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A futuristic digital interface with a glowing Earth globe in the center. The background is dark blue with various data visualizations including bar charts, line graphs, and network diagrams. Text elements like 'BUSINESS', 'NETWORK SEARCH', and 'LADING 100%' are visible. A hand is shown at the bottom, appearing to interact with the interface.

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Geomorphological Studies around Ratona Area, District Sagar, MP, India Supplemented with Field Investigations

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ABSTRACT: The study area chosen for detailed geomorphic studies is covered mainly with the rocks of Vindhyan Supergroup in northern region and Southern part with Deccan traps lava flows. In order to understand the geomorphic development over these rocks, various types of maps have been prepared such as drainage map, drainage frequency, drainage density, relative relief, slope map and superimposed profile etc. It is evident from the studies that overall geomorphic development is controlled by the underlying rock formations. The generally dipping rocks of Vindhyan Supergroup has developed elongated ridges extending in NNE direction which are later on developed gorge in Northwestern region and NE trending ridge in the extreme southern region, which may be the result due to local slumping during their formation or loading caused due to Deccan trap lava flows.

KEYWORDS: Geomorphology, Ratona, Vindhyan, Deccan, Drainage, Relief.

I. INTRODUCTION

Ratona area of Sagar District has very well exposure of sedimentary rocks of Vindhyan Supergroup for primary and secondary structural study. This area falls under the toposheet number 55 I/9 of Survey of India. Geologically, the Ratona area has mainly two types of rocks i.e., igneous rock of Deccan Trap mainly basalt and Sedimentary rocks of Vindhyan Supergroup mainly sandstone. The Bundelkhand Craton covers around half of Madhya Pradesh and parts of Uttar Pradesh. The study area belongs to Bundelkhand Craton, the Meso-Proterozoic Vindhyan basin and the Malwa Plateau of Deccan Volcanic Province. In the Ratona area there are 2 groups of rocks exposed, the sedimentary rocks of Vindhyan supergroup and Deccan Trap basaltic flow (with intertrappeans).

The Vindhyan Sandstone is conformably overlain by the Deccan Traps. The basement of sedimentary rock of Vindhyan supergroup is exposed at some places, The quartzites and sandstone base is overlain by basaltic lava flow interbedded with some beds of intertrappeans. The intertrappean constitutes of chertified and calcareous sediments, they exist in between flows of basaltic lava consisting of a distinctive characteristic. Break in subsequent flows is noticed followed by deposition of chertified and calcareous intertrappean. Generally, Vindhyan rocks occur as inliers in the study area.

II. GEOMORPHOLOGY OF THE STUDY AREA

The area presents remnants of the Vindhyaachal mountains with maximum height of 613m and the minimum is at 500m from MSL. The study area was non-uniform as far as relief is concerned. The overlying Deccan Traps have been eroded which results in the exposure of underlying resistant Vindhyan Supergroup of rocks.

The whole area presents a picture of undulated topography. The Vindhyan, which were buried under the Deccan traps, are once again exposed by the erosion of the trap material denoting the latest cycle of erosion. In the southwestern part of the area a small hill of Vindhyan appears at the same level of Deccan Trap, which shows that at the time of lava flow this area was already a high land.

The topography of the Vindhyan is mainly “exhumed” topography, which indicate by the presence of isolated residual hills. The Vindhyan scenery shows mature stage of its geomorphic development. The Upper Vindhyan sandstone belonging to Rewa Group forms open plateaus that display land-tops and escarpments. Vindhyan seems to be quite uplifted before extrusion of Deccan lava Particularly in Malwa region. They form escarpments at most of the places in our area.

During Upper Cretaceous to Eocene times, there was eruption of huge quantity of basic lava, which flowed over extensive tracts of the western, central and southern India. They formed flat-topped plateaus and are known as the Deccan Trap which literary means “step-like” topography, that is quite clearly visible in the panoramic views in the area.

Deccan Trap is affected by weathering more on the sides than on the top called “lateral- planation” that produces ‘flat top’ mesas and conical hill or ‘butte’ in Succession.

Spheroidal exfoliation is predominant in basalt. It looks like “onion skin features”. It is type of a chemical weathering that creates rounded boulders and helps to create domed monoliths of small dimensions. On chemical weathering Deccan trap produces fertile “black cotton soil” and laterite caps (rich in iron, reddish brown in colour due to oxidation of iron into Oxides). Such caps were observed around Haphsili and Amawani.

Drainage pattern formed by the streams, rivers, and lakes in a particular region. They are governed by the topography of the land, whether a particular region is dominated by hard or soft rocks, and the gradient of the land. The perennial river in study area is Dhasan river. The drainage pattern encountered here mostly dendritic type as there are many contributing streams (analogous to the twigs of a tree) that join the higher order streams at any angle join into the tributaries of the main river as shown in figure 1. They develop where the river channel follows the slope of the terrain. Dendritic systems forming V-shaped valleys; as a result, the rock types must be impervious and nonporous.

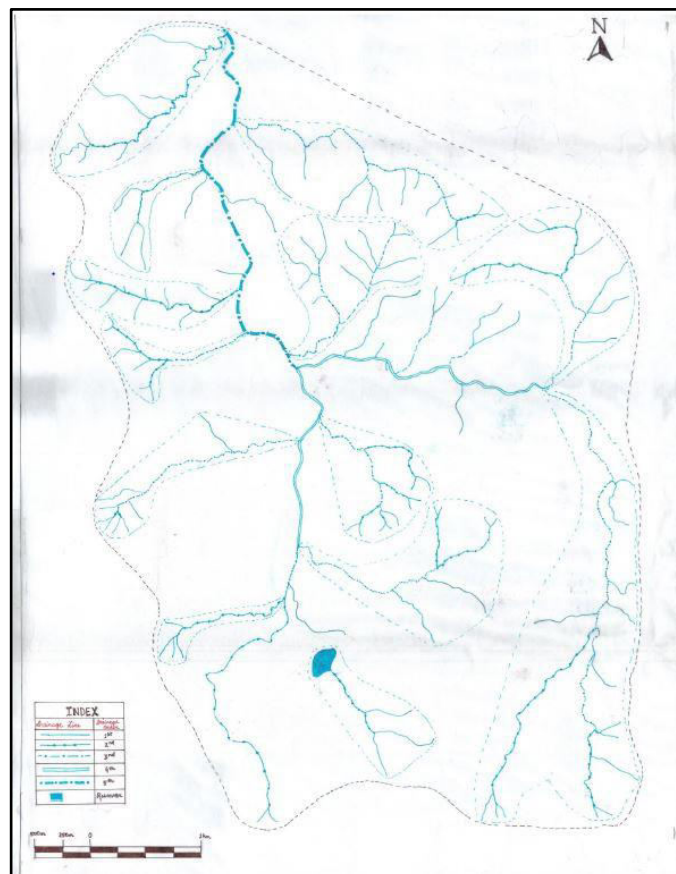


Figure 1 Drainage Map of the study area

III.MORPHOMETRIC ANALYSIS

The measurement and mathematical analysis of the configuration of the earth's surface and of the shape and dimensions of its landform provide the basis of the investigation of maps for a geomorphological survey (Bates & Jackson, 1980). This approach has recently been termed as Morphometry.

A) DRAINAGE DENSITY

Drainage density is a measure of the texture of the network and indicates the balance between the erosive power of Overland flow and the resistance of surface soil and rocks. It plays an important role in surface-runoff processes, influencing the intensity of torrential floods, the concentration, the sediment load and even the water balance in a drainage basin.

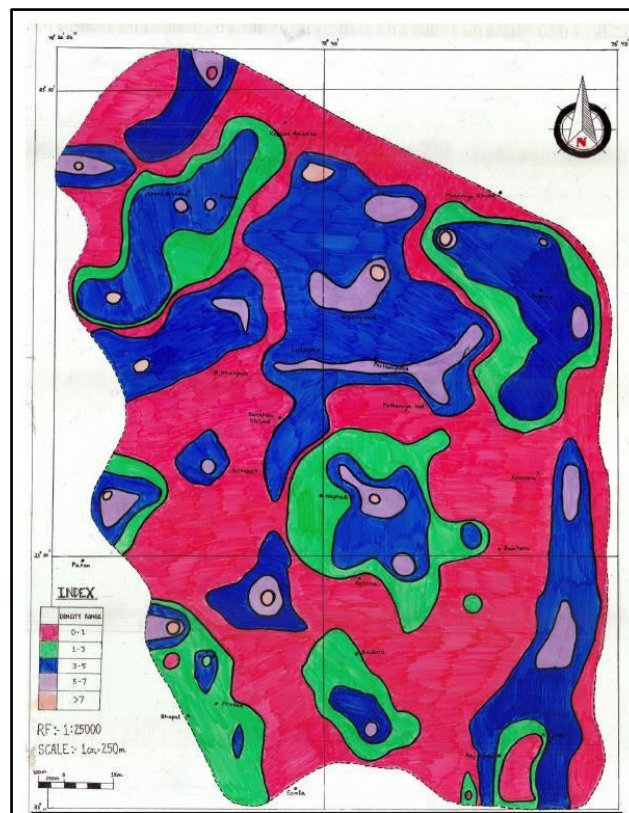


Figure 2 Drainage Density Map of the study area

B) DRAINAGE FREQUENCY

The drainage frequency introduced by Horton ([2] and [3]) means stream frequency (or channel frequency) F_s as the number of stream segments per unit area.

The highest drainage frequency value is 7, which is observed 75° WSW of Banguwa near a Vindhyan Hill. The lowest value of drainage frequency is 0 observed in the alluvial plain on Deccan Alluvium in between the uplifted blocks. The lowest frequency values are more concentrated on the southern portion of the toposheet which are dominated by the Deccan hills/hillocks showing low lying mesa structure due to extensive erosion of the ferromagnesian minerals according to Goldich mineral stability series. Drainage Frequency Map shown in figure 3.

Stream frequency or drainage frequency is defined as the measure of the no. of streams per unit area. It is a part of study of morphometric analysis of a drainage system.

In our study area 2 principal lithologies are present: 1. Vindhyan sandstones 2. Deccan basalts. The frequency values are higher in Vindhyan in comparison to the Deccan basalts since the former consist of resistant rocks while the basalts being basic volcanics are more prone to weathering and erosion.

Moreover, there are numerous lineaments in Vindhyan whose course is followed by 2nd and 3rd order streams.

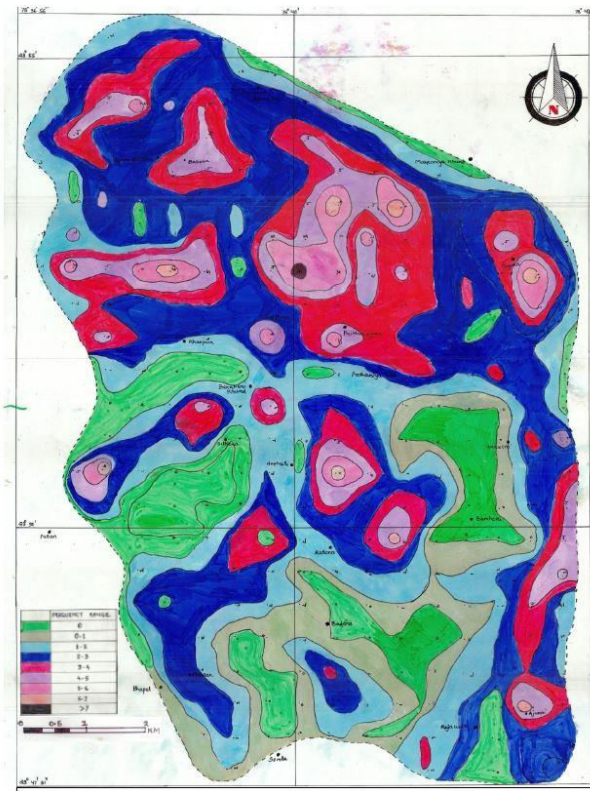


Figure 3 Drainage Frequency Map of the study area

IV.RELATIVE RELIEF MAP

It is one of the methods for the measure of local roughness which is obtained by computing the difference between the highest and lowest elevation [10]. Relative relief acts as a factor in vulnerability studies emphasizing upon pre-disaster investigation for select populated sites, it also controls terrain morphology.

As observed, the deccan basalt ranges from lowest to medium relief (i.e., 0 to 60 m) under which 0-20m is deccan alluvium and rest 20-60m suggest simple terrain morphology, simple drainage distribution and no deformation pattern as can be seen in Figure 4. Low relief areas are very vulnerable for disasters, which are mostly low-lying areas having well developed settlement.

On the other hand, Vindhyan terrain shows high relative relief difference (Ranging from 60 to >80m) as compared to deccan basalt. Vindhyan suggests complex terrain morphology, complex drainage distribution and highly deformed pattern and it is more vulnerable for mass wasting.

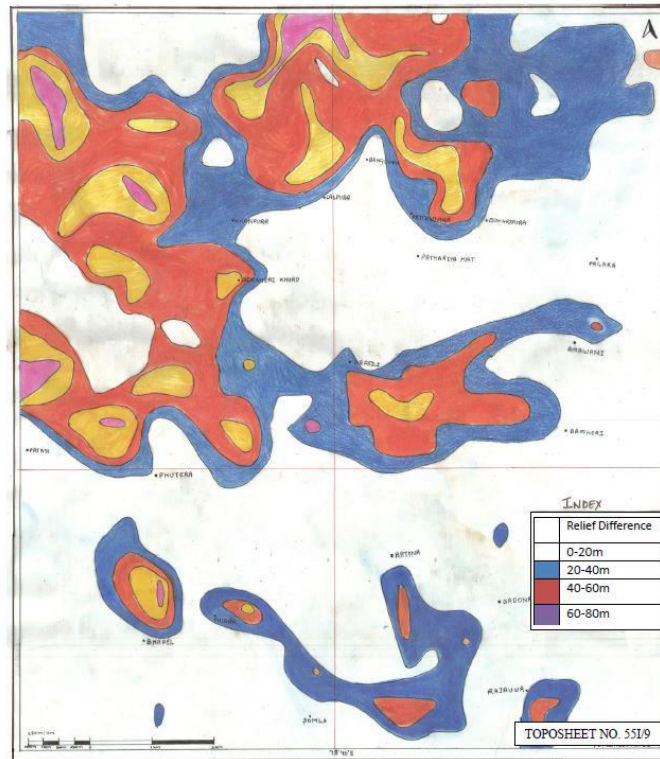


Figure 4 Relative Relief Map of the study area

V.SLOPE MAP

This map provides a colonized representation of slope, generated by using mathematical method. The given area can be divided into two parts: The area below Railway line, 2/3rd part of the area is covered by gently sloping Deccan and rest of the part is covered by sloping Vindhyan. The area above the railway line is steeply sloping with mostly Vindhyan cover as can be seen in figure 5. This area is having rugged topography having presence of escarpment, gorge and dry waterfall. In the western part of the map near Patan, anomalous pattern of sloping behaviour is observed from our collected data, which may indicate a fault.

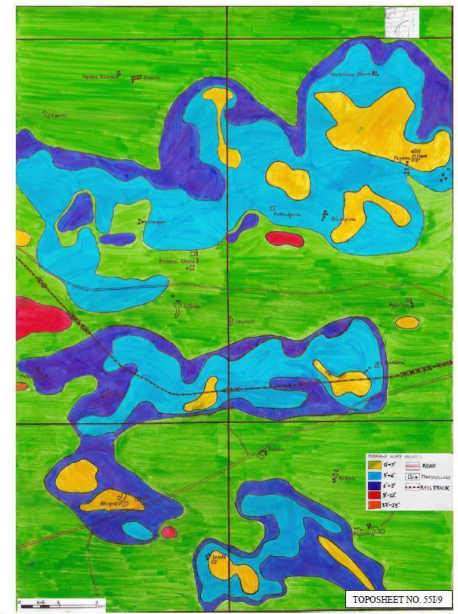


Figure 5 Slope Map of the study area

VI.LINEAMENT MAP

Lineament studies are important for the interpretation of hidden structure of the rocks and it can be applied to decipher the analysis of structural deformation patterns and tectonism of a region and also in exploration of ground water/minerals.

The lineament map prepared in this study area shows that there are at least three sets of major and minor faults/joints that has controlled the development of valleys.

Besides the lineaments drawn from drainage lines, major hill trends have also been marked on the figure 8 providing a broader view of the overall tectonic setting of the area. Most of the study area is underlined by the Vindhyan Supergroup of rocks, which are affected by the joint sets. A Lineament map based on the drainage network and hill trends has been prepared.

There are three major lineament trends in the area that are E-W, NNW-SSE, and NNE-SSW. Most of the hills in the study areas are exposures of Vindhyan sandstones surrounded by Deccan alluvium in the form of inliers. The Hill Trend Rose Diagram figure 7 shows major hills are oriented in the WNW-ESE direction. It is like the trend of the Vindhyan range, Narmada River as well the E-W regional strike of Vindhyan rocks.

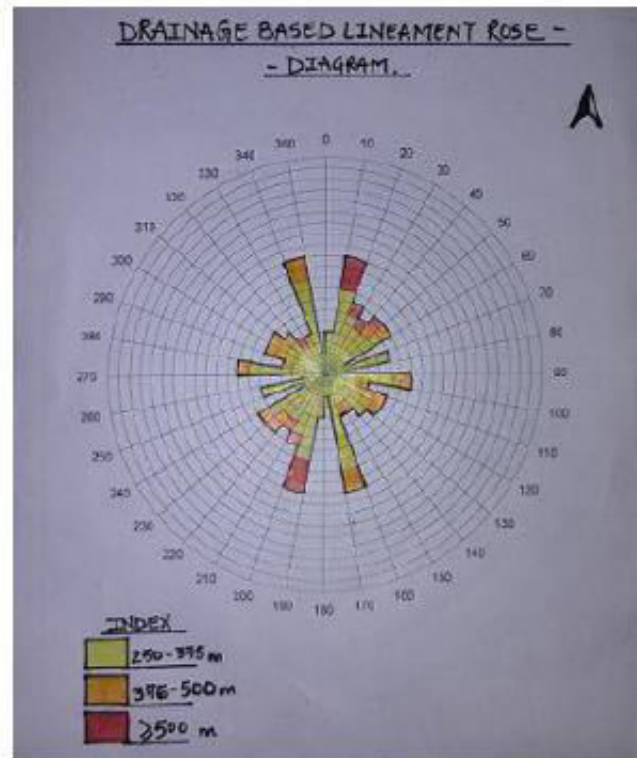


Figure 6 Drainage based lineament rose diagram.

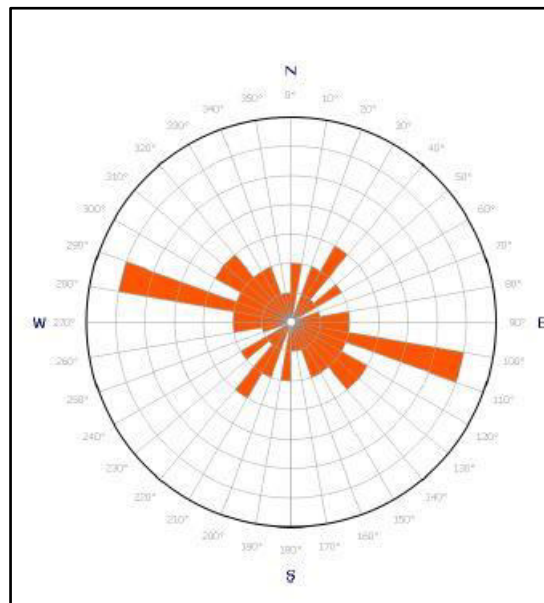


Figure 7 Hill trend rose diagram.

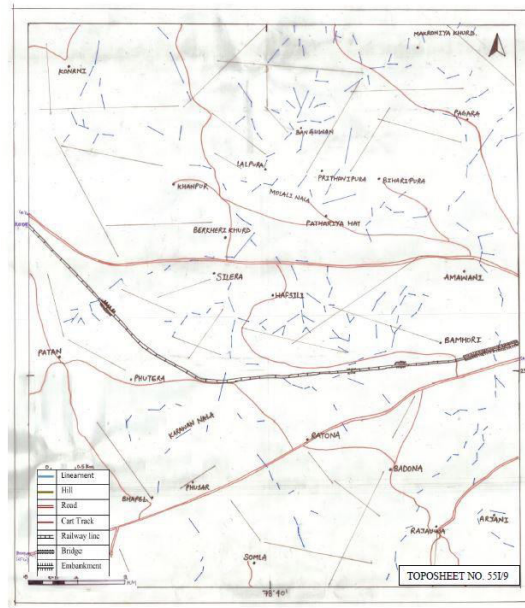


Figure 8 Lineament Map of the study area

VII.SUPERIMPOSED PROFILE

It presents a visual picture of the surface configuration of the study area. The study of superimposed profile and erosional surface help us to understand the geomorphic history of the area in terms of the interruption in the geomorphic cycle. It seems that there may be at least three erosion surfaces on the Vindhyan and one or two on the Deccan Trap as shown on the superimposed map (Figure 9 and 10).

Both the superimposed profiles (latitude and the longitude) show that the highly resistant Vindhyan hill outcrops range in elevation from 560-580m whereas the Deccan alluvium formed after weathering of more readily erodible basic lava flows ranges in elevation from 500-520m. There are some Deccan hills on the southern portion of the toposheet (South of Railway line) whose elevation is like the Vindhyan hills in the toposheet.

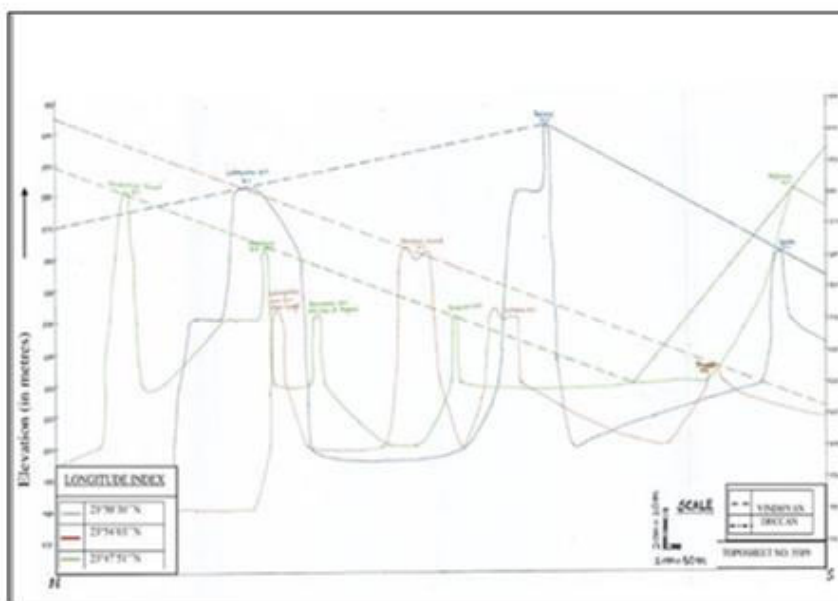


Figure 9 Superimposed Profile (Longitude)

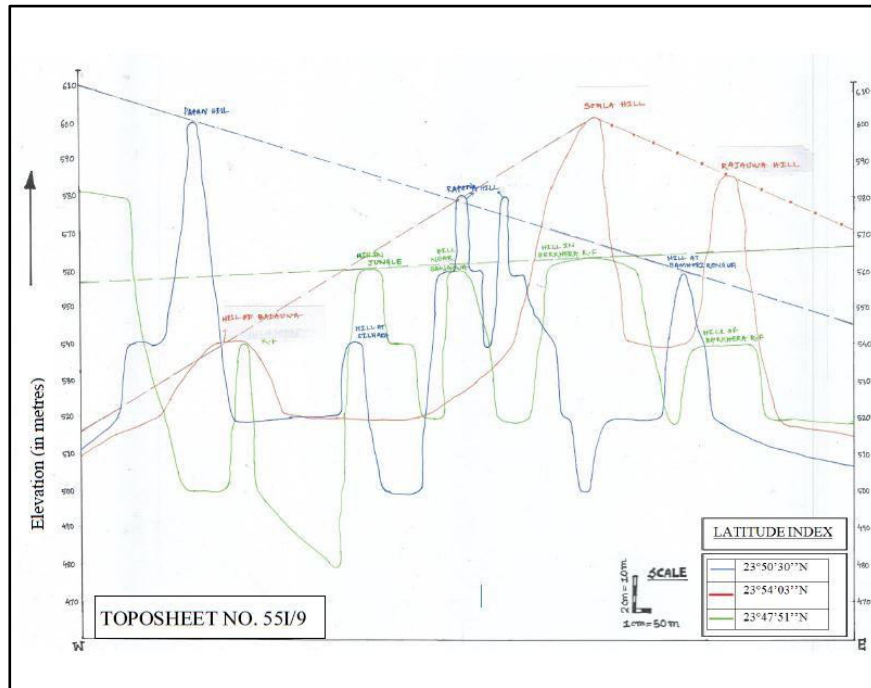


Figure 11 Superimposed Profile (Latitude)

VIII.PALAEOSOLS

A Palaeosol is an ancient soil that developed upon a former a former landscape. Three types of palaeosols may be recognized, relict, buried and exhumed [9]. Buried palaeosols are formed on a pre-existing topography and subsequently buried beneath younger sediments or rocks. A fresh exposure of palaeosol developed on Rewa Sandstone exposed along a road-cutting developed to build a culvert on Bhapel-Ratona road. The section of exposed rocks show alluvium, Deccan lava, soil palaeosol and Rewa sandstone. In the Karawan nala section, near Ratona- Bhapel road, a thin layer of silty sandstone and pebbles is observed. Here angle is around 8-12° between Deccan Traps and Vindhyan are well exposed.

IX.CONCLUSION

Geologically, the area is covered mainly with rocks of Vindhyan and Deccan trap. The northern part is mainly covered with the rocks of Vindhyan Supergroup while the extreme Southern portion of the study area with Deccan Trap. It is evident from the studies that the linear trend of the ridges existing in the northern region may be the result of continued action of geomorphic processes operating on almost horizontally bedded Vindhyan rocks right from their formation, while Deccan traps has formed hummocky and boulder flows, consequently resulted step topography with rounded buttes and tabular mesas. Some of the anomalous drainage characteristics developed in northern region may be the result of local disturbance in structural pattern developed during the time of deposition and later loading by the Deccan traps.

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