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LITHOSTRATIGRAPHY AND STRUCTURE OF THE HUTAR COALFIELD, PALAMAU DISTRICT, BIHAR

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ABSTRACT

Various traverses have been taken along the different nala and stream courses to study the Lower Gondwana sediments in the Hutar Coalfield. Details of lithology of the individual bed are presented. A generalised succession of the beds in Talchir, Karharbari and Barakar formations, present in the coalfield, has been worked out and lithological description of various members and formations is given. Besides, a general idea of the structure of the area is given. The Karharbari Formation has also been demarcated in this coalfield for the first time.

Key-words—Lithostratigraphy, Hutar Coalfield, Karharbari Formation, Barakar Formation, Lower Gondwana (India).

सारांश

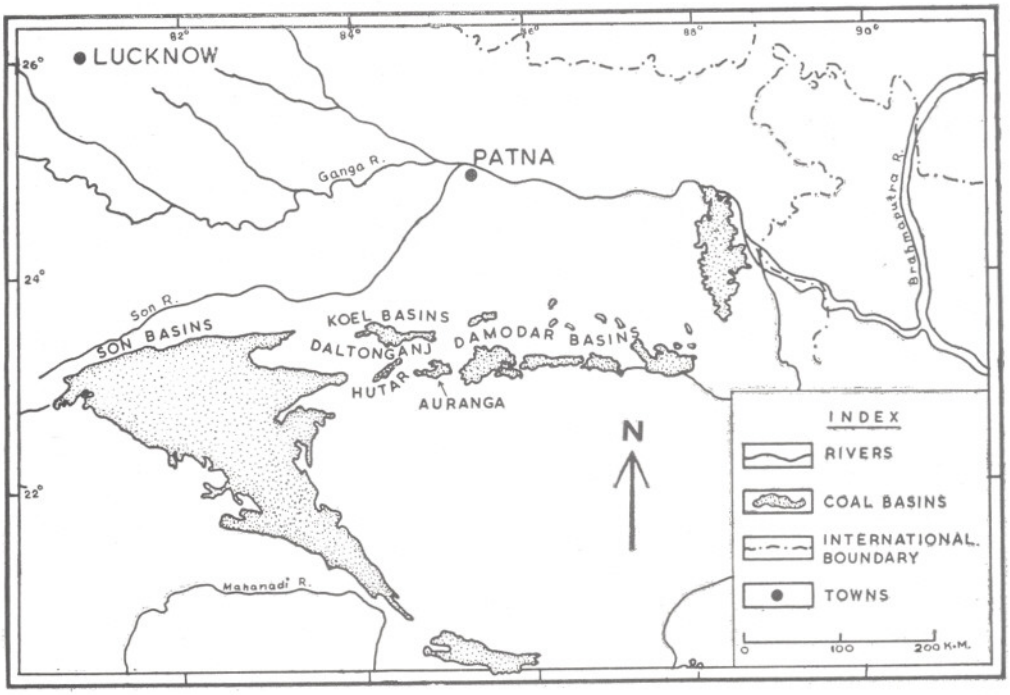
पालामऊ जनपद (बिहार) में हुतार कोयला-क्षेत्र की शैलिकी एवं संरचना – मनोज शुक्ला

हुतार कोयला-क्षेत्र में अधरि गोंडवाना अवसादों का अध्ययन करने के लिए विभिन्न नालों एवं धारा-प्रवाहों के साथ-साथ अलग-अलग चंक्रमों का उपयोग किया गया है। प्रत्येक संस्तर का शैल-विन्यास विस्तृत रूप से प्रस्तुत किया गया है। इस कोयला-क्षेत्र में विद्यमान तालचिर, करहरबारी एवं बाराकार शैल-समूहों में संस्तरों का एक सामान्य अनुक्रम अन्वेषित किया गया है तथा भिन्न-भिन्न सदस्यों एवं शैल-समूहों का शैलिकीय वर्णन भी दिया गया है। इसके अतिरिक्त इस क्षेत्र की संरचना पर एक सामान्य विचार प्रस्तुत किया गया है। इस कोयला-क्षेत्र में करहरबारी-शैल-समूह को भी पहली बार सीमाँकित किया गया है।

INTRODUCTION

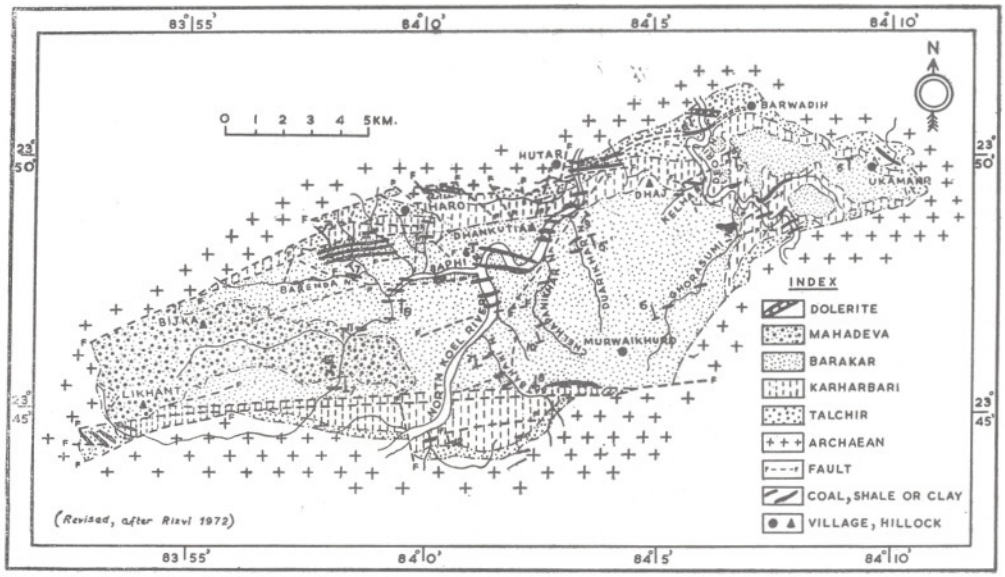
THE Hutar Coalfield (latitude, 23°44′ to 23°52′ and longitude, 83°53′ to 84°11′) lies in E-W trending Gondwana belt along Damodar, Sone, Narmada and Koel valleys. It is among those three coalfields of the Palamau District which have often been referred to as the Palamau coalfields or Koel Valley coalfields. The Hutar Coalfield with an area of about 200 sq km is situated 20 km south of the Daltonganj Coalfield and 20 km west of the Auranga Coalfield (Map 1). It extends from the Ukamnar Village in east to Mangra Pahar in west and Hutar Village in north to Parro Village in South. The Talchir, Karharbari, Barakar and Mahadeva formations are exposed in this area.

Ball (1880) named this coalfield after the village Hutar. He was the first who studied and mapped it systematically and divided the sediments into Talchir Group, Barakar Group and Mahadeva Series in ascending order. In 1886, Feistmantel reported the presence of *Glossopteris indica*, *G. damudica*, *Gangamopteris cyclopteroides*, *Vertebraria indica* and equisetaceous stems, viz., cf. *Phyllotheca* (?) in this area. On the basis of this flora, he suggested the presence of Karharbari sediments near the northern margin of the coalfield. In 1928, Dunn remapped the coalfield on modern toposheets on a scale of 1: 63, 360 and suggested some modifications in the stratigraphic nomenclature adopted by Ball (1880) (see Rizvi, 1972, pp. 7, 18). Later, Rizvi (1972) remapped this coalfield using aerial photographs on a scale of

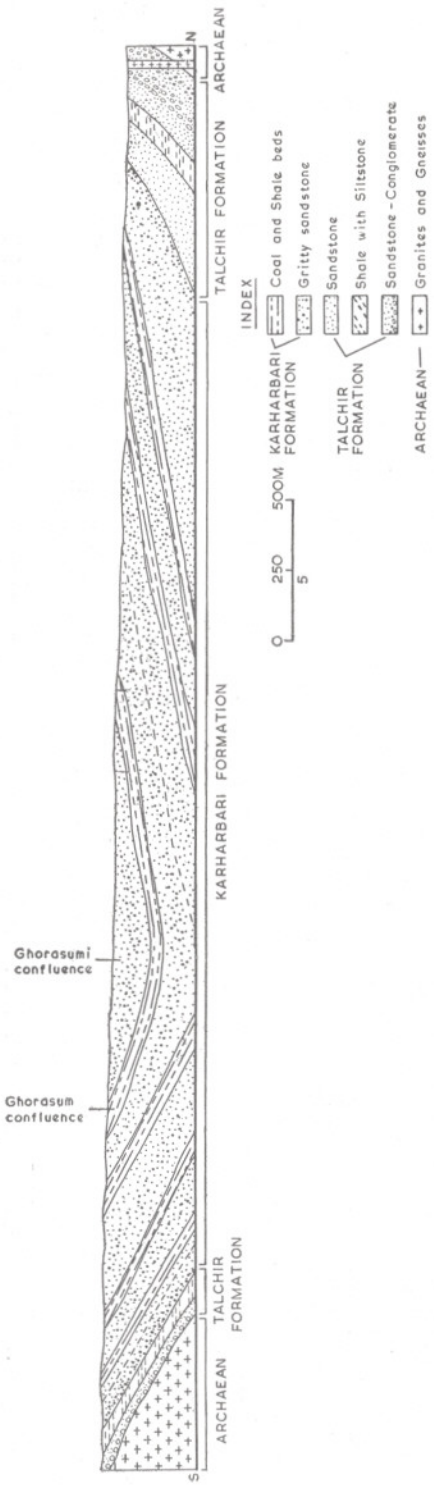


MAP 1

1:31, 680 giving more emphasis to the sedimentological aspects. He, however, agreed with the work of Ball (1880) and Dunn (1928) and also adopted the stratigraphical classification proposed by them. He traced the lithological variation in



MAP 2



TEXT-FIG. 1

different beds and prepared detailed sketches of the area disturbed by faults. He also gave traverse-wise description of different series of rocks and reported breaks in deposition of the Talchir, Barakar and Mahadeva series.

GEOLOGY OF THE AREA

Gondwana sediments in the Hutar Coalfield (Map 2) form a syncline (Text-fig. 1) and are surrounded on all sides by the Archeans. The Talchir Formation rests non-conformably over the Archeans, but sometimes faulted contacts have also been seen (cf. western extremity of the coalfield). The talchir sediments are successively overlain by the Karharbari Formation. A conglomerate at the base of Karharbari sediments marks the possible hiatus between the two formations. The Karharbari-Barakar boundary is mostly faulted except in the east and north-eastern parts of the coalfield. Normal contacts are marked by the ridge forming habit of chocolate brown to red colour of the lower Barakar sandstones. Dhankutia, Dhaj and Ranimai hillocks mark this contact in the eastern and north-north-eastern part of the coalfield. The Barakar sandstone is overlain by massive red sandstone of the Mahadeva Formation with an angular unconformity.

TRAVERSES

The traverses were undertaken along ten different nalas and road cuttings. It was found that no section in the field exposes all the beds. A generalized reference section is therefore, computed from 3 main traverses taken along (i) Deoria Nala, (ii) Koel River, and (iii) the Saphi Nala. Along these traverses, the thickness of beds and details of lithology were noted. Besides the main traverses, several other subsidiary traverses were also undertaken to study the lateral changes in the lighology of these beds and the structural pattern of the basins.

Main Traverse 1 — Deori Nala (*South side*) — This nala shows a nearly complete and best exposed succession of the Karharbari Formation. General succession of beds found in this nala is as follows;

FORMATION	MEMBER	LITHOLOGY
KARHARBARI (130·5 m)	Gritty sandstone Member (120·4 m)	Huge thickness of gritty sandstone with partition of coal and shale beds
	Basal Conglomerate Member (10.0 m)	Calcareous pebbly sandstone
.....	EROSIONAL BREAK	.....
TALCHIR (18·75 m)	Shale Member (15 m)	Rhythmite facies showing shale with siltstone alternation
	Basal sandstone conglomerate Member (3·75 m)	Coarse sandstone as matrix of a conglomerate often shows pseudo-stratification
.....	NONCONFORMITY	.....
ARCHAEAN	Schists, gneisses, granites	

Main Traverse 2 — Koel River (North side) — This river passes from the centre of the coalfield dividing it into two parts. The eastern side of the coalfield exposes older sediments and is less disturbed by tectonic activity. The western side is marked by the younger formations which are also exposed along this river. Succession of the beds along this river is given below:

FORMATION	MEMBER	LITHOLOGY
	Ferruginous sandstone shale Member (48·5 m)	Coarse sandstone with partition of clay and shale beds, carbonaceous matter absent
BARAKAR (224 m)	Gritty sandstone Member (160·5 m)	Gritty sandstone with partition of coal-shale beds
	Compact red sandstone Member (15 m)	Compact chocolate red sandstone with occasional pebble lenses
KARHARBARI (37 m)	Gritty sandstone Member (30 m)	Gritty sandstone with partition of coal-shale
	Basal conglomerate Member (7 m)	Pebbly conglomerate
.....	EROSIONAL BREAK	.....
TALCHIR (27 m)	Upper sandstone Member (9 m)	Coarse green sandstone
	Shale Member (13 m)	Splintery shale
	Basal sandstone conglomerate Member (5 m)	Conglomerate with matrix of green sandstone
.....	NONCONFORMITY	.....
ARCHAEAN		Granite, Gneiss and Schists

Main Traverse 3 — Saphi Nala (North side) — The nala flows in the western half of the coalfield. The area north of this nala is dominated by tectonically disturbed Karharbari and Barakar formations and to the south, the dominant rocks are massive sandstone of the Mahadeva Formation. The nala cuts through the youngest member of the Barakar Formation and the Mahadeva Formation. The sandstone is well-developed but the clay shale beds are generally not seen as they are covered by recent sands brought by this nala. Therefore, these beds were studied in the adjoining area.

FORMATION	MEMBER	LITHOLOGY
BARAKAR (186·5 m)	Ferruginous sandstone and shale Member (185·5 m)	Coarse gritty sandstone with partition of greenish grey shale and clay beds

Besides, several other subsidiary traverses were also taken to study the structure of the coalfield and the extension of various members (Table 1).

LITHOSTRATIGRAPHY

Generalised Reference Section — A generalised succession of the beds in the Hutar Coalfield computed on the basis of the main and subsidiary traverses is as follows:

FORMATIONS	MEMBERS
MAHADEVA	Ferruginous pebbly sandstone Member
..... Angular unconformity	
BARAKAR (302 m)	Ferruginous sandstone — shale Member Gritty sandstone Member Compacted sandstone Member
KARHARBARI (107 m)	Gritty sandstone Member Basal conglomerate Member
..... Erosional contact	
TALCHIR (27 m)	Upper Sandstone Member Shale Member Basal sandstone conglomerate Member
..... Nonconformity	
ARCHAEANS	Granite, gneisses and schists

ARCHAEANS

The Archeans surrounding the Hutar Coalfield belong to a series of metamorphic rocks consisting of granite gneisses with mica, hornblende and quartz veins. These rocks are uniform in nature in this region.

In south of the Hutar Coalfield the area is covered by granite gneisses, traversed by quartz veins having general trend of E 15° N-W 15° S. Some of these veins are up to 30 cm thick. Towards north-west, black synites are present. While in the west of the coalfield the area is covered with gneisses, traversed by pegmatite and quartz veins. And as regards the eastern part of the coalfield it has granite gneisses traversed by dolerite dykes which are trending east-west.

TALCHIR FORMATION

The Talchir Formation in the Hutar Coalfield forms a near continuous band surrounding the Karharbari Formation. The Talchir sediments are seen lying nonconformably over the Archaean basement. The faulted contact between the Talchir sediments and the Archaeans is also seen at certain places. Presence of sandstone-conglomerate on the border, intimate association of shale-siltstone and varves and presence of slump structure, ripple marks cross bedding, graded appearance in individual lamina of varves, and also drop stones in the shale can easily be explained by following the depositional model envisaged by Banerjee (1966) for Talchir of the Raniganj Coalfield. Rizvi (1972) also broadly agrees with this interpretation.

This formation is distinguishable by three members described below in ascending order. Each member has its own lithological characteristics. For stratigraphic classification the scheme proposed by Ghosh and Mitra (1975) has been followed.

1. *Basal Sandstone Conglomerate Member* — This member (Pl. 1, fig. 3) forms the basal part of the Talchir Formation. It is characterized by lateral and vertical variations from conglomerate to sandstone (Pl. 1, fig. 1). Towards the southern side of the coalfield the boulder bed is seen grading into sandstone and shale. Some conglomeratic lenses have also been noticed in the sandstone. Boulders and pebbles forming these beds range between 1.0 cm to 1.0 m in size and are subrounded in nature. Striations are rarely seen on boulders. The granite gneisses, vein-quartz, amphibolite schist, pegmatite, quartzite and Jespar form most of the pebbles and boulders. They are embedded in a sandy matrix. The sandstone varies from fine to medium grained and is poorly sorted. In a vertical section they show pseudostratification (Pl. 1, fig. 1) in the conglomerate.

2. *Shale Member* — This member overlies the Basal sandstone conglomerate member and shows two lithological facies as follows:

(i) *Shale facies* — It is composed of greenish-yellow fine-grained shales which break into small splintery needle-like fragments.

(ii) *Rhythmite facies* — It is represented by varves and shale siltstone alternations. The varves (Pl. 1, fig. 2) are best exposed in the Saphi Nala near the Ukamnar Village and in the Behra Nala near the Putvagarh Village. They show an alternate arrangement between darkgreen clayey and light grey silty layers. These layers invariably exhibit graded appearance within the laminae. The thickness of these layers varies vertically. The variation is more frequent in the light coloured silty layers. Laterally as well as vertically the varves

TABLE 1

Formation	Member	Deori Nala (South)	Deori Nala (North)	Koel River (North)	Saphi Nala (North)	Behra Nala	Saphi Nala (Ukamnar area)	Kelha Nala	Ghora-sumi Nala	Duria-khar	Chelha-panikhar
MAHADEVA	Ferruginous pebbly sandstone										
	ANGULAR UNCONFORMITY			(Fault)							
	Ferruginous sandstone-shale			+	+	+		+		+	+
BARAKAR	Gritty sandstone			+		+				+	+
	Compact red sandstone			+			+				
								(Fault)			
KARHAR-BARI	Gritty sandstone	+	+	+			+	+	+		
	Basal conglomerate	+		+			+				
	EROSIONAL BREAK		(Fault)								
	Upper sandstone		+	+		(Fault)	+				
	Shale	+	+	+		+	+				
	Basal sandstone conglo-merate	+	+	+		+					
	NONCONFORMITY										
ARCHAEAN	Granite, gneisses, schists	+	+	+			+				

grade into shales. In the Ukamnar area they are seen affected by reverse faulting. Ripple marks, current bedding, slump structure, etc. (Pl. 2, figs 1, 3) are also observed in the sediments associated with them. The shales immediately overlying the varves show drop-stones.

As regards the shale siltstone alternation (Pl. 1, fig. 4) these beds are exposed in the Deori Nala, Ukamnar area and the Behra Nala exposures. The silty layers vary in thickness from 2 to 20 cm and can be distinguished from the shales due to differential type of weathering, massive appearance and compact nature. These beds are laterally traceable in the field for long distances.

3. *Upper Sandstone Member* — It is coarse grained and green in colour. It forms the topmost member of the Talchir Formation. It is constituted mostly of immature subrounded quartz grains and rock fragments. This sandstone is overlain by a conglomerate.

Karharbari Formation

The Karharbari Formation in the Hutar Coalfield is seen overlying the Talchir Formation without any discordance in dips, but the beds of these two formations are separated by a bed of conglomerate marking a possible hiatus. This conglomerate bed is noticeable in the Koel Section, Deori Nala Section, at the junction of the Jamtapani Nala with its tributary in the Parro River and west of the Chumna Village in a stream. Some good sections of the Karharbari Formation are exposed in deeper nala and river cuttings through the Barakar sandstones. This formation consists of thick succession of gritty ferruginous sandstones separated by thin coal-shale beds.

At the base of the Karharbari Formation conglomerate indicates an erosional lower contact. The rest of the sediments are predominantly coarse and unsorted indicating the deposition in high energy environment. The intermediate portion of the coal-shale beds indicates a low energy environment of deposition by slow moving currents. The lower contact of shale and coal beds is transitional with the result the velocity of currents gradually slowed down, while the upper contact is abrupt indicating a sudden increase in currents velocity. This formation comprises the following two members.

1. *Basal Conglomerate Member* — It is exposed at the top of the Talchir Formation and at the base of the Karharbari Formation. The pebbles are mostly of granite gneiss, hornblende-schist, mica-schist, chlorite-schist, quartzite, vein-quartz and epidiorites, which are set in a fine sandy matrix. Earlier, these conglomerates were classified alongwith the Talchir boulder beds due to the lithological similarities. In the present work, however, it is taken as the basal unit of the Karharbari Formation marking the end of the Talchir and beginning of the Karharbari cycles of sedimentation respectively.

2. *Gritty Sandstone Member* — It consists of two distinct types of sediments, viz., sandstone and coal-shale. Four coal-shale beds have been observed in the Deori Nala Section, where the Karharbari Formation is best exposed.

The sandstone is medium to coarse grained and reddish brown in colour due to high ferruginous contents. They are poorly sorted and mainly composed of subrounded quartz and feldspar grains. Occasionally, the grains become larger in size and give gritty to pebbly appearance to these sandstones. At places iron nodules are also seen in the sandstone. These nodules are often washed by water action, leaving behind rounded cavities. Frequently, the sandstones are strongly current bedded with their laminae sloping towards east (Pl. 2, fig. 4).

The thin coal beds present in the Karharbari Formation show sharp contacts with sandstone on the upper side, while the lower contact is transitional passing through coaly shale-shale-sandy shale to sandstone. The coal is dull, hard, compact, non-banded, generally of poor quality and durain-type in appearance. Lenses of vitrain are rare. The shales occurring near the sandstones are rich in sandy material and show transitional contact with sandstones, whereas the shales present near the coal-seams are rich in carbonaceous material. The shales are generally grey in colour but due to variable percentage of carbonaceous matter, they show various shades of black colour.

Barakar Formation

The beds overlying the Karharbari Formation and underlying the Mahadeva Formation in this area have been placed in the

Barakar Formation. The upper contact with the Mahadeva Formation is unconformable. These beds can be divided into lower, middle and upper units on the lithological grounds. The middle unit has alternation of coal-shale beds with compact gritty ferruginous sandstone. The upper unit consists of clay and shale beds alternating with gritty ferruginous sandstone. The shales and sandstones of this horizon are greenish in colour. A thick sandstone bed of chocolate-brown to red colour with occasional conglomeratic lenses which is the lower most unit separates Karharbari and Barakar formations at normal contacts. However, in the Hutar Coalfield the Karharbari Formation has generally a faulted contact with the Barakar Formation.

Coarser clastics of the Barakar Formation are also deposited under high energy environment. But the shale and clay beds forming a partition in this sandstone must have been deposited in low energy environment. This transitional contact on both upper and lower sides indicates a gradual decrease and then increase in currents velocity. This formation has the following three members.

1. *Compact red sandstone Member* — It is a characteristic member of this formation and can be taken as marker horizon to separate the Barakar and Karharbari formations. But due to hard and compact nature of this member it stands out in the form of a number of hillocks which marks the Karharbari-Barakar boundary. It is red to chocolate brown, coarse grained and poorly sorted in nature. Occasionally, the lenses of conglomerate are also present. The pebbles are mostly of quartz. The member is sometimes about 100 m thick.

2. *Gritty sandstone Member* — This member is composed of two distinct lithologies, viz., gritty sandstone and coal shale. The sandstone shale is coarse grained, contains ferruginous matter and occasionally becomes gritty. The grains are subrounded. Lenses of conglomerate, made up of immature quartz pebbles, are also present. It is less ferruginous than the underlying Karharbari sandstones. The iron nodules are rare. At few places the carbonaceous grits are also present which are associated with shale beds.

In coal-shale bed the lower Barakar sediments of this coalfield are characterized by thick and frequent coal seams. The coal is generally shaly and dull in nature. The coal seams show gradational contact with sandstones passing through shale and sandy shale beds. Sometimes thin streaks of coaly matter are also seen in the sandstones associated with these beds.

3. *Ferruginous sandstone-shale Member* — It consists of two types of lithologies, viz., the sandstones and clay-shale beds. The sandstones are gritty to pebbly ferruginous and mostly constituted of poorly sorted immature quartz grains. In extreme west near the Barakar-Mahadeva contact, these sandstones show a typical greenish-black colour. The sandstones, in general, have tendency to become more pebbly near the top.

The zone of clay and shale beds shows near absence of carbonaceous matter. The shales are fine grained and show various shades of green and red colours; the clays are massive and non-laminated type and yellow in colour. Occasionally, their surface is stained with iron stains. The significant feature of these shales and clay beds is their similarity with the Talchir shales. This type of lithology is not common in the Barakar Formation of other areas.

Mahadeva Formation

It is represented by a thick massive sandstone which dips 10° to 12° in S 25°W and overlies the Barakar Formation with marked angular unconformity. The hills formed by these sandstones have steep escarpment with uneven top. The sandstones are feldspathic at the base with an occasional thin bed of red ferruginous shale. The extension of various members in Hutar Coalfield is given in Table 1.

DEMARCATION OF KARHARBARI FORMATION

Previous workers like Fox (1934), Ghosh *et al.* (1964), Maithy (1969), Bharadwaj (1974b), etc. have suggested the presence of the Karharbari Formation in the Hutar Coalfield on the basis of some plant remains described by Feistmantel (1886). However, field workers like Ball (1880), Dunn (1928) and Rizvi (1972) failed to demarcate this formation in this coalfield

on the basis of lithological criteria. In the present work this formation is demarcated as a lithological unit for the first time in the Hutar Coalfield. As is evident from the lithological description given in previous pages, the lithology of the Karharbari Formation and the lower portion of the overlying Barakar Formation is more or less same. The only difference, which is conspicuously visible, is in the contact of the coal beds with gritty sandstone. The Karharbari coal beds show a gradational lithology near lower contact passing through coaly shale—shale—sandy shale-sandstone, while the upper contact with sandstone is abrupt. The Barakar coal beds show gradational lithology both near upper and lower contacts. These two sets of beds are separated by a compact red sandstone with occasional lenses of conglomerate. This sandstone is devoid of any carbonaceous facies and has a ridge forming habit. These ridges (Dhankutia Pahar, Dhaj Pahar, Ranimai Pahar, etc.) can easily be traced in the field. Therefore, the compact red sandstone has been taken here as the marker horizon to demarcate the Karharbari Formation from the Barakar Formation. Boundary of the Barakar Formation towards the southern side is marked by two big faults. They start from near Binda and extend up to Murwai Kalan where they join to form the boundary fault. Towards north a fault near Tiharo and the Dhankutia and Dhaj hillocks mark the upper limit of the Karharbari Formation. The lower boundary of the Karharbari Formation coincides with the lower limit of the Barakar Group of Rizvi (1972). This limit is marked by a conglomerate bed.

STRUCTURE OF THE AREA

The Gondwana sediments in the Hutar Coalfield are folded, forming a syncline with its axis tending east-west in the western portion and northeast-southwest in the eastern portion of the area. The eastern half of the coalfield is characterized by hillocks of the Lower Barakar sandstones and this area is comparatively less affected by the structural disturbances. On the contrary the western half is structurally more disturbed and is affected by many faults. Some of these faults extending up to the eastern portion of the coalfield are of regional importance.

The general dip of the beds exposed in the Deori Nala and Koel River sections and belonging to the northern limb of the syncline is 4-12 degrees due south-east. The dip direction of the beds exposed in the west of the Koel River becomes south. On the other hand with the same dip, the inclination of these beds, exposed in Deori Nala section and belonging to the southern limb of the said syncline, is north-west. Ultimately, the direction of the dip of the beds exposed in the Jamtapani and Saphi rivers (west of the Koel River) becomes north. The average dip of the Lower Gondwana Formation and Mahadeva Formation is 4°-7° and 10°-12° respectively (high dips up to 30° have been measured occasionally).

In addition to the known faults (Ball, 1880; Rizvi, 1972), the author has observed a few more faults which are marked by asterisk (*) in the text.

1. *Eastwest or Northeast-Southwest trending faults:*

A. Two major faults are seen in the Satbahni River. They extend up to Murwai Kalan where they join together to form the boundary fault. Towards west, they are traceable in the Koel and Saphi river sections; one of these extends to the Binda Village and mark the Karharbari-Barakar boundary on the southern side of the field. They are also responsible for the reduced thickness of the Barakar sediments in south of the Mahadeva Formation.

B. In the south of the Tiharo Village another fault trending nearly east-west is seen which, alongwith the Dhankutia and Dhaj hillocks, marks the Karharbari-Barakar boundary on northern side of the coalfield.

C. The third east-west trending fault cutting the Saphi River and Barenda Nala takes a northern trend and ends in the second fault.

D. North-western margin of the coalfield is marked by a fault trending northeast south-west. It is most prominent along the escarpment of the Mahadeva Formation.

E. Besides, several other smaller faults of this system are: (i) east-west trending

fault affecting the Talchir sediments near the Barwadih Village in the Deori Nala; (*ii) north-east—south-west trending fault affecting the Karharbari sandstone, south of the Deori-Ghorasumi confluence; (iii) fault affecting the Karharbari sandstone, north of the Deori-Kelha confluence; (iv) east-west trending fault resulting in repetition of the Talchir sediments in the Koel River; (v) smaller faults, west of the Koel River, marking the Talchir-Archaean contact; (vi) north-east-south-west trending fault near the Binda Village marking the Talchir-Archaean contact and ending on the first fault of this system; (vii) north-east-south-west trending fault running along the axis of basin noticed in Koel River affecting the Barakar sediments; and (viii) north-east-south-west trending fault starting from the Mahadeva Formation and ending on third fault of this system affecting the Barakar sediments.

The above faults are marked by silicification in sandstone, change of dips and water seepages seen in different nala sections through which they pass.

2. *North-south trending and allied faults:*

*A. A major fault of this system runs nearly along the Koel River. The movement along this fault has resulted in the difference in strike of the Dhankutia and Dhaj hillocks, situated on both the sides of the fault. Smaller sympathetic faults, formed as a result of this major fault, are seen affecting the third coal-shale bed in the Koel River section. The area west of this major fault is the upthrow side, and the area towards east is the down throw side; thus the Upper Barakar sediments on the west come directly in contact with the Lower Barakar sandstone in the east of this fault.

B. Another fault of this system is seen to cut across the Satbahni Nala and a small, un-named nala-tributary of the Koel River. It is marked by abrupt change of dips and silicification of sandstone at both the places.

C. A few faults of smaller magnitude in the northern fringes of the field show a north-north-west: south-south-east trend and affect the Talchir and Karharbari formations.

Trends of dykes and their relationship with faults — Only two dykes have been seen in the coalfield affecting only the Talchir Formation. The first dyke is seen trending S 60°-E-N 60° W in the Deori Nala Section; the second dyke with similar trend is seen north of the Tiharo. The dyke is disturbed by a small fault trending North-north-east-south-south-west.

In general the following conclusions are surmised on the basis of these faults.

1. Faulting took place at least in two phases—(i) east-west trending faults coming first, and (ii) the oblique faults coming later, as the oblique faults are not seen to cut across the east-west trending faults.

2. Faulting is post-Barakar as it affects the Barakar sediments.

3. Faulting is also post-intrusive as the dyke is affected by these faults.

4. Most of the faults of the Hutar Coalfield are of normal gravity type with their plane of inclination between 70° and vertical. However, some strike slip fault are also seen, e.g. the fault affecting the Karharbari Formation in the Koel River.

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EXPLANATION OF PLATES

PLATE 1

1. Conglomeratic lenses in Talchir sandstone; Deori Nala.
2. Varves clay; Talchir Formation, Behra Nala near Sindharwa Village.
3. Small rounded pebbles embeded in green sandstone; Talchir Formation, Deori Nala.
4. Shale-siltstone alternation; Talchir Formation, Deori Nala.

PLATE 2

5. Slump structure in shales; Talchir Formation, Saphi Nala near Ukamnar Village.
6. A small fault effecting the coalshale bed; Karharbari Formation, Koel River.
7. Ripple marks; Talchir Formation, Saphi Nala near Ukamnar Village.
8. Current beddings in the sandstone; Karharbari Formation, Deori Nala.

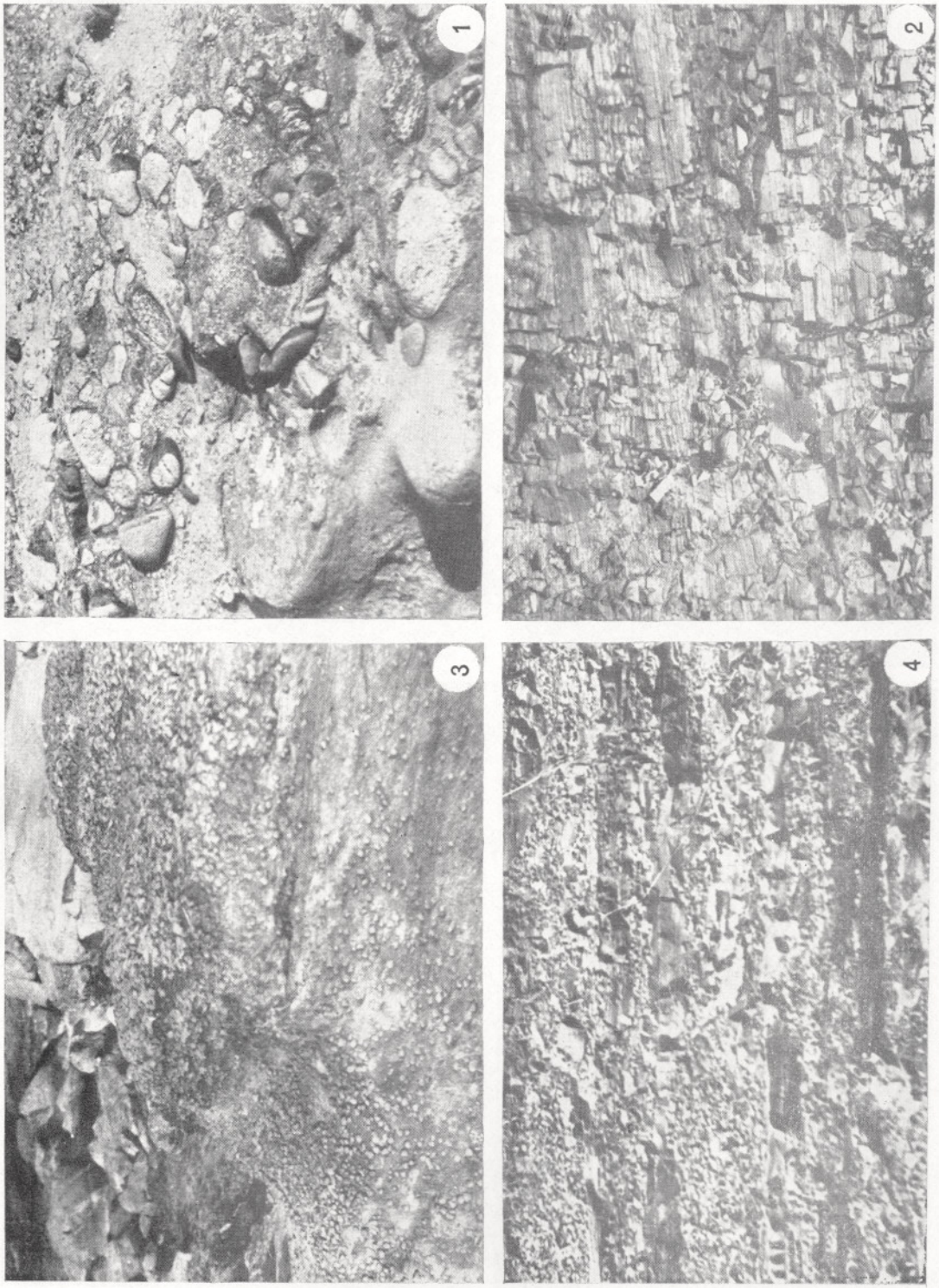

PLATE 1

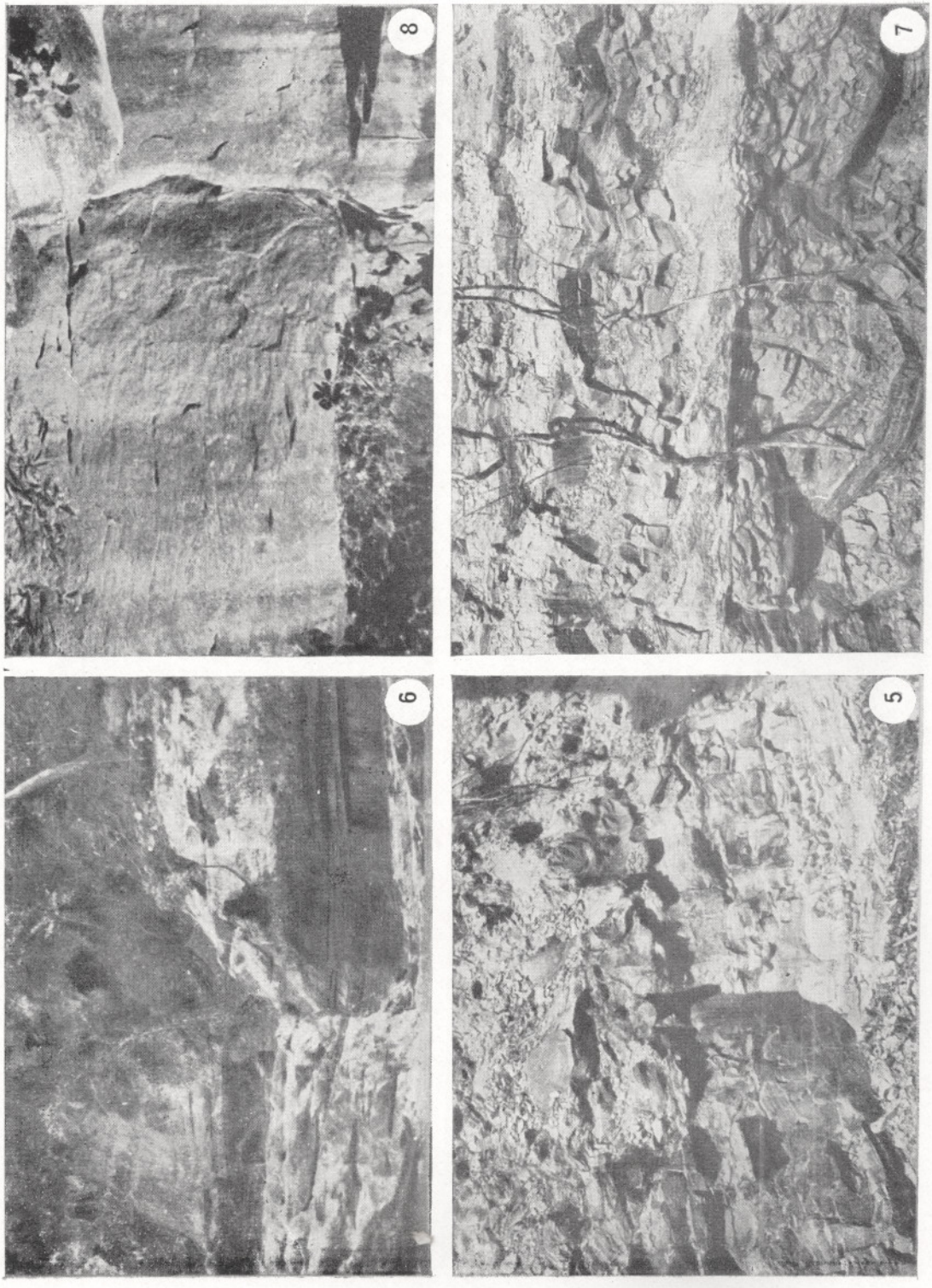

PLATE 2