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A REMOTE SENSING APPROACH TO UNDERSTAND THE MORPHOMETRIC CLASSIFICATION AND GEOLOGIC IMPLICATIONS OF CHAIBASA-NOAMUNDI BASIN, JHARKHAND, INDIA

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ABSTRACT

The Proterozoic Kolhan siliciclastic rocks around Chaibasa-Noamundi region (2.0 - 2.2 Ga) exhibit extensive development of thickly bedded sandstone, impersistent conglomerate and huge deposits of shale with lenticular patches of limestone which lies unconformably over Archaean granitoid basement in the eastern side, whereas western contact is faulted with Iron Ore Group of rocks. The landscape is a result of the coalescence of a number of pediments, and controlled by joints, fractures and lineaments. The present article emphasizes on Digital Elevation Model (DEM), which shows that the western and south western zones of the basin have maximum, while the eastern zone have low topographic gradient. The development of the drainage patterns in Kolhan are related to the gross lithology and structural features. The episode of the dome and dome structure, faults and joints is indicative of a structural adjustment along the Kolhan basin boundaries. The formation of basinal boundary was a result of collective effect of intracratonic extension and thrust tectonics. Morphometric analysis shows overall broad pediplain and valley filled structure which is widely dominated by trellis and dendritic fluvial drainage patterns.

Introduction

The shallow elongated Kolhan basin extends from Chaibasa (85° 48’, 22° 33’) to Noamundi (85°28’, 22° 09’) covering about 60 km in length and maximum 16 km in width along the western extremity of the Singhbhum Granite (Fig.1a). The occurrence of detached outliers of the Kolhan rocks, west of the unconformity on Singhbhum Granite and north of Chaibasa suggests the wide extent of the Kolhan basin in the past (Acharya, 1976, 1984, Saha, 1994; Mukhopadhyay, 2001).

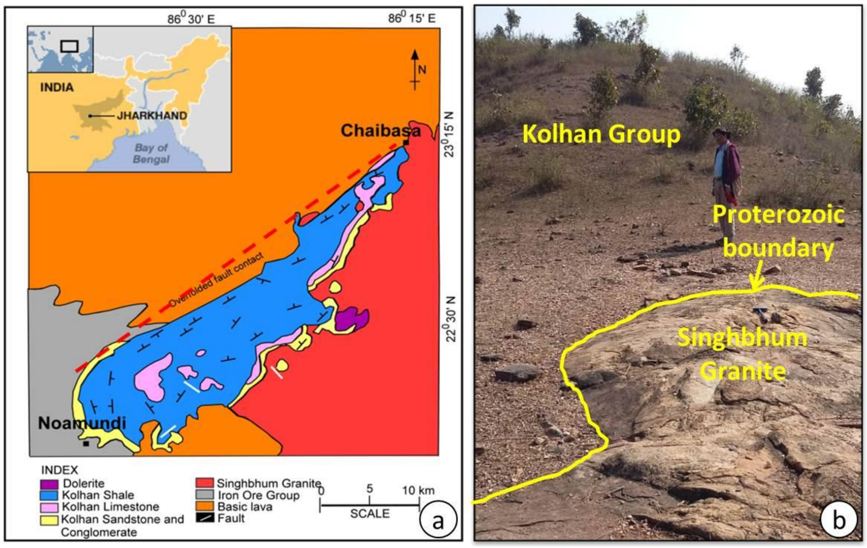

Fig. 1: (a) Geological map of the Chaibasa-Noamundi basin (GSI, 2007), (b) Proterozoic boundary between Kolhan group and Singhbhum granite and

The Kolhan lies unconformably over the Singhbhum Granite (Fig-1b) and shows faulted contact with Iron-Ore Formation (Fig-2 a,b), consisting of basal Conglomerate, sandstone, impersistent Limestone and phyllitic shale with a general westerly dip of 5° to 10° (Bose, 2009, Dunn, 1940, Saha, 1948a and Saha, 1994). The maximum thickness of this Formation is approximately 1.5km (Sahoo and Das, 2015). The geological section along the river Gumuagara near village Rajanka may be taken as reference sections for the Kolhan Shale Formation (Fig.2c).

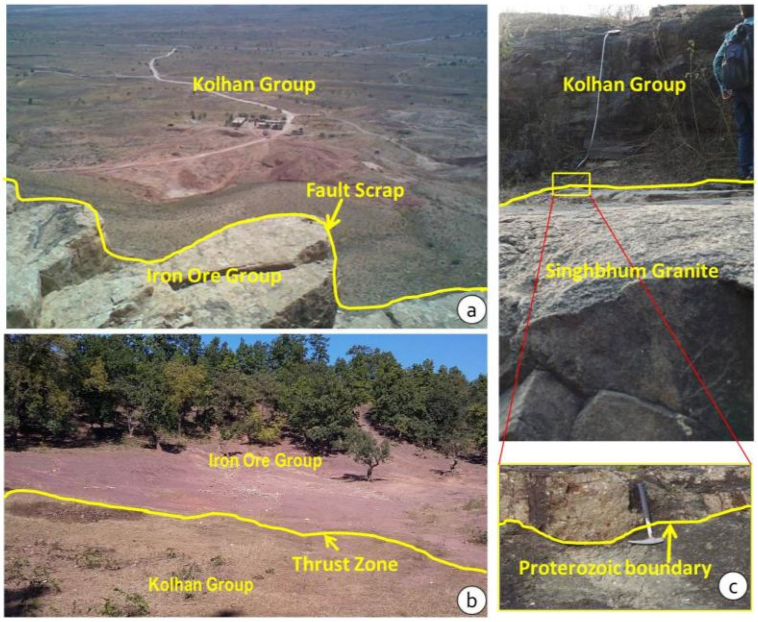

Fig.2: (a)Kolhan group showing faulted contact with Iron Ore Group, (b) Thrust zone between Kolhan group and Iron Ore Group at the western zone at Sagarkatu village and (c) Contact of Singhbhum Granite and Kolhan Group at Gumuagara river section

Geomorphology of the study area

In the study area, various geomorphic features are present which have been identified through image processing techniques. Those are structural hill, denudational hill, residual hill, pediment and inselberg zone, inselburg, valley fill, pediplain and pediment etc (Fig.3). The complex geomorphology is largely the result of varying climatic processes and various erosional surfaces developed (Ramana Rao and Vaidyanadhan, 1974), and as a consequence, the denudational and residual hill developed (Fig. 4 a,b,c)

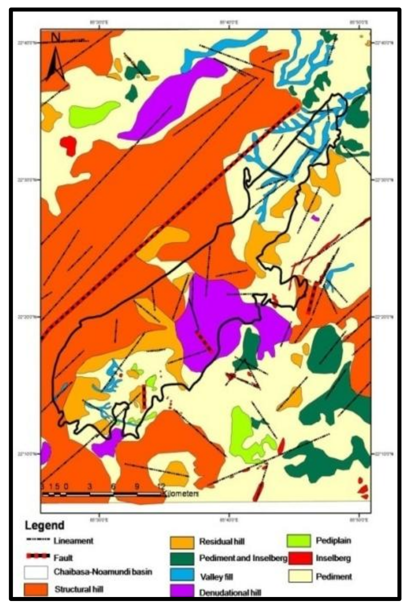

Fig. 3: Geomorphic map of the Kolhan basin showing the structural control over the morphometric developments

Unconsolidated sedimentary deposits which fill or partly fill a valley are known as “valley fill”. In the western part of the basin, valley fill areas are preserved in the hill covered area (Fig.4d). The lineaments, structural trends, and the linear ridges are present throughout the area and all along the trend of the structural hills, narrow river valleys filled up by boulders, gravels, cobbles, and pebbles as valley fill deposits - a change in the drainage pattern from dendritic to trellis from the southern to the northern part of the area (Fig. 4 e,f).

Fig. 4: General physiographic features in the study area. (a) Stuctural hill in the western zone of Kolhan basin (b) Denudational hill (c) Pediment zone (d) Valley fill deposits filled up by gravels and cobbles (e) Pediplain (f) Ephemeral stream at Lupungutu showing the drainage texture controlled by structural trends

The area represents an undulating topography with an average height of 350m and is bounded by hills towards the west and south; the peaks attain an average height of 470m. The most important rivers are the Rorogara and Gumuagara, flowing towards northeast, while the river Devnala has south easterly drainage. The western and southern regions are structural hills comparatively densely forested with many tropical trees. The pediplain surface with some small rugged hillocks, ridges, and ravines is breaking the monotony of the land. The area has an average altitude of 350 m and is bounded by hills towards east where the peaks attain heights ranging between 400- 475m.

Drainage patterns

The drainage pattern is primarily controlled by the gross lithology, orientation of the joints, and fractures. The dendritic drainage pattern is common in the northern part while the meandering drainage pattern is more pronounced in the central part of the area (Fig.5 a,b).

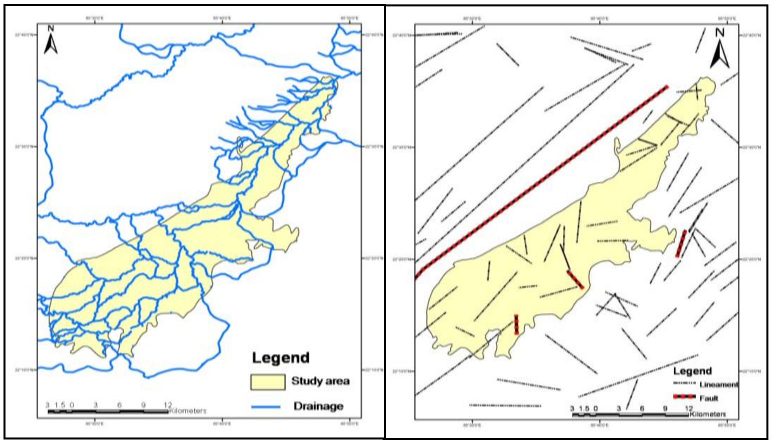

Fig. 5 (a) Drainage map of the area showing the drainage network in the southern part and strong meandering channels development in the northern part (Note : Gumuagara River is the major stream), **(b)**Stuctural map of the Chaibasa - Noamundi basin

The GumuaGara river flowing from north towards south and Dev Posi river flowing towards south- west forms the main drainage system. Several tributaries, designated as 'nalas' meet it at several points. The important nalas are Surnian Gara and Jambira nala. Morphometric analysis of the basin shows broad pediplain and valley filled structure dominated by trellis and dendritic fluvial drainage patterns. The sub-dendritic to sub angular drainage pattern is prevalent in the southern part while meandering becomes more prominent over the central part of the area. The elevated areas are generally composed of hard resistant rocks like quartzitic sandstone, granite gneiss, banded iron jasper, while the low land or pediplains are composed of limestone, shale, tuffaceous and volcanic rocks. The Dev nala river rises in the Kolhan on the western side of the Gamaharia plateau and flows into the South Karo river after a course of about 35 miles. The drainage patterns in Kolhan are controlled by the gross lithology and structural features.

Digital Elevation Model (DEM) shows the following features (Fig. 6).

- a topographic low with patches of few topographic highs, because of the presence of structural ridges
- the extreme western and southern portion of the study area have very high topographic gradient because of the presence of structural hill

- the eastern region shows medium to gentle gradient because of the presence of pediments

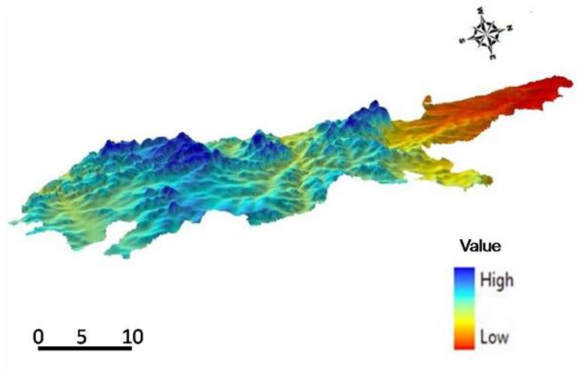

Fig. 6: Digital Elevation Model (DEM) of the study area showing the topographic variations

Conclusion

The different features are suggestive of deposition in a fluvio-lacustrine environment in which the sediments may gradually deposited in the basin from both the eastern and western side. The fluvial-lacustrine transition might occur as a consequence of decreasing the volume of sediment entering the basin per unit time or increasing the capacity of the basin, perhaps as a result of some tectonic event. Or else the stratigraphy and hanging wall onlap relationships might simply reflect the infilling of a basin that is growing in size through time. Even if the volumetric sedimentation rate is constant, initial fluvial sedimentation will eventually give way to lacustrine sedimentation, reflecting the critical moment when the available supply of sediment no longer can completely fill the growing basin and a lake could occupy the space between the depositional surface area and the outlet of the basin. Eventually, as basin subsidence waned near the end of the extensional period, the basin could fill to its lowest outlet, and fluvial sedimentation could return. The Digital Elevation Model (DEM) confirms that the western and south western zones of the basin have maximum, while the eastern zone have low topographic gradient by which the drainage patterns in Kolhan are related which is widely dominated by trellis and dendritic fluvial drainage patterns.

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