Research Paper

ASSESSMENT OF PALEOGEOMORPHOLOGICAL EVOLUTION OF RANCHI CITY, JHARKHAND

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Abstract:

'Paleogeomorphological Evolution of Ranchi City' denotes the study or science of buried relief features of its location which provided the area a geomorphic base for settlement and urbanization. Paleogeomorphic knowledge is highly significant in deciding the urban growth in geomorphologically frazzle zone like Ranchi city of Jharkhand state which is a small state in the eastern part of the Indian peninsular plateau. Ranchi City is situated on the central location of Ranchi Plateau. The southern part and one of the three parts of the Chotanagpur Plateau is nomenclature as Ranchi Plateau. It is the paleogeomorphic characteristic that has elevated the location of Ranchi City at the height of comfortable climate with a land of significance and importance. So the study as well as assessment of its paleogeomorphology is inevitable because it is the study of what the geography was in time past. In fact, the anthropogeomorphological processes have existed since the arrival of Man on Earth, their present powerful impact results from their omnipresent dispersion and their unlimited scale; their influence is mainly, if not entirely, a result of the quantities evolved(Dov Nir,1983). These quantities of earth, rock, water etc. are sources made by paleogeomorphic as well as geomorphic base (Dov Nir,1983). The geomorphic base of Ranchi City is one among some of the well-defined geomorphic units in India. The study aims to find factors behind the paleogeomorphological evolution of this unique area which contributes beneath and above the surface of the land for urbanization and urban growth of Ranchi City.

Keywords:*Paleogeomorphic. geomorphologically frazzle zone . anthropogeomorphological process. comfortable climate. geomorphic base.*

Introduction:

Ranchi is the capital of the state Jharkhand in India. This is a straggling urban centre and consists of tabular and mass. It has even flat surfaces with isolated hillocks. Ranchi City has an average elevation of 651 meter. The city is located on the central Ranchi Plateau. The plateau is said to be evolved through epeirogenic uplift during the Himalayan orogeny consisting of planated surfaces. It presents a rich panorama of topographic features ranging from uplands and lowlands of undulating surfaces and subdued hills and hillocks to entrenched river valleys, steep scarps, summit plains, knife-edge ridges and intruded hills. This plateau is a geomorphological museum.The paleogemorphic feature of Ranchi city is a unique unit to look into for the geomorphological characteristics and sustainable urban growth of the area. The elevation of the area, mountains, hills,

hillocks, agricultural land, sites for settlement, geohydrological characteristics, aquatic ecosystems viz., rivers, ponds, lakes, and reservoirs all are the creations of the paleogeomorphological evolution.

Paleogeomorphology is a branch of geomorphology concerned with the recognition of ancient erosion surfaces and the study of ancient topographies and topographic features that are now concealed beneath the surface and have been removed by erosion. So paleogeomorphology is the study of buried relief features or buried landscapes of the earth. The reconstruction of prehistoric continents and oceans, also of plateaus, hills, rivers, lakes, depends partly on paleogeomorphological factors. The development of a variety of human activities is conditioned by the geomorphology (Giusti, Cecilia, Gonzalez-Diez). Thus paleogeomorphology provides not only the critical evidence for development of continental drift and current plate tectonic theories but also acknowledge the urban geomorphological base. It is a fact that the influence of the geomorphological process on man shows man as an independent geomorphological agent whose activities are guided by his social, economic, and iconographic needs and opportunities. Geographic base of Ranchi city is based on the urban geomorphic base of this city and the geomorphology as well as urban geomorphology of Ranchi City is primarily based on the paleogeomorphological evolution of the land and men's activities to make the area livable. Geomorphic base which is characterized by geological structure, physiography, climate, slope, vegetation, soil etc. have been conditioned by the paleogeomorphic evolution of the location.

It is paleogeomorphological evolution of the area of Ranchi City which has gifted this city area a tabular plateau, useful aquifer, enough water bodies, geomorphic base which could develop soil and vegetation for agriculture and settlements. The location of Ranchi city is on a plateau of tabled land of above 600 meter height and on the tropic of cancer which has imported to it a typical tropical climate. But the unintentional effects of human activities on geomorphic forms and processes have badly affected the natural plan at the city. Modification of terrain by engineering works, excavation and dumping ground of the urban areas and planned construction of residential buildings, growth and construction of numerous apartments, filling up of the natural lakes, ponds have created many urban problems. These are the neglects of paleogeomorphic as well as geomorphic parameters.

Therefore, it is essential for researchers, planners and decision makers to assess the process and impact of paleogeomorphological evolution of Ranchi City Area for sustainable environment and urbanization. The present paper embodies the main observation and findings related to the paleogeomorphic characteristics and urban status in Ranchi City.

Statement of the Problem:

The knowledge, assessment and utilization of underground space as well as paleogeomorphic body resources and attributes is now-a-days very significant for the planning and development of an urban area. It is carried out in the geological body, so it is influenced by the nature and structure of the paleogeomorphological body and the state of groundwater storing. The geological problems of development and utilization of underground space resources in Ranchi City are related to the paleogeomorphological evolution. The problems of rainwater runoff, groundwater storage, the changing of groundwater level, relief, earthquake, karst topography, ground subsidence and fault are imposing some adverse impacts on the urban development of the area .That's why, the paleogeomorphological and geological conditions should be considered as one of the important factors for the formulation of underground space planning. The region around Ranchi City is one of

the richest parts of India for mineral resources. Therefore, it is of great importance to ward off risks, protect environment and achieve sustainable development.

Objectives:

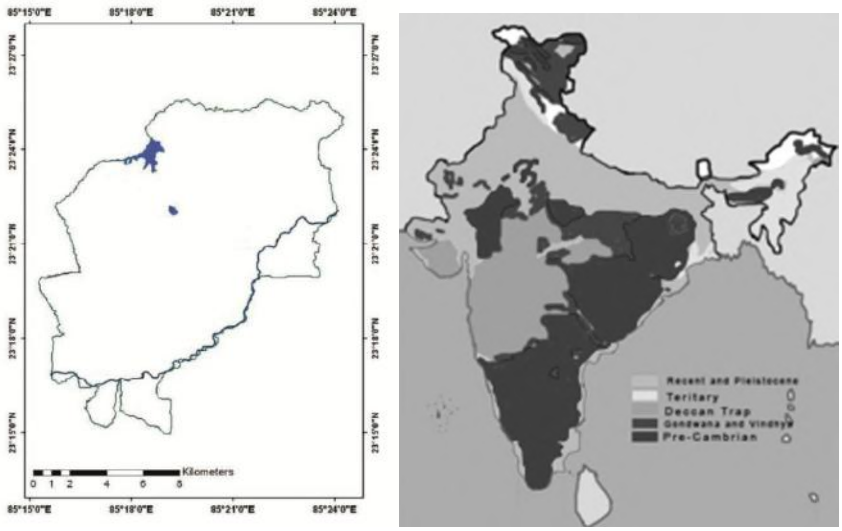
The Specific objectives of the present study are as follows:

- To evaluate the features of paleogeomorphological evolution of Ranchi City.
- To assess the paleogeomorpholgical problems to consider when developmental policies are formulated to make the city sustainable.
- To suggest some solutions for the same.

Study Area:

Ranchi city (Fig. 1) is one of the oldest towns falling in the jurisdiction of the present day Jharkhand state. It lies between the latitude and longitude of 23°15' N - 23°25'30'' N and 85°15' E - 85°24' E and presents largely a tropical location. Its Municipal area is 175.12 Km^2 (67.61 *Sq.ml*) and its average elevation is 651 above sea level. Ranchi has a hilly topography. Its dense tropical forests surround it and contribute to produce usually pleasant climate for which this city is known. Its urban landscape is 'characterized by Ranchi conical hills, beautiful Ranchi Lake, irregular pattern of roads and lanes and new emerged planned area having specification in different function. The morphological characteristics of this urban Centre are also affected due to industrial Centre and habitation of people of various cultural backgrounds. As per 2011 India Census, Ranchi Municipal Corporation has a population of 1,120,374 making the 6th largest Urban City in India. Males constitute 51.3% of the population and females 48.7%. Ranchi City has an average literacy rate of 87.68%.

Figure:1 **Location Map of Ranchi City** ***Figure 2:*** **Origin of Ranchi Plateau in Pre-Cambrian Age**



Source: **Toposheet73E/6, E/7, E/10 and E/II**

Source: GSI

Material and Methods:

Umpteen studies have been done in different corners especially regarding the paleogeomorphological evolution of Ranchi city. The study is based on both primary and secondary

data. While analyzing the landform characteristics Survey of India toposheet on scale 1:50,000 (73E/6, E/7, E/10 and E/ll). GIS reports have been taken. Paleogeomorphological aspect of the city has been analyzed through various research papers, studies, findings, municipal map and on the basis of intensive field surveys. Impact of paleogeomorphology of the city and pattern of city geomorphology and geology are analyzed on the basis of underground, on ground surveys and origin aspects of the Ranchi Plateau. To assess potential and behavior of the paleogeomorphological evolution the relevant geomorphological and geological characteristics are determined through suitable facts and details. Secondary data and relevant information have also been obtained from Geological Survey of India, Central Ground Water Board, Jharkhand Space Application Centre, Ranchi Regional Development Authority, Ranchi Municipal Corporation, Ministry of Urban development, Govt. of Jharkhand.

Discussions and Results:

The urban area of Ranchi city is divided in 55 wards which falls in Ranchi Municipal Area. Ranchi City has three types of physiographic units - moderately pedimented weathered plateau, shallow pedimented weathered plateau and dissected plateau. The area is parted into three distinct units: i. Northern Region – Potpoto – Jumar Basin, ii. Central Region – Manatu Booty Upland and iii. Southern Region – Peneplain Flat. As far as the study of paleogeomorphiological evolution of Ranchi City is concerned that may be discussed as follows:

Origin, Structure and Evolution:

The Ranchi Plateau, on which Ranchi city is situated, is a part of the Indian Peninsular. Its highlands are geologically and structurally very complex characterized with the phases of solidification of the initial molten mass in the form of fundamental basement rocks of dominating granite and gneisses (Figure 3 and Figure 4), sedimentation, emission, intrusions, diastrophism, epeirogeny, weathering and erosion. The Ranchi Plateau has also been subject to warping, tilting, faulting and compressions. It has never been submerged, 'enmasse' under the sea since the Cambrian nor wrinkled into mountain chains (Figure 2). The plateau bears very conspicuous scars of earth movements of different geological periods,

Figure 3 & Figure 4: Granite and Gneisses near Kanke Dam, Ranchi

particularly of the Hercynian and Tertiary evolutions. There is no clear-cut evidence of earth deformation of the Caledonian earth-movements in the plateau, but the coal-bearing basins in long linear fractures and series of trough faults are certainly the results of the Hercynian movements. The planation surfaces of different elevations demarcated by steep scarps are the result of the early, middle and late Tertiary uplifts associated with the Himalayan orogeny of the

Alpine earth movements.

Modeling of gravity profiles across the East Indian Shield (Chotanagpur Granite Gneiss Complex (CGGC), the Shillong Plateau and the Bengal Basin in Bangladesh), constrained from seismic studies suggest crustal thickness of 37-38 km and thrusted high density rocks in the middle crust under the East Indian Shield reducing to 30-32 km with thick sediments of 12-14 km under Bangladesh. Thrusted high density rocks under the CGGC and the Shillong Plateau are in comparison to those under the Eastern Ghat and the Satpura Mobile Belts (EGMB, SMB) respectively suggest the north ward and east ward extensions of these orogenies. Margins of the thrusted block under Shillong Plateau when projected on surface coincide approximately with the south dipping Dauki and the Brahmaputra faults which coincide with central bulge due to lithospheric flexure indicating their surface expositions (Kaila et al., Singh and Mishra, 2002 & Rajashekhar,R. P.,Mishra D. C. 2008) (Figure 5). Some Geomorphologists have inferred that the Archaean mountains were formed principally by movements from north to south and the drainage pattern must have resulted from the resulting structure. This structural characteristic has influenced the present geomorphology of the region. It has, firstly, provided the general strike in normally east-west direction. That is indicated by an awful spectacles of jagged surface of banded gneiss with prominent joints all dipping isoclinically north ward at angles varying from 50° to 60°. This characteristic has resulted into an assemblage of rugged rock blades and waterfalls etc.. The then existing Archaean rivers, secondly, must have formed antecedent drainage over the present surface of the plateau. The antecedent drainage has most probably influenced the present paleogeomorphology and geomorphology of the area providing prominent meandering of the river courses in spite of non-turning of the strike of the jointed gneiss (Figure 6). In the plateau, faulting and rafting are more conspicuous than any other tectonic features. The faulting and rifting during the Permo-Carboniferous period have influenced the geomorphology of the area. The faulting and rifting of the area did produce the scarp bodered nature of the valley which is clearly seen presently. The roughly west-east faulting has caused, within the trough, the rivers to be drained in west- east direction. In the Ranchi city the tributaries of the Subarnarekha River drain mainly in west-east direction and the Subarnarekha River itself starts flowing in west-east direction, but after a few miles it turns in south-north direction and finally blows maintaining west-east direction on the Ranchi plateau.

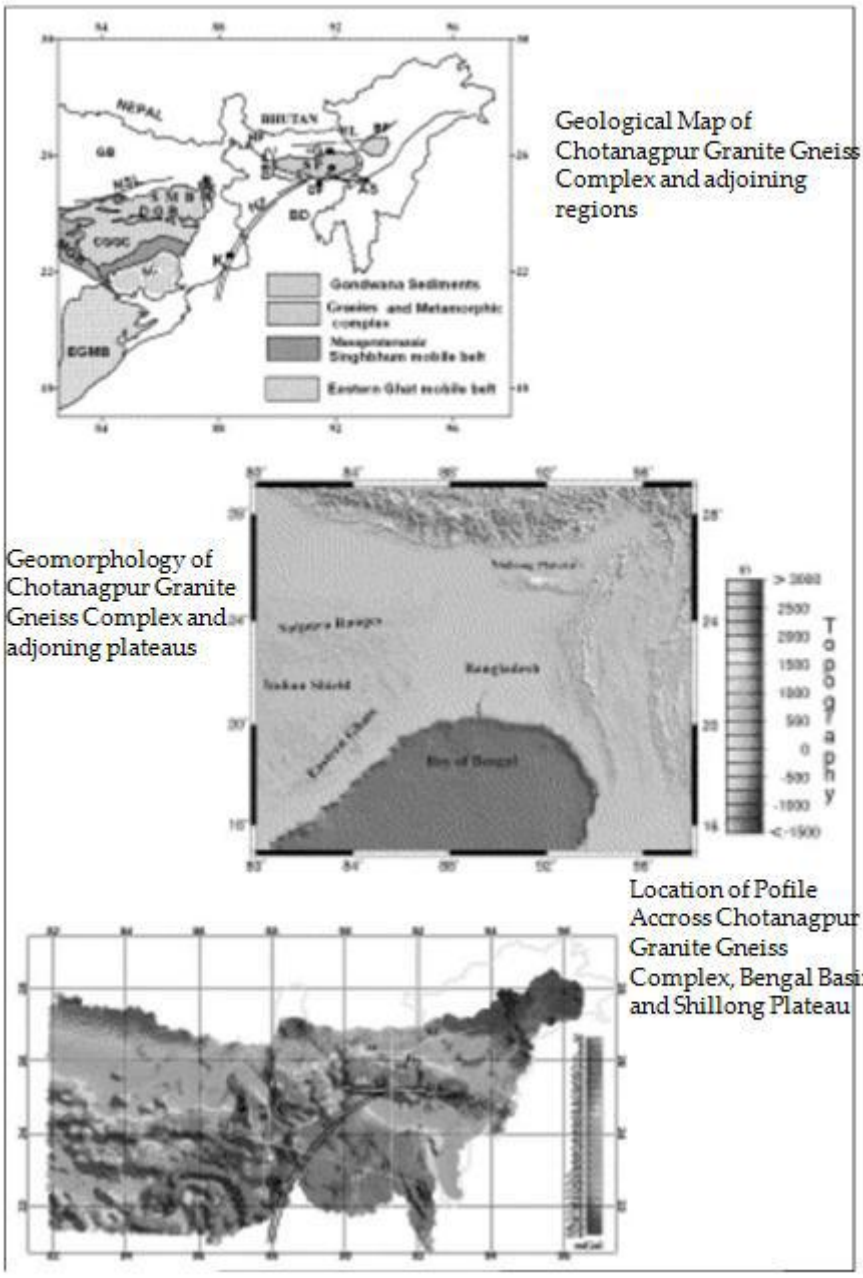
The Ranchi plateau, a part of the Indian peninsula, consists of hard crystalline gneisses and granites. The plateau is supposed to represent an originally solidified crust, gneisses and granites, therefore, belong to the Archaean era, some 1200 million years ago. That's why granite and gneiss topography naturally dominates most of the landscape in the plateau. The oldest sedimentary rocks which presently form the mica-schist were originally deposited as sandy and clayey sediments. But in Ranchi city area the mica-schist occur enclaves in granite gneiss at the Riffle Range Hill and the Tagore Hill. The geomorphology of the area of Ranchi Metropolitan City is greatly influenced by hard and resistant rocks and these present a variety of scenery in the topography of this city and around the area (Figure 6).

Tectonogenetic View:

The surfaces of the Ranchi Plateau, along with the whole Chotanagpur Plateau, were originated by the three successive earth movements during the Himalayan orogeny in the Tertiary periods (Figure 7a). The plateau consists of strong fundamental basement rocks of crystalline geneissic granites; so, it would not be wrinkled but it was faulted and uplifted epeiro-genetically.

Dunn (1941) has assumed that the whole region was a peneplain before the Himalayan orogeny. In the first phase of elevation the present Netarhat Plateau, consisting of basaltic lava was uplifted to the height of 300 meter (Figure 7b). The second movement raised the portions of the Ranchi plateau as well as the Hazaribagh plateau by 300 meter along with the Netarhat Plateau

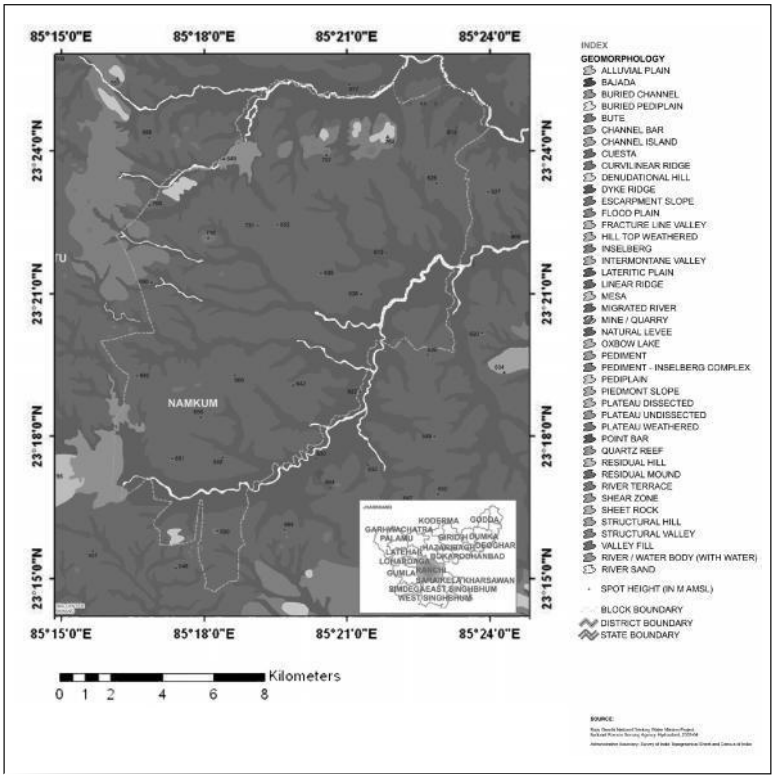
Figure 5: Geological, Gemorphological and Location Profile of Chotanagpur Granite Gneiss Complex



Source: Kaila et al., Singh and Mishra, 2002 & Rajashekhar,R. P.,Mishra D. C. 2008

which was already keeping 300 meter height (Figure 7c). The third movement uplifted the whole area by 300 meter giving the former plateaus an additional height. Consequently the Ranchi plateau gained 600 meter, the Netarhat Plateau remained at 900 meter, the Hazaribagh plateau at 600 meter and the rest of the rest was at 300 meter. The Netarhat plateau has a height of 1100 meter (900 meter + 200 meter of lava capping) (Rajashekhar,R. P.,Mishra D. C. 2008) (Figure 7d). Many hills and

Figure 6: Geomorphological Map of Ranchi City Area



Source: Jharkhand Space Application Centre, Ranchi

ridges, in the study area are too, due to igneous intrusions occurring in different geological periods. The whole plateau is sculptured by exogenic forces and tectonic disturbances. Ahmad (1958) and Singh (1958 and 1969) are some of the main geomorphologists who support the above view.

Climatogenetic View:

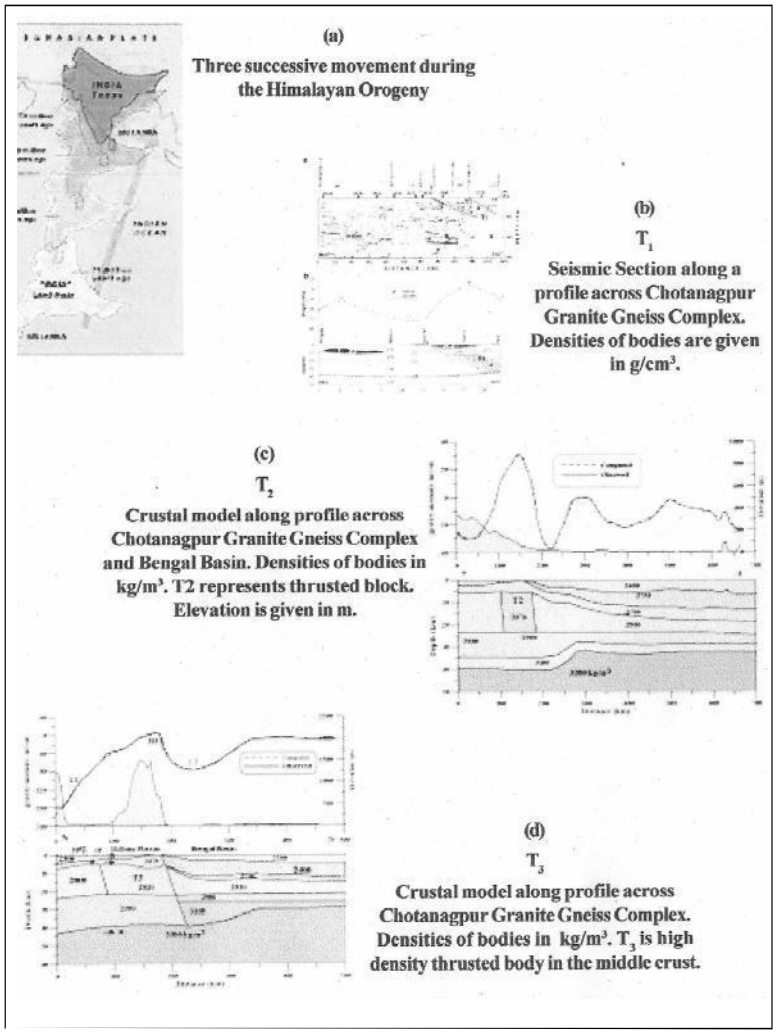
During the last 10-12 million years several changes in climate had taken place. The Ranchi city area, including the whole Chotanagpur region, was under arid or semi-arid climate which shaped the region into the features of an arid region. In the last 10,000 years the climate of the Post Glacial or Holocene epoch is responsible for only 5% of the existing relief while 95% belongs to earlier generations. These climatic conditions cause an enormous production of waste and debris which cannot be transported out from the area of production.

It was climate which externally changed the surfaces of the region in which the study area Ranchi city is located with high importance. Regarding the climatogenetic view it is observed that in

the 99% of the region the bed-rock is practically absent. In the valleys, 5 meter to 7 meter in deep layer of soil and sediments are found consisting of hard rocks. The upper surface of bed-rock and the present ground surface are more or less parallel. The present ground surface has been inherited from the bed-rock which was earlier at higher level than the present ground surface. It has been observed that subsequent weathering and erosion of bed- rock have converted the upper layer into a mantle of waste and debris.

The surface formed by the bed-rock or hard rock generally consists of gneisses and granites. Some geomorphologist have discovered that the surface under study was not an active erosion surface but a fossil and dead erosion level. This level is now under a thick mantle of eroded debris. According to them the dead erosion level was a pediment floor with the possibility of pedimentation in the region in the past. The foreign geomorphologist Pecsi emphasizes that the

Figure 7: Crustal Model of Chotanagpur Granite Gneiss Complex (T_1, T_2, T_3)



Source: Kaila et al., Singh and Mishra, 2002 & Rajashekhar,R. P.,Mishra D. C. 2008

role of the arid or semi-arid climate of the geological part on the fossil erosion surface, so far as the landscape of Ranchi is concerned, it is mostly formed of soil and sediments. There is no question of gravel-beds-lying over the bedrock. The area is characterized by red-loam soils representing on intermediate stage in the process of laterisation. These have developed from acidic rocks like biotite-gneiss and granite-gneiss. The colour of the soil is yellowish red on the surface. It becomes darker with the depth. The soils are well drained. They contain concretion of iron.

It is also observed that the alternate wet and dry seasons along with the high temperature prevailing in the region bring rapid activity and weathering of parent material during the hot season. On the contrary during the wet months intense leaching results in the removal of soluble constituents like calcium and helps in the development of soil rich in iron and alumina. These soils have the characteristic reddish tinge with a tendency to laterisation. On the other hand, the upper layers of the soils are subjected to erosive action by torrential rain. Therefore, the soil groups of this region have been classed as red loam, representing an intermediate stage to the process of laterisation. The other groups of soils, the calcareous soils, developed from basic rocks hornblende schist and these occur in patches scattered all over the area.

EXOGENETIC PROCESS:

Experiencing sub-tropical humid climate of monsoon character and having surface s of different altitude, magnitude, the Ranchi Plateau is drained by various nets of active drainage systems. For Ranchi Metropolitan area the Subarnarekha River, accepting the drainage of its tributaries, flows up to the Bay of Bengal. The Subarnarekha River and its streams are seasonal and intermittent in character. The construction of Hatia Dam, Kanke Dam and Rukka Dam has facilitated the river to be of almost regular flow but in small volume; the monsoonal showers make the volume big.

Geological Factors:

The geological composition of Ranchi can be understood only in context with Chotanagpur which is formed by a great complex of very ancient gneisses and granites. The relation of the complex with the oldest metamorphosed sedimentary rocks is not clear. The geological formations belong to the well-known groups of the Pre-Combrian and Dharwars. Rocks belonging to the Archian Period cover a large extent of the city (Priyadarshi, N,,1998) (Figure:8).

The predominant rock type in the city is Chotanagpur granite, gneiss within which bands and enclaves of mica schist, feldspathised mica schist, quartzite, calc-silicate rock epidiorite etc.(Figure 8). The flowing rocks have been identified in and around the Ranchi city:

Phyllites and Mica Schists: Phyllites are by far the predominant rock type in the south-east portion of this district. The mica schist occur only enclaves in Granite Gneiss at Rifle Range Hill and Tagore Hill.

Quartzite Quartz-Schist: The quartzite rocks occur as bands striking E-W in the south and NW-SE in the north-East and often show Fold Patterns (Jaiswal, O.R., 2003).

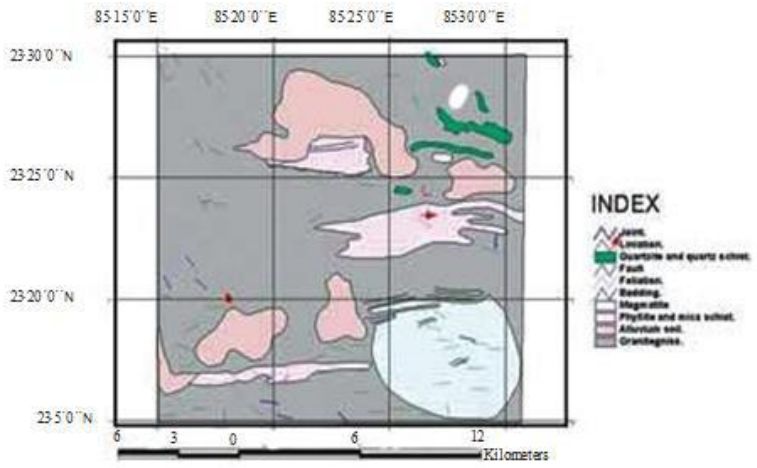
Amphibolites: The amphibolites occur as minor intrusive bodies in the khondalite series. The garnet-sillimante-graphite- schistsis the invariable intruded by the lenticular intrusive body of amphibolites and two places in the bed of Jumar River.

Horn-Blende–Schist: Horn-blende schist and gneiss (Para meta-morphic) of this area are generally hard and compact with planar and linear arrangement.

Chotanagpur Granite Gneiss: This forms the country rock of the district and is a part of the enormous intrusive mass.

Dolerite: Sarker and Jha (1985) have identified small intrusions of dolerite within the granites and Haratu (23° 21'45"N to 85°26'15"E), Katarpa (23°17'E to 85°10'E) and near the Subarnarekha River, north of Similia.

Figure 8 : Geology in and around Ranchi City



Source: Geological Survey of India, Patna

Laterite: A part from chotanagpur granite gneiss, laterite is the most abundant rock formation in these district lateritic exposures, locally known as "moorum" are encountered near the village Borea.
Recent Alluvium: Alluvium is mostly a residual soil derived from the decomposition of granite and its inclusions and the khondalites. Generally the soil capping is very thin, though in places it may be 20ft. or more in thickness (Priyadarshi, N,,1998).

Geomorphology:

Geomorphology has a remarkable influence on our lives today, as it has an all creatures since the beginning billions of years ago. The productivity of soils, its mineral composition, the capacity to store water- all depend upon the geomorphic aspect. Geomorphology also determines the shape of the landscape that is, before being disturbed by humans.

Geomorphologically, the region generally slops towards east. Slopes or relief in this region are variable, though the average slope may be 2 per cent. It is observed that generally the more sloping lands were subjected to sheet erosion for a long time. It caused the formation of rills and gullies. The hill and the valley nature of the area and its environs are not due to any uplift or earth-movement, but on account of denudation of the granite-gneissic topography. It is obvious that in the northern part of the region the special feature of the topography is in the combination of interfluvial uplands, valleys and ravines. The land of the area is fairly undulating erosion surface, alternate dry uplands and gently sloping lowlands. These lands- the tanr and the dons with beautiful flights of terraced fields lay over the latter (Srivastava, Vimala, 1984). In the extreme south-eastern part, the region is upland which gently comes down towards west (Figure: 6).

The major geomorphic units identified in this area are Plateau Weather Shallow (PWS)

which is 8-10 meters, Plateau Weathered Moderate (PWM) which is 10-15 meter and Pediment Inselberg Complex (PIC). Some residual hills and inselberg occur in the western part of the area (Figure 9 & Figure 10). Valley and gullied valley are covered by crossing rivers area and the plateau is covered by the weathered shallow part of area. Urban geomorphology examines the changes caused by the requirements of urban residential, economic and traffic functions. Towns are adjusted to the relief and the relief is also adjusted to the needs of construction and planning (Cooke, R.U., 1976). The changes that occur as a result of urban development are also influenced by their interaction with the disturbed geomorphological process response systems, such as weathering on building stone resulting from air pollution (Ahnert, F., 1998).

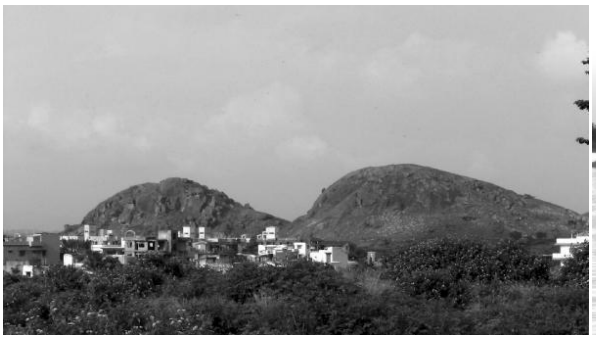


Figure 9: Joda Pahad, Inselberg in the western part Ranchi Hill of the City

Figure 10 : Ranchi Lake and far distant (Inselberg), in the centre of the city

Hydrogeomorphology:

Ranchi city is rich in hydrogeomorphic features.The hydrogeomorphic features of Ranchi City is a unique unit to look into for the geohydrological characteristics and sustainable urban growth of the city. Rivers, ponds, lakes, and reservoirs – all are getting polluted by both domestic and agriculture sources.. The haphazard growth of the city has created several physical problems particularly in the geohydrological characteristics of this urban area. That's why the hydrogeomorphic attributes of Ranchi city are under threat. Here poor management of settlements, waste and sewage are arresting the hydrogeomorphic attributes of the land. It needs to be protected by rich anthropogenic support. Urbanization in Ranchi city is causing changes to the land surface by altering topography and vegetation. Due to this adverse effect water tables are lowering. Extraction of groundwater and vanishing of surface water is changing geohydrologic characters of the landform. These all affect the shallow groundwater systems. The alteration of the permeability field by construction alters groundwater flow paths. It, of course, makes contaminant remediation very difficult. Hydrogeomorphologically, this area is classified into different zones covered by residual hills, inselberg, valley, valley gullied, plateau weathered shallow, plateau weathered moderate, plateau slightly dissected residual hills. They are the products of the process of pediplanation, which reduces the original mountain mass into a series of scattered knolls standing on the Pedi Plains (Thornbry, W.D., 1969).

Local hydrostratigraphy of Ranchi city is represented by a heterogeneous, weathered and fractured aquifer system, typical of the Precambrian suite of rocks in the Indian subcontinent. Intensive development of the fractured aquifers, up to 200 m below ground, has lowered the hydraulic head and resulted in dwindling yields from fractures during the summer. The major source

of recharge for the aquifers is infiltration from rainfall. Groundwater is a dynamic and replenishable natural resource, but in hard rock terrain availability of groundwater is limited. Occurrences of groundwater in such rock are essentially confined to fractured and weathered horizons. In India, 65 per cent of the total geographical area is covered by hard rock formation. Therefore, efficient management and planning of groundwater recharge in these areas is necessary (Saraf, A.K., and Choudhury, P.R., 1997, 1998). The groundwater recharge is the entry of water from unsaturated zone into saturated zone below the surface (Freeze and Cherry, 1979; Sophocleaus, M., 2002). There are many factors controlling the occurrences and path flow of groun dwater like topography, lithology, structure weathering grade, fracture extent, permeability, slope, drainage pattern, land from land use/land cover and climate (Jaiswal, O.R., 2003). To achieve the quantification of these data, it is necessary to identify and characterise the uncertain data (Nilsson, R.H., Ryberg, M., Kristianssan, E., et al., 2006).

The Stratigraphy:

Stratigraphy is a branch of Geology concerned with the study of the occurrence, lithology, composition, sequence, fossils and correlation of rock strata, and especially with the chronological order of succession of rock's formations, by which historical changes in the geography of the earth can be traced. The stratigraphic data of the region in order to find commonalities in this region is to check out and find the reasons for the pattern of archaeological and paleogeomorphic records of this region and have an idea of the early prehistory of this region. The Chotanagpur region includes the Indian states of Bihar and Jharkhand. Parts of it extend out into the states of Madhya Pradesh, Orissa and West Bengal also. It lies between 22º00' N and 25º30' N latitudes and between 83º 47' E and 87º 50' E longitudes covering an area of about 86,239 sq. km. The average height of this region is about 2,000 feet. The entire region seems to have overall similar characteristics. The Ranchi plateau is its very important unit which lies in its centre.

A brief overview of the archaeological context of the region might help us to understand the pattern and nature of human colonization in this area from the earliest days. Mohapatra in 1962 suggested a climatic background of the quaternary on the basis of stratigraphy, with three climatic cycles of alternating wet and dry conditions. The formation and deposition of lateritic gravel forms the starting point at the beginning of Pleistocene, going on to the alternating beds of gravel and silt marking alternating wet and dry climates. Some regional variability is present in the entire region (Ray, Ranjana, 2004). The account given by Ghosh in 1965-66 claims a slightly different stratigraphy. The red lateritic secondary gravel is missing and yellow as well as brown sticky clay take its place. In these layers are found Late Stone Age tools. On top of this is a layer of red soil topped with recent alluvium (Chakrabarti, Dilip K., 1993). Having put all of these issues into context, it may be seen that the Chotanagpur region has many inherent complexities with regard to stratigraphy in the context of many of the sites found. A majority of these sites are surface finds, showing that early human populations may have existed here perhaps well into the historical period.

Water, Soil and Weather:

In India, 65 percent of total geographical area is covered by hard rock formation. Ranchi is physiographically a plateau region. The geomorphologic units consist of shallow weathered pediment, structural hill and residual hill overlain by red and yellow soil along with lateritic soil, which is a major soil in the district resulting in poor fertility, coarse texture and low water capacity. The soil of upland is usually reddish to yellowish colour and lowland consists of miner sandy loam. The

quality of soil attributes agricultural yields and the quality of soil of Ranchi is suitable for vegetation also. It is the geomorphic attributes of Ranchi City and its urban agglomeration which provides it a vast area of vegetation, open land, forest area and agricultural fields. Bad land features are also marked along the course of streams and rivers particularly in the area with moderate to high gradient e.g. the area west of the Rifle Range, Bariatu in Ranchi. These erosional characteristics have made land useless for cultivation (Shrivastava, Bimala, 1984).

Ranchi area has tropical to sub tropical climate with an average rainfall of 1300 mm. Most of the water goes into the rivers and very little water is stored in subsurface, which leads to the scarcity of water in this region. The mean maximum temperature in 2005 and 2010 has been recorded 38.8°C in the month of May and 44.4°C in the month of April, 2010. The minimum temperature was around to 2.3°C in the month of January 2005 and 4.5°C in the month of January 2010. Highest daily maximum temperature 42.4°C has been recorded on 18th of June, 2005 and 41.6°C in June, 2010. The lowest minimum daily temperature has been recorded 4.2°C on (21st) January in 2005 and 2.2°C on January, 2010.

Relief:

Relief is the range of topographic variation within a given area (Pidwirny, Michael, 2008), and is usually measured in differences and variations in elevation, and includes reference to the angle of slopes and the shape of landforms. The moderate variation in terrain relief is ranging from 595 meter to 754 meter and slope 3°to 6° indicating flat to undulating nature of terrain in the Ranchi Township area. Geomorphologically, the region generally slops towards east. Slopes or relief in this region are variable, though the average slope may be 2 per cent. It is observed that generally the more sloping lands were subjected to sheet erosion for a long time. The growing nature of Ranchi city has been altering the topography of the region by the super imposition of the urban profile. In fact the relief isn't a hindrance to urban growth at the major area of the region but the haphazard settlement is creating geomorphic crisis. A scientific mega Master plan can lessen their geomorphic hazards.

Lithology:

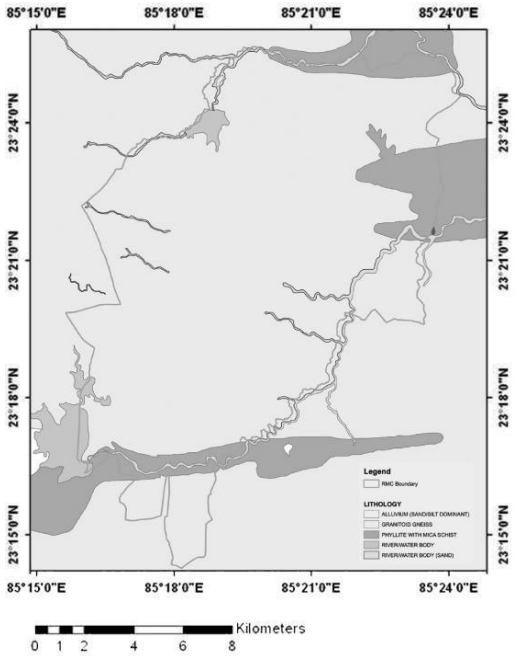
Lithology of the study area is mainly divided into two parts. Most of the parts consist of middle upper proterozoic Chotanagpur granite gneiss rocks. Some lower parts of the area consist of lower middle proterozoic unclassified meta sedimentary phyllite rocks. In this area faults, fracture/ lineament generally act as a medium for movement of ground water in hard rock. Along this zone the yields are significant and the wells are likely to be sustainable for longer duration (Figure 11).

Landforms:

The Ranchi Plateau is a region of flat and gently undulating country with occasional residual ridge (Dunn, J.A., 1939). From the central swell (700 meter Nagri near 'Hatia Dam') of this plateau the Subarnarekha River radiates that drains the streams of Harmu Nadi, Hinoo Nadi, Nati Nadi and Harua Nadi of Ranchi city. The Ranchi Plateau is the largest plateau of the region. It is structurally described by Pascoe as "Ranchi bathylith" or "Ranchi granite"·(Dunn, J.A., 1939). This, the largest granitic mass of the Chotanagpur Plateau, is mostly covered by bathylith and creates Ranchi planation surfaces. The Ranchi Plateau resembles a tableland with some isolated worn hill- tops or inselbergs detached by circumdenudation (Wadia, D.N. (1966)). The 640 meters

contour fixes the Ranchi Plateau limit on three sides, the north, the east and the south, while the western limit is fixed by the 739 meters contour. It is a polycyclic region (Ahmad, E;1958)."

Figure 11: Lithology of Ranchi City Area



Source: Jharkhand Space Application Centre, Ranchi

It seems that the remains of earlier peneplanation have been lost. From the late Tertiary Uplift of 610 meters plateau, the edges have been eroding but the relatively inner uneroded parts represent the central Ranchi (Ahmad, E;1958). It is considered that this line of late Tertiary uplift has formed the eastern edge of the Ranchi Plateau and it is marked by waterfalls- Hundru, Jonha and Hirni.

Geographically, it is found that at the Ranchi planation level a change of climate from more avid condition has cumbered the rock plains with cover and the bedrock is beyond the reach of the forces of weathering and erosion (Shrivastva, Bimla, 1984). In Ranchi city also there are a number of residual hills which are originally rectangular blocks resulting from prominent joints. The monadoncks are referred to as "such deep-seated intrusive bodies of hard igneous rocks like granite exposed by long continued erosion have resisted erosion with reference to the less hard gneiss of the surrounding country, and are known as residual erosion with hills (Ahmad, E., 1965)." The residual hills are locally known as Tongaries. The rectangular block (of these hills) is reduced to the rounded one in due course and later onion-like peeling off is paralleled to the rounded exterior of the mass (Ahmad, E., 1969).

In Ranchi city Hehal Hill, Ranchi Hill (739 meter) known as Pahadi Hill, Tagore Hill (795 meter), Gonda Hill, Jagannath Hill and Bariatu Hill are of most significance, whose summits are generally bare and dome-like or oval shaped and sometimes rugged and irregular with prominent joints. Gullies are not found on steep slopes, but these are most intensive in Ranchi planation surface in Ranchi Plateau where the mantle is thickest (Shrivastva, Bimla, 1984). The surface of Ranchi city

area is mostly uneven, and rolling surfaces are intersected with streams and rivulets. They are studded with a few isolated residual hills and ridges. Alternate dry uplands and gently sloping lowlands the tanrs and the dons with beautiful flights of terraced fields are seen carved in the area of Ranchi city. The tanrs, suitable for agriculture, are capped with this laterite cover (Shrivastva, Bimla, 1984). The area forms a part of the Satpura Orogenic Belt dating between 972 million years and 635 million years (Ghosh, N.C., Shmkin, B.M). It is the paleogeomorphic characteristic that has elevated the location of the Ranchi city at the height of comfortable climate with a land of significance and importance.

Conclusions:

The Ranchi Plateau, on which Ranchi City is located, is a region of great physical inequalities. It comprises four erosion surfaces. The Ranchi Plateau is the second highest plateau of the average 651 meter contour surface in the region of the Chotanagpur Plateau. The paleogeomorphological evolution, resources and attributes of Ranchi City have provided the area raw materials to support the expansion of human population. These include the provision of raw materials for shelter, energy, technology and the space for the disposal of wastes. Urbanization, population growth, industrial expansion and any type of construction on the landscape always need not to disturb paleogeomorphic base. Here paleogeomorphic crisis is forced due to the neglect of suitable sites for locational set-up, relief aspect, urban settlement, solid geology in building material and housing, aquifer parameters, road construction, use of city resources avoiding ecological parameters and dumping of wastes. In fact, traditional approaches to paleogeomorphology have focused mostly on the engineering behavior of the various geological materials below cities in terms of their stability for roads, foundations, earthquake-proof constructions, aquifer safety, stream safety etc.

The process of urbanization and industrialization from last 25 years has caused changes in the water table. Main sources of water, ponds as well as wetlands, in the area of the city are now filled for different construction purpose affecting the water table. Lots of deep boring in the Ranchi city has also forced the water table to move down as the Ranchi Plateau consists of metamorphic rocks which are relatively impermeable and hence serve as poor aquifers. They bear groundwater only in their weathered top portion which rarely exceeds 10 meters. Though Ranchi City receives sufficient amount of rainfall - 1000 mm to 1200 mm every year, but it is not an accurate indicator of groundwater level changes. As Ranchi is the plateau area waste of rainwater in the form of surface runoff varies from 35% to 40%. So, recharging is not so good. There are three major dams (Kanke, Rukka and Hatia) in Ranchi city which is now filled with sediments affecting water table. Due to these sedimentations the storage capacities of all the three dams have decreased many folds.

The relief isn't a hindrance to urban growth at the major area of the region but the haphazard settlement is creating geomorphic crisis. A scientific mega master plan considering paleogeomorphological evolution and attributes can lessen their geomorphic hazards. The principal environmental paleogeomorphogical concerns in urban areas include the provision of sufficient drinking water, waste disposal, soil and landscape degradation and the increasing vulnerability of densely populated urban areas to geological hazards and environmental disasters.

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