrupted thalweg of the river Pench indicates the presence of

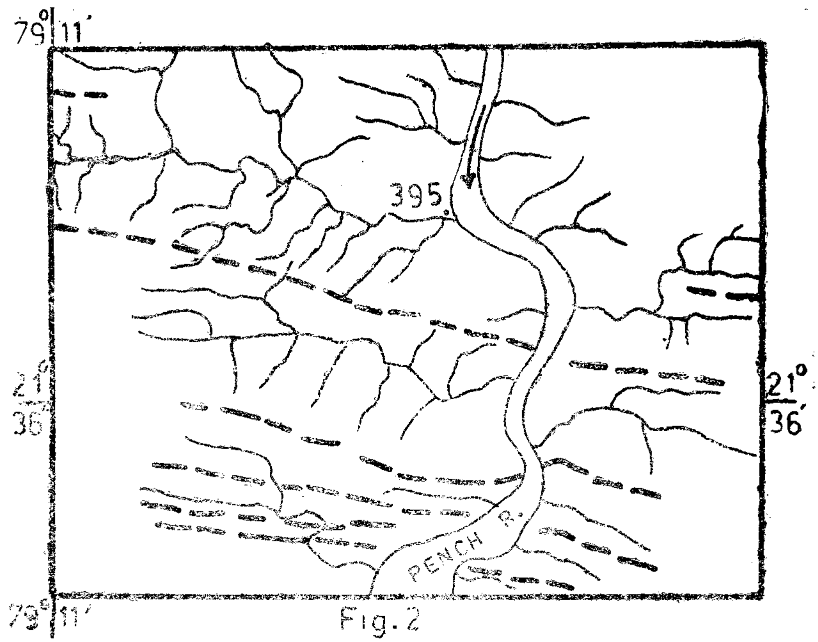


Fig. 2

rapids and falls of low magnitude and formation of potholes at the base of knick points (Fig. 2). The transverse profile exhibits the bedrock terraces and valley -in-valley phenomehon which may be due to rejuvenation. The river Sur, another important transverse stream of the area has truncated its course in the frontal ridge near Ramtek indicating that it has forced its passage through a narrow gorge and has given rise to a magnificent water-gap. At the back of the water-gap lies the huge synclinal basin of Ramsagar.

In general, the drainage system is well adjusted to the underlying geological structure with the resulting trellis pattern (Fig. 2). The streams have cut through the ridges developing a number of water-gaps in the area taking advantage of weaker zones of the rock structure (Fig. 2).

This part of the district is thinly populated due to rugged terrain characteristics. It is well covered with luxuriant forest species with patchy cultivated areas. Economically, it occupies a unique position due to manganese ore deposits and luxuriant forest cover. A dam is being constructed across the river Pench for hydro electric project. This project will supply power as well as water for irrigation which will promote industrial and agricultural development in the district. The scenic value will also be enhanced due to the construction of a dam.

(ii) Plain land

In between the northern hilly terrain and southern plateau tract lies the alluvial plain drained principally by the rivers Kanhan, Sur, Pench, Amb, Kolar and their tributaries. It lies at an elevation ranging from 150 to 300 metres above the mean sea level. It is flat to gently undulating and highly dissected along the river banks. The rivers descending from the northern hilly terrain and the plateau tract suddenly change into sluggish meander ing streams and deposit the material due to loss of gradient. The plain has tapering northwestern border but it is wide and open in the southeast. The general slope of the plain is from northwest to southeast. The crystalline basement of the synclinorium have been exposed in the beds of the rivers Kanhan, Kolar and Wainganga

The low ridges of metamorphic rocks and residual hillocks in the vicinity of Koradih $\frac{79^{0}10'E}{21^{0}15'N}$ Gumthala $\frac{79^{0}3'E}{21^{0}15'N}$ Kamptee $\frac{79^{0}11'E}{21^{0}12'N}$ and Khapa $\frac{79^{0}5'E}{21^{0}17'N}$ are mainly the relicts of the precambrian rocks. The longitudinal ridges of the sedimentary formation are visible mainly in the vicinity of villages Bokara $\frac{75^{0}4'E}{21^{\circ}13'N}$ Patansaongi $\frac{79^{\circ}2'E}{21^{\circ}19'N}$ Saoner and Kelod $\frac{71^{0}50'E}{21^{\circ}28'N}$ (Blanford, 1872). Suryanarayan (1968) while conducting ground water investigations, has reported extension of these sedimentary basins. He named the two parallel basins separated by the crystalline precambrian ridge at Bokara and Kamptee of Lower Gondwana formation and attributed their origin to parallel fault in which the sediments were deposited.

The subdued and worn out ridges and hillocks projected on the plain land have steep dip towards south and strike generally from E-W. They are mainly composed of older crystalline rocks of Precambrian period as well as sedimentaty rocks of Lower Gondwana system. The major rock exposures in the plain land are mainly mica-schist, gneiss, marble and quartzite belonging to the Dharwar system of the Precambrian era while the sedimentary rocks are mainly sandstone and shales belonging to the various series of Lower Gondwana formations. The deposition of Talchir boulder bed in the vicinity of Bokara and Koradih is noteworthy (Pascoe, 1959).

The plain land is drained by the river Kanhan and its tributaries, viz., the Kolar, the Pench, the Sur and the Amb. The alluvial plain is characterised by fine textured dendritic drainage pattern exhibiting lack of strucutural control on the development of tributaries. The rivers, in general, have meandering courses causing lateral erosion.

The presence of alluvial terraces along the flood plain, the severe bank cutting and the incision of the major river courses in the basement rock indicate the phenomenon of rejuvenation in the recent period. This is evident in the downstream of the river confluence Kanhan-Pench and Kanhan-Wainganga. The shifting of river courses from east to west is prominently perceptible on the aerial photographs. The difference in heights between the abandoned channels and present course of the river, indicate the degree of erosion and some recent movements after initial drainage carving. The noncyclic terraces associated with the Wainganga imply continuous down cutting accompanied by lateral erosion. At places, slope wash has completely removed the scarp separating the terraces from one another. The course of the river Kanhan in between $79^{\circ}0'$ to $79^{0}5'$ E and $21^{\circ}20'$ to $21^{\circ}25'$ N and the rever Kolar between $79^{0}2'$ to $79^{0}10'$ E and $21^{0}13'$ to $21^{0}19'$ N exhibit development of badland topogaphy due to severe bank cutting indicating the renewed erosion in the area.

Regionlly the area is known as Wainganga basin receiving a heavier rainfall than the western side of the district. The change in surface configuration with concurrent increase in rainfall and deep alluvial cover has changed the utilization pattern of this tract which is quite different from that in the northern and western parts of the district. The area has greater agricultural potential. The irrigation water from the Pench Project will provide base for a flourishing agricultural economy in the near future. The coal seam deposits associated with the plain land have already made this tract economically important. The flood deposits, along the banks of the major rivers which have favourable texture have attracted the brick and tile industries in the vicinity of Bina, the village located on the confluence of the rivers Pench and Kanhan. The huge deposits of fine sand in the plain land are due to loss of gradient in the loaded river courses descending from the northern hilly terrain. The fine sand are excellent for construction purposes in and around Nagpur. The plain land is a good acquifer for ground water due to sandstone –shale sequence as well as the presence of weathered zones and fractures in the Precambrian rocks (Pande, et al. 1969).

iii) Plateau Land

This unit, comprising the western and southtwestern parts of the districts, is covered by basaltic flows with trappean characterisation. It forms the eastern edge of the Deccan Plateau of Maharashtra and runs from north-west to south-east occupying half the area of the district. The elevation of the plateau land ranges from 300 to 450 metres above the mean sea level with flat-topped summits attaining height of 525 metres above the mean sea level. It slopes gradually towards the west and southwest but exhibits abrupt fall towards the eastern plain. The plateau acts as a water divide for the streams radiating in the east, west and south.

The tract is formed from the horizontal sheets of lava extrtuded through fissures during the early Tertiary obliterating the previously existing topography of Precambrian as well as Lower Gondwana. Around Nagpur, the maximum thickness as revealed from borehole data is 45 metres (Pande, et al. 1969). The trap is hard, compact and is fine to medium grained basalt. In the vicinity of Nagpur vesicular and non–vesicular flows separated by the fossiliferous 'Inter-trappean beds' are commonly encountered (Pascoe, 1963). Though generally the trap has horizantal dispostion, at places it has shown distinct tilting indicating some from displacement due to tectonic forces. For example, 3 km. west of Nagpur on Nagpur-Katol road, in Gitti Khadan quarries near the village Takli the lava beds are tilted towards south with inclination of 15^0 to 20°.

Under the present climatic conditions, trap weathers with characteristic spheroidal exfoliation giving rise to rounded boulders of various magnitude on the outcrops. Prismatic jointing and columnar structure are normally observed in basalt along the hill sides as well as on solping surfaces. In the locality known as Starkey point, 7 km. west of Nagpur city on Nagpur-Amravati Road, the hexagonal structure is conspicuously observed.

The geological structure described earlier is characterised by flat topped hills and step like terraces. The specific characteristic of the basaltic topography is due to variation in hardness and composition of different flows and their differential weathering and erosion. The severe dissection of the plateau results in the formation of flat-topped table lands, mesas and buttes, varing in height from 15 to 50 metres and separated by the escarpment slopes well furrowed on their flanks by the radiating streams which at places have excavated sizeable ampitheatres through scooping action.

At the foot of the scarp lies the pediment zone with moderate relief strewn with rounded boulders rolled down from the scarp faces and deposited by sluggish streams. It is mainly a bed rock surface with thin soil cover formed due to retreat of scarp faces. This unit has been shown in association with the table land as it was not possible to demarcate it separately on the geomorphic map due to limitation of scale.

The zone of low relief located between the pediment and flood plain has been designated as piedmont plain. It is characterized by gentle slope covered with thick deposits of fine clayey outwash from the adjoining table lands and pediments (Fig.1). The rivers Wardha, Wunna and Amb have formed narrow strips of flood plain along their courses as exhibited in (Fig. 1).

The drainage lines of the area are controlled by the topography and geological structure. The rivers of this area are comparatively young indicating predominance of vertical erosion due to high available relief. As they are not adjusted to the underground rock structure, they exhibit numerous breaks in their profiles. The rapids and falls of low magnitude are related to structural variations. The transverse profile shows that the valleys are flanked with escarpment slopes with well developed structural terraces. In genei al, the beds of rivers are rocky and covered with rounded boulders of various sizes depending on the gradient at those places. The characteristics indicated above are associated with the river valleys of Wardha, Wunna, Nand and their tributaries. In the plateau section the rivers display high degree of sinuosity due to the projecting interlocking spurs in the river valleys.

Along the eastern margin of the plateau, the headwater streams of the river Kolar have superimposed their courses on the older sedimentaries cutting through the younger basaltic capping, while in the north western section of the district, the tributaries of the Kanhan have exposed the Precambrian basement cutting through the trap. The phenomenon of superimposition is well exhibited near villages Bokara $\frac{79^{0}4E'}{21^{0}13'N}$ Wihirgaon $\frac{79^{0}10'E}{21^{0}6'N}$ and Kelod $\frac{78^{0}50'E}{21^{0}28'N}$

The topography and rock fractures govern the drainage pattern of the area. The radial pattern is mainly associated with the table lands, mesas and buttes, while the sub-parallel-sub-dendritie pattern is the feature of escarpment slopes. The joints and fractures of the rocks govern the pattern of small streams and streamlets with the development of the rectangular drainage pattern which is well exhibited in the area west of Takalghat village $\frac{(78^{0}55'E)}{(20^{0}10N)}$.

The narrow valleys, piedmont plains and flood plains are covered with very deep, clayey soils having good water holding capacity. The dark gray brown soils associated with these land-scape units are fertile and good for cultivation. The table lands, mesas, buttes and pediments with shallow soils are under thin vegetation. At places they are quarried for boulders and rocks, utilized for construction purposes. The compact traps are poor sources of ground water, but the underlying ones viz. , the intertrappean and lamata formation or gneiss act as good acquifiers (Pande, et al. 1969).

Discussion

The geomorphic study of the three distinct landscape units clearly reveals that they differ from one another in stages of evolution, morphology, lithology, drainage development and land utilization.

The northern hilly tract of folded and faulted strata belongs to the ancient crystalline rocks of precambrian. It is a region of subdued topography presently showing signs of rejuvenation.

The south eastern plain land lying at the edge of the hilly terrain is the peneplained basement over the ancient crystalline rocks as well as the Lower Gondwana sedimentaries. Moderate slopes and low gradients of rivers are important contributing factors for the huge deposition of finer alluvium in this tract. By the renewed excavation by the rejuvenated rivers, the older rock formations capped by the recent lava flow have been exposed in the valley bottoms as the rivers have superimposed their courses through the younger formations. The moderately sloping plain land with resistant sabdued hillocks of ancient formations with accordent summit levels, broad valley floors and subdued interfluvial areas signify the peneplanation of this area.

The plateau land of the west and south-west formed out of basaltic flows has peculiar characteristics of weathering and denudation. Its high elevation, significant local relief, rocky and rugged structure, narrow river valleys, structural breaks in the longitudinal and transverse profiles and dominance of vertical erosion are diagnostic features of a youthful topography.

Conclusion

The denudation chronology of the district brings out that the earlier highly matamorphosed Precambrian basement was peneplained, followed by deposition of sediments of the Lower Gondwana system in block faulted areas with further upheaval and subsequent denudation of the sedimentary land masses. The paleoclimatic sequences reveal a glaciation followed by humid climate as evidenced by the presence of boulderbeds in the vicinity of Bokara and Koradih which are presumed to be old tillites. The revival of hot humid climate in the area has favoured luxuriant growth of vegetation and melting of ice sheets which have transported huge amount of sediments and the vegetation, giving rise to deep alluvium and coal bearing strata presently excavated in the vicinity of Nagpur which are preserved in the block faulted areas. During the redistribution of the Gondwana landscape the surface was fractured into numerous fissures through which the basic lava emitted and spread on the surface covering the old topography and giving rise to the present day basaltic landscape of the district.

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Address of the author

R. M. Pofali, National Bureau of Soil Survey and Land Use Planning, Regional Centre, Nagpur.