GEOLOGICAL SURVEY OF INDIA

REPORT ON REGIONAL EXPLORATION FOR COAL RESOURCES IN BANHARDI SECTOR, AURANGA COALFIELD, PALAMAU DISTRICT, BIHAR.

(Progress Report for the Field Seasons 1988-89 to 1994-95)
(Code No. MIE / CW / CW / 1987 / 110)

By

K. Mondal, Geologist (Sr.)

COAL WING
DECEMBER
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A B S T R A C T

An area of about 18 sq. km. was geologically mapped and a total of 8713.45 m. was drilled in 19 boreholes in course of regional exploration for coal.

The investigation revealed the occurrence of Metamorphics and rocks of Lower Gondwana Group comprising Talchir, Barakar, Raniganj and Panchet Formations with unconformably overlying Mahadeva Formation of Upper Gondwana Group.

Sub-surface database available from these boreholes led to the confirmation of existence of seven regionally persistent coal seam zones i.e. seam zone – II (32.90 m. – 43.75 m. thick), III (13.64 m. – 64.35 m. thick), IV (25.20 m. – 51.00 m. thick), V (23.45 m. – 41.80 m. thick), VI (32.00 m. – 36.55 m. thick), VII (16.55 m. – 55.85 m. thick) and seam zone VIII (29.95 m. – 58.20 m. thick) in Barakar Formation.

The northern and the south eastern part of the sector appears to be the main storehouse of large reserves of coal with encouraging multiseam quarriable prospect.

In general, coal is non-coking belonging to grade 'C' to 'G' with high moisture (3.9 % - 11.7 %), medium to high ash (18.0 % - 51.6 %) and medium to high volatile matter content (20.1 % - 32.3 %).

A 'nett' reserve of 920.39 million tonnes of coal has been estimated for seven regionally persistent coal seam zones (II to VIII) over an area of 18 sq. km. of this virgin sector. Of total reserve, 467.44 m. tonnes, 349.35 m. tonnes and 33.42 m. tonnes belong to the 'Indicated' category in depth ranges of 0 – 300 m., 300 – 600 m. and 600 – 1200 m. respectively. While reserve figures for coal of 'Inferred' category are 2.99 m. tonnes, 29.92 m. tonnes and 37.27 m. tonnes respectively in the corresponding depth ranges.

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I. INTRODUCTION

The east-west trending Auranga Coalfield with an area of about 250 sq. km. is lying in the Palamau district, Bihar (now Jharkhand, since 2000). Though the coalfield was studied as early as 1878 by V. Ball and later systematically mapped by several workers, there has been no attempts to take up any exploratory work, because of the thought that the coalfield was not to have much potentiality. The coal potentiality of this coalfield has been brought to light in the recent past and as a sequel, systematic and large scale geological mapping work was initiated in this coalfield in 1976. In course of geological mapping carried out by Das, S. N. during F. S. 1977-79, four promising sectors / blocks showing development of coal-bearing formation have been identified. These are Jagaldagga (10 sq. km.), Gowa (15 sq. km.), Rajbar (50 sq. km.) and Sabanu (15 sq. km.) sectors / blocks.

Based on large scale geological mapping in this coalfield during 1976-79 and as per recommendations of the Sub-Committee on Coal and Lignite (Gr. VIII of C. G. P. B.), a programme of regional exploration was taken up in the south eastern and north eastern part of the coalfield.

Regional exploration in Jagaldagga block was initiated during F. S. 1979-80 and was completed at the end of F. S. 1982-83 yielding a total of 113.0937 m. tonnes of coal reserve for six (II to VII) regional Barakar Coal Seams and one (I) Karharbari Coal Seam.

The coal exploration in Gowa sector yielding a reserve of 51.48 m. tonnes of coal for three (II to IV) regional Barakar Coal Seams and one (I) Karharbari Coal Seam.

The Rajbar sector, largest of all aforesaid sectors occupies the north and north-eastern part of the coalfield yielding a reserve of 1870.24 m. tonnes of coal for six (II to VII) regional Barakar Coal Seams.

The regional coal exploration in the adjacent Sabanu block on the west proved Coal-Carbonaceous shale zones (II to V) of Barakar Formation. A net reserve of 27.33 m. tonnes of coal has been estimated in this sector.

Keeping this background in view, the present item of investigation was taken up as per the Field Season Programme of Geological Survey of India for F. S. 1988-89.

The programme of investigation was included in Annual Programme of the Geological Survey of India vide item no. C/73A/CW/87/110 of 1988-89 F.S. to 1994-95 F.S. The regional exploration was initiated in Banhardi sector with a view to deciphering the pattern of coal seam development in the easternmost part of the coal basin and to explore the continuity and quality of regional coal seams as well as to assess the coal potentiality of the area. The regional exploration is aided by structural analysis and tectono-sedimentation studies with the help of sedimentary facies organisation brought out from surface and sub-surface geological data-base.

Drilling operation in this sector commenced on 14th June, 1989 and completed on 30th May, 1995 by drilling a total meterage of 8713.45m. in19 boreholes deploying two drill machines (Unit nos. – 267 and 378).

The present report embodies results and findings of the regional exploration carried out by large scale geological and topographical (on 1 : 10,000 scale) survey with 3m. contour interval supported by drilling in the sector.

Location **:**

The Banhardi Sector is located in the easternmost part of Auranga Coalfield and it extends from Borha village in the west to Jamuntoli and Surli village in the east (Plate – I). The sector covering an area of about 18 sq. km. is bounded by Latitudes 23°43′21″ N and 23°45′51″ N and

Longitudes 84°34′43″ E and 84°40′03″ E and is included in the Survey of India Toposheet nos. 73 A / 9 and A / 10 (on 1 : 50,000 scale).

Topography and Drainage :

The Auranga Coalfield with gently undulating terrain and occasional flat-topped hills of sedimentary rocks, is bounded by the Ranchi – plateau to the south and Hazaribagh – plateau to the north.

The rolling terrain with low ridges and depressions characterise the general physiographyic feature of Banhardi sector. The hills represented by the formation of Upper Gondwana Group lying in the north and south of the area rise up to a height of 560m. and 549m. from M.S.L. respectively. However, very low ridges occupied mainly by pebbly to gritty sandstone of Barakar Formation are frequent in the area. The southern portion of the sector is relatively low and undulating.

The Bagdagga nala and Rajdaha nala and their tributaries form the main drainage system of the sector. The courses of the nalas have been developed into cultivated lands and some 'bandh' / artificial dyke have been constructed across the nalas for storage of water for irrigation.

Communication :

The area is well connected by road and rail with the major towns in the south-western part of the state. The area is situated to the north of Gomoh – Barkakana – Dehri-on-Son loop of the Eastern Railway and the nearest rail heads Tori and Latehar are situated at 9 km. distance from the south-eastern and 15 km. away from the north-western parts of the area. The State Highway No. 48 runs to the south of the area. Two nearby towns Chandwa and Latehar to the south-east and to the west of the area respectively lie on this State Highway. Chandwa is well connected with the district town Ranchi and district headquarters Daltonganj which are 100 km. and 110 km. away respectively. Another highway to the far east of the area leading to Hazaribagh to the east and Gaya to the north. The small town Balumath (about 20 km. from Chandwa) situated to the far east of the area, lies on the state highway connecting Grand Trunk Road at Hazaribagh (about 135 km. from Chandwa).

The area is negotiable by three all weather unmetalled roads that connect the main State Highway-48.

***Flora and Fauna* :**

The main floral assemblages in this sector are Sal, Mahua, Palash, Khair, Amla, Sisu, Shimul, Segun etc. together with thorny plants and bushes. Plantation of cactus, locally known as 'Morabba' dot several parts of the sector. The forest and bushy jungle are the habitat of the wild animals like Wolf, Hyena, Fox, Wild Bear, Wild Fox, Snake, Lizard etc.

***Climate* :**

Climate in this area is mainly dry and bracing between October and March. The period from middle of November to January is quite cold. The maximum temperature sometimes comes down to below 4°C for a brief spell. Fairly dry and hot climate prevails during April to June. May is the hottest month when the temperature rises even up to 45°C. Monsoon normally commences around middle of June and continues up to end of September.

***Previous work* :**

The first geological mapping of the coalfield on 1 : 63,360 scale was carried out by V. Ball and documented in Mem. 1878[1]. Subsequently it was followed by resurvey in 1927-28 by J. A. Dunn (1928)[2] and sedimentological studies in the area by S. R. A. Rizvi and A. K. Sen (1972)[3]. However, geological mapping by S. N. Das (1978, 1979)[4,5] on 1 : 63,360 scale lead to a broad delineation of structural set up, disposition of coal seams and identification of few probable potential coal-bearing areas. Subsequently, regional exploration for coal in Jagaldagga, Gowa and Rajbar sectors on 1 : 10,000 scale by M. Das (1983, 1985 and 1988)[6,7,8] indicated the presence of superior quality Karharbari Coal Seams in Jagaldagga and Gowa blocks and high moisture, high ash Barakar Coal Seams in Jagaldagga and Rajbar blocks. Regional exploration for coal in Sabanu block by B. De et al (1992)[9] brought to light the development of four 'carbonaceous shale – coal seam' zones indicating high moisture and high ash coal.

The basal member of the Barakar Rock Formation in certain parts of the coal basin was also found to have non-plastic variety of fire clay which was studied by A. B. Dutt in 1978[10].

1.	Ball, V.	1878	On Auranga and Hutar Coalfields and the ironstone ores of the Palamau and Toree. Mem. Geo. Surv. Ind. Vol. 15, Pt. 1.
2.	Dunn, J. A.	1928	The Auranga Coalfield, Unpublished Geol. Surv. Ind. Report
3.	Rizvi, S. R. A and Sen, A. K.	1972	Geology and sedimentation trends in Palamau Coalfields, Bihar, India. Mem. Geol. Surv. Ind. Vol. 104.
4.	Das, S. N.	1978	Geology of the central and south-eastern parts of the Auranga Coalfields, Palamau district, Bihar. Unpublished Geol. Surv. Ind. Report.
5.	Das, S. N.	1979	Geology of the northern and north eastern part of Auranga Coalfield, Palamau district, Bihar. Unpublished Geol. Surv. Ind. Report.
6.	Das, M.	1983	Geology and coal resources of the Jagaldagga area, Auranga Coalfield, Palamau district, Bihar. Unpublished Geol. Surv. Ind. Report.
7.	Das, M.	1985	Geology and coal resources of the Gowa area, Auranga Coalfield, Palamau district, Bihar. Unpublished Geol. Surv. Ind. Report.
8.	Das, M.	1988	Geology and coal resources of the Rajbar area, Auranga Coalfield, Palamau district, Bihar. Unpublished Geol. Surv. Ind. Report.
9.	De, B; Mondal, K; Mukhopadhaya, S. K and De, G.	1992	Final report on the regional exploration for coal in Sabanu block, Auranga Coalfield, Palamau district, Bihar. Unpublished Geol. Surv. Ind. Report
10.	Dutt, A. B.	1978	A note on the fire clay deposits in parts of Auranga and North Karanpura Coalfields, District Palamau, Bihar. Unpublished Geol. Surv. Ind. Report.

Present Investigation :

Though the regional investigation by drilling in Banhardi sector was started for 1989-90 F. S., the first borehole (AB-1) in this sector commenced on 14.06.1989 due to early release of one drill unit from adjacent Sabanu sector. Finally two drilling rigs, Unit nos. 267 and 378 were deployed in the sector. S/Shri S. L. Mazumder, S. Sundar, S. Haldar, D. N. Malakar and P. L. Sarkar, Drillers from time to time were in charge of Unit no. 267 while Unit no. 378 carried out drilling under S/Shri B. Singh and J. Singh, Drillers.

In course of present investigation, nineteen boreholes were drilled in this sector. Out of nineteen boreholes, only four boreholes (AB – 3, 8, 11 and 16) were drilled through Raniganj Formation in the western part of this sector and rest fifteen boreholes (AB – 1, 2, 4, 5, 6, 7, 9, 10, 12, 13, 14, 15, 17, 18 and 19) were drilled directly on the Barakar Formation. A total of 8713.45m. was drilled in nineteen boreholes (AB – 1 to 19) and the last borehole AB – 19 was closed on 30th May, 1995.

The survey work was carried out by S/Shri N. C. Das, S.T.A. (Surveyor), A.C.Bhowmick and D.N.Dasgupta, J.T.A. (Surveyor), B. C. Dey and C. Chakraborty, Surveyor. The Reduced Levels of the collar of boreholes of Banhardi sector were determined with reference to those of adjacent Sabanu sector. The survey work was carried out with theodolite, plane table and alidade.

The regional geological exploration involved large scale geological mapping (1 : 10,000 scale), logging of borehole lithocores, interpretation of surface and sub-surface data.

An area of about 18 sq. km. was covered by geological mapping. While contouring with 3m. contour interval was carried out over an area of about 11 sq. km. occupied by Barakar sediments in the eastern part of the sector on 1 : 10,000 scale.

Acknowledgement :

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Wing for technical guidance, encouragement and constructive suggestion both in field and at headquarters and during preparation of the report. Thankful acknowledgements are also due to Shri S. K. Shome, the then Director, Project – I and Shri S. Bhadra, Director, Project – I, Coal Wing. The author gratefully acknowledges the help received from S/Shri R. N. Das, K. K. Sen, G. De and other colleagues of Project – I , Coal wing during mapping, core logging and interpretation of surface and sub-surface data. Thanks are also due to the officials of the C. F. R. I., Ranchi for carrying out the analytical work of the coal seams.

II. GENERAL GEOLOGY

On the basis of the data accrued through regional investigation for coal in parts of Auranga Coalfield (1980 – 85) and availability of data of palynological studies of some outcrop samples, the Lower Gondwana rocks belonging to Upper Carboniferous (?) to Lower Triassic ages represented by Talchir, Karharbari, Barakar, Barren Measure, Raniganj and Panchet Formations, overlain unconformably by Upper Triassic Mahadeva Formation, as indicated below, were differentiated in Auranga Basin (Ball, G.S.I., Sr. A. No. 45, Vol. IV, Pt. 1).

TABLE - 1

Age	Group	Formation	Thickness (m)
Up. Triassic	Upper Gondwana	Mahadeva Formation	180 - 210
---------- UNCONFORMITY ----------			
Lr. Triassic	Lower Gondwana	Panchet Formation	130 – 150
Up.Permian		Raniganj Formation	180 – 200
Mid. Permian		Barren Measures	80 – 160
Lr. Permian		Barakar Formation	400 - >600
Lr. Permian		Karharbari Formation	40 – 85
Up. Carboniferous To Lr. Permian		Talchir Formation	30 – 35
---------- UNCONFORMITY ----------			
Precambrian		Metamorphics	

Geology of the area :

Based on the surface and sub-surface data gathered during the regional exploration in Banhardi sector (1989 – 95), the following geological sequence could be built up for the area.

TABLE - 2

Age	Group	Formation	Lithology	Thickness (m)
Up. Triassic	Upper Gondwana	Mahadeva Formation	Brown, coarse to very coarse grained cross-bedded arenaceous and ferruginous sandstone with minor pink shale interbands.	180 – 200
---------- UNCONFORMITY ----------				
Lr. Triassic	Lower Gondwana	Panchet Formation	Pink to greenish, medium to coarse grained ferruginous and micaceous sandstone with mottled shale interbedded with fine grained micaceous, greenish grey sandstone and siltstone.	60 +
Up. Permian	Lower Gondwana	Raniganj Formation	Greenish grey, cross-bedded and laminated micaceous, calcareous and argillaceous sandstone interbedded with micaceous ripple laminated, flaser bedded siltstones, grey shale with carbonaceous shale and minor coal seams.	350 +
Lr. Permian	Lower Gondwana	Barakar Formation	Grey to greenish white, yellowish white, brownish very coarse to fine grained cross-bedded and laminated arkosic and ferruginous sandstones, pebbly to gritty sandstones interbedded with fine grained micaceous sandstone, siltstones, grey shales, carbonaceous shales, thin to thick coal seams and fire clay.	790
Up. Carboniferous to Lr. Permian	Lower Gondwana	Talchir Formation	Greenish to grey and grey siltstone, fine grained sandstone, shale with occasional medium grained sandstone and laminated sandstone, tillite and poorly stratified conglomerate (Diamictite).	15 +
---------- UNCONFORMITY ----------				
Precambrian	Chotonagpur Gneissic Complex	Metamorphics	Granite-gneiss, quartzite, mica-schists, amphibolites, hornblende schists, biotite-gneiss with quartz-pegmatite veins etc.	

Description of the Formations :

The salient features of each formation mapped in Banhardi sector are described below.

a) *Metamorphics* :

The metamorphics constituting the basement of the Gondwana rocks is well exposed in the eastern margin of the sector. The southern and eastern margins of the sector are faulted. The metamorphic rocks consisting of granite gneiss, quartzites, mica-schists, amphibolites, pegmatites, vein-quartz etc. occur to the eastern part of the Banhardi sector. In borehole AB-17 Metamorphics has been intersected at 378.35m. depth and having a faulted contact with overlying Barakar Formation.

b) *Talchir Formation* :

It is interesting to note that though no outcrop of Talchir Formation was delineated on the surface, the sub-surface data (B.H. AB - 6 and AB – 9) indicated the presence of Talchir Formation at depth. In borehole AB-17, the Metamorphics directly underlie the Barakar sediments, apparently without any intervening Talchir strata or omission of the strata due to faulting. This suggests that the Talchir Formation occurs as discontinuous pockets and lenses, deposited in shallow depressions of limited spread.

The Talchir Formation is overlain by Barakar Formation with a gradational contact in boreholes AB – 6 and 9.

The greenish colouration due to abundance of chloritic material in shale, siltstone, sandstone and heterolithic facies of rocks consisting of interlaminated fine grained sandstone and shale and their stratigraphic position suggest the inclusion of rock-type under Talchir Formation

The Talchir Formation is represented by green to greenish white coarse and medium to fine grained sandstone and shale. The pebbly sandstone contains pebbles of quartz, pink and white felspar, coarse grained sandstone rock fragments set in a greenish matrix. The pebbles are rectangular, elongated and irregular shaped and occur in diverse orientations.

c) ***Barakar Formation*** :

This Formation is the most important one containing as many as seven coal seam zones (II to VIII in ascending order) and covers about 55% of the terrain of the total area (PLATE – I). The maximum thickness of the Barakar Formation encountered in a single borehole drilled in this sector is 520.90m. (AB-12).

The rocks of the Barakar Formation forming low linear ridges and valleys cover most of the eastern part of Banhardi Sector. Barakar Formation is juxtaposed against Metamorphics along NW-SE and almost EW trending faults in the east and south respectively. The direct contact is concealed in some places but extensive ferrugination and profusion of strewn pebbles of reef-quartz hint probable faulted contact. Abrupt truncated isopach of Barakar sediment package encountered in boreholes against the Metamorphics also suggests a faulted relationship.

Near Daria village the Barakars / Metamorphics contact is a faulted one (F_5 - F_5) as evidenced by occurrence of quartz–reef. The nature of contact with the underlying Talchir Formation is gradational as reflected in boreholes AB - 6 and AB - 9.

Broadly speaking, lithic–fill in general manifests fining upward sequence from very coarse grained to pebbly sandstone at the bottom through siltstone-shale to coal at the top. The rock types include grey conglomerate, pebbly sandstone, very coarse grained sandstone, coarse to fine grained sandstone, very fine grained sandstone, siltstone, grey shale, carbonaceous shale, sideritic shale, fire clay and coal. Alternation of grey shale and siltstone to very fine grained sandstone or medium to fine grained sandstone and siltstone, grey shale are very common.

In some boreholes, 'debris flow conglomerate' facies have been intersected at different stratigraphic horizons. This facies dominantly consists of immature, unsorted assemblages of sub-angular to angular, large clasts of granite gneiss, schist, vein-quartz, felspar laths, muscovite fragments, sandstones, black shale, carbonaceous shale, vegetal matter and coal clasts set in a dark grey carbonaceous sandy argillaceous matrix. The vegetal material is represented by vitrinised barks.

The thickness of each lithotype e.g. sandstone, siltstone and shale varies from a few cm. to 4-5m. The nature of contact between lithotypes is at places gradational, sharp, erosional and conformable. The sandstone displays planar cross-stratification , while trough cross-stratification are fairly common. Besides, small scale current bedding, ripple drift lamination, flaser bedding, convolute lamination etc. were recorded in borehole cores.

Chemical analysis of fire clay samples (Appendix – VI) collected from NW – SE running small fire clay working along the eastern margin of the sector shows 46.34% - 48.82% SiO_2, 0.88% - 2.82% TiO_2, 31.96% - 35.16% AL_2O_3, 0.10% - 0.76% Fe_2O_3, 0.70% - 0.90% FeO, <0.01% - 0.03% MnO, 0.07% - 0.16% CaO, 0.10% - 0.20% MgO, 0.10% - 0.24% Na_2O, 0.60% - 1.80% K_2O, 11.89% - 14.10% $+H_2O$, 0.33% - 0.87% $-H_2O$, <0.01% - 0.24% P_2O_5, 0.11% - 0.34% Cr_2O_3 and 12.63% - 14.72% L.O.I.

Bioturbation of sediments indicated by the disruption of laminations, either due to churning of sediments or small grooves across or along the laminations filled up with medium to coarse grained sediments are recorded. Occurrences of carbonised rootlets, streaks and lenses of fusain and vitrain in grey shale and common fossil like *Vertebraria sp.*, *Glossopteris sp.*, *Gondwanensis*, *G. nimisha* and Schizoneura sp. have also been documented. Grey shale in borehole AB – 2 occurrence at 350.40m. depth yielded *Pecopteris phegopteroides* (Appendix – V).

The contact between the Barakar Formation and the overlying Raniganj Formation is gradational (?).

d) ***Raniganj Formation*** :

Overlying the Barakar Formation, the Raniganj Formation occupies, covering an area of about 8 sq. km. in the south western part of the sector (PLATE – I). This is the uppermost coal bearing formation in Auranga Coalfield. The thickness of Raniganj Formation encountered in boreholes drilled in Banhardi sector is 269.80m. (B. H. AB – 3), but the maximum thickness is estimated to be more than 250m. Raniganj Formation overlies the Barakar Formation with gradational contact. However, it is rather difficult to differentiate Barren Measures from that of Raniganj Formation – as there is very little distinctive lithological character. It has been reported from other part of this coalfield that Barren

Measures has conformable and gradational contact with both the underlying Barakar Formation and the overlying Raniganj Formation and the contacts are arbitrarily placed above or below the upper most coal seam of the Barakar Formation and the lowermost coal seam of the Raniganj Formation (Misc. Publ. 36, GSI, 1977). However, in Auranga Coalfield, in general, there is very poor development of coal seams in Raniganj Formation. A sequence of non-coal bearing rocks of inconsiderable thickness between the lowermost seam of Raniganj Formation, as revealed in sub-surface data (B. H. AB – 3, 8 and 11) may represent Barren Measures. But in the area under discussion, this sequence of insignificant thickness is considered as part of Raniganj Formation because of its lithological similarity.

The contact between Raniganj Formation and the underlying Barakar Formation runs in a NNW – SSE direction to the west of Nimiya and Siyani village, the contact after being displaced by fault $F_3 - F_3$ swings towards SW direction for a distance of about 1.2 km. up to Tewrahi in the southern part of the sector.

Raniganj Formation dominantly consists of an wave rippled, flaser bedded thinly interlaminated siltstone / fine to very fine grained sandstone and shale, grey shale, carbonaceous shale, green shale, cross-bedded to internally laminated fine to medium grained sandstones interbedded with micaceous siltstones, shales and coal seams, calcareous sandstone and marl. The calcareous character of Raniganj Formation is reflected by occurrence of yellowish green to yellowish white caliche over weathered rock outcrops.

The sandstones of Raniganj Formation are distinct from those of Barakar Formation by their greenish tint, even texture, comparatively finer grain size with less of feldspar and more of mica besides calcareous nature. Coarse grained to pebbly sandstones are less frequent whereas finely laminated and cross-bedded sandstones are abundant.

Glossopteris sp., *Gangamopteris sp.*, *Vertebraria sp.*, *Schizoneura sp.* and some un-identified plant fossils were recorded from Raniganj Formation. *Alethopteris* was also found. There are evidence of bioturbation and trace fossils. The dark grey shale horizons at the depths of 40.61m. and 43.80m. in borehole AB–8 yielded an assemblage of bi-valve *Anthraconauta sp.* (Appendix – V). This Lamellibranch casts have been reported in Raniganj Formation in this sector for the first time by the author and this indicates an age of Up. Carboniferous to Permian.

e) ***Panchet Formation*** :

In the southwest, Raniganj beds are overlain by the rocks of Panchet Formation forming flat topped hillocks. The exposures of Panchet Formation are very scanty in this sector. The contact between Panchet and Raniganj Formations runs ENE – WSW direction in the west swings to E – W direction to the south of Sikni village and further east swings to NW – SE direction to the south of Shantipur and further south to N – S direction to the west of Tewrahi.

The Panchet Formation represented by variegated, medium to coarse grained highly cross-bedded sandstone with interbeds of red, chocolate and green clay and shale are found to occur to the west of Jokha village and south of Sikni village. The beds have general dip of 20° towards west and gradually changes towards south in the south-western part of this sector.

f) ***Mahadeva Formation*** :

The Panchet Formation is overlain by a monotonous sequence of highly ferruginous, coarse grained to pebbly sandstone with thin bands of cherry red siltstone. This litho-assemblage has been designated as Mahadeva Formation and occurs in the south western part of the sector with an unconformable relation to the underlying Panchet Formation.

STRUCTURE :

In the Banhardi sector, Gondwana – Precambrian boundary in the east is marked by NW – SE trending border fault $F_2 – F_2$ as evidenced from the occurrence of extensive quartz reef zone near Daria. This border fault is offset by two cross faults $F_5 – F_5$ and $F_3 – F_3$. The southern boundary of the sector is also marked by a boundary fault $F_1 – F_1$ separating the Gondwana sedimentaries and Precambrian basement. The northern boundary of the sector is marked by an E – W trending fault $F_7 – F_7$ which has been established in the northern adjacent Rajbar sector of the coalfield. All the cross-faults developed in this sector is intrabasinal normal faults.

The Banhardi sector is separated into two parts 1) Western part, 2) Eastern part for the sake of description and development pattern of formations.

1) ***WESTERN PART*** : It is an arcuate shaped area covered by the lithic assemblages of Raniganj Formation overlain by the Panchet Formation towards south and Panchet Formation is in turns unconformably overlain by the Mahadeva Formation to the further south. The regional strike of the beds of Raniganj Formation is WNW – ESE with 15° to 20° southerly dip which changes to NNW – SSE around Shantipur and Jokhaha and further swings to NE – SW near Tewrahi. The dip of beds is 5° to 7° in the extreme western part of the sector near Borha village.

2) ***EASTERN PART*** : Structurally, the eastern part covered by Barakar Formation can be sub-divided into two different segments -- A) Northern segment and B) Southern segment. These two segments are clearly separated by an ENE – WSW trending major intrabasinal cross fault $F_3 – F_3$ hading southerly.

A) ***Northern Segment*** :

The northern segment covers the major part of exposed Barakar Formation and is traversed by a number of ENE – WSW trending intra-basinal cross faults and a NE – SW trending cross fault ($F_6 – F_6$). The coal seam zones of Barakar Formation are affected by these faults offsetting the seam zones. The strike of Barakar sediments is broadly NNW – SSE with 16° to 22° westerly dip. The inclination of beds increases near the boundary fault $F_2 – F_2$ dipping basin-ward.

B) ***Southern segment :***

This segment is structurally more complex compared to the northern segment. In this segment, a synformal structure is preserved between the major intrabasinal cross fault $F_3 - F_3$ dipping southerly and southern basin boundary fault $F_1 - F_1$ with northerly dip. This synformal structure plunges westward with a closure in the east. The nose of the syncline is affected by a set of radial faults $F_3 - F_3$, $F_8 - F_8$ and $F_9 - F_9$. In the northern limb of this syncline, the beds dip at 18° to 20° while in the southern limb it is 7° to 20°. The strike of the beds in the northern limb is WNW – ESE and swings to N – S near closure and then changes to E – W on the southern limb. Most of the faults belong to the sector having NE – SW to ENE – WSW trend while the fault ($F_6 - F_6$) occurring to the west of Damartoli trends NNE – SSW. The only fault ($F_8 - F_8$) on the southern limb has a NW – SE trend.

Fault $F_1 - F_1$: This fault is E – W trending southern boundary fault against which the coal seam zones III, II and lithic package below seam zone II abut. This fault hades towards north.

Fault $F_2 - F_2$: This fault trending NNW – SSE marks the eastern boundary of the basin having westerly hade. This fault has been offset by interbasinal cross faults $F_3 - F_3$ and $F_5 - F_5$. This boundary fault has brought the basement against younger coal seam zones III and IV.

Fault $F_3 - F_3$: It is a major cross fault trending ENE – WSW with a southerly hade. The throw of this fault is about 70m.; the amount of throw decreases near the eastern basin boundary. Northern and southern segments are separated by this fault. In the northern segment, all the coal seam zones are truncated by this fault.

Fault $F_4 - F_4$: This intrabasinal cross fault trending ENE – WSW with northerly dip shows a progressive increase in throw at depth (from 10m. to 60m.) as evidenced from magnitude of displacement from younger (VII) to older coal seam zone (II) which is suggestive of growth fault.

Fault $F_5 - F_5$: This fault too is ENE – WSW trending cross fault having a southerly throw of small magnitude (20m. to 50m.) and also offset the eastern boundary fault. This fault along with the fault $F_4 - F_4$ forms a graben-like structure in the north-central part of the sector.

Fault $F_6 - F_6$: This fault is developed in the northern part of the sector trending NNE – SSW with a throw of about 35m. to 45m. and hades towards NW. This fault brought about dislocation of the incrop of coal seam zones IV to VII.

Fault $F_7 - F_7$: This fault trends E – W with northerly hade and forming northern boundary of this sector. The fault has a considerable throw of the order of 300m. – 400m. causing juxtaposition of coal bearing Barakar Formation against the younger formations (Raniganj Formation and Panchet Formation).

Fault $F_8 - F_8$: It is an intrabasinal fault against which the coal seam zones II to VII have been dislocated with throw of 125m. to 150m. This fault trends NW – SE with westerly hade.

Fault $F_9 - F_9$: This fault approximately trends E – W with southerly dip and is intrabasinal. Throw of this fault generally varies from 50m. to 60m.

III. COAL SEAM

Coal seams hardly crop out in the Banhardi sector with the exception of two small exposuresof coal / carbonaceous shale of Raniganj Formation in nala section in the western part. Stratigraphically, coal seams occur both in Barakar and Raniganj Formations. However, the coal seams of the Raniganj Formation are mostly thin and impersistent in nature.

The sub-surface data indicate the development of a number of coal seam zones mainly comprising coal seams / bands and carbonaceous shale with siltstone and sandstone bands in Banhardi sector. Each coal seam zone has variable number of coal components which is a great impediment in correlating individual coal seams, for which correlation has been attempted on the basis of coal seam zones. However, based on the general stratigraphic position, thickness of the strata interveining between the coal seam zones and Metamorphic -- Barakar Formational contact / Talchir – Barakar Formational contact / Barakar – Raniganj Formational contact, thickness of the coal seam zones, quality and the nature of the zone, seven (7) coal seam zones designated as coal seam zone – II, III, IV, V, VI, VII and VIII in ascending order in Barakar Formation have been established in the Banhardi sector. The lowermost zone in this sector has been designated as coal seam zone – I in Auranga Coalfield occurs in Karharbari Formation.

Besides the seven coal seam zones, minor coal seams occur in Barakar Formation.

Some of the coal seam zones and interseam partings display wide variation in thickness and coalesence of two seam zones sometimes results in super thick seam zone. Sometimes seam zones are found to degenerated both in its coal component and quality of coal. Many seams pinch out completely within a short distance or grade into carbonaceous shale. The variation of thickness of coal seam zones and the major inter-seam parting are as follow :

Coal Seam Zone No.	Parting	Thickness range of Coal Seam zone (m.)	Thickness range of parting (m.)	Grade range
1	2	3	4	5
-	Parting between Raniganj – Barakar contact and Coal Seam zone VIII	--	36.25 – 63.50	--
VIII	--	29.95 – 58.20	--	'D' – 'G'
--	Parting	--	146.95 – 169.46	--
VII	--	16.55 – 83.15	--	'D' – 'G'
--	Parting	--	20.05 – 48.55	--
VI	--	32.00 – 36.55	--	'E' – 'G'
--	Parting	--	20.30 – 39.05	--

1	2	3	4	5
V	--	23.45 – 41.80	--	'E' – 'G'
--	Parting	--	20.45 – 40.93	--
IV	--	25.20 – 48.50	--	'D' – 'G'
--	Parting	--	30.25 – 115.95	--
III	--	13.64 – 64.35	--	'C' – 'F'
--	Parting	--	20.45 – 71.60	--
II	--	32.90 – 43.75	--	'D' – 'F'
--	Parting	--	--	--

Description of Coal Seam Zones :

It has already been stated that the eastern part of the sector which is covered by Barakar Formation has been sub-divided into two different segments (A) Northern segment and (B) Southern segment for the sake of brevity and comprehension. The character of the coal seams in particular seam zone such as variation in thickness, quality, splitting and coalescing of seams and degeneration of seams are described segment-wise in this portion of report.

1) *SEAM ZONE – II* (Table – 3, Plate – II to X) :

The coal seam zone II is the lowermost coal seam zone which was intersected in eight boreholes viz. AB-4, 14, 6, 17 and 19 (in northern segment) and AB-9, 7 and 12 (in southern segment) of this sector. In borehole AB – 17, seam zone II and III are combined and has not been shown in Table – 3.

A) ***Northern Segment*** :

The floor of this seam zone was encountered 56.80m. above Talchir contact in borehole AB – 6. Below seam zone – II, the maximum Barakar sediment package encountered in this segment is of the order of 91.00m. (AB – 4).

The seam zone – II ranges in thickness from 11.75m. to 49.78m. as revealed from sub-surface data base. The maximum thickness of 49.78m. is recorded in borehole AB – 17 drilled in northernmost part of the segment, where it is combined with younger seam zone – III indicating a stable coal forming condition with slow rate of subsidence. The thickness is truncated to 3.30m. in AB – 6 due to fault F5 – F5 intersected at 299.55m. depth.

The seam zone – II is composite one having 4 to 5 split sections. Individual coal split varies in thickness from 0.16m. to a maximum of 20.90m. The splitting increases towards north in this segment. This splitting nature is due to the compaction controlled subsidence accompanied by intermittent channel sedimentation.

Cumulative thickness of coal in this zone ranges from 30.95m. to 36.77m., maintaining a strike and dip-wise uniformity of clean coal content in this segment. Only in borehole AB – 6, this seam zone is truncated by the fault F5 – F5 and is represented by one coal section of 2.00m.

Coal of this zone (excluding band) shows range of moisture, ash and volatile matter percentage of 6.3 – 9.8; 21.0 – 39.6 and 24.1 – 28.5 respectively.

Coal is high ash and medium volatile, non-coking in nature and fall in 'D' to 'F' grade. Strike continuity and dip-wise extension of the seam zone – II are 2.2km. and 1.3km. respectively.

B) *Southern Segment* :

With parting thickness of 148.90m. above the Talchir contact (AB – 9), the seam zone – II is developed in the extreme eastern part of this southern segment.

The zone thickness varies from 32.90m. (AB – 12) to 43.75m. (AB – 9) indicating strike-wise reduction of zone thickness towards west while number of split sections of coal in this zone increases both east and westward.

Thickness of the individual split of coal ranges from 0.10m. to 13.77m. (AB – 9) while around borehole AB – 7, development of single seam of 39.75m. thickness forming this zone indicates a sustained peat forming condition over a considerable period. Cumulative coal content varies from 22.98m. (AB – 12) to 28.62m. (AB – 9) indicating relative increasement of carbonaceous shale content towards west.

On the basis of both overall and ex-band analysis, ash %, moisture % and volatile matter% of the coals within this seam zone vary from 25.3 – 42.4; 3.4 – 8.7 and 25.2 – 29.0 respectively. The coal is high ash, medium volatile and non-coking and falls in grade 'D' to 'F'. Strike continuity and dip-wise extension of Seam Zone – II are 2.4 km. and 1.1 km. respectively in this segment.

TABLE - 3

ZONE – II

Sl. No.		NORTHERN SEGMENT				SOUTHERN SEGMENT		
1	2	3	4	5	6	7	8	9
1.	**Borehole No. AB -**	**4**	**14**	**6**	**19**	**9**	**7**	**12**
2.	Depth range of seam zone (m.)	250.60 to 292.20	217.50 to 261.00	296.25 to 299.55	378.10 to 418.90	153.25 to 197.00	358.52 to 398.27	488.00 to 520.90
3.	Thickness of seam zone (m.)	41.60	43.50	3.30 (Truncated)	40.80	43.75	39.75	32.90
4.	No. of split sections of coal	4	5	1	4	8	1	8
5.	Thickness range of split sections of coal (m.)	3.57 to 15.20	0.16 to 20.90	--	5.50 to 11.05	0.10 to 13.77	--	0.17 to 12.23
6.	Cumulative thickness of split coal sections (m.)	36.77	33.46	--	30.95	28.62	--	22.98
7.	Clean coal (m.)	--	--	2.00	--	--	39.75	--
8.	Range of ash (%)	31.3 to 39.6	30.3 to 36.4	47.6	21.0 to 32.9	31.8 to 42.4	30.0	25.3 to 38.4
9.	Range of moisture (%)	6.3 to 7.8	7.1 to 8.0	5.8	6.5 to 8.5	6.6 to 8.7	6.1	3.4 to 6.7
10.	Range of volatile matter (%)	24.1 to 27.0	24.8 to 27.8	20.1	25.4 to 28.5	25.2 to 27.6	28.1	25.5 to 29.0

2) *SEAM ZONE – III* (Table – 4, Plate – II to X) :

The coal seam zone – III above the seam zone – II is intersected in thirteen boreholes viz. AB – 4, 14, 6, 17, 18, 19, 2 and 1 in northern segment and AB – 10, 9, 7, 12 and 13 in southern segment of this sector. In borehole AB – 17, seam zones II and III occur as combined seam zone, therefore, has not been reflected in Table – 4.

A) *Northern Segments* :

This seam zone succeeds seam zone – II with a parting thickness ranging between 20.45 m. and 70.80m. (AB – 9). In borehole AB – 17, seam zone III and II occur as combined seam zone III + II. In borehole AB – 2, upper part of this zone which is represented by two carbonaceous shale bands, was intersected.

The thickness of this seam zone varies from 21.20 m. (AB – 2) to a maximum of 64.35 m. (AB – 19) and the maximum zone thickness is recorded in the northernmost part.

About one to six coal sections characterise the seam zone – III. The individual split of coal ranges in thickness from 0.20 m. to as much as 27.70 m. In boreholes AB – 1 and AB – 2, this zone is highly degenerated and is practically represented by a few carbonaceous shale bands with or without coal seams.

The cumulative coal thickness of this zone varies from 0.30 m. (AB – 1) to 38.78 m. (AB – 14). The total coal content gradually decreases strike-wise from south to north and also towards dip direction which may possibly be attributed to greater palaeo water level depth.

The strike continuity of the seam zone – III is 2.2 km. and dip-wise extension with respect to borehole AB – 15 is 1.6 km.

Coal belonging to zone – III analyses 21.8 % - 39.6 % ash, 6.3 % - 12.7 % moisture and 22.4 % - 28.3 % volatile matter respectively. Coal is high ash, medium volatile and non-coking in nature belonging to grade 'D' to 'F' in this segment.

B) *Southern Segment* :

With a parting range of 49.87 m. (AB – 7) to 83.30 m. (AB – 10) above the seam zone – II occur seam zone – III in this segment. Thickness of this zone varies from 27.60 m. (AB – 7) to a maximum of 56.45 m. (AB – 12) showing increase of zone thickness strike-wise from east to west in this segment. The seam zone is composite in nature with number of split coal sections varying from 1 to 17. Individual split of coal ranges in thickness from 0.15 m. to as much as 24.15 m. The number of split increases towards west (AB – 13) with reduction of thickness of splits. In borebole

AB – 7, development of single seam zone of 27.60 m. thickness indicates slow subsidence of peat swamp keeping pace with growth of vegetal matter.

The cumulative thickness of coal splits in this zone varies from 5.70 m. (AB – 12) to 29.55 m. (AB – 10). Strike-wise from NE to W, the cumulative coal content is more or less uniform except boreholes AB – 9 and 12 where coal is degenerated. In borehole AB – 7, clean coal content is 27.60 m.

The strike continuity of this zone is about 3.0 km. while dip-wise extension for about 1.1 km. has been established in this segment.

Coal of split sections analyses to 18 % - 41.8 % ash, 4.8 % - 11.7 % moisture and 25.8% - 32.3% volatile matter respectively. Coal is high ash and medium to high volatile and is non-coking in nature belongs to grade 'C' – 'F' category.

TABLE - 4

ZONE - III

Sl. No.		NORTHERN SEGMENT							SOUTHERN SEGMENT				
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	**Borehole No. AB-**	**4**	**14**	**6**	**18**	**19**	**2**	**1**	**10**	**9**	**7**	**12**	**13**
2.	Depth range of seam zone (m)	143.20 to 192.50	124.80 to 186.55	197.45 to 243.45	375.95 to 440.00	293.30 to 357.65	482.00 to 503.20	429.44 to 443.08	163.95 to 205.35	45.00 to 82.45	281.05 to 308.65	378.40 to 434.85	429.30 to 482.00
3.	Thickness of seam zone (m)	49.30	61.75	46.00	64.05	64.35	21.20	13.64	41.40	37.45	27.60	56.45	52.70
4.	No. of split sections of coal	5	6	5	6	4	-	1	2	9	1	9	17
5.	Thickness range of split sections of coal (m)	0.20 to 18.50	0.25 to 22.95	3.80 to 11.05	0.55 to 15.95	1.00 to 27.70	-	-	5.40 to 24.15	0.10 to 7.02	-	0.15 to 2.00	0.20 to 8.50
6.	Cumulative thickness of split coal sections (m)	29.93	38.78	36.45	30.55	37.20	-	-	29.55	15.26	-	5.70	26.14
7.	Clean coal (m)	-	-	-	-	-	-	0.30	-	-	27.60	-	-
8.	Parting thickness between zone III and II (m)	58.10	30.95	52.80	37.30	20.45	-	>58.19	>83.30	70.80	49.87	53.15	-
9.	Range of ash (%)	24.6 to 39.6	27.2 to 38.3	29.7 to 36.1	21.8 to 39.5	28.9 to 36.6	-	-	27.8 to 33.7	19.8 to 37.5	24.0	20.4 to 37.2	18.0 to 41.8
10.	Range of moisture (%)	7.7 to 10.4	8.5 to 12.7	6.7 to 7.6	6.3 to 7.6	7.0 to 7.7	-	-	7.0 to 7.4	8.0 to 8.9	7.7	4.8 to 8.0	7.2 to 11.7
11.	Range of volatile matter (%)	22.4 to 26.5	25.2 to 27.1	25.1 to 28.3	23.7 to 28.2	24.7 to 26.8	-	-	26.4 to 28.3	24.4 to 25.4	29.9	28.2	25.8 to 32.3

3) SEAM *ZONE - IV* (Table – 5; Plate – II to X) :

Coal seam zone – IV has encountered in boreholes AB – 4, 6, 17, 18, 19, 2, 1, 15 and 5 in northern segment and in boreholes AB – 10, 7, 12 and 13 in southern segment. The seam zones IV and V occur as combined seam zone V + IV in boreholes AB – 17, 19 and 5 and has not been shown in Table – 5.

A) *Northern Segment* :

In this part, the seam zone – IV overlies seam zone – III with an interveining parting thickness range of 32.65 m. (AB – 4) to 91.75 m. (AB – 18), but the maximum parting thickness of 115.95 m. occur in borehole AB – 19 where this seam zone is combined with seam zone – V.

The thickness of this zone varies from 25.20 m. (AB – 15) to 40.91 m. (AB – 2). The maximum zone thickness occur in borehole AB – 5 to the tune of 51.00 m. in this segment. Around borehole AB – 14, seam zone IV is degenerated with the development of shale, carbonaceous shale and sandstone facies which may be assigned to increased palaeo water depth and ingression of channel in peat swamp.

The seam zone contains 4 to 10 split sections of coal ranging in thickness from 0.10 m. to 5.29 m. The thick coal sections are generally developed towards the northern part of this segment.

The cumulative thickness of split coal sections varies from 1.30 m. (AB – 6) to 13.20 m. (AB – 18).

The seam zone – IV is well developed in the northern part of this section and occur as combined seam zone with the overlying seam zone V in this part. This seam zone, where well developed continues over a strike length of 0.75 km. and dip extension of about 1.5 km.

The ash, moisture and volatile matter content of the coal splits varies from 21.9% - 46.7%; 5.5 % - 11.1 % and 21.7 % - 27 % respectively based on overall and ex-band analysis of coal. The coals are high ash, medium volatile and non-coking in nature and fall in grade 'D' to 'G'.

B) *Southern segment* :

The parting thickness between seam zone IV and immediately underlying seam zone – III varies from 30.25 m. (AB –10) to 92.90 m. (AB – 12). The zone thickness ranges between 36.81 m. (AB – 12) and 48.50 m. (AB – 7).

The seam zone – IV in this segment consists of 6 to 9 split sections of coal with individual splits varies in thickness from 0.10 m. to 7.50 m. The cumulative thickness of split coal sections varies from 12.08 m. (AB – 10) to 14.16 m. (AB –12)

In borehole AB – 13, a 42.00 m. thick grey shale with thin carbonaceous shale zone is

correlated with seam zone – IV, probably due to increased palaeo water cover depth. The grey shale facies was developed at the extreme western part of this segment at the expense of coal development.

The strike continuity of this zone is about1.4 km. and 1 km. dip-wise extension have been established in this segment.

Coal in this zone – IV is non-coking in character with high moisture, ash and volatile matter content. Ash, moisture and volatile matter content of coal varies between 27.9% - 43.2%, 4.4 % - 8.4 % and 22.5 % - 26.3 % respectively. The coal is of 'E' to 'G' grade.

TABLE - 5

ZONE - IV

Sl. No.		NORTHERN SEGMENT						SOUTHERN SEGMENT		
1	2	3	4	5	6	7	8	9	10	11
1.	**Borehole No. AB-**	**4**	**6**	**18**	**2**	**1**	**15**	**10**	**7**	**12**
2.	Depth range of seam zone (m)	83.90 to 110.55	90.36 to 128.00	255.85 to 284.20	359.30 to 400.21	307.33 to 341.20	381.75 to 406.95	86.40 to 133.70	186.30 to 234.80	248.69 to 285.50
3.	Thickness of seam zone (m)	26.65	37.64	28.35	40.91	33.87	25.20	47.30	48.50	36.81
4.	No. of split sections of coal	6	4	10	6	6	6	6	9	9
5.	Thickness range of split sections of coal (m)	0.10 to 0.63	0.10 to 0.95	0.10 to 5.29	0.30 to 4.19	0.13 to 4.13	0.40 to 4.25	0.20 to 6.23	0.10 to 5.76	0.13 to 7.50
6.	Cumulative thickness of split coal sections (m)	1.38	1.30	13.20	9.52	5.93	7.70	12.08	13.71	19.16
7.	Clean coal (m)	-	-	-	-	-	-	-	-	-
8.	Parting thickness between zone IV and III (m)	32.65	69.45	91.75	81.79	88.24	-	30.25	46.25	92.90
9.	Range of ash (%)	27.2	39.8	29.6 to 46.4	21.9 to 42.5	33.2 to 33.3	31.3 to 46.7	32.0 to 39.9	27.9 to 35.0	36.8 to 43.2
10.	Range of moisture (%)	11.1	6.8	7.6 to 8.8	7.0 to 9.7	5.5 to 8.4	7.7 to 9.3	7.5 to 8.2	7.3 to 8.4	4.4 to 7.7
11.	Range of volatile matter (%)	-	27.0	21.7 to 25.2	22.2 to 24.3	24.7	23.4 to 24.6	24.2 to 25.0	25.2 to 26.3	22.5 to 24.2

4) *SEAM ZONE* – V (Table – 6; Plate – II to X) :

Seam zone V was encountered in boreholes AB – 4, 14, 6, 17, 18, 19, 2, 1, 15 and 5 in northern segment and AB – 10, 7, 12 and 13 in southern segment. In the northern segment, seam zone – V is combined with seam zone – IV in boreholes AB – 17, 19 and 5 in the extreme northern part revealing stable peat forming swamp condition over a longer period than other parts of the basin during deposition of these two seam zones. Boreholes AB – 17, 19 and 5 are not shown in Table – 6, because combined seam zone V + IV occur in these boreholes.

A) *Northern Segment* :

The seam zone – V is developed over seam zone – IV with a parting thickness ranging between 32.36 m. (AB – 6) and 40.93 m. (AB – 1). In borehole AB –14, as the seam zone – IV has not been developed, the seam zone – V is developed with a parting of 82.35 m. above seam zone – III.

Variation of zone thickness from 23.45 m. (AB – 14) to a maximum of 39.60 m. (AB – 15) has been observed from sub-surface database. The zone thickness increases strike-wise towards north.

It is a composite seam zone comprising 1 to 13 split sections of coal with individual split ranges in thickness from 0.10 m. to 12.93 m.

Cumulative thickness of coal content varies from 1.88 m. (AB – 14) to 16.25 m. (AB – 15). In deeper part, coal content is relatively higher than shallower portion of the basin.

The strike continuity of this zone – V is about 1.7 km. and dip-wise extension is 1.4 km.

The ash, moisture and volatile matter content of coals of seam zone – V varies between 21.4 % - 51.6 %, 3.9 % - 11.4 % and 21.3 % - 27.5 % respectively.

Coal of this zone is non-coking with high ash and medium volatile matter content and belongs to 'E' to 'G' grade.

B) *Southern Segment* :

With an interveining parting thickness of 20.45 m. (AB – 10) to 30.42 m. (AB – 7), the seam zone – V has been developed above the seam zone – IV in this segment.

Thickness of this zone varies from 25.48 m. (AB – 7) to a maximum of 41.80 m. (AB – 12). This multiseam coal zone contains 8 to 9 nos. of coal split. The thickness of individual coal split ranges between 0.10 m. and 7.75 m. The cumulative thickness of coal splits varies from 7.98 m. to 14.33 m. The thickness of coal split as well as cumulative coal content decreases strike-wise

towards west. In borehole AB – 13, zone – V is mainly represented by grey shale with thin carbonaceous shale bands and occasionally with interlamination of coal suggestive of deeper water depth in the swamp

The strike continuity and dip extension of this zone – V has been established over a distance of 1.5 km. and 0.8 km. respectively.

Ash, moisture and volatile matter content of coal of this zone varies from 27.1% - 44.3%, 6.7% - 9.7% and 22.2 % - 27.4 %. Coal of this zone is non-coking belonging to grade of 'E' to 'F'.

TABLE - 6

ZONE - V

Sl. No.		NORTHERN SEGMENT							SOUTHERN SEGMENT		
1	2	3	4	5	6	7	8	9	10	11	12
1.	**Borehole No. AB-**	**4**	**14**	**6**	**18**	**2**	**1**	**15**	**10**	**7**	**12**
2.	Depth range of seam zone (m)	21.55 to 49.50	19.00 to 42.45	26.45 to 58.00	194.60 to 223.05	290.15 to 320.32	235.91 to 266.40	310.70 to 350.30	27.60 to 65.95	130.40 to 155.88	182.20 to 224.00
3.	Thickness of seam zone (m)	27.95	23.45	31.55	28.45	30.17	30.49	39.60	38.35	25.48	41.80
4.	No. of split sections of coal	5	7	8	7	4	1	13	8	8	9
5.	Thickness range of split sections of coal (m)	0.10 to 5.79	0.20 to 1.10	0.15 to 3.65	0.16 to 4.25	0.30 to 12.93	-	0.20 to 6.80	0.25 to 7.50	0.10 to 7.75	0.20 to 1.40
6.	Cumulative thickness of split coal sections (m)	9.31	1.88	9.51	7.12	14.76	-	16.25	14.33	9.57	7.98
7.	Clean coal (m)	-	-	-	-	-	4.65	-	-	-	-
8.	Parting thickness between zone V and IV (m)	34.40	-	32.36	32.80	38.98	40.93	35.25	20.45	30.42	24.69
9.	Range of ash (%)	35.8 to 46.3	35.1 to 43.9	22.0 to 35.1	21.4 to 42.8	35.9 to 47.5	32.5	37.3 to 51.6	27.1 to 35.5	29.1 to 39.2	29.2 to 44.3
10.	Range of moisture (%)	7.1 to 8.1	7.9 to 8.9	7.9 to 9.1	8.9 to 11.4	7.3 to 7.7	8.9	3.9 to 8.8	7.4 to 9.3	6.7 to 8.9	6.8 to 9.7
11.	Range of volatile matter (%)	21.4 to 25.1	22.2	25.1 to 26.5	22.7 to 23.2	23.0 to 23.9	27.5	21.3 to 24.8	26.0 to 26.5	27.0	22.2 to 27.4

5) *SEAM ZONE – VI* (Table – 7, Plate – II to X) :

Coal seam zone – VI above seam zone – V is intersected in ten boreholes viz. AB – 18, 19, 2, 1, 15 and 5 in northern segment and boreholes AB – 7, 12 and 13 in southern segment of eastern part of the Banhardi sector. The seam zone – VI is also intersected in boreholes AB - 11 and 3 drilled in the western part of the Banhardi sector, covered by the rocks of Raniganj Formation. In borehole AB – 5, seam zone – VI is combined with seam zone – VII and has therefore not been shown in Table – 7.

A) *Northern Segment* :

The seam zone – VI is encountered above the seam zone – V with a parting thickness ranging between 27.21 m. (AB – 1) and 39.08 m. (AB – 15). The zone thickness varies from 32.00 m. (AB – 2) to 35.40 m. (AB – 18). About 2 to 15 coal sections developed in the seam zone – VI in this segment. Maximum number of split sections is recorded in boreholes AB – 18. The individual section varies in thickness from 0.08 m. (AB – 18) to a maximum of 7.75 m. (AB – 18). The cumulative coal content ranges from 0.87 m. (AB – 2) and 13.17 m. (AB – 18) in this segment. In boreholes AB – 1 and 2, carbonaceous shale content is relatively high than the cumulative coal content.

Based on this observation, it may be postulated that, due to increase of palaeo water depth, more carbonaceous shale sections are developed and thick coal sections along with more cumulative coal content indicate sustained stable peat forming swamps during the deposition of zone – VI.

The strike continuity of this zone for about 2.3 km. and dip extension for about 1 km. have been established. Coal in this zone is non-coking and analyses 31.3 % - 44.3 % ash, 7.1 % - 10.8 % moisture and 22.5 % - 45.1% volatile matter respectively. Coals in this zone belong to 'F' to 'G' grade.

B) *Southern Segment* :

With a parting range of 18.80 m. (AB – 13) to 23.60 m. (AB – 12) above seam zone – V, the seam zone – VI is developed in this segment. The thickness of this zone – VI varies from 34.45 m. to 42.00 m. reflecting that the zone thickness increases towards west.

This is a multiseam zone except in borehole AB – 12 where this zone is represented by a single very thick seam. Number of coal sections increases towards east. Individual coal section varies in thickness from 0.10 m. to 1.37 m. In AB – 13, instead of coal seam zone, it can be designated as grey shale zone because it is completely composed of grey shale with thin carbonaceous shale sections.

The aggregate coal content of 7.05 m. in AB – 7 increases to 36.55 m. in AB – 12. The detail study of this seam zone indicates that in AB – 7, coal seams were developed in repeated ephemeral swamp condition, whereas, excellent peat forming condition was maintained in the slowly subsiding basin during the deposition of seam zone – VI. But the development of grey shale zone in AB – 13 corresponding to this coal zone probably indicate greater palaeo-water depth leading to petrification of vegetal debris. Ash, moisture and volatile matter content of coal of this zone varies from 19.9 % - 48.3 %, 7.5 % - 9.3 % and 22.3 % - 27.2 % respectively.

Coal is non-coking and belongs to grade of 'E' to 'F'.

The strike continuity of this seam zone for about 1.4 km. and its dip-wise extension for about 600 m. have been established by depth probing.

In borehole AB – 11, although the seam zone thickness is 35.65 m., the cumulative coal content is only 4.15 m. disposed in five split sections ranging in thickness from 0.45 m. to 1.10 m. In borehole AB – 3, seam zone – VI has been partly intersected where the aggregate coal content is 13.29 m. having 4 split sections ranging in thickness from 0.45 m. – 11.60 m.

TABLE - 7

ZONE - VI

Sl. No.		NORTHERN SEGMENT					SOUTHERN SEGMENT		WESTERN PART	
1	2	3	4	5	6	7	8	9	10	11
1.	**Borehole No. AB-**	**18**	**19**	**2**	**1**	**15**	**7**	**12**	**11**	**3**
2.	Depth range of seam zone (m)	124.30 to 159.70	48.55 to 82.25	219.10 to 251.10	175.63 to 208.70	238.85 to 271.62	75.65 to 110.10	122.05 to 158.60	525.85 to 561.50	601.40 to 620.50
3.	Thickness of seam zone (m)	35.40	33.70	32.00	33.07	32.77	34.45	36.55	35.65	19.10
4.	No. of split sections of coal	15	6	2	4	9	14	1	5	4
5.	Thickness range of split sections of coal (m)	0.08 to 7.75	0.20 to 2.63	0.34 to 0.53	0.17 to 0.33	0.10 to 0.45	0.10 to 1.37	-	0.45 to 1.10	0.45 to 11.60
6.	Cumulative thickness of split coal sections (m)	13.17	4.33	0.87	1.02	2.13	7.05	-	4.15	13.29
7.	Clean coal (m)	-	-	-	-	-	-	36.55	-	-
8.	Parting thickness between zone VI and V (m)	34.90	27.75	39.05	27.21	39.08	20.30	23.60	-	-
9.	Range of ash (%)	31.3 to 42.1	44.3	-	-	-	19.9 to 48.3	38.1	31.9 to 40.4	24.5 to 37.1
10.	Range of moisture (%)	8.8 to 10.8	7.9	7.1	-	-	7.5 to 9.3	8.0	4.0 to 8.0	7.5 to 8.7
11.	Range of volatile matter (%)	22.5 to 26.4	22.9	45.1	-	-	22.3 to 27.2	24.6	22.6 to 24.5	26.1

6) *SEAM ZONE – VII* (Table – 8 and Plate – II to X) :

The coal seam zone – VII succeeds seam zone – VI with a parting thickness range of 20.05 m. to 43.80 m. and was recorded in boreholes AB – 18, 2, 1, 15 and 5 in northern segment and in AB – 7, 12 and 13 in southern segment of eastern part whereas, in the western part of this sector, this seam zone was intersected in borehole s AB – 3, 8, 11 and 16.

A) *Northern Segments* :

Seam zone – VII overlies seam zone – VI with parting thickness ranging from 20.70 m. (AB – 15) and 45.85 m. (AB – 1). In borehole AB – 5, seam zone – VII and VI are amalgamated to form a combined seam zone – VII + VI and has not shown in Table – 8.

The thickness of the seam zone varies from 38.90 m. (AB – 18) to a maximum of 50.65 m. (AB – 2) based on available sub-surface database. The maximum zone thickness is recorded in the west central part of the northern segment and the zone thickness generally is more or less uniform. This is a composite seam zone with 7 to 13 coal splits ranging in thickness from 0.10 m. to 10.70 m. In the northern portion of this segment, the thickness of coal split is more compare to the southern part of the segment.

The cumulative thickness of coal splits varies from 11.08 m. (AB – 1) to as much as 16.52 m. (AB – 2). The carbonaceous shale content is maximum in AB – 2 probably reflecting the fluctuation of palaeo-water depth in the peat forming swamp.

The strike continuity of this zone for about 2.4 km. and the dip extension of 1.9 km. have been established. Qualitatively, the ash, moisture and volatile matter content of the coal belong to this zone varies from 23.5 % - 43.3 %, 6.1 % - 11.7 % and 21.4 % - 30.3% respectively. The coal is non-coking, high ash and medium volatile in character and falls in 'D' to 'G' grade.

B) *Southern Segment* :

With a parting range of 21.60 m. (AB – 13) to 41.80 m. (AB –7) above the seam zone – VI, seam zone – VII is developed in this segment. The thickness of this zone varies from 33.85 m. (AB – 7) to 54.30 m. (AB – 12). It is a multi seam zone with a number of coal sections varying from 3 to 20. Individual coal split ranges in thickness from 0.20 m. to 8.95 m. The thickness of individual coal split increases strike-wise from east to west.

The cumulative coal content varies from 15.16 m. (AB – 12) to 23.08 m. (AB – 13) westward. The strike continuity of this zone is about 2.0 km. and the dip extension for about 0.5 km. have been established from sub-surface database.

Coal is non-coking having medium to high ash (18.2 % - 42.3 %), high moisture (5 % - 11.2

%) and high volatile matter (23.4 % - 28.7 %) and falls in the grade of 'E' to 'G'.

In the western part of the Banhardi sector, this seam zone – VII has been intersected in AB – 3, 8, 11 and 16 and succeeds zone – VI with a parting thickness ranges from 20.05 m. to 43.80 m. The zone thickness varies from 34.65 m. (AB – 3) to a maximum of 55.85 m. (AB – 16). The number of coal splits varies from 3 to 10 with individual coal split ranges in thickness from 0.10 m. to 7.65 m. The cumulative thickness of coal splits varies from 1.80 m. to 14.48 m.

Qualitatively, the coal is non-coking with 21.0 % - 46.7 % ash, 5.0 % - 10.8 % moisture and 22.2 % - 28.0 % volatile matter content and belongs to grade 'D' to 'G'.

TABLE - 8

ZONE - VII

Sl. No.		NORTHERN SEGMENT				SOUTHERN SEGMENT			WESTERN PART SECTOR			
1	2	3	4	5	6	7	8	9	10	11	12	13
1.	**Borehole No. AB-**	**18**	**2**	**1**	**15**	**7**	**12**	**13**	**3**	**8**	**11**	**16**
2.	Depth range of seam zone (m)	55.45 to 94.35	135.10 to 185.75	88.50 to 129.78	176.90 to 218.15	0.00 to 33.85	39.80 to 94.10	117.25 to 163.90	546.70 to 581.35	517.45 to 534.00	433.35 to 482.05	406.00 to 461.85
3.	Thickness of seam zone (m)	38.90	50.65	41.28	41.25	33.85 (Truncated)	54.30	46.65	34.65	16.55 (Truncated)	48.70	55.85
4.	No. of split sections of coal	12	7	8	13	3	18	20	5	3	10	4
5.	Thickness range of split sections of coal (m)	0.10 to 8.15	0.40 to 4.33	0.16 to 6.94	0.15 to 7.50	0.25 to 0.45	0.20 to 2.55	0.20 to 8.95	0.15 to 1.40	0.40 to 1.00	0.17 to 5.42	0.10 to 7.65
6.	Cumulative thickness of split coal sections (m)	14.75	16.52	11.08	13.42	0.95	15.16	23.08	2.62	1.80	14.48	8.50
7.	Clean coal (m)	-	-	-	-	-	-	-	-	-	-	-
8.	Parting thickness between zone VII and VI (m)	30.10	33.35	45.85	20.70	41.80	27.95	21.60	20.05	-	43.80	-
9.	Range of ash (%)	26.0 to 32.4	23.5 to 40.2	27.0 to 39.7	25.9 to 39.5	-	18.2 to 42.3	24.7 to 40.2	21.0 to 23.5	32.3	32.6 to 46.7	-
10.	Range of moisture (%)	10.9 to 11.7	7.9 to 9.7	6.5 to 9.2	6.1 to 9.1	-	5.0 to 8.2	9.4 to 11.2	9.8 to 10.8	9.1	5.0 to 8.2	-
11.	Range of volatile matter (%)	26.1 to 28.5	23.8 to 30.3	29.4 to 29.6	24.6 to 27.3	-	23.7 to 25.6	23.4 to 28.7	28.0	26.6	22.2 to 24.1	-

7) *SEAM ZONE – VIII* (Table – 9, Plate – II to X) :

Seam zone – VIII is the topmost Barakar seam zone encountered in boreholes AB – 15 and 5 in northern segment and in AB – 3, 8, 11 and 16 in the western part of the Banhardi sector, where surface is occupied by Raniganj Formation.

A) *Northern Segment* :

The zone overlies the seam zone – VII with a parting thickness ranging from 146.95 m. (AB – 15) to 157.20 m. (AB – 5). The zone thickness varies from over 29.95 m. (truncated) in AB – 15 to 54.90 m. in AB – 5. This seam zone – VIII comprises 7 split sections of coal and individual coal section varies in thickness from 0.15 m. to 4.75 m.

The cumulative thickness of coal splits varies 6.90 m. in AB – 15 to 9.95 m. in AB – 5 indicating increase of coal thickness towards north. The strike continuity of this zone is approximately 2.8 km. and its dip extension has been established over a distance of about 1.3 km.

Coal, in this zone, analyses 29.2 % - 47.1 % ash, 7.8 % - 10.6 % moisture and 21.3 % - 26.2 % volatile matter. The coal is non-coking power grade and falls under 'D' to 'G' grade.

B) *Western part of Banhardi sector* :

In this part, the seam zone – VIII is encountered above the seam zone – VII with a parting range of 151.65 m. to 169.46 m. The thickness of seam zone varies from 37.10 m. (AB – 16) to a maximum of 58.20 m. (AB – 11). This zone contains 5 to 16 coal splits with thickness variation of individual coal split ranges from 0.15 m. to as much as 11.75 m. The cumulative coal thickness varies from 3.27 m. to 18.99 m. The maximum coal content occurs in borehole AB – 11. It is observed that, towards north, thick coal seams are developed relative to the south and west.

The strike continuity of this zone in this part has been established over a distance of about 4.5 km. and dip extension has been proved for a distance of over 1.4 km.

The ash, moisture and volatile matter content of coal in this seam zone vary from 19.4 % - 46.2 %, 7 % - 11.1 % and 22.1 % - 30.9 % respectively. Coal in general is of inferior power grade and falls under 'D' to 'G' grade.

TABLE - 9

ZONE - VIII

Sl. No.		NORTHERN SEGMENT		WESTERN PART OF SECTOR			
1	2	3	4	5	6	7	8
1.	**Borehole No. AB-**	**15**	**5**	**3**	**8**	**11**	**16**
2.	Depth range of seam zone (m)	0.00 to 29.95	20.00 to 74.90	326.68 to 377.24	316.80 to 365.65	223.50 to 281.70	210.50 to 247.60
3.	Thickness of seam zone (m)	29.95 (Truncated)	54.90	50.56	48.85	58.20	37.10
4.	No. of split sections of coal	7	7	5	11	14	16
5.	Thickness range of split sections of coal (m)	0.15 to 4.75	0.20 to 4.30	0.16 to 1.15	0.20 to 10.25	0.15 to 11.75	0.15 to 0.70
6.	Cumulative thickness of split coal sections (m)	6.90	9.95	3.27	18.62	18.99	5.00
7.	Clean coal (m.)	-	-	-	-	-	-
8.	Parting thickness between zone VIII and VII (m)	146.95	157.20	169.46	151.85	151.65	158.40
9.	Range of ash (%)	29.2 to 47.1	31.7 to 41.2	30.8 to 46.2	19.4 to 38.1	27.7 to 43.2	30.1
10.	Range of moisture (%)	7.8 to 10.60	8.4 to 9.5	8.5 to 9.6	8.1 to 11.1	7.0 to 10.7	7.9
11.	Range of volatile matter (%)	21.3 to 26.0	23.2 to 26.2	22.1 to 25.5	23.7 to 30.9	24.0 to 28.8	-

IV. QUALITY OF COAL SEAMS

The borehole coal cores were analysed band -by -band as well as overall in some selected sections in the Coal Survey Laboratory of Central Fuel Research Institute at Ranchi. By and large, the coal in Banhardi sector contains high ash, high moisture and medium to high volatile.

The ash, moisture, volatile matter and fixed carbon of different coal bands lie in the range of 18.0 % - 51.6 %, 3.9 % - 11.7 %, 20.1 % - 32.3 % and 22.2 % - 42.0 % respectively.

V. RESERVES

Reserve of coal from Banhardi block, Auranga Coalfield has been estimated as per Standard Procedure modified in 1987. Reserve worked out from regional exploration is classified into 'Indicated' and 'Inferred' categories over the influence areas of 1,000m and 1,000m - 2,000m around observation points (boreholes / outcrop) respectively unless limited by the block boundary. The reserves are estimated depth-wise (0-300m, 300m-600m and 600m-1200m), borehole-wise and seam-wise.

In evaluation of reserves from regional exploration, 'In-band' thickness of coal seams is considered. The 'In-band' thickness is computed by excluding (i) all non-combustible bands (with ash+moisture content more than 75%), and (ii) all combustible bands, 0.3m and above, with ash+moisture content exceeding 55%, from the thickness of the coal seams. Reserves are estimated for coal seams having 'In-band' thickness of 0.9m and above for superior quality (Gr.A, B and C) while for inferior coal (Gr. D - G) 1.2m and above thickness is taken into consideration.

Qualitatively non-coking coals are classified into grades separately. The grading is done on the basis of Proximate Analysis of coal seams (determined / calculated average). The specifications of different grades in non-coking coals are tabulated with the effective sp.gr. for being taken as tonnage multiplier in the metric system.

Grade	Ash+Moisture%	UHV(k.cal/kg)	Sp.gr.
A	up to 20%	up to 6200	1.42
B	>20% - 24%	5600 - <6200	1.45
C	>24% - 29%	4940 - <5600	1.50
D	>29% - 34%	4200 - <4950	1.55
E	>34% - 40%	3360 - <4200	1.60
F	>40% - 47%	2400 - <3360	1.68
G	>47% - 55%	1300 - <2400	1.76

10% of reserve are deducted to arrive at "Net" reserve figure to account for unknown factors such as heave zones of faults, washout , dykes etc.

The areas falling under different depths, thickness and influence zones are measured and the tonnage are calculated as per the formula:

Tonnage (m.tonnes) = Area (sq.km) x Thickness (m) x Sp.gr

Assumptions:

i) Continuity of the coal seams in the peripheral part up to the geological or block boundaries, as the cases may be, from the control points.

ii) Uniformity of variation in thickness and quality of the coal seams throughout the area of influence, from the control points of physical sampling and spot values.

Limitations:

i) The estimation of reserve is dependent on the accuracy of the borehole locations and topographical surveys.

ii) Possibility of creeping of errors in the final adjustments of core thickness in case of poor core recovery.

iii) In case of smaller diameter core barrel there may be poor recovery due to kerfing, depending on rock competency for which the analysed coal quality may develop element of inadvertent errors.

iv) Realistic reserve estimate is beset with personal factor in analysing the chemical parameters.

v) Planar and sectional measurements could have minor omissions and commissions due to weathering and shrinkage of paper, howsoever good in quality.

The confidence level of reserve estimates is dependent on the density of the data points. However, it has been found that the joint overall probability of assurance of quality, tonnage and structure is $P > 0.5$ for "Indicated" and $P < 0.5$ for "Inferred" categories of reserves, viz. corresponding to assurance of +95% and -95%.

In the above area, depth-wise, borehole-wise, seam-wise, grade-wise and categorised reserves were estimated.

The band-by-band proximate analysis of coal seams were obtained from Coal Survey Laboratory of CFRI, Ranchi. These data were collated and computed for Ash%, Moisture%, Useful heat value in Kcal/kg and average grade on weighted average basis and are given in Appendix-IV.

Statistical Analysis :

Statistical analysis of tonnage estimates alongside thickness and raw chemical data of the regional coal seams, have been carried out for evaluating the confidence interval on the overall estimations of grades and reserves of coal in this regionally explored block with a fairly satisfactory sample size. In carrying out statistical test, the normality of distribution has been assumed with

unknown population mean (∝) and standard deviation (σ) and hence this σ is taken as nearly coincident with sample statistic standard deviation (s).

The S.E (Standard Error) of estimation is given as ± (t · s)/√n which is an extension of ∝= □x ± (t x s)/√n, where s = standard deviation and n = sample size and t is the Students's 't' taken as 1 with fiducian level of about 68% considered fair enough for the work.

The different statistical parameters in respect of different seams are tabulated below:

Seam Name	Av.thickness in m. (□x)	sample size (n)	s.d (s)	Error of estimate	Error% of thickness
VIII	9.6	4	±05.937	±2.968	± 31
VII	10.5	8	±03.081	±1.089	± 10
VI	10.8	5	±12.734	±5.695	± 53
V	7.3	9	±03.732	±1.244	± 17
IV+V	13.3	3	±03.774	±2.178	± 08
IV	7.7	7	±02.624	±0.992	± 13
III	23.1	11	±12.633	±3.809	± 16
II	25.7	7	±12.076	±4.564	± 18

Employing the same statistics, the quality in terms of (Ash + Moisture)% of coal for different regional coal seams have been determined and the results are as follows:

Seam Name	Av. (A +M)% □x	Sample size (n)	s.d (s)	Error of estimate	Error %
VIII	38.6	99	±3.784	±0.380	±1
VII	39.2	193	±4.001	±0.287	±1
VI	42.5	154	±6.004	±0.483	±1
V	42.5	200	±4.173	±0.295	±1
IV+V	47.9	102	±3.557	±0.352	±0.7
IV	42.0	216	±2.882	±0.196	±0.5
III	35.9	461	±2.798	±0.130	±0.5
II	38.4	451	±2.323	±0.109	±0.5

Discussions:

It is discernible that the error % of thickness estimates for the seams is moderately significant generally lying in the range of ± 8% to ± 18% which implies significant variation in thickness while for Seam Zone- VIII and VI, error% of thickness variation is appreciably high (31% - 53%)which is ascribed to truncation (B.H. No.AB-15, AB-7 & AB-19) and erratic development of the seam zones.

As regards variation in grade, it has been found that percentage of error is insignificant i.e.1 to 0.5 % . The depth-wise summarised reserve (in million tonnes) is as follows:

Depth Range (m)	Indicated	Inferred	Total	Grand Total
0 - 300	467.44	2.99	470.43	
300 - 600	349.35	29.92	379.27	**920.39**
600 - 1200	33.42	37.27	70.69	

Additional check :

As an effort to compare the tonnages by more than one methods, the exercise was carried out and the result are as under :

Method	Reserve (m.tonne)	Mean	s.d (σ)	Error of estimate	% of Error of estimate
Conventional method	920.39				
Av. thickness-Actual grade-Actual influence area	910.41				
Av. thickness-Av. grade- Actual influence area	910.81	913.97	± 4.617	± 2.308	± 0.25
Actual thickness- Av. grade- Actual influence area	914.25				

This corroborates satisfactorily to the computations and error estimates for justifying the ultimate categorisation by the conventional method. The details of depth-wise, borehole-wise, grade-wise and category-wise reserves is given in APPENDIX--VII

VI. GEOPHYSICAL LOGGING

The geophysical logging comprising 'Resistance', 'SP Log' and 'Natural log' were carried out in borehole AB – 2 in the Banhardi sector up to a depth of 380 m. In this borehole several coal, carbonaceous shale and grey shale horizons are deciphered as per geological logging and are recorded in geophysical log data (Appendix – VIII).

The geophysical logs employing point resistance, self-potential, natural Gamma and Neutorn were recorded in borehole AB – 5 up to a depth of 399.30 m. in this sector. Form the correlation of self-potential, point resistance, Neutron and Natural Gamma logs, several zones of coal, shaly coal, carbonaceous shale and grey shale have been deciphered which more or less corroborate with the lithological logging (Appendix – VIII).

In borehole AB – 8, geophysical logging comprising Point resistance, Self Potential and Natural Gamma were carried out up to a depth of 370 m. against the drilled depth of 400 m. Several high resistive zones, together with supportive self potential and Natural Gamma anomalies are recorded in the geophysical log data (Appendix – VIII) which have indicated the zones of mainly grey shale and few coal with carbonaceous shale intercalation.

Geophysical logs comprising Point resistance, Natural Gamma and Neutron curves were measured to the depth of 390 m., 325 m. and 477 m. respectively in the borehole AB – 11. Five high resistive zones have been deciphered and recorded in the geophysical log data (Appendix – VIII), which correspond to coal, carbonaceous shale and grey shale horizons from lithological logging.

In borehole AB – 18, geophysical logs measuring self-potential, Point resistance, Natural Gamma and Neutron were carried out up to a depth of 388 m. About 16 high resistive zones together with supportive self –potential, Natural Gamma and Neutron log could be deciphered which correspond to coal and shaly coal horizons (Appendix – VIII).

VII. ENVIRONMENTAL ASPECTS AND MINING

The goal of the ecologically sustainable development is to achieve the development of total quality of life both at present and in the future. The society now expects that in each resource sector, high standard environmental management is to be applied. Successful environmental management in the natural resource sector is dependent on recognising and avoiding or minimising environmental hazards.

The availability of substantial coal resources in the Banhardi sector of Auranga coalfield, Bihar would accelerate the development of open cast coal mining projects and various coal based industries in near future which are likely to aggravate geo-environment of the area covered with tree plantation, agricultural land, open grazing grounds. This adversely affect the ecosystem and also the habitation mostly tribal communities whose livelihood is dependent on agriculture and forest based occupation in the area need to be addressed for best environmental management while planning and designing a mine lay out are as follows.

A) *RURAL SETTLEMENT* :

The first management principle is to rehabilitate people to displaced from the proposed mining area.

B) *REHABILITATION* :

It is the process by which the land to be defaced by open cast mining , is to be reclaimed and afforested so that the land is restored for supporting subsistence. Open cast mining projects entail ground morphometric change dotted with man-made excavations and mounds of overburden rocks. Besides, the voids, created by underground coal mining also cause environmental hazards due to subsidence. So the mined areas are to be back filled. Rehabilitated landforms developed, should be visually and environmentally compatible with surrounding low lands and foot hills. Rehabilitation strategy should include establishment of grazing grounds.

C) *WATER MANAGEMENT* :

In coal mining areas, huge gallons of coal mine water containing dissolved solids, suspended solids, some oils and often ammonia is also pumped into river every day. In most of the areas there is a great shortage of water and there is no other alternative but to use this waste water of mines. Hence, it is desirable that the exploiting agencies, before initiation of mining are to carry out a detailed study of mine water quality to highlight inimical chemical pollutants for undertaking suitable treatment measure for improving the quality of water. Mine dewatering and drainage system are to be designed properly to ensure that the mine water does not pollute the water system of the area. However the effluent water from coal mines and other coal processing industries can be controlled without much difficulty. Similarly by systematising the coal extraction the impact on ground water may be reduced.

Special attention may be paid to supply safe and potable water for mine workers and general population in and around the area.

D) *NOISE AND DUST IMPACTS* :

The virgin area like this sector is practically free of noise which is bound to be disturbed with the advent of mining activities involving heavy machinaries in mines and washeries etc. Almost all the machines used in mines produce noise beyond tolerance limit when they are in action.

The dust fall in coal mining areas varies from place to place and also season to season and it is high in summer months due to high wind velocity.

The neighbouring villages and rural properties are to be affected by the impact of noise and dust pollution. The coal mining management is to assess noise and dust impacts and put practical controls on the project design. At the same times efforts should be made to make the machinaries as noiseless as possible.

E) *FLORA AND FAUNA* :

Premining investigation related to the survey of existing flora and fauna, would provide a database for management of flora and fauna.

After exploration of coal resources, mine areas which were once replite with vegetations and fauna are left beroft causing scanty precipitation and excessive soil erosion.

So the individual species of flora and fauna can be identified separately so that the loss of flora and fauna can be monitored properly and the practical system of management has to be evolved.

F) ***SOCIAL IMPACT*** :

In mining areas, excavation, overburden heaves, land subsidence and the fire due to spontaneous combustion of coal cause considerable loss to property. Communication gets snapped in several places due to subsidence of railway lines and roads. The fire, besides, causing damage to coal also damages vast stretches of lands, buildings and roads. Gas, dust and combustible material not only pollute the atmosphere but also claim considerable lives.

Mining organisations are often involved in conflicts with local people regarding acquisition of land and compensation. Many of these conflicts can be effectively managed by convincing and persuading the villagers by taking up welfare measure for communities and providing suitable compensation.

VIII. SUMMARY AND CONCLUSION

The regional exploration in Banhardi sector in the eastern part of the Auranga Coalfield, Bihar has been completed after drilling of 19 boreholes. The results obtained from analysis and interpretation of sub-surface data from these boreholes, have been summarised below .

A) The thickness of Barakar Formation accrued from the boreholes drilled in the northern and southern segments of the eastern part and western part of this sector is 503.20 m., 520.90 m. and 404.00m. respectively. But the maximum thickness is estimated to be of 790 m. The Raniganj Formation of 269.50 m. in thickness has been recorded in boreholes drilled in the western part of the sector, while the maximum true thickness is about 300 m. The Talchirs and Metamorphics of maximum 11.20 m. and 5.30 m. respectively have been encountered in the boreholes drilled in this sector.

B) From the available sub-surface data, it is found that coal – non-coal ratio for Barakar Formation in the northern segment of the eastern part of this sector decreases from about 1 : 5 in the east to 1 : 10 in the west i.e. towards dip.

In the southern segment of the eastern part, that ratio decreases from about 1 : 5 in the east to 1 : 10 in the west along strike. In the western part of Banhardi sector, the coal – non-coal ratio ranges between 1 : 19 in the east and 1 : 28 in the west strike-wise.

C) The existence and continuity of the seven regionally persistent coal seam zones (II to VIII) have been established over a strike length of about 2.8 km. in the northern segment and about 2.3 km. (except seam zones IV to VIII) in the southern segment of the eastern part of Banhardi sector, while for seam zones IV to VI in the southern segment strike length has been established over a distance of 1.4 km.

D) The seven coal seam zones (II to VIII) in Barakar Formation have been developed in the eastern part of the sector, while the topmost seam zone – VIII has not been developed in the southern segment of eastern part of the sector.

These coal seam zones continue through out the eastern part of the sector with variation in zone thickness, cumulative coal content and inter seam-zone partings, which is mainly due to splitting, merging and unequal development of the coal seams in the different parts of the basin.

These seam zones are composite in nature having several split sections of coal and carbonaceous shale. In the northern segment, seam zones IV and V and seam zones VI and VII occur as combined seam zones with a thin interveining parting

E) The splitting of the coal seams with sandstone interbands is quite common in this sector signifying intermittent rapid subsidence and stable peat forming swamp condition in the basin.

The coalescing of the seam zones in certain part of this sector probably indicates sustained peat swamp condition over a longer period than in other parts of the basin

In the western part of southern segment significant facies change degenerating coal facies to carbonaceous shale cum grey shale facies has been documented and this may be ascribed to greater Palaeo water depth. Coal in different seam zones in Barakar lithic-fill in this sector shows variation of ash, moisture, volatile matter and fixed carbon content in the range of 18 % - 51.6 %, 3.9 % - 11.7 %, 20.1 % - 32.3 % and 22.2 % - 42 % respectively and generally belongs to the grades 'C' to 'G'. Coal is high ash, medium to high volatile and non-coking in character.

F) A 'nett' reserves of 920.39 million tonnes of coal of 'C' to 'G' category (I. S. P.) has been estimated for seven regionally persistent coal seam zones (II to VIII) over 18 sq. km. area in this virgin sector. Of the total reserve, 467.44 m. tonnes, 349.35 m. tonnes and 33.42 m. tonnes belong to the 'Indicated' category in the depth ranges of 0 – 300 m., 300 – 600 m. and 600 – 1200 m. respectively, while the corresponding figures for coal of 'Inferred' category are 2.99 m. tonnes, 29.92 m. tonnes and 37.27 m. tonnes.

All the seam zones have multiseam quarriable prospect in the eastern part, seam zones – II and III in particular.

G) Geophysical logs employing point resistance, self potential, natural gamma, neutron were carried out in the boreholes AB – 2, 5, 8, 11 and 18 drilled in this sector and several high resistive zones have been recorded which corresponds well with coal, grey shale and carbonaceous shale horizons of lithological log.

H) Talchir Formation is not exposed in this sector but in some boreholes, sediments of Talchir Formation have been intersected and in only one borehole, Barakar sediments directly overlie the basement metamorphics with a faulted contact. This is probably due to the sporadic and lenticular development of Talchir sediments.

In the post Talchir period, basin deformation took place with development of a few border faults and intra-basinal normal faults.

Sedimentological studies of Barakar lithic sequence have been brought out the following observations :

Barakar lithic-fill displayes several complete and incomplete fining upward sequence. Each sequence commonly starts with very coarse grained to pebbly sandstone with trough cross-bedding overlain by medium to fine grained planer cross-bedded sandstone, shaly sandstone, sandy shale, shale, siltstone, shale-silstone intercalation, siltstone, carbonaceous shale and ends in coal. However each cycle may not be represented by all the lithic units due to variation in the depositional environment, there may be either top truncation or basal truncation.

The fining upward cycle was due to shifting of river channel. With the shifting of the rivers, major parts of depositional provinces were transformed into back swamp areas which were the sites for coal seam development. However, it may be postulated that, during the deposition of the Barakar Formation there were probably rhythmic variation in the rate of subsidence.

However, it may be postulated that, in the distal braided environmental set up, due to concomitant subsidence vertical accretion of sediment cycles took place. Slow and controlled syn-depositional subsidence, keeping pace with the accumulation of vegetal debris gave rise to ideal condition for peat accretion in this sector. Palaeo-depositional environment of the peat swamp were mostly controlled by the variation in water level and type of vegetation.

The newly found potential coal resource in this virgin part of Auranga Coalfield could open up possibilities of industrialisation and economic development

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IX. LOCALITY INDEX

LOCATION	LATITUDE	LONGITUDE
Banhardi	23°45′00″	84°37′45″
Borha	23°45′30″	84°35′41″
Chatesemar	23°43′58″	84°38′46″
Daria	23°44′52″	84°39′15″
Huchhu	23°44′00″	84°38′25″
Jamuntoli	23°44′00″	84°40′03″
Kojram	23°45′28″	84°36′11″
Pathaltoli	23°45′01″	84°37′10″
Rampur	23°43′44″	84°39′39″
Shantipur	23°44′32″	84°37′20″
Sikni	23°45′10″	84°36′08″
Surli	23°44′34″	84°39′08″
Syani	23°44′18″	84°38′22″
Tewrahi	23°43′33″	84°37′43″

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GEOLOGICAL SURVEY OF INDIA

CORRELATION OF REGIONAL COALSEAM ZONES IN BARAKAR FORMATION AND OTHER BOREHOLE DETALS IN BANHARDI SECTOR, AURANGA COALFIELD, BIHAR

APPENDIX - IA

BORE HOLE NO:-	AB-1	AB-2	AB-3	AB-4	AB-5	AB-6	AB-7	AB-8	AB-9	AB-10	AB-11
LATITUDE	23° 44' 42"	23° 44' 11"	23° 44' 28"	23° 44' 17"	23° 44' 53"	23° 44' 44"	23° 43' 59"	23° 45' 00"	23° 43' 56"	23° 44' 09"	23° 45' 20"
LONGITUDE	84° 37' 55"	84° 38' 15"	84° 37' 16"	84° 38' 45"	84° 37' 53"	84° 38' 27"	84° 39' 06"	84° 36' 53"	84° 39' 34"	84° 39' 08"	84° 36' 50"
R.L OF BORE HOLE	439·50 m	432·67 m	425·61 m	440·31 m	431·27 m	432·50 m	441·96 m	415·49 m	456·69 m	448·38 m	419·39 m.
COMMENCED ON	14·6·1989	13·11·1989	20·8·1990	28·5·1991	23·8·1991	8·9·1991	4·12·1991	12·2·1992	20·2·1992	23·5·1992	16·3·1993
COMPLETED ON	13·6·1990	2·5·1991	27·7·1991	10·8·1991	28·1·1992	21·11·1991	2·2·1992	20·7·1992	4·5·1992	27·7·1992	5·1·1994
TOTAL DEPTH	500·00 m	503·20 m	630·00 m	383·20 m	488·50 m	377·00 m	430·15 m	534·00 m	352·00 m	278·00 m	564·00 m
DEPTH OF WATER TABLE FROM SURFACE	—	—	—	—	18·00 m	7·50 m 38·00 m	—	—	—	7·00 m	—
DEPTH OF RANIGANJ/ BARAKAR FORMATION CONTACT FROM SURFACE.	—	—	269·80 m	—	—	—	—	257·70 m	—	—	160·00 m
PARTING	—	—	56·88 m	—	20·00 m.	—	—	59·10 m	—	—	63·50 m
SEAM ZONE VIII (Details of Coal/Carb Shale Sections)	—	—	326·68 – 377·24 = 50·56 m Roof depth (m) / Thickness (m) 326·68 — 3·80 (c·sh) 330·48 — 1·12 (c) 331·60 — 4·00 (c·sh) 363·47 — 1·15 (c) 376·60 — 0·64 (c)	—	20·00 m – 74·90 m = 54·90 m Roof depth (m) / Thickness (m) 20·00 — 0·40 (c·sh) 23·90 — 1·20 (c) 25·10 — 1·00 (c·sh) 24·10 — 1·15 (c) 37·35 — 1·40 (c) 44·95 — 4·35 (c) 73·50 — 1·40 (c)	—	—	316·80 – 365·65 = 48·85 m Roof depth (m) / Thickness (m) 316·80 — 3·95 (c) 340·80 — 0·60 (c) 345·90 — 1·20 (c) 352·45 — 10·25 (c) 365·00 — 0·65 (c)	—	—	223·50 m – 281·70 m = 58·20 m Roof depth (m) / Thickness (m) 223·50 — 0·40 (c) 247·84 — 0·56 (c) 263·05 — 2·85 (c) 267·65 — 11·75 (c) 281·02 — 0·68 (c)
PARTING	88·50 m	135·10 m	169·46 m	—	157·20 m	—	—	151·80 m	—	—	151·65 m
SEAM ZONE VII (Details of Coal/Carb Shale Sections)	88·50 – 129·78 = 41·28 m Roof depth (m) / Thickness (m) 88·50 — 0·28 (c·sh) 88·78 — 2·48 (c) 105·02 — 6·94 (c) 120·78 — 0·87 (c) 124·78 — 3·00 (c·sh)	135·10 – 185·75 = 50·65 m Roof depth (m) / Thickness (m) 135·10 — 0·10 (c·sh) 135·20 — 2·25 (c) 137·45 — 3·52 (c·sh) 140·97 — 4·00 (c) 144·97 — 3·95 (c·sh) 151·92 — 1·10 (c)	546·70 – 581·35 = 34·65 m Roof depth (m) / Thickness (m) 546·70 — 0·20 (c·sh) 546·90 — 1·40 (c) 581·00 — 0·35 (c)	—	232·10 – 315·25 = 83·15 m Roof depth (m) / Thickness (m) 232·10 — 0·12 (c·sh) 232·22 — 3·28 (c) 238·10 — 0·85 (c) 253·05 — 2·20 (c) 264·70 — 10·70 (c) 276·60 — 0·70 (c) 289·39 — 0·91 (c) 303·20 — 0·70 (c) 312·65 — 2·60 (c)	—	0·00 m – 33·85 m = 33·85 m Roof depth (m) / Thickness (m) 16·75 — 0·25 (c·sh) 33·40 — 0·45 (c)	517·45 – 534·00 = 16·55 m Roof depth (m) / Thickness (m) 517·45 — 1·00 (c) 531·25 — 0·40 (c)	—	—	433·35 m – 482·05 m = 48·70 m Roof depth (m) / Thickness (m) 433·35 — 0·70 (c) 436·40 — 1·85 (c) 453·40 — 3·85 (c) 469·90 — 5·42 (c) 475·31 — 1·28 (c·sh) 480·73 — 1·32 (c)
PARTING	45·85 m	33·35 m	20·05 m	—	—	—	41·80 m	—	—	—	43·80 m
SEAM ZONE VI (Details of Coal/Carb Shale Sections)	175·63 m – 208·70 m = 33·07 m Roof depth (m) / Thickness (m) 175·63 — 2·65 (c·sh) 185·30 — 5·50 (c·sh) 198·89 — 1·16 (c·sh) 208·57 — 0·33 (c)	219·10 – 251·10 m = 32·00 m Roof depth (m) / Thickness (m) 219·10 — 0·37 (c·sh) 219·47 — 0·53 (c) 225·80 — 1·82 (c·sh) 248·10 — 3·00 (c·sh)	601·40 m – 620·50 m = 19·10 m Roof depth (m) / Thickness (m) 601·40 — 11·60 (c) 616·26 — 1·24 (c) 617·50 — 3·00 (c·sh)	—	—	—	75·65 m – 110·10 m = 34·45 m Roof depth (m) / Thickness (m) 75·65 — 0·25 (c) 89·25 — 0·85 (c) 90·90 — 1·37 (c) 97·50 — 1·10 (c) 105·60 — 1·20 (c) 109·75 — 0·35 (c)	—	—	—	525·85 m – 561·50 m = 35·65 m Roof depth (m) / Thickness (m) 525·85 — 0·90 (c) 535·50 — 1·10 (c) 537·05 — 0·90 (c) 560·70 — 0·80 (c)
PARTING	27·21 m	39·05 m	9·50 m	21·55 m	31·15 m	26·45 m	20·30 m	—	—	27·60 m	
SEAM ZONE V (Details of Coal/Carb Shale Sections)	235·91 m – 266·40 m = 30·49 m Roof depth (m) / Thickness (m) 235·91 — 0·99 (c·sh) 236·90 — 4·65 (c) 243·37 — 2·19 (c·sh) 245·90 — 2·50 (c)	290·15 m – 320·32 m = 30·17 m Roof depth (m) / Thickness (m) 290·15 — 12·93 (c) 304·10 — 0·75 (c·sh) 308·60 — 1·30 (c·sh) 317·80 — 1·74 (c·sh) 319·54 — 0·78 (c)	—	21·55 m – 49·50 m = 27·95 m Roof depth (m) / Thickness (m) 21·55 — 0·66 (c·sh) 22·21 — 5·79 (c) 42·70 — 0·50 (c) 47·05 — 2·45 (c)	346·40 m – 447·00 m = 100·60 m Roof depth (m) / Thickness (m) 346·40 — 0·50 (c) 376·46 — 1·50 (c) 411·40 — 0·50 (c) 414·08 — 2·37 (c) 417·35 — 0·70 (c) 419·30 — 0·92 (c) 424·70 — 8·80 (c) 434·85 — 1·50 (c) 436·70 — 8·40 (c) 446·29 — 0·71 (c)	26·45 m – 58·00 m = 31·55 m Roof depth (m) / Thickness (m) 26·45 — 0·55 (c) 28·35 — 3·65 (c) 47·87 — 1·89 (c) 53·70 — 2·77 (c) 57·85 — 0·15 (c)	130·40 m – 155·88 m = 25·48 m Roof depth (m) / Thickness (m) 130·40 — 0·60 (c·sh) 131·00 — 7·75 (c) 138·78 — 0·25 (c) 139·03 — 0·25 (c)	—	—	27·60 m – 65·95 m = 38·35 m Roof depth (m) / Thickness (m) 27·60 — 0·40 (c) 28·40 — 0·65 (c) 34·20 — 4·40 (c) 41·40 — 7·50 (c) 50·90 — 0·60 (c) 65·70 — 0·25 (c)	
PARTING	40·93 m	38·98 m	—	34·40 m		32·36 m	30·42 m	—	—	20·45 m	—
SEAM ZONE IV (Details of Coal/Carb Shale Sections)	307·33 m – 341·20 m = 33·87 m Roof depth (m) / Thickness (m) 307·33 — 0·27 (c) 308·87 — 0·85 (c) 315·70 — 4·13 (c) 336·13 — 2·00 (c·sh) 338·83 — 2·37 (c·sh)	359·30 m – 400·21 m = 40·91 m Roof depth (m) / Thickness (m) 359·30 — 0·40 (c·sh) 362·95 — 4·19 (c) 367·85 — 3·00 (c) 386·85 — 1·10 (c·sh) 387·95 — 1·02 (c) 399·51 — 0·70 (c)	—	83·90 m – 110·55 m = 26·65 m Roof depth (m) / Thickness (m) 83·90 — 0·15 (c) 100·52 — 0·63 (c) 110·45 — 0·10 (c)		90·36 m – 128·00 m = 37·64 m Roof depth (m) / Thickness (m) 90·36 — 0·10 (c) 127·05 — 0·95 (c)	186·30 m – 234·80 m = 48·50 m Roof depth (m) / Thickness (m) 186·30 — 0·12 (c·sh) 186·42 — 5·76 (c) 196·00 — 0·85 (c) 197·85 — 1·00 (c) 199·95 — 1·95 (c) 226·10 — 3·35 (c) 234·70 — 0·10 (c)	—	—	86·40 m – 133·70 m = 47·30 m Roof depth (m) / Thickness (m) 86·40 — 0·12 (c·sh) 86·52 — 6·23 (c) 95·45 — 2·00 (c) 126·60 — 3·00 (c) 133·50 — 0·20 (c)	—
PARTING	88·24 m	81·79 m	—	32·65 m		69·45 m	46·25 m	—	45·00 m	30·25 m	—
SEAM ZONE III (Details of Coal/Carb Shale Sections)	429·44 m – 443·08 m = 13·64 m Roof depth (m) / Thickness (m) 429·44 — 1·76 (c·sh) 434·60 — 1·58 (c·sh) 437·80 — 2·10 (c·sh) 440·51 — 1·00 (c·sh) 441·91 — 1·27 (c·sh)	482·00 m – 503·20 m = 21·20 m Roof depth (m) / Thickness (m) 482·00 — 0·70 (c·sh) 488·60 — 0·40 (c·sh)	—	143·20 m – 192·50 m = 49·30 m Roof depth (m) / Thickness (m) 143·20 — 18·50 (c) 167·05 — 7·85 (c) 186·10 — 0·78 (c) 189·90 — 2·60 (c)	—	197·45 m – 243·45 m = 46·00 m Roof depth (m) / Thickness (m) 197·45 — 10·75 (c) 209·95 — 4·55 (c) 214·80 — 6·30 (c) 224·55 — 3·80 (c) 232·40 — 11·05 (c)	281·05 m – 308·65 m = 27·60 m Roof depth (m) / Thickness (m) 281·05 — 27·60 (c)	—	45·00 m – 82·45 m = 37·45 m Roof depth (m) / Thickness (m) 45·00 — 0·24 (c) 45·45 — 0·50 (c) 49·65 — 1·15 (c) 52·70 — 1·28 (c·sh) 53·98 — 7·92 (c) 76·60 — 5·45 (c) 82·05 — 0·40 (c·sh)	163·95 m – 205·35 m = 41·40 m Roof depth (m) / Thickness (m) 163·95 — 5·40 (c) 170·65 — 24·15 (c) 204·55 — 0·80 (c·sh)	—
PARTING	—	—	—	58·10 m	—	52·80 m	49·87 m	—	71·60 m	—	—
SEAM ZONE II (Details of Coal/Carb Shale Sections)	—	—	—	250·60 m – 292·20 m = 41·60 m Roof depth (m) / Thickness (m) 250·60 — 0·30 (c·sh) 250·90 — 15·20 (c) 269·00 — 4·90 (c) 274·93 — 3·57 (c) 279·10 — 13·10 (c)	—	296·25 m – 299·55 m = 3·30 m Roof depth (m) / Thickness (m) 296·25 — 1·00 (c·sh) 297·25 — 2·00 (c) 299·25 — 0·30 (c·sh) (Seam zone truncated)	358·52 m – 398·27 m = 39·75 m Roof depth (m) / Thickness (m) 358·52 — 39·75 (c)	—	153·25 m – 197·00 m = 43·75 m Roof depth (m) / Thickness (m) 153·25 — 0·36 (c) 155·55 — 13·77 (c) 170·05 — 4·30 (c) 174·95 — 8·00 (c) 184·95 — 1·40 (c) 193·35 — 1·11 (c·sh) 196·69 — 0·31 (c)	—	—
PARTING	—	—	—	—	—	66·25 m	—	—	148·90 m	—	—
TALCHIR FORMATION	—	—	—	—	—	11·20 m	—	—	6·10 m	—	—
METAMORPHICS	—	—	—	—	—	—	—	—	—	—	—

GEOLOGICAL SURVEY OF INDIA

CORRELATION OF REGIONAL COALSEAM ZONES IN BARAKAR FORMATION AND OTHER BOREHOLE DETAILS IN BANHARDI SECTOR, AURANGA COALFIELD, BIHAR.

APPENDIX - IB

BORE HOLE NO	AB-12	AB-13	AB-14	AB-15	AB-16	AB-17	AB-18	AB-19
LATITUDE	23° 43′ 55″	23° 43′ 46″	23° 44′ 30″	23° 44′ 22″	23° 45′ 04″	23° 45′ 07″	23° 44′ 34″	23° 44′ 52″
LONGITUDE	84° 38′ 37″	84° 38′ 13″	84° 38′ 36″	84° 38′ 00″	84° 35′ 26″	84° 38′ 08″	84° 38′ 13″	84° 38′ 05″
R.L. OF BORE HOLE	436·61 m	430·26 m	437·36 m	431·43 m	399·45 m	425·47 m	438·52 m	427·47 m
COMMENCED ON	30·8·1992	15·2·1993	4·6·1993	23·8·1993	1·2·1994	13·6·1994	28·9·1994	1·3·1995
COMPLETED ON	9·2·1993	24·5·1993	2·8·1993	27·4·1994	26·5·1994	29·8·1994	17·2·1995	30·5·1995
TOTAL DEPTH	520·90 m	507·70 m	329·80 m	477·70 m	552·85 m	383·65 m	477·30 m	423·50 m
DEPTH OF WATER TABLE FROM SURFACE	—	—	—	—	—	—	—	—
DEPTH OF RANIGANJ/ BARAKAR FORMATION CONTACT FROM SURFACE	—	—	—	—	174·25 m	—	—	—
PARTING	—	—	—	—	36·25 m	—	—	—
SEAM ZONE VIII (Details of Coal/Carb. Shale Sections)	—	—	—	0·00 m - 29·95 m = 29·95 m Roof depth (m) / Thickness (m): 18·30 — 0·90 (c); 21·90 — 0·68 (c); 23·75 — 1·86 (c); 29·75 — 0·20 (c)	210·50 m - 247·60 m = 37·10 m Roof depth (m) / Thickness (m): 210·50 — 0·25 (c); 242·40 — 0·70 (c); 247·40 — 0·20 (c)	—	—	—
PARTING	39·80 m	117·25 m	—	146·95 m	158·40 m	—	55·45 m	—
SEAM ZONE VII (Details of Coal/Carb. Shale Sections)	39·80 m - 94·10 m = 54·30 m Roof depth (m) / Thickness (m): 39·80 — 0·11 (c.Sh); 53·20 — 2·55 (c); 66·85 — 1·20 (c); 69·20 — 0·65 (c); 72·60 — 1·30 (c); 81·80 — 0·90 (c); 89·05 — 2·50 (c); 93·10 — 1·00 (c)	117·25 m - 163·90 m = 46·65 m Roof depth (m) / Thickness (m): 117·25 — 0·40 (c); 119·28 — 0·55 (c); 120·70 — 8·95 (c); 131·35 — 1·00 (c); 132·65 — 1·00 (c); 134·85 — 2·70 (c); 138·15 — 1·38 (c); 143·65 — 4·50 (c); 155·75 — 1·00 (c); 163·45 — 0·45 (c)	—	176·90 m - 218·15 m = 41·25 m Roof depth (m) / Thickness (m): 176·90 — 0·10 (c); 177·55 — 0·60 (c); 185·18 — 1·32 (c); 187·89 — 0·90 (c); 193·15 — 7·50 (c); 207·85 — 1·25 (c); 215·55 — 0·55 (c); 217·80 — 0·35 (c)	406·90 m - 461·85 m = 55·85 m Roof depth (m) / Thickness (m): 406·00 — 0·35 (c.Sh); 406·35 — 7·45 (c); 461·75 — 0·10 (c)	—	55·45 m - 94·35 m = 38·90 m Roof depth (m) / Thickness (m): 55·45 — 0·10 (c); 55·80 — 2·70 (c); 70·30 — 8·15 (c); 79·25 — 1·60 (c); 93·20 — 1·15 (c.Sh)	—
PARTING	27·95 m	21·60 m	—	20·70 m		—	29·95 m	48·55 m
SEAM ZONE VI (Details of Coal/Carb. Shale Sections)	122·05 m - 158·60 m = 36·55 m Roof depth (m) / Thickness (m): 122·05 — 36·55 (c)	185·50 m - 273·65 m = 88·15 m Roof depth (m) / Thickness (m): Mainly grey to dark grey shale with Carbonaceous shale intercalation and thin Coal laminae		238·85 m - 271·65 m = 32·80 m Roof depth (m) / Thickness (m): 238·85 — 0·40 (c); 270·92 — 0·73 (c.Sh)	—	—	124·30 m - 159·70 m = 35·40 m Roof depth (m) / Thickness (m): 124·30 — 0·15 (c.Sh); 126·80 — 0·40 (c); 130·65 — 1·10 (c); 132·65 — 7·75 (c); 151·85 — 1·40 (c); 158·37 — 1·15 (c.Sh); 159·52 — 0·18 (c)	48·55 m - 82·25 m = 33·70 m Roof depth (m) / Thickness (m): 48·55 — 0·07 (c.Sh); 48·62 — 2·63 (c); 81·85 — 0·40 (c)
PARTING	23·60 m		19·00 m	39·05 m		15·20 m	34·90 m	27·75 m
SEAM ZONE V (Details of Coal/Carb. Shale Sections)	182·20 m - 224·00 m = 41·80 m Roof depth (m) / Thickness (m): 182·20 — 1·40 (c); 190·00 — 1·20 (c); 194·83 — 1·32 (c); 197·21 — 1·09 (c); 218·30 — 1·35 (c); 222·25 — 1·00 (c.Sh); 223·25 — 0·57 (c); 223·82 — 0·18 (c.Sh)		19·00 m - 42·45 m = 23·45 m Roof depth (m) / Thickness (m): 19·00 — 0·45 (c.Sh); 41·20 — 1·10 (c); 42·30 — 0·15 (c.Sh)	310·70 m - 350·30 m = 39·60 m Roof depth (m) / Thickness (m): 310·70 — 1·55 (c); 313·35 — 1·90 (c); 316·30 — 1·50 (c); 318·15 — 6·80 (c); 328·95 — 1·00 (c.Sh); 334·90 — 3·55 (c.Sh); 338·45 — 1·25 (c); 341·50 — 1·20 (c); 345·50 — 3·00 (c); 350·10 — 0·20 (c)	—	15·20 m - 107·45 m = 92·25 m Roof depth (m) / Thickness (m): 15·20 — 0·35 (c); 23·30 — 5·45 (c); 32·25 — 5·37 (c); 37·62 — 2·77 (c); 51·43 — 1·19 (c); 59·30 — 0·88 (c); 64·75 — 1·35 (c.Sh); 71·04 — 0·96 (c); 78·20 — 1·97 (c); 94·20 — 6·05 (c); 103·45 — 4·00 (c)	194·60 m - 223·05 m = 28·45 m Roof depth (m) / Thickness (m): 194·60 — 0·20 (c); 195·40 — 0·53 (c); 204·15 — 4·25 (c); 220·75 — 1·07 (c.Sh); 221·82 — 1·23 (c)	110·00 m - 177·35 m = 67·35 m Roof depth (m) / Thickness (m): 110·00 — 5·50 (c); 115·98 — 2·54 (c); 169·02 — 2·14 (c); 174·15 — 3·20 (c)
PARTING	24·69 m	36·35 m	—	31·45 m	—		32·80 m	
SEAM ZONE IV (Details of Coal/Carb. Shale sections)	248·69 m - 285·50 m = 36·81 m Roof depth (m) / Thickness (m): 248·69 — 0·13 (c.Sh); 248·82 — 1·49 (c); 255·08 — 0·54 (c); 246·65 — 1·90 (c.Sh); 273·05 — 7·50 (c); 281·90 — 3·60 (c)	310·00 m - 352·00 m = 42·00 m Roof depth (m) / Thickness (m): Mainly grey to dark grey Shale with Carbonaceous shale intercalation		381·75 m - 406·95 m = 25·20 m Roof depth (m) / Thickness (m): 381·75 — 0·45 (c); 384·50 — 4·25 (c); 405·25 — 1·70 (c)	—		255·85 m - 284·20 m = 28·35 m Roof depth (m) / Thickness (m): 255·85 — 0·20 (c); 256·55 — 0·50 (c); 259·65 — 0·70 (c); 261·91 — 5·29 (c); 274·67 — 2·63 (c); 281·22 — 2·98 (c)	
PARTING	92·90 m	77·30 m	82·35 m		—	58·15 m	91·75 m	115·95 m
SEAM ZONE III (Details of Coal/Carb. Shale Sections)	378·40 m - 434·85 m = 56·45 m Roof depth (m) / Thickness (m): 378·40 — 0·60 (c); 406·85 — 0·90 (c); 408·50 — 1·97 (c); 434·15 — 0·70 (c)	429·30 m - 482·00 m = 52·70 m Roof depth (m) / Thickness (m): 429·30 — 1·60 (c); 431·10 — 1·30 (c); 436·25 — 2·00 (c); 438·70 — 0·80 (c); 450·70 — 6·70 (c); 461·50 — 8·50 (c); 471·60 — 1·00 (c); 474·05 — 0·65 (c); 476·45 — 0·51 (c); 481·40 — 0·60 (c)	124·80 m - 186·55 m = 61·75 m Roof depth (m) / Thickness (m): 124·80 — 0·63 (c); 130·90 — 22·95 (c); 155·30 — 10·38 (c); 171·45 — 1·55 (c); 183·53 — 3·02 (c)	—	—	165·60 m - 264·98 m = 99·35 m Roof depth (m) / Thickness (m): 165·60 — 6·60 (c); 179·50 — 3·85 (c); 190·50 — 5·00 (c); 214·00 — 1·75 (c); 216·80 — 2·35 (c); 221·30 — 11·00 (c); 234·10 — 3·40 (c); 238·40 — 2·70 (c); 243·80 — 1·79 (c); 246·97 — 0·94 (c); 250·75 — 4·55 (c); 255·80 — 6·81 (c); 264·35 — 0·60 (c.Sh)	375·95 m - 440·00 m = 64·05 m Roof depth (m) / Thickness (m): 375·95 — 15·95 (c); 393·15 — 7·85 (c); 402·35 — 0·85 (c); 407·80 — 0·95 (c); 421·00 — 4·30 (c); 435·70	293·30 m - 357·65 m = 64·35 m Roof depth (m) / Thickness (m): 293·30 — 27·70 (c); 321·50 — 1·00 (c); 327·10 — 3·25 (c); 352·40 — 5·25 (c)
PARTING	53·15 m		30·95 m					20·45 m
SEAM ZONE II (Details of Coal/Carb. Shale Sections)	488·00 m - 520·90 m = 32·90 m Roof depth (m) / Thickness (m): 488·00 — 0·20 (c); 489·00 — 0·80 (c); 493·00 — 1·48 (c); 499·00 — 6·80 (c); 505·40 — 0·85 (c); 507·15 — 12·23 (c); 519·38 — 1·52 (Gn.Sh + C.Sh)		217·50 m - 261·00 m = 43·50 m Roof depth (m) / Thickness (m): 217·50 — 0·11 (c.Sh); 218·00 — 3·60 (c); 228·15 — 20·90 (c); 252·60 — 8·40 (c)					378·10 m - 418·90 m = 40·80 m Roof depth (m) / Thickness (m): 378·10 — 7·00 (c); 390·25 — 11·05 (c); 404·70 — 5·50 (c); 411·50 — 7·40 (c)
PARTING	—	—		—	—	113·40 m	—	
TALCHIR FORMATION	—	—	—	—	—	—	—	—
METAMORPHICS	—	—	—	—	—	5·30 m	—	—

APPENDIX - II

Summarised Lithologs of Boreholes AB-1 to AB-19 Drilled in Banhardi Sector, Auranga Coalfield, Palamau District, Bihar

Borehole No. : AB – 1

Location	:	**Lat. 23° 44′ 42″**	Drilling Unit	:	**267**
		Long. 84° 37′ 55″	Date of commencement	:	**14.06.1989**
R. L.	:	**439.50 m.**	Date of completion	:	**13.06.1990**
Final Depth	:	**500.00 m.**	Logged by	:	K. Mondal

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	12.10	12.10	1.00	Sludge of fine to medium grained sand.
12.10	24.97	12.87	12.87	Coarse to very coarse grained brownish to pinkish often micaceous sandstone interbanded with grey shale and thin fire clay, bottom more shaly.
24.97	59.85	34.88	33.18	Alternate banded and laminated black siltstone and dark brown ironstone shale / silty shale.
59.85	71.42	11.57	11.57	Hetrolithic sequence of grey shale, silty shale and medium to coarse buff felspathic sandstone. Bottom fine grained sandstone.
71.42	71.86	0.44	0.44	Carbonaceous shale.
71.86	75.15	3.29	3.29	Very coarse to coarse grained grey felspathic sandstone with few bands of dark grey shale, slickensided, silicification, fault dip 55° – 60° at 72.00 m. to 74.00 m.
75.15	76.29	1.14	1.14	COAL.
76.29	78.76	2.47	2.47	Grey shale with thin laminae and streaks of dull coal. Towards top whitish medium to coarse grained sandstone.
78.76	79.67	0.91	0.91	COAL.
79.67	79.79	0.12	0.12	Carbonaceous shale
79.79	83.47	3.68	3.68	Grey shale intercalated with carbonaceous shale with coal streaks.
83.47	88.50	5.03	5.03	Grey shale with coal laminae and streaks, white medium grained sandstone towards top.
88.50	88.78	0.28	0.28	Carbonaceous shale. (Seam Zone – VII)

88.78	91.46	2.68	2.68	COAL. (Seam Zone – VII)
91.46	105.02	13.56	13.56	Buff coloured coarse to medium grained sandstone , banded and laminated with grey shale. Bottom light grey shale.
105.02	111.96	6.94	6.94	COAL. (Seam Zone – VII)
111.96	120.78	8.82	8.82	Interbanded grey shale, silty shale and sandstone with few thin dull coal laminae and streaks and bands.
120.78	121.65	0.87	0.87	COAL. (Seam Zone – VII)
121.65	126.78	5.13	5.13	Grey to dark grey shale intercalated at places with carbonaceous shale with siltstone and fine sandstone laminae.
126.78	129.78	3.00	3.00	Carbonaceous shale. (Seam Zone – VII)
129.78	132.45	2.67	2.67	Grey shale with fine grained sandstone bands.
132.45	137.18	4.73	4.73	Interbanded grey shale and medium to fine grained sandstone with carbonaceous intercalations at places.
137.18	137.88	0.70	0.70	COAL.
137.88	142.82	4.94	4.94	Grey shale interbanded with medium to fine grained sandstone with carbonaceous shale.
142.82	143.90	1.08	1.08	COAL.
143.90	152.57	8.67	8.67	Alternation and interlamination of grey shale, silty shale and fine grained sandstone.
152.57	165.23	12.66	12.66	Heterolithic sequence of siltstone, very fine buff coloured sandstone and grey to dark grey shale.
165.23	166.00	0.77	0.77	Carbonaceous shale.
166.00	170.00	4.00	4.00	Hetrolithic sequence of medium and coarse grained felspathic sandstone, siltstone with occasional thin bands of grey shale.
170.00	171.00	1.00	1.00	Carbonaceous shale.
171.00	175.63	4.63	4.63	Dark grey shale with bands and laminae of very fine grained sandstone.
175.63	178.28	2.65	2.65	Carbonaceous shale. (Seam Zone – VI)
178.28	185.30	7.02	7.02	Alternation of buff coloured fine grained sandstone and grey to dark grey shale.
185.30	187.35	2.05	2.05	Carbonaceous shale.
187.35	187.60	0.25	0.25	COAL. (Seam Zone – VI)
187.60	192.60	5.00	5.00	Carbonaceous shale with a 0.75m. fine grained sandstone to siltstone band at middle.

192.60	195.84	3.24	3.24	Interbanded fine grained buff coloured sandstone and dark grey shale.
195.84	196.01	0.17	0.17	COAL. (Seam Zone – VI)
196.01	198.89	2.88	2.88	Alternate sequence of siltstone and grey shale with thin coal laminae and streaks.
198.89	200.05	1.16	1.16	Carbonaceous shale. (Seam Zone – VI)
200.05	207.46	7.41	7.41	Debris flow deposit.
207.46	207.73	0.27	0.27	COAL. (Seam Zone – VI)
207.73	208.37	0.64	0.64	Carbonaceous shale.
208.37	208.70	0.33	0.33	COAL. (Seam Zone – VI)
208.70	212.01	3.31	3.31	Grey shale occasionally silty at places.
212.01	215.10	3.09	3.09	White micaceous fine grained sandstone, grades to grey shale.
215.10	220.50	5.40	5.40	Carbonaceous shale.
220.50	231.85	11.35	11.35	Medium to fine grained arkosic sandstone banded with grey to dark grey shale.
231.85	233.41	1.56	1.56	Carbonaceous shale.
233.41	235.91	2.50	2.50	Very fine to medium grained felspathic sandstone with frequent shale bands at places.
235.91	236.90	0.99	0.99	Carbonaceous shale. (Seam Zone – V)
236.90	241.55	4.65	4.65	COAL (Seam Zone – V)
241.55	259.29	17.74	17.74	Heterolithic sequence of very coarse grained felspathic sandstone, medium to fine grained micaceous, felspathic sandstone, grey to dark grey shale and siltstone. At depth of 243.37m. one 2.19m. carbonaceous shale band.
259.29	262.93	3.64	3.64	Carbonaceous shale with grey shale at places.
262.93	263.90	0.97	0.97	Very fine grained micaceous sandstone.
263.90	266.40	2.50	2.50	Carbonaceous shale with coal streaks. (Seam Zone – V)
266.40	271.18	4.78	4.78	Interbanded grey shale, carbonaceous shale and siltstone.
271.18	279.33	8.15	8.15	Very coarse to coarse grained micaceous, felspathic sandstone with grey shale and carbonaceous shale at places.
279.33	288.46	9.13	9.13	Interbanded very coarse grained felspathic sandstone and very fine grained siltstone with frequent grey shale at places.
288.46	289.94	1.48	1.48	Carbonaceous shale.
289.94	295.20	5.26	5.26	Interbanded medium to fine grained felspathic sandstone and grey shale.

295.20	307.33	12.13	12.13	Interbanded medium to coarse grained felspathic sandstone and grey shale.
307.33	307.60	0.27	0.27	COAL. (Seam Zone – IV)
307.60	308.87	1.27	1.27	Very fine grained micaceous sandstone with grey shale.
308.87	309.72	0.85	0.85	COAL. (Seam Zone – IV)
309.72	315.70	5.98	5.98	Interbanded grey shale with carbonaceous intercalation and coarse to medium grained felspathic sandstone.
315.70	319.83	4.13	4.13	COAL. (Seam Zone – IV)
319.83	322.15	2.32	2.32	Interbanded grey shale and medium to coarse grained arkosic sandstone.
322.15	322.47	0.32	0.32	COAL. (Seam Zone – IV)
322.47	333.77	11.30	11.30	Fine to very fine grained micaceous sandstone interbanded with grey shale. Carbonaceous intercalation at places.
333.77	334.00	0.23	0.23	COAL.
334.00	336.00	2.00	2.00	Grey shale with thin vitrain laminae and bands.
336.00	336.13	0.13	0.13	COAL.
336.13	338.13	2.00	2.00	Carbonaceous shale. (Seam Zone – IV)
338.13	338.83	0.70	0.70	Grey shale.
338.83	341.20	2.37	2.37	Carbonaceous shale. (Seam Zone – IV)
341.20	350.85	9.65	9.65	Grey to dark grey shale interbanded with fine to medium grained felspathic sandstone.
350.85	354.25	3.40	3.40	Coarse grained felspathic sandstone grades upward to carbonaceous shale through fine grained sandstone to siltstone.
354.25	363.24	8.99	8.99	Interbanded very coarse grained spongy felspathic sandstone and grey shale / silty shale.
363.24	378.00	4.76	4.76	Whitish coarse to very coarse grained felspathic sandstone.
378.00	386.00	8.00	8.00	Carbonaceous shale.
386.00	392.80	6.80	6.80	Interbanded grey shale and medium to coarse grained massive felspathic sandstone.
392.80	397.00	4.20	4.20	Carbonaceous shale with thin to thick coal laminae.
397.00	429.44	32.44	32.44	Heterolithic sequence of grey to dark grey shale, siltstone, medium to coarse grained whitish felspathic sandstone, coarse grained quartzo-felspathic sandstone of 2.40m. at 413.50m. depth. Slickensided at 414.00m. depth.

429.44	431.20	1.76	1.76	Carbonaceous shale. (Seam Zone – III)
431.20	434.60	3.40	3.40	White siltstone intercalated with carbonaceous matter.
434.60	436.18	1.58	1.58	Carbonaceous shale. (Seam Zone – III)
436.18	437.80	1.62	1.62	White coarse to very coarse grained arkosic sandstone. Bottom 0.60m. carbonaceous shale.
437.80	439.90	2.10	2.10	Carbonaceous shale with biochurned faint silty laminae. Glossopteries present. (Seam Zone – III)
439.90	441.51	1.61	1.61	Medium to coarse grained felspathic sandstone, bottom 1.00m. carbonaceous shale with stem of vertebraria.
441.51	441.81	0.30	0.30	COAL.
441.81	443.08	1.27	1.27	Carbonaceous shale with stem of vertebraria, bottom silty shale. (Seam Zone – III)
443.08	452.60	9.52	9.52	Whitish medium to coarse massive felspathic sandstone. Bottom 1.70m. silty shale.
452.60	462.00	9.40	9.40	Interbanded fine to medium grained buff coloured felspathic sandstone and grey shale / silty shale. Biochurning at places and signature of escape burrowing at 459.71m. depth.
462.00	487.20	25.20	24.00	Interbanded grey shale and silty shale. Laminae are highly biochurned. Top 1.64m. very coarse grained arkosic sandstone.
487.20	493.30	6.10	6.10	Coarse to very coarse grained whitish massive quartzo-felspathic sandstone.
493.30	500.00	6.70	6.70	Dark grey grey shale / silty shale. At middle 1.30m. coarse grained quartzo-felspathic massive sandstone.

Borehole closed at 500.00 m. depth in Barakar Formation

Borehole No. : AB – 2

Location	:	**Lat. 23° 44′ 11″**	Drilling Unit	:	**378**
		Long. 84° 38′ 15″	Date of commencement	:	**13.11.1989**
R. L.	:	**432.67 m.**	Date of completion	:	**02.05.1991**
Final Depth	:	**503.20 m.**	Logged by	:	K. Mondal

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	7.20	7.20	7.00	Sludge of coarse brown sand.
7.20	16.30	9.10	9.10	Interlaminated grey shale and fine grained white sandstone.
16.30	18.25	1.95	1.95	Dark grey to black carbonaceous shale.
18.25	31.90	13.65	13.65	Interbanded grey shale and siltstone with frequent coarse to very coarse grained felspathic sandstone.
31.90	51.73	19.83	19.83	Top 14.00m. carbonaceous shale and rest silty shale with ironstone bands.
51.73	57.50	5.77	5.77	Very coarse grained sandstone with few shale and siltstone bands.
57.50	66.35	8.85	8.85	Interlaminated siltstone and grey shale with ironstone bands. Laminae highly biochurned at places.
66.35	79.00	12.65	12.65	Interbanded and interlaminated very coarse grained felspathic sandstone and grey shale with silty laminae.
79.00	81.30	2.30	2.30	Fire clay.
81.30	133.40	52.10	52.10	Dark grey shale intercalated with carbonaceous shale at places. Bioturbated at places. Rootlets common.
133.40	135.10	1.70	1.70	Grey silty shale intercalated with carbonaceous shale.
135.10	135.20	0.10	0.10	Carbonaceous shale. (Seam Zone-VII)
135.20	137.45	2.25	2.25	Coal with 0.12m. grey shale band at 136.16m. depth.
137.45	140.97	3.52	3.52	Carbonaceous shale. (Seam Zone-VII)
140.97	144.97	4.00	4.00	Coal. (Seam Zone-VII)
144.97	148.92	3.95	3.95	Carbonaceous shale. (Seam Zone-VII) .
148.92	151.92	3.00	3.00	Grey shale.
151.92	153.02	1.10	1.10	Coal. (Seam Zone-VII)

153.02	160.74	7.72	7.72	Heteroliths of medium to coarse grained felspathic sandstone, fine to very fine grained micaceous sandstone and siltstone with paper thin laminae of grey shale.
160.74	161.88	1.14	1.14	Coal. (Seam Zone-VII)
161.88	162.15	0.27	0.27	Carbonaceous shale. (Seam Zone-VII)
162.15	166.48	4.33	4.33	Coal. (Seam Zone-VII)
166.48	167.15	0.67	0.67	Grey shale with carbonaceous matter at places.
167.15	167.55	0.40	0.40	Coal. (Seam Zone-VII)
167.55	173.85	6.30	6.30	Grey shale interlaminated with siltstone. Bottom 1.50m. carbonaceous shale, slickenslided at places.
173.85	177.15	3.30	3.30	Coal with 0.11m. siderite shale band at 175.81m. depth. (Seam Zone-VII)
177.15	189.00	11.85	11.85	Top 5cm. carbonaceous shale. Interbanded sequence of grey shale, siltstone and carbonaceous shale with occasional medium to coarse grained arkosic sandstone. Sand filled escape burrowing at 184.70m. and at 188.50m.
189.00	196.40	7.40	7.40	Very coarse to coarse whitish grey arkosic sandstone banded with very fine sandstone towards bottom. Biochurning at places.
196.40	196.73	0.33	0.33	Coal.
196.73	209.40	12.67	12.67	Top 50cm. carbonaceous fine grained sandstone and rest is medium to fine grained felspathic sandstone interbanded and interlaminated with grey shale and siltstone.
209.40	216.25	6.85	6.85	Very coarse grained arkosic felspathic sandstone.
216.25	219.10	2.85	2.85	Interlaminated grey shale and siltstone. Pyrite encrustation and Glossopteris at 217.25m.
219.10	219.47	0.37	0.37	Carbonaceous shale. (Seam Zone-VI)
219.47	220.00	0.53	0.53	Coal. (Seam Zone-VI)
220.00	222.85	2.85	2.85	Grey shale laminated with siltstone with carbonaceous shale. Vertebraria at 221.20m. and 222.00m. Slickenslides towards bottom.
222.85	225.80	2.95	2.95	Interbanded coarse to very coarse grained felspathic sandstone and siltstone with grey shale. Pyrite ball at 225.45m.

225.80	227.62	1.82	1.82	Carbonaceous shale.
227.62	242.11	14.49	14.49	Heterolithic sequence of grey shale, siltstone, medium to coarse grained felspathic and micaceous sandstone. Finer facies towards top and coarser towards bottom. Slickenslide at 235.21m. and escape burrow feature at 236.10m.
242.11	242.45	0.34	0.34	Coal.
242.45	248.10	5.65	5.65	Interbanded sequence of grey shale, micaceous silty shale and very coarse quartzo-felspathic sandstone.
248.10	251.10	3.00	3.00	Carbonaceous shale. (Seam Zone-VI)
251.10	254.40	3.30	3.30	Very coarse quartzo-felspathic sandstone.
254.40	274.80	20.40	20.40	Alternate and interbedded sequence of very coarse to coarse felspathic sandstone, micaceous fine sandstone, siltstone and grey shale. Flaser bedding at 255.00m. Burrowing at 264.00m., escape burrowing at 265 50m.and 271.00m.
274.80	275.20	0.40	0.40	Coal.
275.20	278.80	3.60	3.60	Heterolithic sequence of grey shale, carbonaceous shale, fine micaceous sandstone, siltstone and medium to coarse grained quartzo-felspathic sandstone.
278.80	279.40	0.60	0.60	Carbonaceous shale.
279.40	280.20	0.80	0.80	Coal.
280.20	290.15	8.95	8.95	Interbanded grey shale and medium to coarse grained felspathic sandstone with carbonaceous streaks at places.
290.15	303.08	12.93	12.93	Coal. (Seam Zone-V)
303.08	303.40	0.32	0.32	Carbonaceous shale.
303.40	304.10	0.70	0.70	Grey silty shale.
304.10	304.85	0.75	0.75	Coal (Seam Zone-V)
304.85	305.40	0.55	0.55	Grey silty shale.
305.40	306.20	0.80	0.80	Carbonaceous shale.
306.20	307.03	0.83	0.83	Carbonaceous shale with siderite band towards bottom.
307.03	307.10	0.07	0.07	Coal.
307.10	317.50	10.40	10.40	Top 1.50m. felspathic fine grained sandstone, 1.30m. Carbonaceous shale, 2.00m. silty shale and rest is carbonaceous shale with grey shale intercalation at places.

317.50	319.54	2.04	2.04	Carbonaceous shale with 30cm. coal band at 317.50m.
319.54	320.32	0.78	0.78	Coal. (Seam Zone-V)
320.32	320.80	0.48	0.48	Carbonaceous shale.
320.80	329.00	8.20	8.20	Grey silty shale.
329.00	344.95	15.95	15.95	Very coarse to gritty quartzo-felspathic sandstone banded with grey shale and silty shale. Vertebraria at 341.80m.
344.95	356.06	11.11	11.11	Interbanded medium to coarse grained sandstone and grey shale and siltstone. Glossopteris at 350.40m., 350.55m and 350.85m. in shale and Trizygya (?) at 354.40m.
356.06	357.00	0.94	0.94	Medium grained arkosic sandstone.
357.00	359.30	2.30	2.30	Coarse to fine grained sandstone banded with grey silty shale.
359.30	359.70	0.40	0.40	Carbonaceous shale. (Seam Zone-IV)
359.70	360.00	0.30	0.30	Coal. (Seam Zone-IV)
360.00	361.38	1.38	1.38	Very coarse grained sandstone banded with silty shale.
361.38	361.98	0.60	0.60	Carbonaceous shale.
361.98	362.65	0.67	0.67	Grey siltstone with Glossopteris.
362.65	362.95	0.30	0.30	Carbonaceous shale.
362.95	367.14	4.19	4.19	Coal. (Seam Zone-IV)
367.14	367.60	0.46	0.46	Medium to fine grained sandstone.
367.60	367.85	0.25	0.25	Carbonaceous shale.
367.85	370.85	3.00	3.00	Coal. (Seam Zone-IV)
370.85	372.25	1.40	1.40	Fine grained sandstone.
372.25	375.25	3.00	3.00	Medium grained sandstone grades upward to very coarse massive quartzo-felspathic sandstone. Carbonaceous streaks and laminae towards top and bottom.
375.25	375.83	0.58	0.58	Silty shale.
375.83	376.14	0.31	0.31	Coal. (Seam Zone-IV)
376.14	376.63	0.49	0.49	Carbonaceous shale.
376.63	378.55	1.92	1.92	Grey siltstone laminated with paper thin laminae of shale. Bottom 50cm. ferruginous siltstone.
378.55	378.85	0.30	0.30	Silty shale, bottom slickenslided.

378.85	386.85	8.00	8.00	Very coarse quartzo-felspathic massive sandstone.
386.85	387.95	1.10	1.10	Carbonaceous shale.
387.95	388.97	1.02	1.02	Coal. (Seam Zone-IV)
388.97	389.45	0.48	0.48	Carbonaceous shale.
389.45	399.26	9.81	9.81	Interbanded and interlaminated grey shale, fine grained to medium grained sandstone and siltstone with occasional coarse grained sandstone bands.
399.26	399.51	0.25	0.25	Carbonaceous shale.
399.51	400.21	0.70	0.70	Coal. (Seam Zone-IV)
400.21	404.82	4.61	4.61	Grey shale with thin bands of carbonaceous shale.
404.82	419.37	14.55	7.55	Very coarse to coarse grained massive sandstone.
419.37	421.84	2.47	2.47	Interlaminated sequence of very fine grained sandstone and grey shale.
421.84	424.16	2.32	2.32	Very coarse grained sandstone with thin lenses of carbonaceous shale.
424.16	425.68	1.52	1.52	Light grey very fine grained sandstone interlaminated with grey shale, carbonaceous shale and thin coal laminae.
425.68	425.90	0.22	0.22	Coal.
425.90	427.67	1.77	1.77	Grey shale with thin siltstone laminae.
427.67	428.07	0.40	0.40	Coal.
428.07	428.72	0.65	0.65	Grey shale.
428.72	431.62	2.90	2.90	Alternate sequence of fine to very fine grained sandstone and grey shale.
431.62	432.60	0.98	0.98	Light greyish medium to coarse grained sandstone with thin shale bands.
432.60	437.60	5.00	5.00	Very coarse grained quartzose gritty sandstone.
437.60	438.40	0.80	0.80	Interlamination of dark grey shale and siltstone.
438.40	439.15	0.75	0.75	Coarse to medium grained felspathic sandstone.
439.15	440.35	1.20	1.20	Coal.
440.35	440.85	0.50	0.50	Carbonaceous shale with thin coal bands.
440.85	442.72	1.87	1.87	Interlaminated sequence of grey shale and light grey siltstone / very fine grained sandstone. Core dip-17° to 18°.

442.72	444.25	1.53	1.00	Carbonaceous shale with thin vitrain laminae and few siltstone bands at places.
444.25	454.85	10.60	10.60	Coarse to very coarse grained felspathic sandstone.
454.85	456.70	1.85	1.85	Dark grey shale laminated with siltstone.
456.70	457.45	0.75	0.75	Light grey fine grained sandstone with thin grey shale laminae.
457.45	458.90	1.45	1.45	Dark grey shale with thin coal laminae at places.
458.90	460.05	1.15	1.15	Light grey very fine grained sandstone with grey shale.
460.05	464.80	4.75	4.75	Medium to coarse gained sandstone.
464.80	466.75	1.95	1.95	Dark grey shale with thin silty laminae.
466.75	468.15	1.40	1.40	Grey shale laminated with siltstone, top 20cm. carbonaceous shale.
468.15	468.60	0.45	0.45	Carbonaceous shale.
468.60	471.40	2.80	2.80	Very fine grained sandstone.
471.40	482.00	10.60	10.60	Dark grey shale interbanded with very fine grained sandstone / siltstone.
482.00	482.70	0.70	0.70	Carbonaceous shale. (Seam Zone-III)
482.70	483.05	0.35	0.35	Fine grained sandstone.
483.05	485.60	2.55	2.55	Dark grey shale laminated with siltstone.
485.60	486.00	0.40	0.40	Medium grained felspathic sandstone.
486.00	487.30	1.30	1.30	Dark grey shale.
487.30	488.60	1.30	1.30	Medium to fine grained felspathic sandstone.
488.60	489.00	0.40	0.40	Carbonaceous shale. (Seam Zone-III)
489.00	493.00	4.00	4.00	Dark grey shale interbanded with very fine to fine grained sandstone.
493.00	502.75	9.75	9.75	Dark grey shale with occasional thin laminae of siltstone.
502.75	503.20	0.45	0.45	Medium grained felspathic sandstone.

Borehole closed at 503.20 m. depth in Barakar Formation

Borehole No. : AB – 3

Location	:	**Lat. 23° 44′ 28″**	Drilling Unit	:	**267**
		Long. 84° 37′ 16″	Date of commencement	:	**20.08.1990**
R. L.	:	**425.61 m.**	Date of completion	:	**27.07.1991**
Final Depth	:	**630.00 m.**	Logged by	:	K. Mondal

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	23.50	23.50	10.00	Sludge of greenish grey fine grained sand.
23.50	50.15	26.65	26.65	Interbanded sequence of greenish grey fine to very fine grained micaceous, flaser bedded, cross-bedded sandstone and grey to dark grey silty shale, siltstone (flaser bedded) and occasional grey shale. One grey to dark grey shale band of 1.00m. at 28.15m. depth. Core dip - 20°.
50.15	51.17	1.02	1.02	Medium to coarse grained greenish grey felspathic, massive sandstone.
51.17	59.36	8.19	8.19	Interbanded greenish grey micaceous parallel bedded and flaser bedded sandstone and medium grained little felspathic, micaceous, greenish grey sandstone. Laminae biochurned.
59.36	68.00	8.64	8.64	Interbedded and interlaminated fine to very fine grained greenish grey micaceous parallel bedded, flaser bedded sandstone and grey to black silty shale, laminae at places biochurned.
68.00	69.70	1.70	1.70	Interbedded very coarse grained quartzo-felspathic massive sandstone and fine to medium grained greenish grey sandstone.
69.70	73.00	3.30	3.30	Interbedded very fine grained greenish grey sandstone and grey to black shale.
73.00	74.64	1.64	1.64	Grey to dark grey shale with silty shale lamination, bottom 0.34m. carbonaceous shale with vitrain laminae & streaks.
74.64	90.45	15.81	15.81	Interbedded greenish grey fine to very fine grained micaceous, flaser and parallel bedded sandstone and grey silty shale. Biochurning prominent.
90.45	92.10	1.65	1.65	Medium to coarse grained quartzo-felspathic massive sandstone with streaks of coal.

92.10	95.35	3.25	3.25	Interbedded dark grey shale and thin carbonaceous shale with thin vitrain laminae.
95.35	107.25	11.90	11.90	Interbanded and laminated grey shale and greyish white siltstone. Laminae are biochurned.
107.25	114.35	7.10	7.10	Carbonaceous shale with vitrain bands at places. Occasional grey shale intercalation.
114.35	122.00	7.65	7.65	Interbedded grey shale and greenish grey, micaceous, flaser bedded siltstone with occasional carbonaceous shale bands.
122.00	134.00	12.00	12.00	Interbanded grey micaceous very fine grained sandstone and grey to dark grey shale.
134.00	135.56	1.56	1.56	Coarse grained micaceous sandstone with shale laminae and clast.
135.56	146.48	10.92	10.92	Interbedded sequence of very fine grained greenish grey micaceous flaser bedded sandstone and grey shale.
146.48	147.43	0.95	0.95	Coarse to very coarse grained hard and compact sandstone.
147.43	165.67	18.24	18.24	Interbedded sequence of very fine grained greenish grey micaceous sandstone, siltstone and dark grey shale with occasional carbonaceous shale.
165.67	167.55	1.88	1.88	Coarse grained to medium grained greenish grey to grey micaceous sandstone and dark grey shale.
167.55	198.12	30.57	30.57	Alternate bedded sequence of very fine to fine grained micaceous, flaser bedded sandstone laminated with dark grey shale and coarse to very coarse grained felspathic sandstone banded with dark grey shale and siltstone. Core dip - 18°.
198.12	209.53	11.41	11.41	Grey to dark grey shale with thin vitrain bands towards bottom, very fine grained micaceous sandstone laminae towards top, slickenside at 198.90m.
209.53	219.50	9.97	9.97	Interbanded coarse to medium grained arkosic sandstone, very fine grained sandstone and grey shale, slickensided at 219.00m. Core dip – 19° - 20°.
219.50	220.85	1.35	1.35	Grey shale with vitrain bands.
220.85	225.65	4.80	4.80	Interbanded coarse to medium grained sandstone and grey shale with fine grained sandy bands.
225.65	229.70	4.05	4.05	Dark grey shale with thin vitrain bands. Slickenside at 228.00m.

229.70	234.00	4.30	4.30	Interbanded sequence of light grey shale and siltstone with carbonaceous shale bands.
234.00	245.90	11.90	11.90	Greenish grey micaceous fine grained sandstone interbanded with grey to dark grey shale and silty shale. Slickenside at 234.90m., 236.20m., 241.50m., 241.80m. and 242.45m., microfault at 243.05m., fault zone at 244.70m. to 245.15m. Dip of fault 60° to 65° and core dip – 18° to 20°.
245.90	257.00	11.10	11.10	Interbanded sequence of grey shale, siltstone and fine grained micaceous sandstone with occasional medium grained sandstone band. Fault at 245.66m., 248.50m. and 257.00m. Dip of fault 60° to 65° and core dip – 12° to 25°.
257.00	262.15	5.15	5.15	Dark grey claystone with silty intercalation.
262.15	262.53	0.38	0.38	Carbonaceous shale.
262.53	263.25	0.72	0.72	COAL.
263.25	269.80	6.55	6.55	Grey shale interlaminated and banded with siltstone and few fine grained sandstone bands. Slickenside at 269.70m.

---------- **Contact between Raniganj Formation and Barakar Formation** ----------

269.80	273.85	4.05	4.05	Fine to medium grained sandstone laminated and banded with grey shale.
273.85	281.10	7.25	7.25	Grey shale with carbonaceous shale bands.
281.10	283.25	2.15	2.15	Grey coarse grained felspathic sandstone with thin shale bands.
283.25	294.40	11.15	11.15	Interbanded and interlaminated sequence of grey shale, fine to medium grained sandstone and very fine grained sandstone / siltstone.
294.40	301.40	7.00	7.00	Greyish white siltstone interlaminated with dark grey shale with few carbonaceous shale laminae. Core dip - 18°.
301.40	302.50	1.10	1.10	Carbonaceous shale.
302.50	305.50	3.00	3.00	Dark grey shale with shale intercalation.
305.50	311.15	5.65	5.65	Very coarse to coarse grained felspathic sandstone interbanded with grey to dark grey shale / silty shale.
311.15	311.27	0.12	0.12	COAL.
311.27	316.75	5.48	5.48	Interbanded sequence of silty shale and coarse to medium

grained felspathic sandstone.

316.75	322.30	5.55	5.55	Heterolithic sequence of fine to medium grained sandstone, grey shale with very coarse sandy intercalation.
322.30	323.95	1.65	1.65	Grey to dark grey shale interbanded and intercalated with carbonaceous shale with vitrain bands and laminae.
323.95	326.68	2.73	2.73	Fine to medium grained sandstone, laminated and banded with carbonaceous and grey shale.
326.68	330.48	3.80	3.80	Carbonaceous shale with thin bands of grey shale. (Seam Zone - VIII)
330.48	331.60	1.12	1.12	COAL. (Seam Zone – VIII)
331.60	335.60	4.00	4.00	Grey to dark grey shale intercalated with carbonaceous shale with few vitrain bands.
335.60	351.32	15.72	15.72	Interbanded sequence of fine to medium grained sandstone, silty shale, grey shale and occasional coarse sand bands. Coal clast, lenses in grey shale.
351.32	351.52	0.20	0.20	COAL. (Seam Zone – VIII)
351.52	354.59	3.07	3.07	Grey shale with vitrain laminae and coal clast.
354.59	354.75	0.16	0.16	COAL. (Seam Zone – VIII)
354.75	355.87	1.12	1.12	Grey shale with thin bands of coal.
355.87	359.10	3.23	3.23	Very coarse grained massive felspathic sandstone.
359.10	363.67	4.57	4.57	Grey shale interbanded and intercalated with carbonaceous shale, bottom 0.18m. carbonaceous shale.
363.67	364.82	1.15	1.15	COAL. (Seam Zone – VIII)
364.82	372.94	8.12	8.12	Interbanded sequence of coarse to medium grained felspathic sandstone, fine grained sandstone and silty shale / grey shale.
372.94	375.22	2.28	2.28	Grey shale.
375.22	376.60	1.38	1.38	Coarse grained sandstone, bottom 20cm. grey shale.
376.60	377.24	0.64	0.64	COAL. (Seam Zone – VIII)
377.24	398.15	20.91	20.91	Alternate banded sequence of grey shale / silty shale and coarse to very coarse grained felspathic sandstone, carbonaceous shale at places.
398.15	404.38	6.23	6.23	Very coarse grained sandstone banded with medium grained sandstone.
404.38	410.60	6.22	6.22	Alternation and interbanded sequence of very coarse to

				medium grained felspathic sandstone and grey shale and silty shale. Leaf impression at 404.70m. Core dip-15° to 16°
410.60	411.02	0.42	0.42	COAL.
411.02	416.60	5.58	5.58	Light grey micaceous fine to medium grained micaceous sandstone with coal streaks.
416.60	443.21	26.61	26.61	Interbanded sequence of medium grained sandstone and fine to very fine grained sandstone. Bottom interlaminated with grey shale intercalated with carbonaceous shale.
443.21	445.66	2.45	2.45	Grey shale banded with coarse grained sandstone carbonaceous intercalation at places.
445.66	457.97	12.31	12.31	Heterolithic sequence of grey shale with carbonaceous intercalation at places, fine to medium grained sandstone and coarse grained sandstone.
457.97	458.14	0.17	0.17	COAL.
458.14	476.05	17.91	17.91	Interlaminated and banded medium to fine grained sandstone, coarse grained sandstone and grey shale, carbonaceous shale and siltstone. Core dip-18°.
476.05	487.80	11.75	11.75	Grey to dark grey shale / silty shale banded and intercalated with carbonaceous shale towards bottom.
487.80	497.87	10.07	10.07	Alternation of medium to coarse grained felspathic sandstone banded with grey shale, and grey to dark grey shale laminated with siltstone. Core dip-18°.
497.87	509.50	11.63	11.63	Dark grey shale with thin fraction of carbonaceous shale intercalation. Rootlets at places.
509.50	527.57	18.07	18.07	Dark grey shale with rootlets intercalated and interlaminated with siltstone.
527.57	541.58	14.01	14.01	Dark grey shale interbanded and intercalated with medium to coarse grained sandstone and siltstone at places. Rootlets. Slickenslide with silicification at 535.27m. depth.
541.58	545.40	3.82	3.82	Top 5cm. Coal. Rest is grey shale and carbonaceous shale interlaminated and interbanded with fine to very fine grained sandstone and siltstone.
545.40	546.70	1.30	1.30	Medium to fine grained felspathic sandstone with intercalation of grey siltstone and grey shale.
546.70	546.90	0.20	0.20	Carbonaceous shale. (Seam Zone –VII)

546.90	548.30	1.40	1.40	COAL.	(Seam Zone – VII)
548.30	548.60	0.30	0.30	Carbonaceous shale.	
548.60	554.57	5.97	5.97	Interbanded sequence of coarse to medium grained felspathic sandstone and fine grained sandstone to siltstone and grey to dark grey shale.	
554.57	560.57	6.00	6.00	Dark grey shale interbanded with grey siltstone, bioturbation and biochurning at places.	
560.57	560.83	0.26	0.26	Carbonaceous shale.	(Seam Zone – VII)
560.83	562.46	1.63	1.63	Dark grey shale with carbonaceous shale intercalation.	
562.46	562.59	0.13	0.13	Carbonaceous shale.	
562.59	562.96	0.37	0.37	COAL.	(Seam Zone-VII)
562.96	568.45	5.49	5.49	Interlaminated dark grey shale, fine grained sandstone, siltstone and occasional carbonaceous shale laminae.	
568.45	576.65	8.20	8.20	Medium to coarse grained felspathic sandstone interbanded and intercalated with grey shale and silty shale with carbonaceous shale.	
576.65	577.00	0.35	0.35	COAL.	(Seam Zone-VII)
577.00	580.20	3.20	3.20	Grey shale interbanded and intercalated with very fine grained sandstone.	
580.20	580.35	0.15	0.15	COAL.	(Seam Zone-VII)
580.35	581.00	0.65	0.65	Grey shale.	
581.00	581.35	0.35	0.35	COAL.	(Seam Zone-VII)
581.35	591.70	10.35	10.35	Dark grey shale interbanded and interlaminated with very fine and medium to coarse grained sandstone and carbonaceous shale.	
591.70	601.40	9.70	9.70	Interbanded grey shale and fine to very fine grained sandstone.	
601.40	613.00	11.60	7.90	COAL.	(Seam Zone-VI)
613.00	614.71	1.71	1.71	Carbonaceous shale interbanded with siltstone and medium grained sandstone.	
614.71	615.16	0.45	0.45	COAL.	(Seam Zone-VI)
615.16	616.26	1.10	1.10	Dark grey shale.	
616.26	617.50	1.24	1.24	COAL.	(Seam Zone-VI)
617.50	620.50	3.00	3.00	Carbonaceous shale with thin grey shale bands and coal	

				streaks. (Seam Zone-VI)
620.50	630.00	9.50	9.50	Grey shale with thin coal laminae at places.
		Borehole closed		**at 630.00 m. depth in Barakar Formation**

Borehole No. : AB – 4

Location	:	**Lat. 23° 44′ 17″**	Drilling Unit	:	**378**
		Long. 84° 38′ 45″	Date of commencement	:	**28.05.1991**
R. L.	:	**440.31 m.**	Date of completion	:	**10.08.1991**
Final Depth	:	**383.20 m.**	Logged by	:	K. Mondal

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	21.55	21.55	1.10	Yellowish to greenish yellow fine to very fine grained sandy sludge.
21.55	22.21	0.66	0.66	Carbonaceous shale intercalated at places with grey shale. (Seam Zone – V)
22.21	28.00	5.79	5.79	COAL. (Seam Zone – V)
28.00	28.30	0.30	0.30	Carbonaceous shale. (Seam Zone – V)
28.30	31.50	3.20	3.20	Interbanded grey shale and siltstone.
31.50	34.95	3.45	1.20	Coarse to medium grained sandstone with thin to thick grey shale and carbonaceous shale band.
34.95	37.45	2.50	2.50	Interbanded very fine grained sandstone and grey shale with coal streaks and carbonaceous laminae.
37.45	41.65	4.20	4.20	Very fine grained sandstone with grey shale laminae banded with very coarse grained sandstone. Glossopteris in grey shale at 40.20m. depth. Core dip 15° to 18°. Bottom 30cm. medium grained sandstone with coal streaks.
41.65	41.75	0.10	0.10	COAL. (Seam Zone – V)
41.75	42.05	0.30	0.30	Very fine grained sandstone with grey shale laminae.
42.05	42.27	0.22	0.22	Carbonaceous shale.
42.27	42.39	0.12	0.12	COAL. (Seam Zone – V)
42.39	42.70	0.31	0.31	Carbonaceous shale.
42.70	43.20	0.50	0.50	COAL. (Seam Zone – V)
43.20	44.30	1.10	1.10	Medium grained sandstone, fining downward to very fine grained sandstone with grey shale laminae.
44.30	44.40	0.10	0.10	COAL.

44.40	44.70	0.30	0.30	Carbonaceous shale.
44.70	44.95	0.25	0.25	COAL.
44.95	47.05	2.10	2.10	Grey shale intercalated with carbonaceous shale.
47.05	49.50	2.45	2.45	COAL. (Seam Zone – V)
49.50	55.65	6.15	6.15	Interbanded very coarse and medium to fine grained sandstone, top 0.60m. grey shale with siltstone laminae.
55.65	56.15	0.50	0.50	Carbonaceous shale.
56.15	59.40	3.25	3.25	Very fine grained sandstone interbanded with grey shale. Bioturbation at places. Core dip 18°.
59.40	60.70	1.30	1.30	Medium to coarse grained felspathic sandstone.
60.70	66.00	5.30	5.30	Alternate sequence of siltstone and grey shale, at middle one 0.30m. carbonaceous shale band.
66.00	69.25	3.25	3.25	Fine to medium grained sandstone laminated with grey shale.
69.25	70.55	1.30	1.30	Grey shale laminated with siltstone.
70.55	72.05	1.50	1.50	Very coarse to coarse grained sandstone interbanded with siltstone and grey shale.
72.05	76.25	4.20	4.20	Interbanded grey shale and siltstone, bottom shale with coal laminae.
76.25	76.47	0.22	0.22	COAL.
76.47	78.65	2.18	2.18	Grey shale with coal laminae at places.
78.65	83.90	5.25	5.25	Coarse grained sandstone grades upward to fine grained sandstone.
83.90	84.05	0.15	0.15	COAL. (Seam Zone – IV)
84.05	85.25	1.20	1.20	Siltstone banded with grey shale.
85.25	86.45	1.20	1.20	Coarse to medium grained sandstone interbanded with grey shale.
86.45	90.70	4.25	4.25	Coarse to very coarse grained massive sandstone.
90.70	96.30	5.60	5.60	Interbanded grey shale and medium to coarse grained sandstone with occasional carbonaceous shale bands at places.
96.30	99.00	2.70	2.70	Grey shale interlaminated with siltstone.
99.00	99.20	0.20	0.20	COAL.
99.20	100.10	0.90	0.90	Grey shale slickensided at middle.

100.10	100.20	0.10	0.10	COAL.
100.20	100.40	0.20	0.20	Intercalation of siltstone and very coarse grained arkosic sandstone.
100.40	100.52	0.12	0.12	Carbonaceous shale.
100.52	101.15	0.63	0.63	COAL.
101.15	102.55	1.40	1.40	Interlaminated siltstone and grey shale.
102.55	103.00	0.45	0.45	Carbonaceous shale.
103.00	108.20	5.20	5.20	Grey shale interlaminated with siltstone.
108.20	108.40	0.20	0.20	COAL.
108.40	110.45	2.05	2.05	Grey shale interlaminated with siltstone.
110.45	110.55	0.10	0.10	COAL. (Seam Zone – IV)
110.55	116.65	6.10	6.10	Grey shale interlaminated, banded with siltstone and carbonaceous shale.
116.65	117.65	1.00	1.00	Very coarse grained felspathic sandstone.
117.65	130.45	12.80	12.80	Interbanded and laminated medium to fine grained sandstone and grey shale with siltstone. Top 9.00m. more sandy and rest part is more shaly.
130.45	132.05	1.60	1.60	Very coarse grained arkosic sandstone.
132.05	133.45	1.40	1.40	Grey shale interbanded with coarse to very coarse grained gritty sandstone.
133.45	133.81	0.36	0.36	COAL.
133.81	134.71	0.90	0.90	Grey shale intercalated with carbonaceous shale at places.
134.71	135.34	0.63	0.63	COAL.
135.34	142.70	7.36	7.36	Top 0.12m. carbonaceous shale, rest are very coarse grained massive sandstone.
142.70	143.20	0.50	0.50	Grey shale with occasional carbonaceous shale laminae.
143.20	161.70	18.50	18.50	COAL. (Seam Zone – III)
161.70	167.05	5.35	5.35	Interbanded sequence of grey shale, very coarse grained and fine grained sandstone.
167.05	174.90	7.85	7.85	COAL. (Seam Zone – III)
174.90	186.10	11.20	11.00	Very coarse grained sandstone interbanded with fine grained sandstone, laminated with grey shale. Bottom 0.10m. ironstone

				shale.
186.10	186.88	0.78	0.78	COAL.
186.88	187.10	0.22	0.22	Carbonaceous shale.
187.10	187.40	0.30	0.30	Very coarse grained sandstone.
187.40	187.70	0.30	0.30	Carbonaceous shale.
187.70	187.90	0.20	0.20	COAL.
187.90	188.05	0.15	0.15	Carbonaceous shale.
188.05	189.90	1.85	1.85	Siltstone interlaminated with grey shale and carbonaceous shale laminae.
189.90	192.50	2.60	2.60	COAL. (Seam Zone – III)
192.50	195.15	2.65	2.65	Dark grey shale interbanded with siltstone, fine and coarse grained sandstone.
195.15	203.30	8.15	8.15	Very coarse grained sandstone with grey shale, siltstone and fine grained sandstone interbanding.
203.30	203.45	0.15	0.15	COAL.
203.45	210.08	6.63	6.63	Very coarse grained massive sandstone, bottom 0.63m. sandy shale and 0.08m. carbonaceous shale.
210.08	211.20	1.12	1.12	Carbonaceous shale with 0.17m. and 0.20m. coal band at the top and bottom respectively.
211.20	212.70	1.50	1.50	Medium grained sandstone with thin shale bands.
212.70	213.00	0.30	0.30	COAL.
213.00	221.50	8.50	8.50	Interbanbded medium to coarse grained sandstone and grey shale.
221.50	247.00	25.50	25.50	Very coarse grained to gritty felspathic sandstone.
247.00	250.60	3.60	3.60	Siltstone interlaminated with grey shale.
250.60	250.90	0.30	0.30	Carbonaceous shale. (Seam Zone – II)
250.90	266.10	15.20	15.20	COAL. (Seam Zone – II)
266.10	269.00	2.90	2.90	Interbanded grey shale and medium to fine grained sandstone.
269.00	273.90	4.90	4.90	COAL. (Seam Zone – II)
273.90	274.80	0.90	0.90	Fine grained sandstone grades down to dark grey shale.
274.80	274.93	0.13	0.13	Carbonaceous shale.
274.93	278.50	3.57	3.57	COAL. (Seam Zone – II)

278.50	279.10	0.60	0.60	Grey shale.
279.10	292.20	13.10	13.10	COAL. (Seam Zone – II)
292.20	296.10	3.90	3.90	Interbanded grey shale, medium grained sandstone and siltstone.
296.10	301.60	5.50	5.50	Coarse to very coarse grained sandstone, bottom sideritic shale, slickensided.
301.60	304.50	2.90	2.90	Shale laminated with siltstone.
304.50	304.75	0.25	0.25	COAL.
304.75	305.30	0.55	0.55	Carbonaceous shale.
305.30	307.20	1.90	1.90	Interlamination of grey shale and siltstone.
307.20	309.00	1.80	1.80	Debris flow conglomerate.
309.00	322.76	13.76	13.76	Coarse to medium grained massive sandstone banded with fine to very fine grained sandstone and grey shale with carbonaceous shale intercalation.
322.76	326.80	4.04	4.04	Interbanded medium grained sandstone and grey shale.
326.80	332.10	5.30	5.30	Very coarse grained granular to pebbly sandstone.
332.10	339.05	6.95	6.50	Dark grey shale with carbonaceous shale intercalation, interbanded with coarse to very coarse grained sandstone.
339.05	339.50	0.45	0.45	COAL.
339.50	340.90	1.40	1.40	Dark grey shale with siltstone.
340.90	341.05	0.15	0.15	COAL.
341.05	341.20	0.15	0.15	Very coarse grained sandstone.
341.20	341.50	0.30	0.30	COAL.
341.50	345.80	4.30	4.30	Interbanded grey shale, coarse and fine grained sandstone, with occasional siltstone.
345.80	349.85	4.05	4.05	Interbanded very coarse grained sandstone, coarse to medium grained sandstone, grey shale and siltstone.
349.85	352.15	2.30	2.30	Siltstone interbanded with grey shale and medium grained sandstone.
352.15	353.15	1.00	1.00	Very coarse grained granular massive sandstone.
353.15	359.30	6.15	5.00	Grey to dark grey shale, bottom slickensided.
359.30	371.90	12.60	10.00	Very coarse grained to pebbly with thin grey shale, fine grained sandstone and very thin fire clay intercalation.
371.90	380.00	8.10	8.00	Very coarse grained gritty to pebbly sandstone.

380.00	382.70	2.70	2.70	Cherry red shale with fine grained sandstone and grey shale interbanding.
382.70	383.20	0.50	0.50	Medium to fine grained sandstone.

Borehole closed at 383.20 m. depth in Barakar Formation

Borehole No. : AB – 5

Location	:	**Lat. 23° 44′ 53″**	Drilling Unit	:	**267**
		Long. 84° 37′ 33″	Date of commencement	:	**23.08.1991**
R. L.	:	**431.27 m.**	Date of completion	:	**28.01.1992**
Final Depth	:	**488.50 m.**	Logged by	:	K. Mondal
Water Table	:	**18.00 m. (Artesian)**			

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	3.00	3.00	1.00	Sludge.
3.00	5.90	2.90	1.00	Ferruginous fine grained sandstone.
5.90	14.00	8.10	5.30	Interbanded medium to coarse grained sandstone and fireclay.
14.00	16.00	2.00	1.50	Interbanded fire clay and grey shale.
16.00	18.14	2.14	2.14	Very coarse grained sandstone grades upward to medium grained sandstone.
18.14	18.60	0.46	0.46	Carbonaceous shale.
18.60	20.00	1.40	1.40	Grey shale interbanded with fine to medium grained sandstone.
20.00	20.40	0.40	0.40	Carbonaceous shale. (Seam Zone - VIII)
20.40	20.60	0.20	0.20	COAL.
20.60	21.00	0.40	0.40	Very coarse grained sandstone.
21.00	21.25	0.25	0.25	COAL.
21.25	21.90	0.65	0.65	Carbonaceous shale.
21.90	23.10	1.20	1.20	COAL.
23.10	24.10	1.00	1.00	Carbonaceous shale.
24.10	25.25	1.15	1.15	COAL.
25.25	30.50	5.25	5.25	Grey shale.
30.50	37.10	6.60	6.60	Interbanded grey shale, carbonaceous shale and very thin fine grained sandstone
37.10	37.35	0.25	0.25	Carbonaceous shale.
37.35	38.75	1.40	1.40	COAL.
38.75	39.85	1.10	1.10	Grey shale with carbonaceous shale.

39.85	44.75	4.90	4.90	Very coarse to coarse grained sandstone.
44.75	44.95	0.20	0.20	Grey shale.
44.95	49.30	4.35	4.35	COAL.
49.30	51.95	2.65	2.65	Carbonaceous shale. Top grey shale.
51.95	59.65	7.70	7.70	Coarse to very coarse grained sandstone with interbands of grey shale.
59.65	73.50	13.85	13.85	Very coarse grained sandstone grades upward to fine grained sandstone.
73.50	74.90	1.40	1.40	COAL. (Seam Zone - VIII)
74.90	80.90	6.00	6.00	Coarse grained arkosic sandstone.
80.90	95.38	14.48	14.48	Medium grained arkosic cross-bedded sandstone fining upward to very fine grained sandstone to grey shale.
95.38	102.45	7.07	7.07	Very coarse grained arkosic sandstone grades upward to grey shale.
102.45	111.80	9.35	9.35	Very coarse grained arkosic sandstone fining upward to fine grained sandstone intercalated with grey shale.
111.80	132.00	20.20	20.20	Very coarse grained sandstone fining upward to fine grained sandstone.
132.00	133.95	1.95	1.95	Fine to very fine grained sandstone interbanded with grey shale.
133.95	134.05	0.10	0.10	COAL.
134.05	139.20	5.15	5.15	Very coarse grained arkosic sandstone fining upward to silty shale.
139.20	148.10	8.90	8.70	Medium grained arkosic sandstone interbanded with grey shale.
148.10	155.50	7.40	7.40	Interbanded coarse to very coarse grained arkosic sandstone and fine grained sandstone with silty laminae.
155.50	231.00	75.50	75.50	Dark grey to grey shale with siderite shale bands at places. Rootlets.
231.00	232.10	1.10	1.10	Fine to medium grained sandstone with disrupted shale laminae.
232.10	232.22	0.12	0.12	Carbonaceous shale. (Seam Zones – VII + VI)
232.22	235.50	3.28	3.28	COAL. (Seam Zones – VII + VI)
235.50	238.10	2.60	2.60	Grey to dark grey shale banded with carbonaceous shale and coarse grained sandstone band towards top.

238.10	238.95	0.85	0.85	COAL.	
238.95	242.20	3.25	3.25	Carbonaceous shale intercalated with grey shale.	
242.20	242.38	0.18	0.18	COAL.	
242.38	243.15	0.77	0.77	Carbonaceous shale.	
243.15	252.05	8.90	8.60	Grey shale.	
252.05	252.30	0.25	0.25	COAL.	
252.30	252.40	0.10	0.10	Grey shale.	
252.40	252.73	0.33	0.33	COAL.	
252.73	253.05	0.32	0.32	Grey shale.	
253.05	255.25	2.20	2.20	COAL.	(Seam Zones – VII + VI)
255.25	256.15	0.90	0.90	Carbonaceous shale.	
256.15	256.40	0.25	0.25	COAL.	
256.40	256.80	0.40	0.40	Grey shale.	
256.80	257.10	0.30	0.30	COAL.	
257.10	258.70	1.60	1.60	Grey shale.	
258.70	258.90	0.20	0.20	COAL.	
258.90	260.00	1.10	1.10	Grey shale.	
260.00	260.40	0.40	0.40	COAL.	
260.40	264.60	4.20	4.20	Coarse grained arkosic sandstone.	
264.60	264.70	0.10	0.10	Carbonaceous shale.	
264.70	275.40	10.70	10.70	COAL.	(Seam Zones – VII + VI)
275.40	276.60	1.20	1.20	Grey shale.	
276.60	277.30	0.70	0.70	COAL.	
277.30	288.05	10.75	10.75	Grey shale interbanded with carbonaceous shale and fine to medium grained sandstone.	
288.05	289.39	1.34	1.34	Carbonaceous shale.	
289.39	290.30	0.91	0.91	COAL.	(Seam Zones – VII + VI)
290.30	291.40	1.10	1.10	Grey shale.	
291.40	291.85	0.45	0.45	COAL.	
291.85	294.72	2.87	2.87	Fine grained sandstone grades upward to grey shale.	
294.72	299.50	4.78	4.78	Coarse grained sandstone grades upward to grey shale.	

299.50	303.20	3.70	3.70	Grey shale with coarse grained sandstone band at middle and at top Glossopteris.
303.20	303.90	0.70	0.70	COAL.
303.90	305.20	1.30	1.30	Siltstone interlaminated with grey shale.
305.20	305.60	0.40	0.40	COAL.
305.60	312.65	7.05	7.05	Grey shale interbanded with carbonaceous shale and fine to medium grained sandstone. Glossopteris at 307.15m.
312.65	315.25	2.60	2.60	COAL. (Seam Zones - VII + VI)
315.25	319.35	4.10	4.10	Grey shale intercalated with carbonaceous shale with a coarse sandstone band at middle.
319.35	330.30	10.95	10.95	Grey shale with interbands of siltstone and fine grained sandstone. Slickensides at 326.85m. to330.30 m. Fracture 50° – 60°.
330.30	333.15	2.85	2.85	Grey shale with coarse sandstone interbands, highly slickensided with silicification (331.50m), Fault?
333.15	337.50	4.35	4.35	Coarse grained sandstone grades upward to medium grained sandstone.
337.50	342.60	5.10	5.10	Medium to coarse grained sandstone with interbands of grey shale and carbonaceous shale.
342.60	346.40	3.80	3.80	Grey shale intercalated with carbonaceous shale with medium grained sandstone lense at middle.
346.40	346.90	0.50	0.50	COAL. (Seam Zones – V + IV).
346.90	348.00	1.10	1.10	Grey shale, rootlets.
348.00	348.40	0.40	0.40	COAL.
348.40	349.45	1.05	1.05	Grey shale with interbands of fine grained sandstone.
349.45	351.90	2.45	2.45	Carbonaceous shale with occasional medium grained sandstone.
351.90	355.00	3.10	3.10	Very coarse grained sandstone fining upward to fine grained sandstone .
355.00	355.50	0.50	0.50	Grey shale with Glossopteris, Schizoneura.
355.50	355.80	0.30	0.30	COAL.
355.80	361.25	5.45	5.45	Medium grained sandstone grades upward to grey shale. Glossopteris, Schizoneura at 358.00m. to 361.25m.

Slickensided at 361.25m.

361.25	372.33	11.08	11.08	Grey to dark grey shale intercalated with carbonaceous shale, banded with fine to very fine grained sandstone towards bottom. Glossopteris and Vertebraria within 364.00m. to 366.00m. depth.
372.33	372.63	0.30	0.30	COAL.
372.63	372.93	0.30	0.30	Grey shale.
372.93	373.23	0.30	0.30	COAL.
373.23	374.34	1.11	1.11	Grey shale, bottom carbonaceous shale.
374.34	374.74	0.40	0.40	COAL.
374.74	375.44	0.70	0.70	Grey shale.
375.44	375.71	0.27	0.27	COAL.
375.71	376.46	0.75	0.75	Grey shale.
376.46	377.96	1.50	1.50	COAL.
377.96	381.20	3.24	3.24	Very coarse grained sandstone grades upward to grey shale.
381.20	381.55	0.35	0.35	Grey shale.
381.55	381.90	0.35	0.35	COAL.
381.90	382.00	0.10	0.10	Grey shale.
382.00	382.15	0.15	0.15	COAL.
382.15	384.40	2.25	2.25	Grey shale.
384.40	384.88	0.48	0.48	COAL.
384.88	388.05	3.17	3.17	Grey shale with interbands of medium to coarse grained cross-bedded sandstone.
388.05	396.00	7.95	7.95	Grey shale intercalated with carbonaceous shale with occasional interbands of fine grained sandstone at middle.
396.00	396.40	0.40	0.40	COAL.
396.40	401.70	5.30	5.30	Grey shale with thin coal bands at places.
401.70	402.05	0.35	0.35	COAL.
402.05	402.50	0.45	0.45	Carbonaceous shale.
402.50	403.95	1.45	1.45	Interbanded grey shale and medium grained sandstone.

403.95	404.30	0.35	0.35	COAL.
404.30	410.95	6.65	6.65	Grey shale interbanded with fine grained sandstone.
410.95	411.40	0.45	0.45	Coarse to very coarse grained arkosic sandstone.
411.40	411.90	0.50	0.50	COAL.
411.90	412.35	0.45	0.45	Carbonaceous shale with 0.15m. coal band at 412.12m. depth.
412.35	413.15	0.80	0.80	Grey shale.
413.15	413.30	0.15	0.15	COAL.
413.30	413.95	0.65	0.65	Grey shale with thin coal bands.
413.95	414.08	0.13	0.13	Carbonaceous shale.
414.08	416.45	2.37	2.37	COAL.
416.45	416.55	0.10	0.10	Carbonaceous shale.
416.55	416.85	0.30	0.30	Grey shale with thin vitrain laminae.
416.85	417.10	0.25	0.25	COAL.
417.10	417.35	0.25	0.25	Grey shale.
417.35	418.05	0.70	0.70	COAL.
418.05	419.30	1.25	1.25	Grey shale.
419.30	420.22	0.92	0.92	COAL.
420.22	420.45	0.23	0.23	Carbonaceous shale.
420.45	424.70	4.25	4.25	Coarse grained sandstone grades upward to grey shale.
424.70	433.50	8.80	8.80	COAL. (Seam Zones – V + IV)
433.50	434.70	1.20	1.20	Grey shale interlaminated with fine grained sandstone.
434.70	434.85	0.15	0.15	Carbonaceous shale.
434.85	436.35	1.50	1.50	COAL.
436.35	436.70	0.35	0.35	Carbonaceous shale.
436.70	445.10	8.40	8.40	COAL.
445.10	446.05	0.95	0.95	Carbonaceous shale interbanded with medium to coarse grained sandstone.
446.05	446.29	0.24	0.24	Carbonaceous shale.
446.29	447.00	0.71	0.71	COAL. (Seam Zones – V + IV)
447.00	453.00	6.00	6.00	Interbanded grey shale medium to coarse and fine grained

				sandstone. 10cm. coal band at 448.85m.
453.00	456.75	3.75	3.75	Top 0.25m. carbonaceous shale, rest interbanded very coarse to coarse grained sandstone and grey shale.
456.75	463.25	6.50	6.50	Interbanded and intercalated grey shale, fine grained sandstone and medium to coarse grained sandstone.
463.25	474.29	11.04	11.04	Alternation and intercalation of coarse to very coarse grained sandstone, grey shale and siltstone.
474.29	484.00	9.71	9.71	Very coarse grained felspathic sandstone.
484.00	488.50	4.50	4.50	Very coarse grained sandstone banded with medium grained sandstone and grey shale towards top.

Borehole closed at 488.50 m. depth in Barakar Formation

Borehole No. : AB – 6

Location	:	**Lat. 23° 44′ 44″**	Drilling Unit	:	**378**
		Long. 84° 38′ 27″	Date of commencement	:	**08.09.1991**
R. L.	:	**432.50 m.**	Date of completion	:	**21.11.1991**
Final Depth	:	**377.00 m.**	Logged by	:	K. Mondal
Water Table	:	**7.50m. and 38.00m.(Artesian)**			

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	4.00	4.00	0.10	Sludge of yellow coarse grained sand.
4.00	9.50	5.50	2.00	Coarse to very coarse grained ferruginous sandstone.
9.50	12.50	3.00	2.50	Very coarse grained ferruginous sandstone grades upward to sideritic shale.
12.50	24.90	12.40	12.40	Very coarse to gritty sandstone grades upward to very fine grained sandstone.
24.90	26.45	1.55	1.55	Grey to dark grey shale.
26.45	27.00	0.55	0.55	COAL. (Seam Zone – V)
27.00	28.35	1.35	1.35	Grey to dark grey shale.
28.35	32.00	3.65	3.65	COAL. Core dip 16° to 19°.
32.00	33.20	1.20	1.20	Dark grey shale with interbands of fine grained sandstone at middle.
33.20	33.85	0.65	0.65	Carbonaceous shale.
33.85	34.00	0.15	0.15	COAL.
34.00	34.70	0.70	0.70	Siltstone.
34.70	34.85	0.15	0.15	COAL.
34.85	35.60	0.75	0.75	Very coarse grained sandstone grades upward to very fine grained carbonaceous sandstone.
35.60	35.65	0.05	0.05	COAL.
35.65	43.70	8.05	8.05	Very coarse grained arkosic sandstone grades upward to fine grained sandstone.
43.70	46.80	3.10	3.10	Very coarse grained gritty sandstone grades upward to carbonaceous siltstone.

46.80	47.10	0.30	0.30	Dark grey shale.
47.10	47.30	0.20	0.20	COAL.
47.30	47.70	0.40	0.40	Fine to medium grained sandstone.
47.70	47.87	0.17	0.17	Carbonaceous shale.
47.87	49.76	1.89	1.89	COAL.
49.76	49.95	0.19	0.19	Carbonaceous shale.
49.95	53.70	3.75	3.75	Very coarse grained sandstone grades upward to very fine grained ferruginous sandstone.
53.70	56.47	2.77	2.77	COAL.
56.47	56.55	0.08	0.08	Carbonaceous shale.
56.55	57.85	1.30	1.30	Dark grey shale.
57.85	58.00	0.15	0.15	COAL. (Seam Zone – V)
58.00	60.80	2.80	2.80	Very fine to fine grained sandstone interbanded with grey shale, carbonaceous shale and at places medium to coarse grained sandstone.
60.80	70.85	10.05	10.05	Very coarse grained sandstone grades upward to grey shale.
70.85	80.85	10.00	10.00	Very coarse grained sandstone grades upward to fine grained sandstone.
80.85	90.36	9.51	9.51	Coarse to very coarse grained sandstone with interbands of grey to dark grey shale.
90.36	90.46	0.10	0.10	COAL. (Seam Zone – IV)
90.46	92.21	1.75	1.75	Grey shale with interbands of fine to medium grained sandstone at middle.
92.21	92.31	0.10	0.10	COAL.
92.31	97.80	5.49	5.49	Medium to coarse grained arkosic sandstone with interband of fine to very fine grained sandstone and grey shale. Glossopteris at 92.50m. to 96.00m. depth.
97.80	99.85	2.05	2.05	Very coarse grained feldspathic sandstone grades upward to dark grey shale.
99.85	100.35	0.50	0.50	Very fine grained crudely cross-bedded felspathic sandstone.
100.35	101.60	1.25	1.25	Dark grey shale, Glossopteris.
101.60	101.75	0.15	0.15	COAL.

101.75	102.70	0.95	0.95	Dark grey shale, Glossopteris.
102.70	106.95	4.25	4.25	Coarse to very coarse grained arkosic sandstone.
106.95	111.85	4.90	4.90	Grey to dark grey shale with coarser sand band towards bottom. Glossopteris at 108.00m. to 109.50m. depth.
111.85	116.15	4.30	4.30	Grey to dark grey shale interbanded with fine grained sandstone and occasional coarse grained sandstone bands.
116.15	123.40	7.25	7.25	Grey to dark grey shale with interbands of fine grained sandstone.
123.40	127.05	3.65	3.65	Grey to dark grey shale with ironstone shale interbands.
127.05	128.00	0.95	0.95	COAL. (Seam Zone – IV)
128.00	129.45	1.45	1.45	Very fine grained sandstone with occasional coarse grained sandstone band.
129.45	135.25	5.80	5.80	Alternation and intercalation of grey shale and siltstone, slickensided at bottom.
135.25	140.10	4.85	4.85	Very coarse grained sandstone grades upward to grey shale.
140.10	142.55	2.45	2.45	Coarse grained sandstone grades upward to grey shale.
142.55	147.00	4.45	4.45	Coarse to very coarse grained sandstone with grey shale at top.
147.00	151.10	4.10	4.10	Medium grained sandstone grades upward to grey shale.
151.10	151.47	0.37	0.37	COAL.
151.47	151.70	0.23	0.23	Carbonaceous shale.
151.70	154.45	2.75	2.75	Grey shale with interbands of fine to medium grained sandstone at middle.
154.45	155.65	1.20	1.20	COAL.
155.65	163.50	7.85	7.85	Alternation and intercalation of grey shale and coarse grained arkosic sandstone, bottom grey shale, Glossopteris at 162.15m. to 163.45m. depth.
163.50	166.95	3.45	3.45	COAL.
166.95	168.70	1.75	1.75	Coarse grained sandstone with interbands of fine grained sandstone and grey shale, top grey shale.
168.70	173.25	4.55	4.55	Very coarse grained sandstone fining upward to grey shale.
173.25	182.35	9.10	9.10	Alternation and intercalation of grey shale, siltstone, medium and coarse grained sandstone. Glossopteris at 173.30m. to 182.35m. depth.

182.35	187.05	4.70	4.70	COAL.
187.05	188.45	1.40	1.40	Alternation of grey shale and fine grained sandstone, Glossopteris at 187.20m. to 188.45m. depth.
188.45	188.55	0.10	0.10	COAL.
188.55	197.45	8.90	8.90	Alternation of medium grained sandstone and grey shale, bottom grey shale, Glossopteris and Vertebraria at 189.00m. to 196.00m. depth.
197.45	208.20	10.75	10.75	COAL. (Seam Zone – III)
208.20	208.65	0.45	0.45	Carbonaceous shale.
208.65	209.95	1.30	1.30	Grey shale.
209.95	214.50	4.55	4.55	COAL.
214.50	214.80	0.30	0.30	Grey shale.
214.80	221.10	6.30	6.30	COAL.
221.10	224.55	3.45	3.45	Fine grained sandstone interbanded with grey shale, top and bottom fine grained sandstone.
224.55	228.35	3.80	3.80	COAL.
228.35	232.40	4.05	4.05	Alternation of siltstone and grey shale, top siltstone, bottom grey shale.
232.40	243.45	11.05	11.05	COAL. (Seam Zone – III)
243.45	247.80	4.35	4.35	Coarse grained sandstone grades upward to carbonaceous shale.
247.80	253.80	6.00	6.00	Medium grained sandstone interbanded with grey shale, Glossopteris at 249.10m. depth.
253.80	254.70	0.90	0.90	Grey shale.
254.70	255.55	0.85	0.85	Carbonaceous shale.
255.55	256.20	0.65	0.65	COAL.
256.20	258.80	2.60	2.60	Coarse grained sandstone with grey shale at top.
258.80	262.55	3.75	3.75	Grey shale intercalated with carbonaceous shale.
262.55	266.60	4.05	4.05	Coarse grained sandstone.
266.60	274.80	8.20	8.20	Coarse grained sandstone fining upward to fine grained sandstone with grey shale.
274.80	276.15	1.35	1.35	Coarse grained sandstone fining upward to fine grained

				sandstone.	
276.15	280.25	4.10	4.10	Coarse grained sandstone fining upward to grey shale.	
280.25	287.00	6.75	6.75	Conglomerate fining upward to fine grained sandstone with grey shale.	
287.00	295.75	8.75	8.75	Medium grained sandstone with interbands of fine to very fine grained sandstone.	
295.75	296.25	0.50	0.50	Grey shale.	
296.25	297.25	1.00	1.00	Carbonaceous shale.	(Seam Zone – II)
297.25	299.25	2.00	2.00	COAL.	(Seam Zone – II)
299.25	299.55	0.30	0.30	Carbonaceous shale.	(Seam Zone – II)
299.55	302.20	2.65	2.65	Unsorted and angular clasts of quartz and felspar embedded within grey carbonaceous fine to medium grained sandy matrix. (Debris flow conglomerate).	
302.20	306.75	4.55	4.55	Coarse grained sandstone fining upward to fine grained sandstone with grey shale.	
306.75	310.25	3.50	3.50	Fine grained sandstone interbanded with grey shale, bottom grey shale, slickensided with silicification at 306.95m. to 310.25m. depth. Fault at 306.95m. to 309.00m. depth.	
310.25	310.65	0.40	0.40	COAL.	
310.65	315.40	4.75	4.75	Grey shale interbanded with very coarse grained arkosic sandstone.	
315.40	318.95	3.55	3.55	Very coarse grained to pebbly sandstone fining upward to medium grained sandstone.	
318.95	323.65	4.70	4.70	Coarse grained sandstone fining upward to grey shale. Slickensided ai 319.00m. to 323.35m. depth.	
323.65	332.45	8.80	8.80	Very coarse to coarse grained sandstone interbanded with grey shale. Glossopteris at 331.00m. to 332.45m. depth.	
332.45	336.15	3.70	3.70	Very coarse grained to pebbly sandstone fining upward to grey shale.	
336.15	343.85	7.70	7.70	Grey shale interbanded with carbonaceous shale. Bottom 1.30m. carbonaceous shale. Glossopteris, Vertebraria and Schizoneura at 337.25m. to 338.50m. depth.	
343.85	344.25	0.40	0.40	COAL.	

344.25	348.20	3.95	3.95	Very coarse grained arkosic sandstone fining upward to grey shale. Slickensided at middle.
348.20	350.40	2.20	2.20	Very coarse grained arkosic sandstone fining upward to grey shale.
350.40	358.35	7.95	7.95	Pebbly sandstone fining upward to carbonaceous shale bottom with red shale intercalation.
358.35	365.80	7.45	7.45	Pebbly sandstone fining upward to red shale.

----------Contact between Barakar Formation and Talchir Formation----------

365.80	374.00	8.20	8.20	Coarse grained mottled green to greenish sandstone with red shale intercalation; fresh , angular felspar at places.
374.00	377.00	3.00	3.00	Medium to fine grained micaceous green to greenish grey sandstone with fresh felspar at places.

Borehole closed at 377.00 m. depth in Talchir Formation

Borehole No. : AB – 7

Location	:	**Lat. 23° 43′ 59″**	Drilling Unit	:	**378**
		Long. 84° 39′ 06″	Date of commencement	:	**04.12.1991**
R. L.	:	**441.96 m.**	Date of completion	:	**02.02.1992**
Final Depth	:	**430.15 m.**	Logged by	:	K. Mondal

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	7.65	7.65	0.20	Sludge of medium grained sand..
7.65	14.70	7.05	7.05	Coarse to very coarse grained sandstone interbanded with grey shale and sandy shale.
14.70	16.75	2.05	2.05	Interbanded and intercalated fine grained sandstone and grey shale.
16.75	17.00	0.25	0.25	Carbonaceous shale. (Seam Zone – VII)
17.00	17.25	0.25	0.25	COAL. (Seam Zone – VII)
17.25	21.10	3.85	3.85	Carbonaceous fine grained sandstone with grey shale interbanding.
21.10	21.35	0.25	0.25	COAL.
21.35	23.15	1.80	1.80	Interbanded and intercalated coarse to medium grained sandstone and grey shale.
23.15	23.55	0.40	0.40	Carbonaceous shale.
23.55	27.15	3.60	3.60	Very coarse grained sandstone interbanded with grey shale.
27.15	29.30	2.15	2.15	Alternation of coarse to very coarse grained sandstone and gritty sandstone.
29.30	32.50	3.20	3.20	Medium to coarse grained sandstone interbanded with fine grained sandstone.
32.50	33.40	0.90	0.90	Grey shale, bottom slickensided.
33.40	33.85	0.45	0.45	COAL. (Seam Zone – VII)
33.85	39.30	5.45	5.45	Grey shale interbanded with fine to very fine grained sandstone, often bioturbated.
39.30	45.25	5.95	5.95	Very coarse grained to granular arkosic crudely cross-bedded sandstone.

45.25	53.15	7.90	7.90	Coarse grained sandstone grades upward to grey shale.
53.15	54.25	1.10	1.10	Carbonaceous shale.
54.25	55.25	1.00	1.00	COAL.
55.25	56.40	1.15	1.15	Fine grained bioturbated sandstone.
56.40	57.45	1.05	1.05	Coarse grained sandstone grades upward to grey shale.
57.45	57.85	0.40	0.40	Grey shale.
57.85	57.95	0.10	0.10	COAL.
57.95	61.70	3.75	3.75	Very fine grained argillaceous sandstone interlaminated with grey shale.
61.70	62.35	0.65	0.65	Carbonaceous shale.
62.35	63.75	1.40	1.40	Fine grained sandstone interlaminated with grey shale and carbonaceous shale. Bottom 0.20m. carbonaceous shale.
63.75	63.90	0.15	0.15	COAL.
63.90	70.85	6.95	6.95	Interbanded and intercalated fine to medium grained sandstone (bioturbated) and grey shale.
70.85	72.85	2.00	2.00	Very coarse grained to granular sandstone.
72.85	75.65	2.80	2.80	Coarse grained sandstone interbanded with grey shale and siltstone.
75.65	75.90	0.25	0.25	COAL. (Seam Zone – VI)
75.90	81.95	6.05	6.05	Fine to very fine grained sandstone interbanded with grey shale, often bioturbated.
81.95	82.30	0.35	0.35	COAL.
82.30	83.80	1.50	1.50	Grey shale.
83.80	84.05	0.25	0.25	COAL.
84.05	85.20	1.15	1.15	Grey shale.
85.20	86.80	1.60	1.60	Very coarse grained cross-bedded sandstone.
86.80	86.90	0.10	0.10	COAL.
86.90	87.80	0.90	0.90	Sandy shale interbanded with fine grained sandstone.
87.80	87.95	0.15	0.15	COAL.
87.95	89.25	1.30	1.30	Very coarse to gritty sandstone.
89.25	90.10	0.85	0.85	COAL.

90.10	90.90	0.80	0.80	Interbanded grey shale and fine to medium grained sandstone, bottom grey shale.
90.90	92.27	1.37	1.37	COAL.
92.27	95.60	3.33	3.33	Alternation of fine grained sandstone and grey shale, bottom grey shale.
95.60	96.05	0.45	0.45	COAL
96.05	96.75	0.70	0.70	Grey shale.
96.75	97.05	0.30	0.30	COAL.
97.05	97.50	0.45	0.45	Grey shale.
97.50	98.60	1.10	1.10	COAL.
98.60	99.70	1.10	1.10	Grey shale interbanded with fine grained sandstone, bioturbated at places.
99.70	103.50	3.80	3.80	Coarse to very coarse grained cross-bedded arkosic sandstone.
103.50	105.60	2.10	2.10	Grey shale.
105.60	106.80	1.20	1.20	COAL.
106.80	109.75	2.95	2.95	Interbanded grey shale and coarse to medium grained sandstone with coal bands of 0.10m., 0.13m., 0.20m. at 107.24m., 108.05m. and 108.50m. depth respectively.
109.75	110.10	0.35	0.35	COAL. (Seam Zone – VI)
110.10	112.80	2.70	2.70	Very coarse grained to gritty sandstone fining upward to grey shale.
112.80	129.60	16.80	16.80	Alternate banding of medium grained sandstone, grey shale and fine grained sandstone.
129.60	130.40	0.80	0.80	Grey shale.
130.40	131.00	0.60	0.60	Carbonaceous shale. (Seam Zone – V)
131.00	138.75	7.75	7.75	COAL. (Seam Zone – V)
138.75	142.80	4.05	4.05	Grey shale interbanded with very fine and coarse grained sandstone.
142.80	142.95	0.15	0.15	COAL.
142.95	144.05	1.10	1.10	Grey shale.

144.05	144.15	0.10	0.10	COAL.
144.15	151.55	7.40	7.40	Fine to medium grained sandstone interbanded with grey shale with two 0.25m. thick coal bands at 145.05m. and 146.40m. depth.
151.55	151.85	0.30	0.30	COAL.
151.85	152.55	0.70	0.70	Coarse grained sandstone.
152.55	152.78	0.23	0.23	Carbonaceous shale.
152.78	153.30	0.52	0.52	COAL. (Seam Zone – V)
153.30	155.63	2.33	2.33	Coarse grained sandstone interbanded with fine grained sandstone and grey shale.
155.63	155.88	0.25	0.25	COAL. (Seam Zone – V)
155.88	163.75	7.87	7.87	Alternate banding of coarse to medium grained sandstone, fine grained sandstone and grey shale.
163.75	164.15	0.40	0.40	Carbonaceous shale.
164.15	168.10	3.95	3.95	Interbanded medium to fine grained sandstone and grey shale.
168.10	176.22	8.12	8.12	Very coarse to gritty sandstone fining upward to sandy shale.
176.22	181.70	5.48	5.48	Interbanded grey shale, medium to coarse and fine grained sandstone. Bioturbation at places.
181.70	183.70	2.00	2.00	Grey shale.
183.70	183.80	0.10	0.10	COAL.
183.80	186.30	2.50	2.50	Grey shale interbanded and intercalated with medium to fine grained sandstone, bottom slickensided, rootlets, Vertebraria at places within grey shale.
186.30	186.42	0.12	0.12	Carbonaceous shale. (Seam Zone – IV)
186.42	192.18	5.76	5.76	COAL. (Seam Zone – IV)
192.18	192.30	0.12	0.12	Sideritic shale.
192.30	196.00	3.70	3.70	Very coarse grained arkosic sandstone interbanded with grey shale and fine grained sandstone, bottom grey shale.
196.00	196.85	0.85	0.85	COAL. (Seam Zone – IV)
196.85	196.95	0.10	0.10	Carbonaceous shale.
196.95	197.85	0.90	0.90	Grey shale interbanded and intercalated with fine and medium grained sandstone. Bottom grey shale.

197.85	198.85	1.00	1.00	COAL. (Seam Zone – IV)
198.85	199.95	1.10	1.10	Interbanded and laminated fine grained sandstone and grey shale. Bottom fine grained sandstone.
199.95	201.90	1.95	1.95	COAL. (Seam Zone – IV)
201.90	202.40	0.50	0.50	Fine to medium grained carbonaceous sandstone with dispersed quartz and felspar clasts.
202.40	202.52	0.12	0.12	Carbonaceous shale.
202.52	202.92	0.40	0.40	COAL.
202.92	203.55	0.63	0.63	Carbonaceous shale.
203.55	220.40	16.85	16.85	Interbanded and intercalated very coarse to coarse, medium to fine grained sandstone and grey shale. Bioturbation occasional.
220.40	222.45	2.05	2.05	Interbanded grey shale and fine grained sandstone.
222.45	223.35	0.90	0.90	Unsorted and angular clasts of quartz and felspar embedded within the grey carbonaceous fine to medium sandy matrix (Debris flow conglomerate).
223.35	226.10	2.75	2.75	Very coarse to coarse grained felspathic sandstone, bottom 50 cm. grey shale.
226.10	229.45	3.35	3.35	COAL.
229.45	232.15	2.70	2.70	Grey shale interbanded with fine to medium grained sandstone, top grey shale.
232.15	232.25	0.10	0.10	COAL.
232.25	232.55	0.30	0.30	Fine grained sandstone.
232.55	232.75	0.20	0.20	COAL. (Seam Zone – IV)
232.75	234.70	1.95	1.95	Medium grained sandstone with grey shale interbands.
234.70	234.80	0.10	0.10	COAL. (Seam Zone – IV)
234.80	235.00	0.20	0.20	Grey shale.
235.00	241.10	6.10	6.10	Interbanded and intercalated fine to medium grained sandstone, coarse to very coarse grained sandstone and grey shale with signature of bioturbation at places.
241.10	247.90	6.80	6.80	Granular to pebbly felspathic sandstone.
247.90	254.07	6.17	6.17	Grey shale interbanded and intercalated with fine to medium grained sandstone (cross-bedded).
254.07	259.43	5.36	5.36	Grey shale laminated and banded with siltstone, medium to fine

				grained cross-bedded sandstone.
259.43	272.40	12.97	12.97	Coarse to very coarse grained sandstone banded with fine grained sandstone and grey shale.
272.40	281.05	8.65	8.65	Grey shale interlaminated with siltstone and fine grained sandstone with occasional bands of coarse grained sandstone. Glossopteris, Vertebraria and burrows signature at places. Bottom grey shale.
281.05	308.65	27.60	27.60	COAL. (Seam Zone – III)
308.65	326.00	17.35	17.35	Grey shale interbanded / laminated with siltstone, fine grained sandstone. Top grey shale.
326.00	327.40	1.40	1.40	Interbanded medium grained sandstone with siltstone and grey shale.
327.40	358.52	31.12	31.12	Very coarse to granular arkosic sandstone.
358.52	398.27	39.75	39.75	COAL. (Seam Zone – II)
398.27	408.70	10.43	10.43	Grey shale interbanded with medium to coarse grained sandstone. Top grey shale.
408.70	420.55	11.85	11.85	Very coarse to granular sandstone interbanded with grey shale and fine to medium grained sandstone. Signature of slumping and faulting at places.
420.55	428.05	7.50	7.50	Interbanded coarse to very coarse grained sandstone and grey shale with fine to medium grained sandstone laminae.
428.05	430.15	2.10	2.10	Grey shale interbanded with fine to medium grained sandstone, thin coal bands at places.

Borehole closed at 430.15 m. depth in Barakar Formation.

Borehole No. : AB – 8

Location	:	**Lat. 23° 45′ 00″**	Drilling Unit	:	**267**
		Long. 84° 36′ 53″	Date of commencement	:	**12.02.1992**
R. L.	:	**415.49 m.**	Date of completion	:	**20.07.1992**
Final Depth	:	**534.00 m.**	Logged by	:	K. Mondal

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	5.70	5.70	0.30	Sludge of fine grained sand.
5.70	11.10	5.40	2.40	Fine to medium grained micaceous sandstone laminated with clay.
11.10	15.50	4.40	3.00	Light grey to greenish grey shale / mudstone with laminae of very fine grained sandstone towards bottom. Vertebraria, rootlets and Schizoneura.
15.50	19.35	3.85	3.00	Greenish grey, micaceous, hard and compact very fine to fine grained sandstone intercalated with grey shale. Vertebraria, rootlets at 16.00m. Slickensided at 18.00m.
19.35	19.50	0.15	0.15	COAL.
19.50	28.50	9.00	9.00	Interbanded fine grained micaceous cross-laminated sandstone and grey shale, silty shale with slumping signatures. Rootlets at bottom. Top with fine grained sandstone.
28.50	33.27	4.77	4.77	Interbanded and interlaminated medium grained sandstone, grey shale, siltstone and fine grained sandstone. Bottom with grey shale.
33.27	33.40	0.13	0.13	COAL.
33.40	37.90	4.50	4.50	Grey shale interbanded and laminated with siltstone and very fine grained cross-laminated sandstone. Bioturbation at places. Grey shale at top.
37.90	40.70	2.80	2.80	Grey shale intercalated with carbonaceous shale, Glossopteris and Anthracanauta lamilebranch at 40.61m. in silty shale / grey shale unit.
40.70	41.35	0.65	0.65	Carbonaceous shale with thin coal bands.
41.35	42.10	0.75	0.75	Dark grey shale.
42.10	42.40	0.30	0.30	Carbonaceous shale with thin coal bands.

42.40	43.35	0.95	0.95	Dark grey shale intercalated with carbonaceous shale, Schizoneura.
43.35	43.45	0.10	0.10	COAL.
43.45	48.05	4.60	4.60	Grey shale interbanded and laminated with fine to very fine grained cross-bedded sandstone and siltstone. Top 50cm. grey shale. Anthracanauta lamilebranch species in grey shale at 43.80m. Bioturbation at middle.
48.05	49.84	1.79	1.79	Grey shale.
49.84	50.82	0.98	0.98	Fine sandstone interbanded and laminated with grey shale, burrowing present at places.
50.82	50.92	0.10	0.10	COAL.
50.92	53.65	2.73	2.73	Top 80cm. grey shale and rest is interbanded / laminated with fine cross-laminated sandstone.
53.65	53.85	0.20	0.20	COAL.
53.85	55.99	2.14	2.14	Top 60cm. grey shale and rest medium to coarse grained felspathic sandstone.
55.99	62.80	6.81	6.81	Interbedded grey shale and fine to very fine grained compact, less felspathic cross-laminated and wavy bedded sandstone.
62.80	64.15	1.35	1.35	Very coarse grained sandstone.
64.15	68.13	3.98	3.98	Interbanded grey shale and very fine micaceous compact sandstone. Bottom 30cm. carbonaceous shale.
68.13	68.18	0.05	0.05	COAL.
68.18	77.35	9.17	9.17	Interbanded and laminated coarse to very coarse grained sandstone, medium grained cross-bedded sandstone and grey shale. Schizoneura at 69.05m. depth.
77.35	80.65	3.30	3.30	Grey shale interlaminated and intercalated with fine grained sandstone. Vertebraria in grey shale.
80.65	80.80	0.15	0.15	COAL.
80.80	82.05	1.25	1.20	Grey shale with a coarse grained sandstone band, Vertebraria, rootlets.
82.05	82.40	0.35	0.35	COAL with carbonaceous shale laminae.
82.40	86.90	4.50	4.30	Grey shale interlaminated with siltstone towards top. Rootlets, Vertebraria. Bottom slickensided.
86.90	102.10	15.20	15.00	Grey shale interbanded with coarse to medium grained,

				compact micaceous cross-bedded sandstone, Vertebraria, rootlets. Core dip 20° to 25°.
102.10	104.65	2.55	2.55	Grey shale interlaminated and intercalated with siltstone. Slickensided at 102.90m. to 103.10m. Burrowing, Glossopteris.
104.65	104.80	0.15	0.15	COAL.
104.80	112.35	7.55	7.55	Grey shale interlaminated and intercalated with siltstone and very fine grained cross-laminated and wavy laminated sandstone. Burrowing at top, Vertebraria at middle.
112.35	112.45	0.10	0.10	COAL.
112.45	121.75	9.30	9.30	Grey shale interlaminated with siltstone and very fine grained compact, micaceous sandstone. Vertebraria at 116.70m. depth.
121.75	125.70	3.95	3.95	Fine to medium grained compact, micaceous and calcereous cross-laminated sandstone. Core dip 8° to 12°.
125.70	134.80	9.10	9.10	Interbanded and laminated grey shale and fine to medium grained buff colored compact, micaceous sandstone. Vertebraria, Glossopteris, Schizoneura and rootlets towards top and middle.
134.80	134.95	0.15	0.15	COAL.
134.95	144.15	9.20	9.00	Interbedded sequence of grey shale, black shale and fine to very fine grained hard and compact micaceous, calcareous cross-laminated and wavy laminated sandstone. Slickenside towards top.
144.15	148.85	4.70	4.70	Dark grey shale with carbonaceous sandstone towards bottom. Glossopteris at 147.00m. depth.
148.85	150.45	1.60	1.60	Carbonaceous shale with a 0.17m. thick coal band at 149.30m. depth.
150.45	167.15	16.70	16.70	Grey shale interbanded / interlaminated with fine to very fine grained compact micaceous sandstone and siltstone, cross-laminated at middle. Vertebraria, Schizoneura, Glossopteris throughout the unit.
167.15	167.45	0.30	0.30	COAL.
167.45	185.50	18.05	18.05	Grey shale interbanded and interlaminated with fine to very fine grained compact, hard, cross-laminated, micaceous sandstone and carbonaceous shale. Highly bioturbated towards top,

				slickenside with silicification at 168.05m., 180.70m. Core dip 6° to 8° at 176.15m., 15° at 181.85m. and 21° at 183.10m.
185.50	186.90	1.40	1.40	Dark grey shale, Schizoneura, Glossopteris, Vertebraria.
186.90	188.30	1.40	1.40	Interlaminated grey shale and micaceous very fine cross-laminated sandstone, siltstone, Schizoneura.
188.30	193.10	4.80	4.80	Dark grey shale with thin silty laminae at places. Schizoneura, Glossopteris at top.
193.10	194.80	1.70	1.70	Interlaminated grey shale and fine grained sandstone.
194.80	201.25	6.45	6.45	Interbanded and interlaminated grey shale and coarse to very coarse grained cross-bedded sandstone and fine to very fine grained sandstone. Bottom grey shale.
201.25	201.40	0.15	0.15	COAL.
201.40	205.30	3.90	3.90	Medium to coarse grained sandstone interbanded and laminated with grey shale.
205.30	209.00	3.70	3.70	Fine to very fine grained sandstone interbanded and intercalated with grey shale, bottom coarse grained sandstone.
209.00	209.50	0.50	0.50	COAL with carbonaceous shale.
209.50	228.25	18.75	18.75	Coarse to very coarse grained cross-bedded sandstone, interbanded and laminated and often intercalated with medium to fine grained sandstone, very fine grained sandstone and grey shale.
228.25	242.65	14.40	14.40	Interbanded and laminated grey shale, fine grained sandstone, siltstone and often medium to coarse grained sandstone. Laminae at places biochurned.
242.65	249.10	6.45	6.45	Interbanded very coarse to gritty sandstone and fine to medium grained sandstone. Burrowing at middle.
249.10	257.70	8.60	8.60	Interlaminated grey shale and fine grained sandstone / siltstone. Top bioturbated.
				---------- Contact between Raniganj Formation and Barakar Formation ----------
257.70	271.00	13.30	13.30	Alternation and intercalation of very coarse to fine grained sandstone and grey shale. Burrowing towards bottom. Glossopteris, Schizoneura towards bottom.
271.00	276.50	5.50	5.50	Dark grey to grey shale laminated with siltstone / fine to very fine grained sandstone and at places carbonaceous shale.

				Glossopteris, Schizoneura towards top.
276.50	286.10	9.60	9.60	Very coarse to granular arkosic sandstone often banded with medium to fine grained sandstone. Biochurning, burrowing and slumping at middle.
286.10	303.30	17.20	17.20	Grey to dark grey shale interlaminated with siltstone and very fine to fine grained sandstone. Silicification at 302.40m. and burrowing towards bottom.
303.30	316.80	13.50	13.50	Heterolithic sequence of coarse to very coarse grained felspathic sandstone and fine to medium grained sandstone with grey shale and fine to very fine grained sandstone.
316.80	320.75	3.95	3.95	COAL. (Seam Zone – VIII)
320.75	321.50	0.75	0.75	Top 50cm. carbonaceous shale with thin coal bands and rest grey shale, sandy shale.
321.50	329.02	7.52	7.52	Interbanded and laminated very coarse to coarse grained sandstone and grey shale. Top half sandy and bottom half shaly.
329.02	329.50	0.48	0.48	COAL.
329.50	330.75	1.25	1.25	Grey shale intercalated with siltstone.
330.75	331.05	0.30	0.30	COAL.
331.05	338.30	7.25	7.25	Top 2.50m. very coarse grained sandstone and rest very fine grained sandstone interlaminated with grey shale and medium grained sandstone.
338.30	338.51	0.21	0.21	Carbonaceous shale.
338.51	338.90	0.39	0.39	COAL.
338.90	340.80	1.90	1.90	Grey shale intercalated with silty shale.
340.80	341.40	0.60	0.60	COAL.
341.40	343.35	1.95	1.95	Grey shale intercalated with siltstone and very coarse grained sandstone. Vertebraria towards top.
343.35	343.65	0.30	0.30	COAL.
343.65	345.90	2.25	2.25	Grey shale, Glossopteris.
345.90	347.10	1.20	1.20	COAL.
347.10	347.20	0.10	0.10	Carbonaceous shale.
347.20	349.35	2.15	2.15	Grey shale laminated with siltstone, carbonaceous shale and intercalated with coarse grained sandstone. Laminae biochurned at places.

349.35	349.65	0.30	0.30	COAL.
349.65	351.60	1.95	1.95	Grey shale laminated with siltstone and fine grained sandstone. Laminae biochurned at places
351.60	351.80	0.20	0.20	COAL.
351.80	352.45	0.65	0.65	Grey shale with very coarse grained sandstone.
352.45	362.70	10.25	10.25	COAL.
362.70	365.00	2.30	2.30	Very coarse grained to granular sandstone with fine grained sandstone and grey shale laminae.
365.00	365.65	0.65	0.65	COAL. (Seam Zone – VIII)
365.65	381.75	16.10	16.10	Coarse to very coarse grained cross-bedded sandstone interbanded with fine to medium grained sandstone and grey shale with carbonaceous shale, coal band of 40cm. at 380.60m. depth. Bioturbation at places.
381.75	393.10	11.35	11.35	Grey shale, laminated with siltstone and fine grained sandstone, banded with medium to coarse grained sandstone, rootlets, Vertebraria, Glossopteris, Schizoneura within depth range of 381.75m. to 389.85m. Burrows present at places.
393.10	393.60	0.50	0.50	COAL.
393.60	393.80	0.20	0.20	Carbonaceous shale.
393.80	401.75	7.95	7.95	Grey shale interlaminated and interbanded with fine grained sandstone and siltstone. Bioturbation at places. Rootlets, Schizoneura, Vertebraria within 400.40m. to 401.75m. depth.
401.75	406.40	4.65	4.65	Very coarse grained arkosic sandstone interbaned with grey shale, very fine grained sandstone, siltstone. Rootlets, Vertebraria within depth of 404.10m. and 406.40m.
406.40	408.17	1.77	1.77	COAL.
408.17	408.40	0.23	0.23	Carbonaceous shale.
408.40	426.60	18.20	18.20	Grey shale interbanded, interlaminated and intercalated with fine to very fine grained sandstone, siltstone and often medium to coarse grained sandstone with Debris flow deposit. Glossopteris, Rootlet and burrowing present. Schizoneura, Vertebraria within 418.80m. and 426.60m.
426.60	426.75	0.15	0.15	COAL.
426.75	438.20	11.45	11.45	Grey shale alternately banded with medium grained arkosic sandstone towards top and laminated with siltstone towards

				bottom. 20cm. coal band at 436.45m.
438.20	443.65	5.45	5.45	Coarse grained cross-bedded arkosic sandstone.
443.65	475.20	31.55	31.55	Grey shale laminated with very fine grained sandstone, siltstone, banded with medium to coarse grained arkosic cross-bedded sandstone. 30cm. coal band at 467.50m.
475.20	476.60	1.40	1.40	COAL.
476.60	486.90	10.30	10.30	Grey shale intercalated with medium to coarse grained sandstone. Coal bands of 15cm. and 40 cm. at 479.35m. and 481.20m. depth respectively. Rootlets, Glossopteris and burrowing present.
486.90	507.40	20.50	20.50	Alternate sequence of Debris flow deposit and grey shale and coarse to very coarse grained cross-bedded arkosic sandstone. Coal bands of 20cm. and 35cm. at 500.45m. and 504.30m. depth respectively.
507.40	517.45	10.05	10.05	Grey shale interbanded with fine to medium grained sandstone. Coal bands of 30cm.. 40cm. and 40cm. at 507.70m., 509.25m. and 512.85m. depth respectively.
517.45	518.45	1.00	1.00	COAL. (Seam Zone – VII)
518.45	528.80	10.35	10.35	Debris flow deposit intercalated with grey shale and carbonaceous shale.
528.80	534.00	5.20	5.20	Grey shale interbanded and intercalated with medium grained sandstone and siltstone. Coal bands of 40cm. at 529.50m. and 531.25m. depths.

Borehole closed at 534.00 m. depth in Barakar Formation

Borehole No. : AB – 9

Location	:	**Lat. 23° 43′ 56″**	Drilling Unit	:	**378**
		Long. 84° 39′ 34″	Date of commencement	:	**20.02.1992**
R. L.	:	**456.69 m.**	Date of completion	:	**04.05.1992**
Final Depth	:	**352.00 m.**	Logged by	:	K. Mondal

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	12.10	12.10	0.90	Sludge of medium grained sand.
12.10	12.70	0.60	0.60	Very fine grained sandstone.
12.70	19.20	6.50	6.50	Very coarse grained to granular sandstone.
19.20	21.65	2.45	2.45	Coarse to very coarse grained sandstone with bands of fine grained sandstone.
21.65	25.00	3.35	3.35	Claystone with silty shale.
25.00	26.05	1.05	1.05	Medium to coarse grained sandstone.
26.05	26.45	0.40	0.40	Carbonaceous shale.
26.45	26.65	0.20	0.20	COAL.
26.65	27.28	0.63	0.63	Carbonaceous shale.
27.28	27.50	0.22	0.22	COAL.
27.50	28.80	1.30	1.30	Fine grained carbonaceous sandstone.
28.80	29.50	0.70	0.70	Carbonaceous shale.
29.50	30.20	0.70	0.70	Shale with silty laminae.
30.20	30.90	0.70	0.70	Carbonaceous shale.
30.90	34.85	3.95	3.95	Fine grained sandstone coarsening down to coarse grained cross-bedded sandstone.
34.85	35.05	0.20	0.20	COAL with carbonaceous shale.
35.05	36.03	0.98	0.98	Carbonaceous siltstone.
36.03	36.23	0.20	0.20	Carbonaceous shale.
36.23	38.10	1.87	1.87	Coarse grained bioturbated sandstone, bottom grey shale with carbonaceous shale.
38.10	38.47	0.37	0.37	COAL.

38.47	45.00	6.53	6.50	Interbanded medium to coarse grained sandstone, fine grained sandstone and grey shale. Bottom with fine grained cross-bedded sandstone.
45.00	45.24	0.24	0.24	COAL with shale. (Seam Zone – III)
45.24	45.65	0.41	0.41	Very fine to fine grained sandstone with grey shale at bottom.
45.65	45.80	0.15	0.15	COAL.
45.80	46.50	0.70	0.70	Fine grained carbonaceous sandstone.
46.50	46.60	0.10	0.10	COAL.
46.60	47.40	0.80	0.80	Shale with fine grained sandstone laminae, bottom slickensided.
47.40	47.60	0.20	0.20	COAL with shale.
47.60	48.45	0.85	0.85	Sandstone with shale, bottom grey shale.
48.45	48.95	0.50	0.50	COAL.
48.95	49.65	0.70	0.70	Top 10cm. carbonaceous shale, rest coarse grained sandstone with grey shale.
49.65	50.80	1.15	1.15	COAL.
50.80	52.70	1.90	1.90	Grey shale with coarse grained carbonaceous sandstone.
52.70	53.98	1.28	1.28	Carbonaceous shale with coal bands of 0.20m. and 0.14m. at 52.70m. and 53.15m. depth respectively.
53.98	61.00	7.02	7.02	COAL.
61.00	63.18	2.18	2.18	Alternation of grey to dark grey shale and medium to fine grained sandstone with a very thin coal band at middle.
63.18	63.48	0.30	0.30	COAL.
63.48	65.98	2.50	2.50	Interbanded grey shale and medium to coarse grained sandstone.
65.98	66.33	0.35	0.35	COAL.
66.33	69.30	2.97	2.97	Alternation of coarse grained sandstone and grey shale.
69.30	76.60	7.30	7.30	Coarse to very coarse grained cross-bedded arkosic sandstone.
76.60	82.05	5.45	5.45	COAL. (Seam Zone – III)
82.05	82.45	0.40	0.40	Carbonaceous shale. (Seam Zone – III)
82.45	84.75	2.30	2.30	Medium to coarse grained sandstone with grey shale at top and

bottom.

84.75	85.00	0.25	0.25	COAL.
85.00	86.30	1.30	1.30	Grey shale laminated with siltstone and fine grained sandstone.
86.30	90.45	4.15	4.15	Very coarse grained to granular quartzo-felspathic sandstone.
90.45	92.15	1.70	1.70	Very coarse grained to granular sandstone with carbonaceous shale and grey shale at bottom.
92.15	92.55	0.40	0.40	Carbonaceous shale.
92.55	102.10	9.55	9.55	Interbanded and interlaminated grey shale, very coarse grained sandstone, siltstone and fine grained sandstone.
102.10	114.55	12.45	12.45	Fine to medium grained felspathic sandstone, interbanded with coarse to very coarse grained sandstone, grey shale and siltstone. Bottom grey shale, cross-lamination in fine grained sandstone.
114.55	114.75	0.20	0.20	COAL.
114.75	122.30	7.55	7.55	Medium grained felspathic sandstone grades down to very coarse to gritty cross-bedded (set height 6cm.) sandstone with siltstone lense. At top grey shale.
122.30	122.75	0.45	0.45	COAL.
122.75	124.70	1.95	1.95	Interlaminated grey shale and fine to very fine grained bioturbated sandstone.
124.70	128.18	3.48	3.48	Medium grained bioturbated sandstone grades down to coarse to very coarse grained cross-bedded sandstone (set height 6cm.). Bottom 0.13m. carbonaceous shale.
128.18	129.65	1.47	1.47	COAL.
129.65	131.15	1.50	1.50	Fine grained felspathic sandstone banded with grey shale at middle. Top grey shale.
131.15	131.25	0.10	0.10	COAL.
131.25	133.75	2.50	2.50	Interbanded and interlaminated medium grained felspathic sandstone, grey shale and fine grained sandstone.
133.75	136.30	2.55	2.55	Very coarse grained to gritty cross-bedded sandstone, bottom slickensided and silicified.
136.30	141.00	4.70	4.70	Fine grained bioturbated carbonaceous sandstone grades down to siltstone with grey shale at bottom.
141.00	143.55	2.55	2.55	Debris flow deposit.

143.55	143.75	0.20	0.20	COAL.
143.75	146.75	3.00	3.00	Interbanded fine grained to medium grained felspathic sandstone and grey shale.
146.75	148.15	1.40	1.40	Very coarse grained to gritty cross-bedded felspathic sandstone with thin grey shale band.
148.15	153.25	5.10	5.10	Interbanded and interlaminated fine to medium grained sandstone, grey shale and siltstone. Bottom grey shale. Core dip – 15° to 16°.
153.25	153.60	0.35	0.35	COAL. (Seam Zone – II)
153.60	154.85	1.25	1.25	Interlaminated grey shale, medium to fine grained sandstone, siltstone. Glossopteris, rootlets,. Slickenside with silicification at middle.
154.85	154.95	0.10	0.10	COAL.
154.95	155.55	0.60	0.60	Grey shale with siltstone, bottom grey shale.
155.55	169.32	13.77	13.77	COAL.
169.32	170.05	0.73	0.73	Grey shale with sideritic shale, top slickensided, bottom fine grained sandstone.
170.05	174.35	4.30	4.30	COAL.
174.35	174.95	0.60	0.60	Grey shale with silty shale.
174.95	182.95	8.00	8.00	COAL.
182.95	184.95	2.00	2.00	Grey shale with thin debris flow deposit at middle.
184.95	186.35	1.40	1.40	COAL.
186.35	193.35	7.00	7.00	Unsorted and angular clasts of quartz and felspar embedded within grey, carbonaceous fine to medium grained sandy matrix (Debris flow conglomerate) with grey shale bands at top and bottom.
193.35	194.46	1.11	1.11	Carbonaceous shale with very thin coal bands.
194.46	194.85	0.39	0.39	COAL.
194.85	196.69	1.84	1.84	Grey shale with fine carbonaceous sandstone at middle, bottom 0.39m. carbonaceous shale.
196.69	197.00	0.31	0.31	COAL.
197.00	198.35	1.35	1.35	Unsorted and angular clasts of quartz and felspar embedded within grey, carbonaceous fine to medium grained sandy matrix

				(Debris flow conglomerate); bottom 0.30m. grey shale.
198.35	198.60	0.25	0.25	COAL.
198.60	205.75	7.15	7.15	Interbanded and laminated grey shale, very fine to medium grained sandstone, siltstone, fireclay and often carbonaceous shale. Vertebraria, Glossopteris, Schizoneura at middle and towards top.
205.75	209.60	3.85	3.85	Very coarse to gritty cross-bedded sandstone, bottom grey shale with silty intercalation.
209.60	210.30	0.70	0.70	COAL.
210.30	211.00	0.70	0.70	Grey shale intercalated with carbonaceous shale.
211.00	215.15	4.15	4.15	Very coarse grained felspathic cross-bedded (set height – 8cm.) sandstone grades upward to fine grained felspathic sandstone and fire clay.
215.15	217.00	1.85	1.85	Grey shale, slickensided.
217.00	218.40	1.40	1.40	Carbonaceous shale.
218.40	221.45	3.05	3.05	Debris flow deposit. Top and bottom 0.70m. grey shale.
221.45	223.30	1.85	1.85	Grey shale, top slickensided.
223.30	226.30	3.00	3.00	Interbanded / laminated grey shale and very fine grained to fine grained sandstone, bioturbated and slickensided bottom.
226.30	227.75	1.45	1.45	Medium grained cross-laminated arkosic sandstone.
227.75	233.55	5.80	5.80	Interbanded / laminated grey shale, medium grained and fine grained to very fine grained sandstone, slickensided at middle.
233.55	237.05	3.50	3.50	Grey shale, bottom slickensided, rootlets, Glossopteris.
237.05	238.65	1.60	1.60	Grey shale interbanded with medium to coarse grained sandstone and fine grained sandstone.
238.65	240.05	1.40	1.40	Medium grained cross-bedded sandstone grades down to coarse to very coarse grained to pebbly sandstone.
240.05	244.80	4.75	4.75	Grey shale interbanded with very coarse to coarse grained quartzo-felspathic sandstone band, top and bottom slickensided.
244.80	247.80	3.00	3.00	Medium to coarse grained quartzo-felspathic cross-bedded sandstone with grey shale bands. Bioturbation is present.
247.80	248.90	1.10	1.10	Grey to dark grey shale.
248.90	249.30	0.40	0.40	COAL.

249.30	252.95	3.65	3.65	Grey shale interbanded with fine grained sandstone, siltstone and medium to coarse grained cross-bedded sandstone, bioturbation and slickenside common.
252.95	254.35	1.40	1.40	Pebbly sandstone.
254.35	254.45	0.10	0.10	COAL.
254.45	259.50	5.05	5.05	Very coarse to coarse grained quartzo-felspathic sandstone with grey shale bands at top and bottom.
259.50	259.90	0.40	0.40	COAL.
259.90	262.40	2.50	2.50	Grey shale interbanded with medium grained sandstone, pebbly sandstone and coarse grained sandstone.
262.40	266.10	3.70	3.70	Coarse to very coarse grained cross-bedded sandstone interbanded and laminated with fine grained sandstone and grey shale.
266.10	266.40	0.30	0.30	Carbonaceous shale.
266.40	267.90	1.50	1.50	Interbanded very coarse grained sandstone and grey shale.
267.90	268.20	0.30	0.30	COAL.
268.20	268.85	0.65	0.65	Coarse grained sandstone and grey shale, top sandstone, bottom grey shale.
268.85	270.15	1.30	1.30	Carbonaceous shale with coal bands.
270.15	273.30	3.15	3.15	Mainly grey shale with coarse grained sandstone filled burrows at places.
273.30	285.25	11.95	11.95	Interbanded and interlaminated coarse to very coarse grained cross-bedded sandstone, medium to fine grained cross-laminated sandstone and grey shale. Glossopteris, rootlets at middle, bioturbation towards top and bottom.
285.25	290.60	5.35	5.35	Very coarse grained to granular (gritty) arkosic sandstone.
290.60	299.55	8.95	8.95	Interbanded and interlaminated grey shale and siltstone, fine grained sandstone with occasional bands of coarse to very coarse grained sandstone and debris flow sandstone. Bottom with bioturbation, top with Vertebraria, rootlets.
299.55	306.75	7.20	7.20	Pebbly sandstone with thin shale lenses.
306.75	314.80	8.05	8.05	Grey shale with thin to thick siltstone laminae. Occasionally thick debris flow deposit, very coarse grained gritty sandstone band at places.
314.80	325.65	10.85	10.85	Very coarse grained to gritty sandstone grades down to pebbly

				sandstone to conglomerate with thin to thick grey shale band and debris flow unit.
325.65	332.05	6.40	6.40	Very coarse to granular sandstone interbanded with grey shale and siltstone. Fault at middle, Glossopteris, Vertebraria, rootlets, Sphenopteris at 330.60m. (?).
332.05	345.90	13.85	13.85	Alternate banded deposit of coarse to very coarse grained to gritty sandstone and grey shale with siltstone laminae. Unit is highly slickensided, cross-laminated etc.

---------- **Contact between Barakar Formation and Talchir Formation** ----------

345.90	352.00	6.10	6.10	Medium to coarse grained greenish white to greenish sandstone grades upward to fine to very fine grained greenish sandstone with shale bands, chloritic laminae, lense etc. sandstone is micaceous. Slickenside with silicification at top and bottom.

Borehole closed at 352.00 m. depth in Talchir Formation

Borehole No. : AB – 10

Location	:	**Lat. 23° 44′09″**	Drilling Unit	:	**378**
		Long. 84° 39′08″	Date of commencement	:	**23.05.1992**
R. L.	:	**448.38 m.**	Date of completion	:	**27.07.1992**
Final Depth	:	**278.00 m.**	Logged by	:	K. Mondal
			Water table	:	7.00m.

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	9.45	9.45	0.20	Sludge of medium to fine grained sand..
9.45	27.60	18.15	18.15	Grey shale interbanded and intercalated with siltstone and medium to fine and occasional coarse grained sandstone.
27.60	28.00	0.40	0.40	COAL. (Seam Zone – V)
28.00	28.40	0.40	0.40	Grey shale.
28.40	29.05	0.65	0.65	COAL.
29.05	34.20	5.15	5.15	Grey shale interbanded with medium to coarse grained sandstone. Top and bottom with grey shale.
34.20	38.60	4.40	4.40	COAL.
38.60	41.40	2.80	2.80	Grey shale laminated with siltstone, top grey shale and bottom very coarse to gritty sandstone.
41.40	48.90	7.50	7.50	COAL.
48.90	50.90	2.00	2.00	Grey shale intercalated with carbonaceous shale.
50.90	51.50	0.60	0.60	COAL.
51.50	54.90	3.40	3.40	Coarse grained cross-bedded sandstone grades upward to medium to fine grained sandstone with grey shale at top.
54.90	58.10	3.20	3.20	Grey shale interlaminated with siltstone, bioturbation at places.
58.10	62.65	4.55	4.55	Coarse to very coarse grained cross-bedded sandstone.
62.65	63.15	0.50	0.50	Grey shale.
63.15	63.40	0.25	0.25	COAL.
63.40	63.80	0.40	0.40	Grey shale.
63.80	64.12	0.32	0.32	Carbonaceous shale.
64.12	64.40	0.28	0.28	COAL.

64.40	64.55	0.15	0.15	Carbonaceous shale.
64.55	65.70	1.15	1.15	Grey shale, top very coarse grained sandstone.
65.70	65.95	0.25	0.25	COAL. (Seam Zone – V)
65.95	75.70	9.75	9.75	Grey shale interbanded and intercalated with medium to coarse grained sandstone.
75.70	86.40	10.70	10.70	Alternation of very coarse grained cross-bedded sandstone and grey shale. Bottom interbanded with debris flow deposit and grey shale.
86.40	86.52	0.12	0.12	Carbonaceous shale. (Seam Zone – IV)
86.52	92.75	6.23	6.23	COAL.
92.75	93.00	0.25	0.25	Sideritic shale.
93.00	94.40	1.40	1.40	Medium to coarse grained sandstone interbanded with grey shale.
94.40	94.65	0.25	0.25	COAL.
94.65	95.65	1.00	1.00	Medium to coarse grained sandstone interbanded with grey shale.
95.65	97.65	2.00	2.00	COAL.
97.65	104.50	6.85	6.85	Grey shale interbanded and intercalated with fine to coarse grained sandstone and occasionally with debris flow.
104.50	116.60	12.10	12.10	Coarse to very coarse grained cross-bedded sandstone.
116.60	123.40	6.80	6.80	Alternation of grey shale and medium to coarse grained cross-bedded sandstone.
123.40	123.80	0.40	0.40	COAL.
123.80	126.60	2.80	2.80	Grey shale intercalated with carbonaceous shale and medium grained sandstone.
126.60	129.60	3.00	3.00	COAL. (Seam Zone – IV)
129.60	133.50	3.90	3.90	Grey shale intercalated with carbonaceous shale and banded with conglomerate, rootlets, Glossopteris, Vertebraria.
133.50	133.70	0.20	0.20	COAL. (Seam Zone – IV)
133.70	163.95	30.25	30.25	Grey shale laminated with siltstone and fine to coarse grained sandstone, bottom portion more shaly. Silicification and slickenside at places. Rootlets, Glossopteris and Vertebraria at places.

163.95	169.35	5.40	5.40	COAL. (Seam Zone – III)
169.35	170.55	1.20	1.20	Grey shale laminated with fine grained sandstone and siltstone.
170.55	194.70	24.15	24.15	COAL.
194.70	195.05	0.35	0.35	Carbonaceous shale.
195.05	202.55	7.50	7.50	Grey shale (highly fractured, slickensided) interbanded with siltstone and fine grained sandstone.
202.55	204.55	2.00	2.00	Very coarse grained cross-bedded sandstone.
204.55	205.35	0.80	0.80	Carbonaceous shale. (Seam Zone – III)
205.35	232.35	27.00	20.00	Alternation of grey shale and fine to medium grained sandstone and occasionally with coarse grained sandstone. Total unit is highly fractured. Slickensided, broken and crushed and also faulted (loss of cores).
232.35	258.80	26.45	11.70	Very coarse to gritty sandstone interbanded with grey shale. Total unit is fractured, crushed, silicified, slickensided and faulted (loss of cores).
258.80	263.80	5.00	3.00	Fine grained sandstone interlaminated with grey shale, highly crushed and fractured, faulted (loss of cores).
263.80	271.15	7.35	5.35	Very coarse to pebbly sandstone with debris flow deposit. Total unit is highly crushed and fractured, slickensided, faulted (loss of cores).
271.15	278.00	6.85	3.50	Fine grained ferruginous sandstone. Fractured, crushed and faulted (loss of cores).

Borehole closed at 278.00 m. depth in Barakar Formation

Borehole No. : AB – 11

Location	:	**Lat. 23° 45′ 20″**	Drilling Unit	:	**267**
		Long. 84° 36′ 50″	Date of commencement	:	**16.03.1993**
R. L.	:	**419.39 m.**	Date of completion	:	**05.01.1994**
Final Depth	:	**564.00 m.**	Logged by	:	K. Mondal

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	13.50	13.50	0.50	Sludge of very fine grained sand.
13.50	24.60	11.10	10.40	Interbanded and laminated grey shale, very fine grained hard and compact sandstone, siltstone. Sandstone is micaceous, calcareous and slickensided. Signatures of slumping, stem impression of Vertebraria, leaf impression of Glossopteris and rootlets.
24.60	24.80	0.20	0.20	COAL.
24.80	25.30	0.50	0.50	Grey shale.
25.30	25.75	0.45	0.45	COAL.
25.75	30.25	4.50	4.50	Grey shale with Glossopteris, Vertebraria and Schizoneura, rootlets.
30.25	50.15	19.90	17.65	Grey shale interbanded and laminated with fine to very fine grained and medium grained sandstone. Sandstone is hard compact, micaceous and greenish grey in colour. Glossopteris, Vertebraria and rootlets at places.
50.15	60.00	9.85	4.50	Grey shale with silty intercalation towards bottom.
60.00	63.10	3.10	3.10	Coarse to very coarse grained feldspathic sandstone.
63.10	73.00	9.90	7.00	Grey shale, sandy at middle. Rootlets, Vertebraria at places.
73.00	95.10	22.10	17.00	Interbanded and laminated grey shale, fine to very fine grained hard, compact and micaceous sandstone. Laminae at places biochurned. Rootlets, Vertebraria and Schizoneura at places.
95.10	95.20	0.10	0.10	COAL.
95.20	96.70	1.50	1.50	Grey shale with silty laminae towards bottom, Vertebraria, Schizoneura, rootlets.
96.70	96.90	0.20	0.20	COAL.

96.90	112.70	15.80	15.80	Interlaminated and banded grey shale, fine to very fine grained hard, compact, micaceous, greenish grey, cross-bedded, flaser bedded sandstone and siltstone. Vertebraria, Glossopteris, Schizoneura and rootlets present.
112.70	112.90	0.20	0.20	COAL.
112.90	116.75	3.85	3.85	Grey shale laminated with fine to very fine grained greenish grey micaceous sandstone. Rootlets, Vertebraria.
116.75	130.40	13.65	13.65	Very fine to fine grained hard, compact, micaceous, greenish grey sandstone with pebbles and granules imbrication at middle.
130.40	136.43	6.03	6.03	Dark grey hard shale with thin laminae of siltstone. Bottom carbonaceous shale of 0.13m. at 136.30m. depth.
136.43	136.60	0.17	0.17	COAL.
136.60	137.28	0.68	0.68	Carbonaceous shale.
137.28	137.41	0.13	0.13	COAL.
137.41	138.15	0.74	0.74	Carbonaceous shale.
138.15	150.10	11.95	11.95	Interbanded and laminated grey shale and very fine grained sandstone.
150.10	154.50	4.40	4.20	Hard and compact grey shale.
154.50	156.75	2.25	2.25	Grey shale laminated and banded with fine to medium grained sandstone.
156.75	160.00	3.25	3.25	Grey shale interbanded and laminated with fine to very fine grained sandstone, siltstone and silty shale.
---------- **Contact between Raniganj Formation and Barakar Formation** ----------				
160.00	179.05	19.05	19.05	Alternate sequence of very fine to fine grained sandstone and grey shale, impressions of Glossopteris, Schizoneura, rotlets. Signatures and penecotemporaneous structures and signature of biochurning at places. Core dip – 8° to 10°.
179.05	180.05	1.00	1.00	Grey shale.
180.05	190.00	9.95	9.95	Grey shale interbanded and laminated with fine to very fine grained sandstone, siltstone and coarse to very cosrse grained cross-bedded sandstone. Glossopteris, rootlets at places.
190.00	198.55	8.55	8.55	Coarse to very coarse grained cross-bedded sandstone with

				interbeds of medium grained cross-bedded sandstone, grey shale, sandy shale.
198.55	223.50	24.95	24.95	Heterolithic sequence of grey shale, coarse to very coarse grained, medium grained, fine to very fine grained sandstone and siltstone. Glossopteris, Vertebraria, rootlets at places.
223.50	225.30	1.80	1.80	Grey shale with thin coal bands. (Seam Zone – VIII)
225.30	225.68	0.38	0.38	COAL.
225.68	225.96	0.28	0.28	Carbonaceous shale.
225.96	237.35	11.39	11.39	Grey shale intercalated with carbonaceous shale laminated and banded with medium to fine grained sandstone, siltstone. Glossopteris, rootlets. Slickensided at places.
237.35	237.67	0.32	0.32	COAL.
237.67	238.10	0.43	0.43	Carbonaceous shale.
238.10	247.70	9.60	9.60	Grey shale laminated and banded with medium to fine grained sandstone, siltstone.
247.70	247.84	0.14	0.14	Carbonaceous shale.
247.84	248.40	0.56	0.56	COAL.
248.40	263.05	14.65	14.65	Grey shale with fine to medium grained sandstone, siltstone. Coal bands of 0.40m. thick at 248.65m. and 251.25m. depth and three 30cm. thick coal bands at 253.70m., 258.80m. and 262.50m. depths.
263.05	265.90	2.85	2.85	COAL.
265.90	267.65	1.75	1.75	Grey shale with fine to medium grained sandstone and siltstone.
267.65	279.40	11.75	11.75	COAL.
279.40	281.02	1.62	1.62	Grey shale intercalated with carbonaceous shale.
281.02	281.70	0.68	0.68	COAL. (Seam Zone – VIII)
281.70	296.50	14.80	14.80	Heterolithic sequence of grey shale, fine to medium grained and occasional coarse to very coarse grained cross-bedded sandstone with coal bands and laminae.
296.50	300.50	4.00	4.00	Grey shale with thin coal bands and laminae.
300.50	313.35	12.85	12.85	Heterolithic sequence of grey shale, fine to medium grained sandstone, often cross-bedded with thin coal bands.
313.35	313.95	0.60	0.60	COAL.

313.95	325.60	11.65	11.65	Grey shale with biochurned laminae of fine to very fine grained sandstone and siltstone and thin coal band.
325.60	327.60	2.00	2.00	COAL.
327.60	341.60	14.00	14.00	Grey shale with fine grained cross-laminated sandstone and siltstone.
341.60	352.60	11.00	11.00	Grey shale with fine to very fine grained sandstone and occasional thin coal seams at middle.
352.60	396.55	43.95	43.95	Heterolithic sequence of grey shale, fine to very fine grained, medium grained sandstone and siltstone with thin coal seams at places. Bottom 0.20m. carbonaceous shale.
396.55	397.50	0.95	0.95	COAL.
397.50	422.75	25.25	25.25	Grey shale with fine to very fine grained sandstone, siltstone and medium to coarse grained sandstone at places. Several thin coal bands at top and middle.
422.75	433.35	10.60	10.60	Heterolithic sequence of grey shale, siltstone, very fine grained and medium to coarse grained sandstone with very thin coal bands at places.
433.35	434.05	0.70	0.70	COAL. (Seam Zone – VII)
434.05	436.40	2.35	2.35	Grey shale with thin silty laminae. Debris flow conglomerate unit towards bottom Two thin coal bands towards top and bottom.
436.40	438.25	1.85	1.85	COAL.
438.25	451.40	13.15	13.15	Unsorted and angular clasts of quartz and felspar embedded within grey, carbonaceous fine to medium grained sandy matrix (Debris flow conglomerate) with thin grey shale.
451.40	453.40	2.00	2.00	Grey shale with thin coal laminae at middle.
453.40	457.25	3.85	3.85	COAL.
457.25	463.90	6.65	6.65	Grey shale with fine to medium grained sandstone. 1.00m. debris flow unit towards bottom.
463.90	464.43	0.53	0.53	Carbonaceous shale.
464.43	464.80	0.37	0.37	COAL.
464.80	465.33	0.53	0.53	Carbonaceous shale.
465.33	465.50	0.17	0.17	COAL.
465.50	466.80	1.30	1.30	Grey shale with thin coal laminae at middle.
466.80	469.90	3.10	3.10	Carbonaceous shale with thin coal bands of 0.22m., 0.19m.

				and 0.29m. at 466.90m., 467.59m. and 467.94m. depths respectively.
469.90	475.32	5.42	5.42	COAL.
475.32	476.60	1.28	1.28	Carbonaceous shale.
476.60	480.25	3.65	3.65	Grey shale with coarse grained felspathic sandstone band at middle. Bottom with very fine grained sandstone.
480.25	480.73	0.48	0.48	Carbonaceous shale.
480.73	482.05	1.32	1.32	COAL. (Seam Zone – VII)
482.05	487.40	5.35	5.35	Very coarse grained to granular cross-bedded sandstone with grey shale and carbonaceous shale laminae at places.
487.40	500.00	12.60	12.60	Alternate sequence of grey shale and medium to coarse grained felspathic sandstone with occasional very fine grained sandstone to siltstone laminae.
500.00	519.55	19.55	19.55	Interbanded and laminated sequence of grey shale, fine to medium grained sandstone, siltstone and occasional coarse grained sandstone band at places.
519.55	525.85	6.30	6.30	Heterolithic sequence of grey shale, fine to medium grained, coarse grained sandstone and siltstone.
525.85	526.75	0.90	0.90	COAL. (Seam Zone – VI)
526.75	535.50	8.75	8.75	Alternate sequence of grey shale, fine to medium grained coarse grained sandstone and siltstone. Thin coal laminae at places.
535.50	536.60	1.10	1.10	COAL.
536.60	536.85	0.25	0.25	Claystone / grey shale.
536.85	537.05	0.20	0.20	Carbonaceous shale.
537.05	537.95	0.90	0.90	COAL.
537.95	560.70	22.75	22.75	Heterolithic sequence of grey shale, siltstone, fine grained, medium grained, coarse grained sandstone and a thin coal laminae towards top.
560.70	561.50	0.80	0.80	COAL. (Seam Zone – VI)
561.50	564.00	2.50	2.50	Coarse grained arkosic sandstone with grey shale band at middle.

Borehole closed at 564.00 m. depth in Barakar Formation

Borehole No. : AB – 12

Location	:	**Lat. 23° 43′ 55″**	Drilling Unit	:	**378**
		Long. 84° 38′ 37″	Date of commencement	:	**30.08.1992**
R. L.	:	**436.61 m.**	Date of completion	:	**09.02.1993**
Final Depth	:	**520.90 m.**	Logged by	:	K. Mondal

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	11.00	11.00	0.30	Sludge of sand.
11.00	14.35	3.35	1.10	Siltstone intercalated with mudstone.
14.35	16.15	1.80	1.80	COAL.
16.15	18.90	2.75	2.75	Grey shale with silty laminae.
18.90	19.95	1.05	1.05	Coarse grained sandstone grades upward to medium grained sandstone.
19.95	20.75	0.80	0.80	Grey shale.
20.75	21.10	0.35	0.35	COAL.
21.10	22.85	1.75	1.75	Grey shale with medium grained cross-bedded sandstone at bottom.
22.85	23.30	0.45	0.45	COAL.
23.30	28.40	5.10	5.10	Dark grey shale.
28.40	29.05	0.65	0.65	Carbonaceous shale.
29.05	33.35	4.30	4.30	Grey shale intercalated with medium grained sandstone at middle.
33.35	33.60	0.25	0.25	COAL.
33.60	39.80	6.20	6.20	Grey shale interbanded and intercalated with fine grained sandstone and siltstone.
39.80	39.91	0.11	0.11	Carbonaceous shale (Seam Zone – VII).
39.91	40.32	0.41	0.41	COAL.
40.32	40.80	0.48	0.48	Carbonaceous shale and bottom 0.23m. Sandy grey shale.
40.80	41.70	0.90	0.90	Grey shale.
41.70	41.90	0.20	0.20	COAL.

41.90	45.40	3.50	3.50	Grey shale interbanded with medium grained sandstone at middle.
45.40	46.40	1.00	1.00	Coarse grained cross-bedded sandstone.
46.40	47.70	1.30	1.30	Grey shale.
47.70	48.40	0.70	0.70	Carbonaceous shale.
48.40	48.70	0.30	0.30	COAL.
48.70	50.70	2.00	2.00	Grey shale intercalated with carbonaceous shale.
50.70	50.98	0.28	0.28	Carbonaceous shale.
50.98	51.36	0.38	0.38	COAL.
51.36	52.10	0.74	0.74	Carbonaceous shale.
52.10	52.30	0.20	0.20	COAL.
52.30	53.05	0.75	0.75	Grey shale intercalated with carbonaceous shale.
53.05	53.20	0.15	0.15	Carbonaceous shale.
53.20	55.75	2.55	2.55	COAL.
55.75	55.95	0.20	0.20	Carbonaceous shale.
55.95	56.85	0.90	0.90	Medium grained sandstone with thin shale laminae.
56.85	58.05	1.20	1.20	COAL.
58.05	58.50	0.45	0.45	Grey shale.
58.50	58.90	0.40	0.40	COAL.
58.90	59.90	1.00	1.00	Grey shale with thin vitrain laminae and streaks.
59.90	60.30	0.40	0.40	COAL.
60.30	69.20	8.90	8.90	Grey shale with thin laminae at places, medium grained sandstone band at middle. Rootlet, Glossopteris, biochurning at places.
69.20	69.85	0.65	0.65	COAL.
69.85	69.95	0.10	0.10	Carbonaceous shale.
69.95	71.35	1.40	1.40	Grey shale intercalated with carbonaceous shale at middle with thin vitrain bands. Schizoneura , Glossopteris, Rootlets towards top and bottom.
71.35	71.70	0.35	0.35	COAL.
71.70	72.60	0.90	0.90	Top 0.60m. carbonaceous shale and rest grey shale.

72.60	73.90	1.30	1.30	COAL.
73.90	75.40	1.50	1.50	Grey shale.
75.40	75.70	0.30	0.30	COAL.
75.70	79.30	3.60	3.60	Interbanded grey shale and siltstone. Bottom intercalated with carbonaceous shale.
79.30	79.75	0.45	0.45	COAL.
79.75	81.70	1.95	1.95	Grey shale interbanded and intercalated with fine grained sandstone, siltstone and carbonaceous shale.
81.70	81.80	0.10	0.10	Carbonaceous shale.
81.80	82.30	0.50	0.50	COAL.
82.30	84.00	1.70	1.70	Grey shale with thin silty laminae.
84.00	84.30	0.30	0.30	COAL.
84.30	86.93	2.63	2.63	Grey shale containing Glossopteris, rootlet. Bottom 0.09m. Siderite shale.
86.93	88.25	1.32	1.32	COAL.
88.25	88.45	0.20	0.20	Carbonaceous shale.
88.45	89.05	0.60	0.60	Grey shale.
89.05	91.55	2.50	2.50	COAL.
91.55	92.05	0.50	0.50	Grey shale containing thin coal laminae, top sandy shale.
92.05	92.50	0.45	0.45	COAL.
92.50	93.10	0.60	0.60	Grey shale intercalated with siltstone at places, bottom with carbonaceous shale.
93.10	94.10	1.00	1.00	COAL. (Seam Zone – VII).
94.10	96.55	2.45	2.45	Grey shale interlaminated with siltstone and fine grained sandstone, occasional coarse sandstone band at places. Top, grey shale.
96.55	106.05	9.50	9.50	Very coarse to coarse grained cross-bedded sandstone grades down to grey shale.
106.05	107.70	1.65	1.65	Debris flow deposit intercalated with siltstone at places.
107.70	119.05	11.35	11.35	Debris flow deposit interbanded with grey shale containing thin siltstone laminae at places.
119.05	120.45	1.40	1.40	Light grey shale with sandy shale towards top. Rootlet,

				Glossopteris.
120.45	122.05	1.60	1.60	Coarse grained sandstone containing carbonaceous shale bands and signature of microfault, slumping. Bottom coarse grained sandstone.
122.05	158.60	36.55	36.55	COAL. (Seam Zone – VI).
158.60	160.15	1.55	1.55	Grey shale containing thin siltstone laminae.
160.15	163.40	3.25	3.25	Pebbly sandstone grades upward to coarse to very coarse grained sandstone.
163.40	163.80	0.40	0.40	COAL.
163.80	168.75	4.95	4.95	Alternation and intercalation of grey shale and fine to very fine grained sandstone.
168.75	168.88	0.13	0.13	Carbonaceous shale.
168.88	169.65	0.77	0.77	COAL.
169.65	182.20	12.55	12.55	Grey shale interlaminated with very fine to fine and medium grained sandstone. Occasional coarse sandstone and carbonaceous shale bands at places. Bioturbation towards top. Carbonaceous shale at top and at the bottom.
182.20	183.60	1.40	1.40	COAL. (Seam Zone – V).
183.60	184.75	1.15	1.15	Grey shale with paper thin silty laminae. Vertebraria rootlets.
184.75	186.40	1.65	1.65	Medium to coarse grained sandstone with grey shale intercalation at places.
186.40	190.00	3.60	3.60	Grey shale with fine grained sandstone bands towards top and carbonaceous shale bands at bottom.
190.00	191.20	1.20	1.20	COAL.
191.20	193.10	1.90	1.90	Very coarse to coarse grained cross-bedded sandstone. Top and bottom carbonaceous shale.
193.10	193.50	0.40	0.40	COAL.
193.50	194.65	1.15	1.15	Grey shale containing thin coal laminae.
194.65	194.83	0.18	0.18	Carbonaceous shale.
194.83	196.15	1.32	1.32	COAL.
196.15	197.05	0.90	0.90	Grey shale.
197.05	197.21	0.16	0.16	Carbonaceous shale.
197.21	198.30	1.09	1.09	COAL.

198.30	201.70	3.40	3.40	Grey shale containing fine to medium grained sandstone bands towards bottom.
201.70	201.90	0.20	0.20	COAL.
201.90	203.30	1.40	1.40	Grey shale intercalated at places with siltstone.
203.30	203.75	0.45	0.45	COAL.
203.75	218.30	14.55	14.55	Alternation and interlamination of grey shale and medium to very coarse grained cross-bedded sandstone. Bottom carbonaceous shale.
218.30	219.65	1.35	1.35	COAL.
219.65	222.25	2.60	2.60	Grey shale laminated with siltstone.
222.25	223.25	1.00	1.00	Carbonaceous shale.
223.25	223.82	0.57	0.57	COAL.
223.82	224.00	0.18	0.18	Carbonaceous shale. (Seam Zone – V)
224.00	227.20	3.20	3.20	Grey shale interbanded with coarse grained sandstone.
227.20	229.65	2.45	2.45	Coarse to very coarse grained sandstone with thin carbonaceous shale laminae.
229.65	236.65	7.00	7.00	Grey shale interbanded with medium to coarse grained sandstone, and siltstone, carbonaceous shale bands at places. At bottom carbonaceous medium grained sandstone.
236.65	236.91	0.26	0.26	COAL.
236.91	237.35	0.44	0.44	Carbonaceous shale.
237.35	241.40	4.05	4.05	Grey shale intercalated at places with siltstone and medium to fine grained sandstone. Rootlet, Glossopteris.
241.40	245.15	3.75	3.75	Coarse to very coarse grained cross-bedded sandstone banded with grey shale and carbonaceous shale.
245.15	248.69	3.54	3.54	Medium to coarse grained sandstone interbanded with grey shale and carbonaceous sandstone.
248.69	248.82	0.13	0.13	Carbonaceous shale / shaly coal. (Seam Zone – IV)
248.82	250.31	1.49	1.49	COAL with 0.08m. sideritic shale band at 249.39m. depth.
250.31	250.95	0.64	0.64	Grey shale.
250.95	251.15	0.20	0.20	COAL.
251.15	254.83	3.68	3.68	Grey shale with a band of medium grained sandstone at middle.

254.83	255.08	0.25	0.25	Carbonaceous shale.
255.08	255.62	0.54	0.54	COAL.
255.62	255.78	0.16	0.16	Carbonaceous shale with coal bands.
255.78	256.58	0.80	0.80	Grey shale.
256.58	256.83	0.25	0.25	COAL.
256.83	257.08	0.25	0.25	Carbonaceous shale with thin coal laminae.
257.08	259.25	2.17	2.17	Grey shale with occasional silty shale.
259.25	259.40	0.15	0.15	COAL.
259.40	263.95	4.55	4.55	Coarse grained sandstone grades upward to grey shale.
263.95	266.65	2.70	2.70	Interbanded and intercalated grey shale and medium to coarse grained sandstone. Bottom grey shale.
266.65	268.55	1.90	1.90	Carbonaceous shale.
268.55	270.55	2.00	2.00	Grey shale interbanded with medium to fine grained sandstone.
270.55	270.85	0.30	0.30	COAL.
270.85	273.95	3.10	3.10	Grey shale with one band of medium grained sandstone at middle.
273.95	281.45	7.50	7.50	COAL with a 0.35m. sideritic shale band at 276.88m. depth.
281.45	281.90	0.45	0.45	Grey shale.
281.90	285.50	3.60	3.60	COAL. (Seam Zone – IV)
285.50	293.55	8.05	8.05	Very coarse grained sandstone grades upward to grey shale.
293.55	318.32	24.77	24.77	Interbanded and intercalated grey shale, fine to coarse grained sandstone. Bottom grey shale.
318.32	318.85	0.53	0.53	COAL.
318.85	319.27	0.42	0.42	Grey shale.
319.27	319.52	0.25	0.25	COAL.
319.52	322.05	2.53	2.53	Grey shale interbanded with fine to medium grained sandstone.
322.05	327.55	5.50	5.50	Very coarse grained arkosic sandstone.
327.55	330.45	2.90	2.90	Grey shale interbanded with fine to very fine grained sandstone.
330.45	336.55	6.10	6.10	Coarse to very coarse grained arkosic cross-bedded sandstone.
336.55	337.05	0.50	0.50	Grey shale.

337.05	337.68	0.63	0.63	COAL.
337.68	338.05	0.37	0.37	Carbonaceous shale.
338.05	338.55	0.50	0.50	Grey shale.
338.55	338.98	0.43	0.43	Carbonaceous shale.
338.98	339.55	0.57	0.57	COAL.
339.55	340.05	0.50	0.50	Grey shale.
340.05	341.82	1.77	1.77	COAL.
341.82	341.95	0.13	0.13	Sandy grey shale with carbonaceous shale band.
341.95	347.55	5.60	5.60	Top 0.75m. grey shale and rest coarse grained cross-bedded arkosic sandstone to fine grained sandstone.
347.55	347.75	0.20	0.20	COAL.
347.75	357.95	10.20	10.20	Grey shale interbanded and intercalated with fine to very fine grained sandstone. Laminae biochurned at places.
357.95	358.43	0.48	0.48	COAL.
358.43	358.55	0.12	0.12	Carbonaceous shale.
358.55	360.55	2.00	2.00	Fine grained sandstone interbanded with grey shale with slump signature.
360.55	365.05	4.50	4.50	Medium to coarse grained cross-bedded sandstone.
365.05	371.35	6.30	6.30	Grey shale.
371.35	378.40	7.05	7.05	Grey shale interbanded with siltstone and fine to medium grained cross-bedded sandstone. Bottom grey shale.
378.40	379.00	0.60	0.60	COAL. (Seam Zone – III)
379.00	389.30	10.30	10.30	Very coarse grained to gritty sansdstone.
389.30	392.40	3.10	3.10	Grey shale interbanded with fine to medium grained sandstone.
392.40	392.80	0.40	0.40	COAL.
392.80	396.85	4.05	4.05	Interbanded grey shale, siltstone and medium grained sandstone.
396.85	397.15	0.30	0.30	COAL.
397.15	397.85	0.70	0.70	Grey shale intercalated with carbonaceous shale.
397.85	398.30	0.45	0.45	COAL.
398.30	406.65	8.35	8.35	Interbanded grey shale, siltstone and fine grained sandstone.

				Bottom grey shale.
406.65	407.45	0.80	0.80	COAL.
407.45	408.50	1.05	1.05	Grey shale interbanded with fine grained sandstone. Top and bottom grey shale.
408.50	410.37	1.87	1.87	COAL.
410.37	411.05	0.68	0.68	Grey shale.
411.05	413.85	2.80	2.80	Grey shale, silty towards top.
413.85	414.65	0.80	0.80	Carbonaceous shale.
414.65	415.45	0.80	0.80	Grey shale.
415.45	419.20	3.75	3.75	Fine to very fine grained sandstone with grey shale laminae at places. Laminae biochurned.
419.20	421.90	2.70	2.70	Grey shale.
421.90	426.70	4.80	4.80	Interbanded and laminated siltstone, fine grained sandstone and grey shale. Laminae at places biochurned. Bottom 65cm. grey shale.
426.70	426.85	0.15	0.15	COAL.
426.85	427.05	0.20	0.20	Grey shale.
427.05	427.35	0.30	0.30	COAL.
427.35	427.95	0.60	0.60	Grey shale.
427.95	434.15	6.20	6.20	Coarse to very coarse grained arkosic cross-bedded sandstone with 20cm. to 60cm. grey shale band at 5 places. Bottom 50cm. grey shale.
434.15	434.85	0.70	0.70	COAL. (Seam Zone – III)
434.85	438.00	3.15	3.15	Interbanded medium to coarse grained cross-bedded sandstone, fine grained sandstone and grey shale.
438.00	443.65	5.65	5.65	Very coarse grained to gritty sandstone grades down to fine grained arkosic sandstone.
443.65	446.15	2.50	2.50	Grey shale.
446.15	450.00	3.85	3.85	Grey shale laminated with siltstone and very fine grained sandstone at places. Slump signatures towards bottom.
450.00	452.00	2.00	2.00	Grey shale.
452.00	458.85	6.85	6.85	Interbanded and interlaminated fine to medium grained cross-bedded sandstone and grey shale with siltstone.

458.85	462.25	3.40	3.40	Grey shale with thin silty laminae towards bottom.
462.25	464.55	2.30	2.30	Very coarse grained to gritty cross-bedded sandstone.
464.55	468.55	4.00	4.00	Interbanded and interlaminated grey shale, fine grained and siltstone.
468.55	469.50	0.95	0.95	Grey shale.
469.50	478.50	9.00	9.00	Very coarse to coarse grained sandstone grades upward to fine grained cross-laminated sandstone laminated with grey shale towards top.
478.50	484.75	6.25	6.25	Interbanded and interlaminated fine grained sandstone and grey shale. Burrowing and biochurning at places.
484.75	487.00	2.25	2.25	Very coarse grained to pebbly sandstone.
487.00	488.00	1.00	1.00	Very fine to fine and medium to coarse grained sandstone intercalation, slumping at places (fracture - 60°).
488.00	488.20	0.20	0.20	COAL. (Seam Zone – II)
488.20	489.00	0.80	0.80	Carbonaceous shale with thin coal laminae.
489.00	489.80	0.80	0.80	COAL.
489.80	490.70	0.90	0.90	Medium grained sandstone.
490.70	491.80	1.10	1.10	Grey shale.
491.80	492.25	0.45	0.45	COAL.
492.25	493.00	0.75	0.75	Grey shale, bottom 35cm. carbonaceous shale.
493.00	494.48	1.48	1.48	COAL.
494.48	495.12	0.64	0.64	Carbonaceous shale with thin coal laminae.
495.12	495.29	0.17	0.17	COAL.
495.29	495.45	0.16	0.16	Carbonaceous shale.
495.45	497.00	1.55	1.55	Grey shale, fine grained sandstone intercalation towards top.
497.00	503.80	6.80	6.80	COAL.
503.80	504.50	0.70	0.70	Carbonaceous shale.
504.50	505.40	0.90	0.90	Debris flow conglomerate.
505.40	506.25	0.85	0.85	COAL.
506.25	507.00	0.75	0.75	Grey shale.

507.00	507.15	0.15	0.15	Carbonaceous shale.
507.15	519.38	12.23	12.23	COAL.
519.38	520.90	1.52	1.52	Grey shale, top 7cm. carbonaceous shale. (Seam Zone – II)

Borehole closed at 520.90 m. depth in Barakar Formation

Borehole No. : AB – 13

Location	:	**Lat. 23° 43′ 46″**	Drilling Unit	:	**378**
		Long. 84° 38′ 13″	Date of commencement	:	**15.02.1993**
R. L.	:	**430.26 m.**	Date of completion	:	**24.05.1993**
Final Depth	:	**507.70 m.**	Logged by	:	K. Mondal

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	17.30	17.30	1.00	Soil and sludge of grey silt.
17.30	24.90	7.60	7.60	Grey shale with intercalation of little carbonaceous shale.
24.90	25.20	0.30	0.30	Carbonaceous shale.
25.20	25.65	0.45	0.45	COAL.
25.65	30.80	5.15	5.15	Grey shale interlaminated and interbanded with siltstone and fine grained sandstone. Biochurning at middle, slumping at 28.40m depth.
30.80	31.15	0.35	0.35	Carbonaceous shale.
31.15	35.50	4.35	4.35	Grey shale interbanded with siltstone and fine grained sandstone at middle, biochurning at places.
35.50	35.95	0.45	0.45	Carbonaceous shale.
35.95	42.15	6.20	6.20	Grey shale, towards top thin silty lamination and biochurning.
42.15	51.25	9.10	9.10	Fine grained sandstone and siltstone with laminae of grey shale towards top and bottom. Biochurning towards top.
51.25	58.80	7.55	7.55	Grey shale interlaminated and interbanded with fine grained sandstone and siltstone. Biochurning at middle.
58.80	61.45	2.65	2.65	Hard and compact silicified siltstone with few grey shale laminae.
61.45	68.20	6.75	6.75	Grey to dark grey shale laminated with fine grained sandstone and siltstone. Silicification at places.
68.20	68.85	0.65	0.65	Carbonaceous shale.
68.85	70.20	1.35	1.35	Dark grey shale.
70.20	70.70	0.50	0.50	Carbonaceous shale.
70.70	79.60	8.90	8.90	Dark grey shale intercalated with carbonaceous shale at places. Laminated with siltstone towards top and middle.

				Biochurning at middle.
79.60	85.35	5.75	5.75	Grey to dark grey shale.
85.35	85.90	0.55	0.55	Carbonaceous shale.
85.90	94.05	8.15	8.15	Grey to dark grey shale with biochurned silty laminae, bottom 1.00m. coarse to very coarse grained sandstone. Schizoneura at middle.
94.05	94.50	0.45	0.45	COAL.
94.50	96.30	1.80	1.80	Grey shale, towards bottom bands and laminae of fine to medium grained sandstone. Bottom grey shale.
96.30	96.78	0.48	0.48	COAL.
96.78	97.10	0.32	0.32	Carbonaceous shale.
97.10	110.75	13.65	13.65	Grey shale intercalated with fire clay, laminae of fine grained sandstone, siltstone and banded with medium grained sandstone. Biochurning towards top. Glossopteris, rootlets, Vertebraria at top. Slickenside with silicification at middle.
110.75	117.25	6.50	6.50	Grey shale interlaminated with very fine grained sandstone and siltstone. Slickenside with silicification at middle.
117.25	117.65	0.40	0.40	COAL. (Seam Zone – VII)
117.65	119.05	1.40	1.40	Grey shale interbanded with fine to coarse grained sandstone.
119.05	119.28	0.23	0.23	Carbonaceous shale with thin coal laminae.
119.28	119.83	0.55	0.55	COAL.
119.83	120.70	0.87	0.87	Carbonaceous shale with thin coal laminae.
120.70	129.65	8.95	8.95	COAL.
129.65	130.80	1.15	1.15	Grey shale with biochurned silty laminae.
130.80	131.10	0.30	0.30	COAL.
131.10	131.35	0.25	0.25	Grey shale.
131.35	132.35	1.00	1.00	COAL.
132.35	132.65	0.30	0.30	Grey shale intercalated with carbonaceous shale.
132.65	133.65	1.00	1.00	COAL.
133.65	134.85	1.20	1.20	Grey shale with paper thin silty laminae.
134.85	137.55	2.70	2.70	COAL.

137.55	138.15	0.60	0.60	Dark grey shale.
138.15	139.53	1.38	1.38	COAL.
139.53	139.65	0.12	0.12	Carbonaceous shale.
139.65	143.65	4.00	4.00	Grey shale intercalated with fire clay and laminated with siltstone.
143.65	148.15	4.50	4.50	COAL.
148.15	151.75	3.60	3.60	Interbanded and interlaminated grey shale and very fine grained sandstone and siltstone.
151.75	154.85	3.10	3.10	Medium grained sandstone grades down to coarse to very coarse grained sandstone.
154.85	155.75	0.90	0.90	Grey shale interlaminated and intercalated with very fine grained sandstone, siltstone and carbonaceous shale.
155.75	156.75	1.00	1.00	COAL.
156.75	161.80	5.05	5.05	Grey shale laminated with siltstone and very fine grained sandstone.
161.80	162.20	0.40	0.40	COAL.
162.20	162.40	0.20	0.20	Grey shale.
162.40	162.65	0.25	0.25	COAL.
162.65	163.00	0.35	0.35	Grey shale.
163.00	163.20	0.20	0.20	COAL.
163.20	163.45	0.25	0.25	Grey shale.
163.45	163.90	0.45	0.45	COAL. (Seam Zone – VII)
163.90	168.30	4.40	4.40	Grey shale interlaminated with silty shale and very fine grained sandstone.
168.30	185.50	17.20	17.20	Grey shale interbanded with siltstone, fine to medium grained and coarse to very coarse grained sandstone.
185.50	242.30	56.80	56.80	Grey to dark grey grey shale, intercalation of carbonaceous shale at places, thin streaks of coal at places.
242.30	246.30	4.00	4.00	Grey shale laminated with siltstone and very fine grained sandstone. Rootlets, Glossopteris.
246.30	254.80	8.50	8.50	Coarse to very coarse grained cross-bedded arkosic sandstone and banded with medium to fine grained sandstone.

254.80	257.80	3.00	3.00	Grey shale interbanded with medium to fine grained sandstone and occasional siltstone laminae.
257.80	260.45	2.65	2.65	Grey shale intercalated with siltstone and carbonaceous shale.
260.45	266.85	6.40	6.40	Alternation and interlamination of very fine to coarse grained sandstone and grey shale. Rootlets present.
266.85	273.65	6.80	6.80	Grey shale intercalated with carbonaceous shale at places.
273.65	277.15	3.50	3.50	Grey shale with bands of medium to fine grained sandstone at middle.
277.15	279.55	2.40	2.40	Medium grained feldspathic sandstone grades upward to very coarse grained sandstone.
279.55	285.40	5.85	5.85	Siltstone, hard and compact laminated with grey shale, slickensides at places.
285.40	429.30	143.90	143.90	Dark grey to grey shale. Slickensided at 323.85m. to 368.50m. zone. Intercalated with carbonaceous shale at places.
429.30	430.90	1.60	1.60	COAL. (Seam Zone – III)
430.90	431.10	0.20	0.20	Grey shale.
431.10	432.40	1.30	1.30	COAL.
432.40	434.00	1.60	1.60	Grey shale interlaminated and intercalated with carbonaceous shale.
434.00	435.70	1.70	1.70	COAL with a 0.82m. carbonaceous shale band at 434.53m. depth.
435.70	436.25	0.55	0.55	Grey shale.
436.25	438.25	2.00	2.00	COAL.
438.25	438.70	0.45	0.45	Grey shale.
438.70	439.50	0.80	0.80	COAL.
439.50	441.85	2.35	2.35	Grey shale laminated with siltstone and very fine grained sandstone.
441.85	442.10	0.25	0.25	COAL.
442.10	443.90	1.80	1.80	Grey shale interbanded with fine grained sandstone.
443.90	444.10	0.20	0.20	COAL.
444.10	450.70	6.60	6.60	Grey shale interbanded with very fine to medium grained

				sandstone.
450.70	457.40	6.70	6.70	COAL.
457.40	458.80	1.40	1.40	Grey shale.
458.80	459.25	0.45	0.45	COAL.
459.25	460.00	0.75	0.75	Grey shale.
460.00	460.20	0.20	0.20	COAL.
460.20	460.95	0.75	0.75	Grey shale.
460.95	461.25	0.30	0.30	COAL.
461.25	461.50	0.25	0.25	Grey shale.
461.50	470.00	8.50	8.50	COAL.
470.00	471.60	1.60	1.60	Grey shale laminated with very fine grained sandstone.
471.60	472.60	1.00	1.00	COAL.
472.60	474.05	1.45	1.45	Grey shale.
474.05	474.70	0.65	0.65	COAL.
474.70	475.70	1.00	1.00	Grey shale.
475.70	476.45	0.75	0.75	Carbonaceous shale.
476.45	476.96	0.51	0.51	COAL.
476.96	477.30	0.34	0.34	Carbonaceous shale.
477.30	478.60	1.30	1.30	Grey shale.
478.60	478.80	0.20	0.20	COAL.
478.80	479.60	0.80	0.80	Carbonaceous shale.
479.60	481.40	1.80	1.80	Grey shale.
481.40	482.00	0.60	0.60	COAL. (Seam Zone – III)
482.00	487.10	5.10	5.10	Grey shale laminated with very fine grained sandstone, and siltstone. Laminae at places biochurned.
487.10	491.10	4.00	4.00	Medium grained feldspathic sandstone grades upward to fine grained felspathic sandstone.
491.10	507.70	16.60	16.60	Grey shale interbanded and intercalated with very fine grained sandstone and siltstone. Rootlets, Glossopteris, biochurning.

Borehole closed at 507.70 m. depth in Barakar Formation

Borehole No. : AB – 14

Location	:	**Lat. 23° 44′ 30″**	Drilling Unit	:	**378**
		Long. 84° 38′ 36″	Date of commencement	:	**04.06.1993**
R. L.	:	**437.360 m.**	Date of completion	:	**02.08.1993**
Final Depth	:	**329.80 m.**	Logged by	:	K. Mondal

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	16.75	16.75	0.30	Sludge of medium grained yellowish sand.
16.75	19.00	2.25	2.25	Coarse grained felspathic sandstone with grey silty shale.
19.00	19.45	0.45	0.45	Carbonaceous shale. (Seam Zone – V)
19.45	22.60	3.15	3.15	Carbonaceous shale with coal bands.
22.60	23.55	0.95	0.95	Grey shale, rootlets.
23.55	23.73	0.18	0.18	Carbonaceous shale.
23.73	23.93	0.20	0.20	COAL.
23.93	24.77	0.84	0.84	Carbonaceous shale.
24.77	25.05	0.28	0.28	COAL.
25.05	29.15	4.10	4.10	Coarse grained felspathic sandstone grades upward to grey shale. Rootlets at places in grey shale.
29.15	39.80	10.65	10.65	Very coarse to gritty sandstone with thin irregular clay bands grades upward to grey shale laminated with siltstone.
39.80	40.50	0.70	0.70	Grey shale containing Glossopteris laminated with very fine grained sandstone.
40.50	40.80	0.30	0.30	COAL.
40.80	41.20	0.40	0.40	Grey shale.
41.20	42.30	1.10	1.10	COAL.
42.30	42.45	0.15	0.15	Carbonaceous shale. (Seam Zone – V)
42.45	51.50	9.05	9.05	Predominantly grey shale (Rootlets, Glossopteris) with laminae and thin bands of grey sandstone, siltstone and a thick band of coarse grained sandstone at middle.
51.50	51.70	0.20	0.20	COAL.
51.70	64.70	13.00	13.00	Coarse to very coarse grained cross-bedded felspathic

				sandstone grades upward to grey shale laminated with very fine grained sandstone. Biochurning at places.
64.70	72.80	8.10	8.10	Coarse to very coarse grained feldspathic sandstone grades upward to grey shale with laminae of very fine grained sandstone, biochurning at places.
72.80	83.45	10.65	10.65	Grey shale (Glossopteris, rootlet) laminated with very fine grained sandstone and siltstone.
83.45	89.00	5.55	5.55	Top 3.00m. medium to coarse grained cross-bedded sandstone and rest grey shale (Glossopteris, rootlest) laminated with very fine grained sandstone (biochurned).
89.00	106.65	17.65	17.65	Interlaminated and banded medium to coarse grained cross-bedded felspathic sandstone, grey shale and occasional gritty sandstone.
106.65	110.95	4.30	4.30	Grey shale interbanded with medium to fine grained sandstone. Biochurning at places. Bottom grey shale.
110.95	111.11	0.16	0.16	COAL.
111.11	111.59	0.48	0.48	Carbonaceous shale.
111.59	111.75	0.16	0.16	COAL.
111.75	115.65	3.90	3.90	Grey shale with bands of medium to fine grained sandstone. Rootlets and Glossopteris at places.
115.65	121.50	5.85	5.85	Very coarse grained to gritty felspathic sandstone with occasional bands of grey shale and medium grained sandstone.
121.50	124.80	3.30	3.30	Grey shale with laminae of siltstone, rootlets and Glossopteris present.
124.80	125.43	0.63	0.63	COAL. (Seam Zone – III)
125.43	126.10	0.67	0.67	Carbonaceous shale.
126.10	126.35	0.25	0.25	COAL.
126.35	130.90	4.55	4.55	Grey shale with laminae of fine grained sands (biochurned). Carbonaceous shale with coal streaks at middle.
130.90	153.85	22.95	22.95	COAL.
153.85	155.30	1.45	1.45	Fine grained sandstone laminated with grey shale, bottom grey shale.
155.30	165.68	10.38	10.38	COAL.
165.68	165.90	0.22	0.22	Carbonaceous shale.

165.90	171.45	5.55	5.55	Grey shale (rootlet) interbanded and laminated with fine grained sandstone. Laminae biochurned at places.
171.45	173.00	1.55	1.55	COAL.
173.00	183.45	10.45	10.45	Mainly grey shale. Towards bottom laminae and bands of fine to very fine grained sandstone. Rootlet, biochurning present. At top and bottom grey shale.
183.45	183.53	0.08	0.08	Carbonaceous shale.
183.53	186.55	3.02	3.02	COAL. (Seam Zone – III)
186.55	211.70	25.15	25.15	Coarse grained cross-bedded sandstone with bands and laminae of grey shale and fine to medium grained sandstone. Slickenside and silicification at 189.00m. depth.
211.70	217.50	5.80	5.80	Alternation of medium to coarse grained sandstone and grey shale. Rootlets, Glossopteris and Schizoneura.
217.50	217.61	0.11	0.11	Carbonaceous shale with grey shale intercalation. (Seam zone – II)
217.61	217.77	0.16	0.16	COAL.
217.77	218.00	0.23	0.23	Carbonaceous shale.
218.00	221.60	3.60	3.60	COAL.
221.60	222.30	0.70	0.70	Grey shale laminated with very fine grained sandstone. Rootlets and Glossopteris.
222.30	222.70	0.40	0.40	COAL with thin carbonaceous shale laminae.
222.70	228.15	5.45	5.45	Alternation and interlamination of grey shale, fine to very fine grained sandstone and occasional siltstone. Rootlet, Glossopteris.
228.15	249.05	20.90	20.90	COAL.
249.05	252.60	3.55	3.55	Grey shale, ironstone shale, intercalated with siltstone. Slickenside and silicification at places.
252.60	261.00	8.40	8.40	COAL. (Seam Zone – II)
261.00	262.60	1.60	1.60	Interlaminated grey shale and siltstone.
262.60	262.90	0.30	0.30	COAL.
262.90	268.05	5.15	5.15	Fine to medium grained sandstone with bands of grey shale. Sandstone highly slickensided.

268.05	269.37	1.32	1.32	Carbonaceous shale.
269.37	269.55	0.18	0.18	COAL.
269.55	276.75	7.20	7.20	Very coarse to pebbly sandstone. Bottom grey shale.
276.75	277.55	0.80	0.80	Carbonaceous shale.
277.55	277.65	0.10	0.10	COAL.
277.65	278.02	0.37	0.37	Carbonaceous shale.
278.02	278.15	0.13	0.13	COAL.
278.15	290.45	12.30	12.30	Interbedded sequences of grey shle, fine to medium grained sandstone and coarse to pebbly sandstone. Top grey shale.
290.45	290.85	0.40	0.40	COAL.
290.85	295.45	4.60	4.60	Interbedded medium to fine grained sandstone, grey shale, very coarse to pebbly sandstone, fire clay and siltstone. Highly slickensided unit.
295.45	296.80	1.35	1.35	Grey shale with carbonaceous shale at middle.
296.80	297.20	0.40	0.40	COAL.
297.20	297.40	0.20	0.20	Grey shale.
297.40	298.90	1.50	1.50	Thin coal and grey shale.
298.90	313.80	14.90	14.90	Very coarse grained to gritty to pebbly sandstone grades upward to grey shale intercalated with carbonaceous shale. Sand filled burrow structure, slump structure present.
313.80	329.80	16.00	16.00	Interbedded sequence of very coarse to pebbly sandstone, medium to coarse grained sandstone, grey shale, silty shale and very fine grained sandstone.

Borehole closed at 329.80m. depth in Barakar Formation

Borehole No. : AB – 15

Location	:	**Lat. 23° 44′ 22″**	Drilling Unit	:	**378**
		Long. 84° 38′ 00″	Date of commencement	:	**23.08.1993**
R. L.	:	**431.43 m.**	Date of closing	:	**27.04.1994**
Final Depth	:	**477.70 m.**	Logged by	:	K. Mondal

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	6.00	6.00	0.90	Sludge of medium grained sand.
6.00	15.25	9.25	4.60	Grey mudstone and claystone intercalated with ferrugineous siltstone.
15.25	15.55	0.30	0.30	COAL. (Seam Zone – VIII)
15.55	18.30	2.75	2.75	Grey shale / claystone with sideritic streaks, bottom with carbonaceous shale intercalation.
18.30	19.20	0.90	0.90	COAL.
19.20	20.05	0.85	0.85	Claystone.
20.05	20.40	0.35	0.35	COAL.
20.40	20.60	0.20	0.20	Carbonaceous shale.
20.60	20.85	0.25	0.25	COAL.
20.85	21.90	1.05	1.05	Grey shale.
21.90	22.58	0.68	0.65	COAL.
22.58	23.75	1.17	1.13	Carbonaceous shale with minor coal band.
23.75	25.61	1.86	1.77	COAL. (Seam Zone – VIII)
25.61	29.25	3.64	3.64	Interbedded medium to coarse grained sandstone and grey shale.
29.25	29.40	0.15	0.15	COAL. (Seam Zone – VIII)
29.40	29.75	0.35	0.35	Grey shale.
29.75	29.95	0.20	0.20	COAL. (Seam Zone – VIII)
29.95	47.05	17.10	17.10	Interbedded sequence of medium to coarse grained sandstone, fine grained sandstone, siltstone and grey shale, bioturbation at 36.00m. depth.

47.05	61.55	14.50	12.50	Fine grained sandstone with occasional grey shale and silty shale laminae.
61.55	68.95	7.40	7.40	Grey silty shale with carbonaceous shale laminae.
68.95	79.45	10.50	10.50	Interbedded sequence of fine grained cross-laminated sandstone, grey shale and silty shale. Coarser influx towards top.
79.45	98.20	18.75	18.75	Gritty to arkosic sandstone grades upward to grey shale with thin coal laminae.
98.20	113.00	14.80	14.80	Alternate sequence of medium to coarse grained arkosic sandstone, fine grained cross-laminated sandstone, grey shale and siltstone.
113.00	158.10	45.10	45.10	Grey shale with thin silty and carbonaceous shale laminae at places. Rootlet at places. Bottom grey shale.
158.10	159.40	1.30	1.30	COAL.
159.40	167.85	8.45	8.45	Grey shale with thin laminae of carbonaceous shale, fire clay and siltstone. Coal seams of 40cm. and 10cm. at 160.30m. and 162.70m. depths respectively.
167.85	176.90	9.05	9.05	Alternate sequence of coarse grained sandstone and grey shale.
176.90	177.00	0.10	0.10	COAL. (Seam Zone – VII)
177.00	177.55	0.55	0.55	Grey shale.
177.55	178.15	0.60	0.60	COAL. (Seam Zone – VII)
178.15	185.00	6.85	6.85	Grey shale with carbonaceous shale and sandy / silty laminae. Thin coal bands at places.
185.00	185.18	0.18	0.18	Carbonaceous shale.
185.18	186.50	1.32	1.32	COAL.
186.50	187.75	1.25	1.25	Grey shale with thin coal laminae at places.
187.75	187.85	0.10	0.10	Carbonaceous shale.
187.85	188.35	0.50	0.50	COAL.
188.35	188.45	0.10	0.10	Carbonaceous shale.
188.45	193.15	4.70	4.70	Grey shale with fine grained sandstone band and thin silty and carbonaceous shale laminae. Biochurning towards top. Bottom grey shale.
193.15	200.65	7.50	7.50	COAL.

200.65	204.15	3.50	3.50	Grey shale interlaminated with fine grained sandstone. High biochuring, rootlets, Glossopteris present.
204.15	204.55	0.40	0.40	COAL.
204.55	207.85	3.30	3.30	Grey shale interbanded with fine grained sandstone with thin carbonaceous shale and coal band at places.
207.85	209.10	1.25	1.25	COAL.
209.10	209.50	0.40	0.40	Carbonaceous shale.
209.50	211.10	1.60	1.60	Alternate sequence of grey shale and coal of 25cm., 30cm. and 15cm. at depths of 209.70m., 210.05m. and 210.75m.
211.10	214.55	3.45	3.45	Grey shale with medium to coarse grained sandstone bands and thin ironstone shale laminae at places.
214.55	215.55	1.00	1.00	Alternate bands of thin coal seams of 20cm. and 15cm. at depths of 214.55m. and 214.95m. respectively and grey shale.
215.55	216.10	0.55	0.55	COAL.
216.10	217.80	1.70	1.70	Grey shale with thin carbonaceous shale laminae and sandstone bands.
217.80	218.15	0.35	0.35	COAL. (Seam Zone – VII)
218.15	229.05	10.90	10.90	Interbanded grey shale, fine grained sandstone and medium to coarse grained cross-bedded sandstone. Biochurning present at places.
229.05	230.10	1.05	1.05	Carbonaceous shale with 15cm. coal at 229.25m. depth.
230.10	238.85	8.75	8.75	Interbanded sequence of grey shale, fine to medium grained sandstone and thin coal bands.
238.85	239.25	0.40	0.40	COAL. (Seam Zone – VI)
239.25	246.85	7.60	7.60	Interbanded sequence of grey shale, fine to medium grained sandstone and thin coal bands.
246.85	270.50	23.65	23.65	Heterolithic sequence of grey shale and siltstone to coarse grained sandstone with thin coal seams of 10cm., 25cm., 45cm., 15cm. and 20cm at depths of 262.30m., 264.90m., 266.45m., 268.45m. and 269.95m. respectively.
270.50	270.78	0.28	0.26	Carbonaceous shale.
270.78	270.92	0.14	0.13	COAL. (Seam Zone – VI)
270.92	271.65	0.73	0.66	Carbonaceous shale.

271.65	278.85	7.20	7.20	Grey shale with silty to fine grained sandstone laminae.
278.85	290.55	11.70	11.70	Grey shale with fine to medium grained cross-bedded sandstone bands.
290.55	291.34	0.79	0.79	Carbonaceous shale.
291.34	291.95	0.61	0.61	COAL.
291.95	300.20	8.25	8.25	Alternate sequence of medium grained sandstone, grey shale and thin coal bands of 20cm., 30cm., 40cm., 30cm. and 25cm. at depths of 293.15m., 293.85m., 294.45m., 295.25m. and 299.95m. respectively.
300.20	305.75	5.55	5.55	Grey shale with fine to medium grained sandstone and 40cm. thick coal seam at bottom.
305.75	310.70	4.95	4.95	Alternation of claystone and medium grained sandstone.
310.70	312.25	1.55	1.55	COAL. (Seam Zone – V)
312.25	312.55	0.30	0.30	Carbonaceous shale.
312.55	313.35	0.80	0.80	Grey shale with medium to coarse grained sandstone bands.
313.35	315.25	1.90	1.90	COAL.
315.25	316.30	1.05	1.05	Grey shale with 30cm. coal seams at 315.60m.
316.30	317.80	1.50	1.50	COAL.
317.80	318.15	0.35	0.35	Grey shale.
318.15	324.95	6.80	6.80	COAL.
324.95	328.95	4.00	4.00	Grey shale with thin coal bands of 20cm at 325.45m. and 326.65m. depths.
328.95	329.95	1.00	0.80	Carbonaceous shale with coal bands.
329.95	334.90	4.95	4.95	Grey shale with fine grained sandstone and a 45cm. coal seam at 330.85m. depth.
334.90	338.45	3.55	3.55	Carbonaceous shale with thin coal bands.
338.45	339.70	1.25	1.25	COAL.
339.70	341.50	1.80	1.80	Grey shale with fine grained sandstone band and two coal seams of 40cm. and 20cm. at 340.20m. and 341.10m. respectively.
341.50	342.70	1.20	1.20	COAL.
342.70	345.50	2.80	2.80	Grey shale with thin silty laminae.

345.50	346.50	1.00	1.00	COAL. (Seam Zone – V)
346.50	347.20	1.70	1.70	Alternation of grey shale and coarse grained sandstone.
347.20	347.40	0.20	0.20	COAL. (Seam Zone – V)
347.40	349.80	2.40	2.40	Grey shale.
349.80	350.00	0.20	0.20	COAL. (Seam Zone – V)
350.00	350.10	0.10	0.10	Grey shale.
350.10	350.30	0.20	0.20	COAL. (Seam Zone – V)
350.30	352.30	2.00	2.00	Alternation of grey shale and medium to coarse grained sandstone.
352.30	368.15	5.85	5.85	Alternation of grey shale and coarse grained cross-bedded sandstone.
368.15	379.90	11.75	11.75	Interlaminated grey shale and fine to very fine grained sandstone.
379.90	381.75	1.85	1.85	Interbedded sequence of grey shale, fine to medium grained cross-bedded sandstone and silstone.
381.75	382.20	0.45	0.45	COAL. (Seam Zone – IV)
382.20	383.60	1.40	1.40	Grey shale with thin silty laminae.
383.60	384.05	0.45	0.45	COAL. (Seam Zone – IV)
384.05	384.30	0.25	0.25	Grey shale.
384.30	384.50	0.20	0.20	Carbonaceous shale.
384.50	388.75	4.25	4.25	COAL.
388.75	393.70	4.95	4.95	Grey shale with fine grained sandstone to silty laminae and two coal seams of 45cm. and 40cm. at 389.45m. and 393.30m. respectively. A thick gritty sandstone band towards middle.
393.70	405.25	11.55	11.55	Gritty sandstone with occasional shale laminae grades upward to grey shale.
405.25	406.95	1.70	1.70	COAL. (Seam Zone – IV)
406.95	412.00	5.05	5.05	Grey shale with bands of fine to medium grained sandstone, siltstone and coal streaks at places. Leaf impression at places.
412.00	417.05	5.05	5.05	Coarse to very coarse grained sandstone. Bottom 1.00m. grey shale.
417.05	418.60	1.55	1.55	Grey shale thin carbonaceous shale laminae and two coal seams of 15cm. and 30cm. at 417.05m. and 417.90m. depth.

418.60	423.90	5.30	5.30	Grey shale with siltstone and fine to medium grained sandstone.
423.90	429.70	5.80	5.80	Very coarse to gritty sandstone with fine grained sandstone and shale bands at places.
429.70	443.95	14.25	14.25	Very coarse to gritty cross-bedded sandstone grades upward to grey shale / silty shale.
443.95	444.02	0.07	0.07	Carbonaceous shale.
444.02	444.73	0.71	0.71	COAL.
444.73	444.85	0.12	0.12	Carbonaceous shale.
444.85	445.45	0.60	0.60	Parallel laminated siltstone.
445.45	445.60	0.15	0.15	Carbonaceous shale.
445.60	446.75	1.15	1.15	COAL.
446.75	446.85	0.10	0.10	Carbonaceous shale.
446.85	447.25	0.40	0.40	Carbonaceous siltstone.
447.25	447.65	0.40	0.40	Carbonaceous shale.
447.65	447.85	0.20	0.20	COAL.
447.85	448.15	0.30	0.30	Medium to coarse grained sandstone.
448.15	453.10	4.95	4.95	COAL.
453.10	453.25	0.15	0.15	Carbonaceous shale.
453.25	459.55	6.30	6.30	Medium to coarse grained cross-bedded sandstone grades upward to grey shale intercalated with carbonaceous shale.
459.55	464.45	4.90	4.90	Interbanded grey shale and very fine grained sandstone.
464.45	470.95	6.50	6.50	Very coarse to gritty sandstone with bands of fine grained sandstone.
470.95	477.70	6.75	6.75	Interbanded grey shale, very fine grained sandstone and siltstone.

Borehole closed at 477.70 m. depth in Barakar Formation

Borehole No. : AB – 16

Location	:	**Lat. 23° 45′ 04″**	Drilling Unit	:	**267**
		Long. 84° 35′ 26″	Date of commencement	:	**01.02.1994**
R. L.	:	**399.450 m.**	Date of completion	:	**26.05.1994**
Final Depth	:	**552.85 m.**	Logged by	:	K. Mondal

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	8.60	8.60	1.00	Sludge of fine grained sand.
8.60	15.00	6.40	6.40	Fine to medium grained micaceous greenish grey sandstone with coarse grained cross-bedded sandstone and clay laminae.
15.00	25.85	10.85	10.85	Thinly interlaminated very fine grained micaceous sandstone, siltstone and grey shale. Bioturbation at places.
25.85	28.05	2.20	2.20	Grey shale with carbonaceous shale band at middle and a 40cm. coal band at 26.75m. depth. Lower contact gradational.
28.05	36.00	7.95	7.95	Interbedded sequence of grey shale with coal streaks and very fine grained micaceous cross-laminated sandstone, siltstone with clay flaser. Bioturbation at places.
36.00	46.60	10.60	10.60	Grey siltstone and silty shale with fine sandy cross laminae at places. Bioturbation and slump signature at places.
46.60	50.25	3.65	3.65	Very coarse to coarse grained cross-bedded sandstone with fine sandstone bands at places.
50.25	69.35	19.10	19.10	Grey silty claystone with coarser influx at places.
69.35	71.15	1.80	1.80	Grey shale with coal and carbonaceous streaks and laminae and stem impressions at places.
71.15	75.80	4.65	4.65	Alternate sequence of grey shale (Stem impression) and grey medium grained sandstone with carbonaceous material.
75.80	80.20	4.40	4.40	Grey siltstone with occasional lenticular patches of shale and silty shale.
80.20	82.40	2.20	2.20	Grey shale with few coal steaks and medium grained sandstone towards top.
82.40	95.55	13.15	13.15	Grey shale with interbands of siltstone, very coarse sandstone to gritty sandstone, fine grained sandstone and carbonaceous streaks. Sandstone often cross-bedded.

95.55	132.00	36.45	36.45	Grey shale with interbands of very fine grained sandstone and siltstone showing flaser bedding and cross-lamination. Slumping at 125.00m. and rootlet at places.
132.00	133.20	1.20	1.20	Carbonaceous shale with coal bands.
133.20	140.35	7.15	7.15	Grey shale with interbands of siltstone and very fine grained sandstone.
140.35	166.00	25.65	25.65	Grey shale interbanded and interlaminated with very fine grained sandstone showing flaser bedding.
166.00	188.30	22.30	22.30	Alternate sequence of grey shale and very fine to fine grained sandstone with flaser bedding and cross-lamination. Silicification at 173.25m.

---------- **Contact between Raniganj Formation and Barakar Formation** ----------

188.30	193.70	5.40	5.40	Alternate sequence of coarse to very coarse grained felspathic sandstone and grey shale with flaser bedding in very fine grained sandstone
193.70	201.10	7.40	7.40	Grey shale with interbands of flaser bedded and cross-laminated very fine grained sandstone.
201.10	210.50	9.40	9.40	Medium to coarse grained cross-bedded sandstone with interbands of grey shale.
210.50	210.75	0.25	0.25	COAL. (Seam Zone – VIII)
210.75	231.75	21.00	21.00	Grey shale with interbands of very fine grained cross-laminated sandstone. Thin coal seams of 0.30m., 0.20m., 0.40m., 0.30m., 0.45m., 0.30m., 0.15m., 0.30m., 0.15m., 0.20m. and 0.30m. at depths of 212.05m., 214.70m., 215.30m., 217.20m., 221.80m., 223.55m., 224.60m., 225.15m., 227.40m., 228.00m. and 231.45m. respectively.
231.75	242.40	10.65	10.65	Grey shale with medium to fine grained sandstone bands at places. One 40cm. coal seam at 241.50m. depth.
242.40	243.10	0.70	0.70	COAL.
243.10	246.30	3.20	3.20	Grey shale with occasional fine grained sandstone.
246.30	246.70	0.40	0.40	COAL. (Seam Zone – VIII)
246.70	247.40	0.70	0.70	Grey shale.
247.40	247.60	0.20	0.20	COAL. (Seam Zone – VIII)

247.60	252.00	4.40	4.40	Grey shale.
252.00	258.00	6.00	6.00	Grey shale with very fine grained felspathic sandstone and occasional medium grained cross-bedded sandstone.
258.00	263.60	5.60	5.60	Coarse grained cross-bedded sandstone grades upward to grey shale.
263.60	270.50	6.90	6.90	Coarse to very coarse grained felspathic sandstone grades upward to medium grained felspathic sandstone with shale laminae at places.
270.50	275.45	4.95	4.95	Grey shale with thin laminae of very fine grained sandstone, siltstone. Carbonaceous shale laminae at places.
275.45	275.60	0.15	0.15	Carbonaceous shale.
275.60	276.15	0.55	0.55	COAL.
276.15	279.70	3.55	3.55	Coarse grained felspathic sandstone with a grey shale band at top.
279.70	284.10	4.40	4.40	Grey shale with fine to medium grained cross-bedded sandstone and siltstone with mud flaser.
284.10	285.40	1.30	1.30	COAL.
285.40	286.80	1.40	1.40	Medium to coarse grained sandstone.
286.80	288.00	1.20	1.20	COAL.
288.00	288.40	0.40	0.40	Carbonaceous shale.
288.40	305.05	16.65	16.65	Grey shale with interbands of coarse to very coarse grained cross-bedded sandstone.
305.05	308.45	3.40	3.40	Grey shale with thin laminae of very fine grained sandstone and occasional coarse grained felspathic sandstone.
308.45	313.10	4.65	4.65	Very coarse grained to gritty felspathic sandstone grades upward to very thin grey shale band with coal streaks.
313.10	314.50	1.40	1.40	Grey silty shale, bottom 40cm. carbonaceous shale.
314.50	315.50	1.00	1.00	COAL.
315.50	320.60	5.10	5.10	Very coarse grained to pebbly felspathic sandstone grades upward to grey shale.
320.60	327.60	7.00	7.00	Heterolithic sequence of coarse grained to gritty feldspathic sandstone, grey shale and fine grained sandstone.

327.60	327.77	0.17	0.17	Carbonaceous shale with coal bands.
327.77	328.30	0.53	0.53	COAL.
328.30	345.75	17.45	17.45	Grey shale with medium to coarse grained sandstone. Very fine grained sandstone to siltstone laminae and coal bands of 0.25m. and 0.30m. at 331.40m. and 335.70m. depths.
345.75	347.20	1.45	1.45	Carbonaceous shale with 0.18m. and 0.13m. coal bands at 346.12m. and 346.62m. depth.
347.20	366.55	19.35	19.35	Alternate sequence of grey shale, medium to coarse grained sandstone and very fine grained to siltstone. 0.15m. and 0.45m. coal bands at 350.10m. and 355.15m. depth.
366.55	406.00	39.45	39.45	Interlaminated and intercalated grey shale, fine grained sandstone to coarse grained sandstone, siltstone with thin coal laminae and bands at places.
406.00	406.35	0.35	0.35	Carbonaceous shale. (Seam Zone – VII)
406.35	414.00	7.65	7.65	COAL. (Seam Zone – VII)
414.00	417.85	3.85	3.85	Grey shale with bands of medium grained sandstone and carbonaceous shale at places. One 0.30m. coal band at middle.
417.85	418.65	0.80	0.80	Carbonaceous shale.
418.65	430.10	11.45	11.45	Interbanded and laminated grey shale, medium to fine grained sandstone laminae at places. Biochurning common.
430.10	438.35	8.25	8.25	Grey shale with bands and laminae of coarse to very coarse grained sandstone, medium to fine grained sandstone, siltstone. Sandstones are cross-bedded at places.
438.35	443.66	5.31	5.31	Very coarse grained to gritty sandstone.
443.66	452.20	8.54	8.54	Grey shale interbanded and laminated with fine grained sandstone and occasional medium grained sandstone.
452.20	456.65	4.45	4.45	Coarse to fine grained felspathic sandstone with laminae and bands of grey shale and coal streaks at places. Rootlets present in shale.
456.65	461.00	4.35	4.35	Grey shale with coal stringers and streaks, silty shale bands at middle.
461.00	461.45	0.45	0.45	COAL.
461.45	461.75	0.30	0.30	Grey shale.
461.75	461.85	0.10	0.10	COAL. (Seam Zone – VII)
461.85	465.40	3.55	3.55	Grey shale with very fine grained sandstone bands towards

				bottom and very thin coal laminae and streaks towards top.
465.40	473.55	8.15	8.15	Medium to fine grained cross-bedded feldspathic sandstone laminated and intercalated with grey shale towards bottom and banded with siltstone towards top. Grey shale laminae and slumped shale patches at places towards top.
473.55	496.90	23.35	23.35	Heterolithic sequence of a) grey shale, b) fine grained feldspathic sandstone, c) medium grained cross-bedded feldspathic sandstone and d) grey shale laminated with very fine grained sandstone. Laminae biochurned at places.
496.90	501.85	4.95	4.95	Very coarse grained cross-bedded sandstone grades upward to medium grained cross-bedded felspathic sandstone.
501.85	502.10	0.25	0.25	Grey shale with silty laminae at places.
502.10	502.25	0.15	0.15	COAL.
502.25	505.75	3.50	3.50	Fine to medium grained felspathic sandstone with slump patches of grey shale, bands and laminae of grey shale. Laminae are biochurned. At middle 55cm. very coarse grained to gritty felspathic sandstone.
505.75	511.80	6.05	6.05	Grey shale laminated with biochurned laminae of very fine grained sandstone, siltstone and medium grained ferrugineous sandstone bands towards bottom.
511.80	514.55	2.75	2.75	Grey shale laminated with siltstone.
514.55	514.75	0.20	0.20	COAL.
514.75	516.25	1.50	1.50	Grey shale, Vertebraria, Glossopteris, rootlet, top part is very fine grained sandstone.
516.25	516.35	0.10	0.10	COAL.
516.35	531.15	14.80	14.80	Alternate sequence of grey shale and medium to fine grained cross-bedded sandstone. Bottom slickensided.
531.15	537.15	6.00	6.00	Heterolithic sequence of grey shale, very fine grained slightly ferrugeneous sandstone and medium to coarse grained feldspathic sandstone. Silicification towards top.
537.15	552.85	15.70	15.70	Alternate sequence of grey shale, medium grained feldspathic cross-bedded sandstone and very fine grained sandstone with grey shale towards bottom.

Borehole closed at 552.85 m. depth in Barakar Formation

Borehole No. : AB – 17

Location	:	**Lat. 23° 45′ 07″**	Drilling Unit	:	**267**
		Long. 84° 38′ 08″	Date of commencement	:	**13.06.1994**
R. L.	:	**425.47 m.**	Date of completion	:	**29.08.1994**
Final Depth	:	**383.65 m.**	Logged by	:	K. Mondal

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	5.50	5.50	0.30	Sandy sludge with soil.
5.50	11.50	6.00	6.00	Grey shale interbanded and laminated with cherry red shale and claystone with coarse grained ferrugineous sandstone band at middle.
11.50	15.20	3.70	3.70	Heterolithic sequence of grey shale, siltstone, medium to coarse grained sandstone and occasional cherry red shale, core dip – 18° to 20°.
15.20	15.55	0.35	0.35	COAL. (Seam Zone – V + IV)
15.55	17.15	1.60	1.60	Carbonaceous medium grained, ferrugineous coarse to very coarse grained sandstone with grey shale laminae towards bottom.
17.15	17.62	0.47	0.47	COAL.
17.62	18.00	0.38	0.38	Carbonaceous shale.
18.00	21.45	3.45	3.45	Grey shale with thin bands of very fine grained sandstone, siltstone and streaks of coal at places. Core dip -18° to 20°.
21.45	21.75	0.30	0.30	COAL.
21.75	23.30	1.55	1.55	Grey shale with thin bands of very fine grained sandstone and siltstone. Bottom grey shale.
23.30	28.75	5.45	5.45	COAL.
28.75	29.75	1.00	1.00	Grey shale.
29.75	30.45	0.70	0.70	Carbonaceous shale.
30.45	32.25	1.80	1.80	Fine to medium grained cross-bedded sandstone grades down to coarse to very coarse grained carbonaceous sandstone, grey shale at top. Bottom with fine grained sandstone.
32.25	37.62	5.37	5.37	Carbonaceous shale with minor interbands of coal.

37.62	40.39	2.77	2.77	COAL. (Seam Zone – V + IV)
40.39	41.00	0.61	0.61	Carbonaceous shale with thin band of coal and sandy shale.
41.00	49.10	8.10	8.10	Alternate banded grey shale with fine grained sandstone laminae (biochurned) and coarse to very coarse grained cross-bedded sandstone with thin irregular vitrain laminae and streaks.
49.10	51.10	2.00	2.00	Grey shale laminated with siltstone, laminae biochurned at places.
51.10	51.43	0.33	0.33	Carbonaceous shale.
51.43	52.62	1.19	1.19	COAL.
52.62	53.20	0.58	0.58	Carbonaceous shale.
53.20	58.20	5.00	5.00	Granular sandstone grades upward to grey shale through coarse to very coarse grained cross-bedded sandstone, fine to medium grained sandstone with silty laminae, biochurned at places.
58.20	59.30	1.10	1.10	Grey shale with silty laminae.
59.30	60.18	0.88	0.88	COAL.
60.18	61.30	1.12	1.12	Carbonaceous shale with very thin coal band.
61.30	64.10	2.80	2.80	Grey shale with three coal seams of 0.20m., 0.25m. and 0.15m. at depths of 62.20m., 62.55m. and 63.75m. respectively.
64.10	64.40	0.30	0.30	Carbonaceous shale.
64.40	64.75	0.35	0.35	COAL.
64.75	66.10	1.35	1.35	Carbonaceous shale.
66.10	71.04	4.94	4.94	Very coarse grained sandstone with grey shale bands, coal streak. Bottom grey shale intercalated with carbonaceous shale.
71.04	72.00	0.96	0.96	COAL.
72.00	77.90	5.90	5.90	Very coarse to coarse grained sandstone grades upward to grey shale through very fine grained sandstone and siltstone.
77.90	78.20	0.30	0.30	Carbonaceous shale.
78.20	80.17	1.97	1.97	COAL. (Seam Zone – V + IV)
80.17	80.40	0.23	0.23	Carbonaceous shale.

80.40	83.45	3.05	3.05	Interbanded and laminated fine to medium grained sandstone and grey shale. Slumping signature at places. Bottom grey shale.
83.45	83.93	0.48	0.48	COAL.
83.93	84.20	0.27	0.27	Carbonaceous shale.
84.20	94.20	10.00	10.00	Heterolithic sequence of grey shale laminated with siltstone, very fine grained sandstone, medium to coarse grained feldspathic cross-bedded sandstone. Laminae at places biochurned. Bottom 10cm. carbonaceous shale.
94.20	100.25	6.05	6.05	COAL. (Seam Zone – V + IV)
100.25	103.10	2.85	2.85	Grey shale laminated with siltstone and very fine grained sandstone.
103.10	103.45	0.35	0.35	Carbonaceous shale.
103.45	107.45	4.00	4.00	COAL. (Seam Zone – V + IV)
107.45	114.10	6.65	6.65	Granular to pebbly sandstone grades upward to grey shale (laminated and intercalated with siltstone) through very fine to medium grained sandstone.
114.10	114.25	0.15	0.15	COAL.
114.25	116.20	1.95	1.95	Grey shale interbanded with very fine grained sandstone.
116.20	116.40	0.20	0.20	COAL.
116.40	128.45	12.05	12.05	Heterolithic sequence of grey shale banded with fine to very fine grained sandstone, medium and coarse grained sandstone. Biochurning, slumping occasionally present, Vertebraria.
128.45	128.55	0.10	0.10	COAL.
128.55	135.05	6.50	6.50	Grey shale laminated with fine to very fine grained sandstone, top very coarse grained to granular sandstone.
135.05	142.35	7.30	7.30	Very coarse grained cross-bedded sandstone grades upward to fine grained sandstone. Fault at 136m. depth.
142.35	151.60	9.25	9.25	Granular sandstone grades upward to grey shale laminated with very fine grained sandstone / siltstone.
151.60	165.60	14.00	14.00	Alternate sequence of grey shale, fine grained, medium to coarse grained cross-bedded sandstone. Bottom grey shale, slickensided, silicification, micro-fault at 160m. to 162m. depth.
165.60	172.20	6.60	6.60	COAL. (Seam Zone – III + II)

172.20	179.50	7.30	7.30	Heterolithic sequence of grey shale, fine grained sandstone, very coarse grained to granular sandstone with patches of medium grained sandstone and flaser bedding present. Top and bottom grey shale.
179.50	183.35	3.85	3.85	COAL.
183.35	189.90	6.55	6.55	Heterolithic sequence of grey shale, grey shale with fine to very fine grained sandstone laminae and medium to coarse grained cross-bedded sandstone. Top and bottom grey shale.
189.90	190.10	0.20	0.20	COAL.
190.10	190.50	0.40	0.40	Carbonaceous shale.
190.50	195.50	5.00	5.00	COAL. (Seam Zone – III + II)
195.50	197.55	2.05	2.05	Grey shale with three coal seams of 0.20m., 0.10m. and 0.10m. at depths of 195.60m., 195.90m. and 197.55m.
197.55	207.30	9.75	9.75	Alternation and interlamination of grey shale, fine grained sandstone, cross-laminated at places.
207.30	207.60	0.30	0.30	COAL.
207.60	209.65	2.05	2.05	Grey shale with 0.30m. and 0.35m. coal seams at 208.70m. and 209.10m. depths.
209.65	214.00	4.35	4.35	Grey shale interbanded and laminated with fine to medium grained sandstone and coarse grained sandstone. Bottom grey shale.
214.00	215.75	1.75	1.75	COAL.
215.75	216.80	1.05	1.05	Grey shale intercalated at places with carbonaceous shale.
216.80	219.15	2.35	2.35	COAL.
219.15	221.30	2.15	2.15	Grey shale intercalated at places with carbonaceous shale.
221.30	232.30	11.00	11.00	COAL.
232.30	234.10	1.80	1.80	Grey shale with silty laminae at places.
234.10	237.50	3.40	3.40	COAL.
237.50	238.40	0.90	0.90	Grey shale intercalated with carbonaceous shale.
238.40	241.10	2.70	2.70	COAL.
241.10	243.80	2.70	2.70	Medium grained carbonaceous sandstone with bands of fine grained silicified sandstone and grey shale. Top and bottom grey shale.
243.80	245.59	1.79	1.79	COAL.

245.59	246.97	1.38	1.38	Grey shale, top 0.11m. and bottom 0.17m. carbonaceous shale.
246.97	247.91	0.94	0.94	COAL.
247.91	250.75	2.84	2.84	Grey shale laminated with very fine grained sandstone and siltstone , top 0.09m. carbonaceous shale.
250.75	255.30	4.55	4.55	COAL.
255.30	255.80	0.50	0.50	Grey shale with coal streaks.
255.80	262.61	6.81	6.81	COAL.
262.61	264.35	1.74	1.74	Carbonaceous shale with 0.13m. coal at 263.65m. depth. Bottom 0.20m. grey shale.
264.35	264.95	0.60	0.60	Carbonaceous shale. (Seam Zone – III + II)
264.95	270.55	5.60	5.60	Heterolithic sequence of grey shale, fine to coarse grained sandstone and laminated grey shale.
270.55	276.55	6.00	6.00	Medium to coarse grained cross-bedded sandstone.
276.55	289.30	12.75	12.75	Grey shale laminated and intercalated with siltstone and sandy shale, biochurning at places. 0.30m., 0.25m. and 0.20m. coal seams at 280.50m., 284.80m. and 288.75m. respectively.
289.30	293.75	4.45	4.45	Medium to coarse grained cross-bedded sandstone.
293.75	294.30	0.55	0.55	Debris flow deposit.
294.30	296.90	2.60	2.60	Fine to very fine grained ferruginous sandstone grades upward to very coarse grained to gritty sandstone. Silicification at places.
296.90	306.00	9.10	9.10	Heterolithic sequence of medium to coarse grained silicified sandstone, grey silty shale, fine grained sandstone, pebbly sandstone and debris flow.
306.00	318.35	12.35	12.35	Alternation and intercalation of grey shale with siltstone, very fine to medium grained cross-bedded sandstone. Bottom grey shale.
318.35	319.15	0.80	0.80	Carbonaceous shale.
319.15	319.89	0.74	0.74	Grey shale, bottom 0.14m. carbonaceous shale.
319.89	320.40	0.51	0.51	COAL.
320.40	328.75	8.35	8.35	Heterolithic sequence of coarse to very coarse grained cross-bedded sandstone with thin laminae of grey shale, very fine to fine grained sandstone. Top grey shale.

328.75	339.75	11.00	11.00	Grey shale with sandy intercalation at places, lamination of siltstsone with interbeds of fine to medium grained sandstone and pebbly sandstone.
339.75	358.45	18.70	18.70	Heterolithic sequence of grey shale with laminae of very fine grained sandstone / siltstone, very coarse to granular cross-bedded sandstone and fine to medium grained sandstone.
358.45	378.35	19.90	19.90	Interbanded medium to coarse grained cross-bedded sandstone and pebbly sandstone.

---------- **Faulted Contact between Barakar Formation and Metamorphics** ----------

378.35	383.65	5.30	5.30	Top 60cm. white quartzite, rest quartz-biotite-chlorite schist, chlorite-quartz schist and highly foliated granite gneiss.

Borehole closed at 383.65 m. depth in Metamorphics

Borehole No. : AB – 18

Location	:	**Lat. 23° 44′ 34″**	Drilling Unit	:	**267**
		Long. 84° 38′ 13″	Date of commencement	:	**28.09.1994**
R. L.	:	**438.52 m.**	Date of completion	:	**17.02.1995**
Final Depth	:	**477.30 m.**	Logged by	:	K. Mondal

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	5.50	0.10	0.10	Sludge of sand. / Sandy sludge.
5.50	13.50	8.00	8.00	Light grey mudstone with coal and carbonaceous streaks, cherry red shale laminae, rootlets.
13.50	21.60	8.10	8.10	Grey shale, silty shale intercalated with carbonaceous shale, with coal streaks at places.
21.60	22.30	0.70	0.70	COAL.
22.30	25.45	3.15	3.15	Grey shale intercalated at places with carbonaceous shale and a very coarse grained sandstone band at middle. A coal band of 0.25m. in thickness intersected at 24.55m. depth.
25.45	31.15	5.70	5.70	Alternate sequence of very coarse grained felspathic ferruginous sandstone and fine to very fine grained felspathic sandstone with laminae of cherry red shale.
31.15	46.65	15.50	15.50	Heterolithic sequence of grey shale, medium to coarse grained ferruginous cross-bedded sandstone, silty shale and fine to very fine grained sandstone laminated with grey shale. Two coal bands towards top and bottom. (0.20m & 0.20m).
46.65	47.50	0.85	0.85	COAL.
47.50	55.45	7.95	7.95	Interbanded grey shale, siltstone, coarse grained sandstone band at places, fine grained sandstone towards bottom.
55.45	55.55	0.10	0.10	COAL. (Seam Zone – VII)
55.55	55.80	0.25	0.25	Grey shale.
55.80	58.50	2.70	2.70	COAL. (Seam Zone – VII)
58.50	70.30	11.80	11.80	Interbanded, interlaminated grey shale, very fine to fine grained sandstone, siltstone and occasional medium grained sandstone. Two coal bands of 0.35m. and 0.20m. at depths of 60.95m. and 66.40m. respectively. Laminae biochurned at places.

70.30	78.45	8.15	8.15	COAL.
78.45	79.25	0.80	0.80	Interlamination and intercalation of grey shale and fine grained sandstone.
79.25	80.85	1.60	1.60	COAL.
80.85	88.30	7.45	7.45	Grey shale intercalated with very fine grained sandstone, interlaminated with siltstone and fine grained sandstone. Five thin coal bands of 0.30m., 0.35m., 0.35m., 0.30m., and 0.10m. in thickness at depths of 82.10m., 82.65m., 83.80m., 84.45m. and 88.20m. respectively.
88.30	93.20	4.90	4.90	Grey shale interbanded and interlaminated with medium to coarse grained sandstone. A coal band of 0.35m. at depths of 89.00m.
93.20	94.35	1.15	1.15	Carbonaceous shale. (Seam Zone - VII)
94.35	104.48	10.13	10.13	Heterolithic sequence of grey shale; grey shale with laminae and bands of siltstone and fine grained sandstone and medium to coarse grained cross-bedded felspathic sandstone. Bottom 0.48m. carbonaceous shale, 0.15m. coal band at 102.40m. depth.
104.48	105.60	1.12	1.12	COAL.
105.60	108.25	2.65	2.65	Grey shale intercalated with siltstone with thin laminae and irregular streaks of coal, 0.10m. and 0.20m. coal bands at 106.00m. and at 107.65m. depths respectively.
108.25	124.30	16.05	15.70	Heterolithic sequence of grey shale, fine to medium grained sandstone with laminae of grey shale, very coarse grained silicified and slickensided sandstone at 117.40m. and 120.80m. depths. Biochurning at places.
124.30	124.45	0.15	0.15	Carbonaceous shale. (Seam Zone – VI)
124.45	124.59	0.14	0.14	COAL.
124.59	124.77	0.18	0.18	Carbonaceous shale.
124.77	125.10	0.33	0.33	COAL.
125.10	126.50	1.40	1.40	Very coarse grained sandstone with grey shale laminae. 0.35m. coal band at 125.70m. depth.
126.50	126.80	0.30	0.30	Carbonaceous shale.
126.80	127.40	0.60	0.60	COAL.
127.40	127.50	0.10	0.10	Carbonaceous shale.

127.50	130.65	3.15	3.15	Interlaminated and interbanded grey shale and medium to coarse grained sandstone. Biochurning at places. Peatified streaks occasionally present.
130.65	131.75	1.10	1.10	COAL.
131.75	131.85	0.10	0.10	Carbonaceous shale.
131.85	132.65	0.80	0.80	Grey shale, bottom slickensided.
132.65	140.40	7.75	7.75	COAL.
140.40	149.00	8.60	8.60	Grey shale interbanded and interlaminated with siltstone, very fine to fine grained sandstone.0.20m. coal bands at 141.50m. and 141.90m. depths and 0.30m. coal band at 142.40m. depth.
149.00	151.85	2.85	2.85	Carbonaceous shale with coal bands of 0.08m., 0.12m. and 0.09m. at 149.08m., 151.06m. and 151.61m. respectively.
151.85	153.25	1.40	1.40	COAL.
153.25	156.55	3.30	3.30	Grey shale, silty shale interlaminated with fine to very fine grained sandstone with carbonaceous shale. Intercalation and coal streaks at places.
156.55	159.52	2.97	2.97	Carbonaceous shale with coal bands of 0.10m., 0.15m., and 0.37m. at depths of 156.55m., 156.93m., and 158.00m. respectively.
159.52	159.70	0.18	0.18	COAL. (Seam Zone - VI)
159.70	169.00	9.30	9.30	Alternate sequence of coarse to very coarse grained felspathic sandstone and grey shale (interlaminated and banded with very fine to fine grained sandstone, siltstone, sandstone at places cross-laminated). 0.30m. coal at 176.45m. depth.
169.00	194.60	25.60	25.60	Heterolithic sequence of grey shale, medium grained sandstone and coarse to very coarse grained sandstone.
194.60	194.80	0.20	0.20	COAL. (Seam Zone - V)
194.80	195.40	0.60	0.60	Grey shale.
195.40	195.93	0.53	0.53	COAL. (Seam Zone - V)
195.93	196.15	0.22	0.22	Carbonaceous shale.
196.15	204.15	8.00	8.00	Grey shale interbanded with medium to coarse grained felspathic cross-bedded sandstone. One 0.30m. coal band at

				197.50m. depth.
204.15	208.40	4.25	4.25	COAL.
208.40	209.55	1.15	1.15	Medium to coarse gained felspathic cross-bedded sandstone interlaminated with grey shale and siltstone.
209.55	209.73	0.18	0.18	Carbonaceous shale.
209.73	209.89	0.16	0.16	COAL.
209.89	210.15	0.26	0.26	Carbonaceous shale.
210.15	220.75	10.60	10.60	Interbanded medium to coarse grained cross-bedded sandstone, fine grained sandstone and very coarse grained to granular sandstone with thin laminae of grey shale towards top, towards bottom grey shale with thin laminae of siltstone, streaks of carbonaceous shale. 0.45m. coal at 214.90m. depth.
220.75	221.82	1.07	1.07	Carbonaceous shale.
221.82	223.05	1.23	1.23	COAL. (Seam Zone - V)
223.05	226.05	3.00	3.00	Grey shale with laminae of siltstone / very fine grained sandstone, biochurning at places.
226.05	232.00	5.95	5.95	Medium to coarse grained felspathic sandstone, very coarse grained sandstone towards bottom.
232.00	240.85	8.85	8.85	Grey shale laminated and banded with fine to very fine grained sandstone. Towards bottom occasional bands of coarse to very coarse grained sandstone. Laminae biochurning at places.
240.85	240.97	0.12	0.12	Carbonaceous shale.
240.97	243.30	2.33	2.33	COAL.
243.30	255.85	12.55	12.55	Grey shale laminated with fine to very fine grained sandstone and interbanded with medium to coarse grained sandstone. 0.25m. coal band at 247.65m. depth.
255.85	256.05	0.20	0.20	COAL. (Seam Zone - IV)
256.05	259.40	3.35	3.35	Grey shale with 0.50m., 0.10m., and 0.30m. coal bands at 256.55m., 257.35m. and 258.75m. depth respectively.
259.40	259.65	0.25	0.25	Carbonaceous shale.
259.65	260.35	0.70	0.70	COAL.
260.35	261.10	0.75	0.75	Grey shale intercalated with silty shale.
261.10	261.91	0.81	0.81	Carbonaceous shale with 0.19m. coal seam at 261.30m. depth.
261.91	267.20	5.29	5.19	COAL.

267.20	268.20	1.00	1.00	Carbonaceous shale with bottom 0.55m. sandy shale.
268.20	274.25	6.05	6.05	Interbanded sequence of grey shale and medium to coarse grained cross-bedded sandstone. One 0.25m. coal seam at 272.40m. depth.
274.25	274.67	0.42	0.42	Carbonaceous shale with very thin band of coal and sideritic shale.
274.67	277.30	2.63	2.63	COAL.
277.30	281.22	3.92	3.92	Alternation and interlamination of grey shale and medium grained sandstone with a 0.25m. coal seam. Bottom with carbonaceous shale.
281.22	284.20	2.98	2.98	COAL. (Seam Zone - IV)
284.20	299.10	14.90	14.90	Granular felspathic cross-bedded sandstone grades upward to grey shale with carbonaceous shale through very coarse to coarse grained cross-bedded sandstone, fine grained sandstone laminated with grey shale. Biochurning and burrowing at places.
299.10	303.40	4.30	4.30	Granular to very coarse grained sandstone, top 1.30m. grey shale with silty laminae.
303.40	312.45	9.05	9.00	Grey shale interlaminated with siltstone and interbanded at places with medium to coarse grained cross-bedded sandstone, signature of burrowing and bioturbation at places.
312.45	315.40	2.95	2.95	Grey shale with silty laminae and 0.20m., 0.15m. and 0.45m. coals at 312.90m., 313.55m. and at 314.75m. respectively.
315.40	319.85	4.45	4.45	Very coarse grained sandstone grades upward to fine grained sandstone.
319.85	324.30	4.45	4.45	Granular sandstone grades upward to fine grained sandstone interlaminated with grey shale.
324.30	331.20	6.90	6.90	Interbanded and interlaminated grey shale, fine to very fine grained sandstone. At bottom, coarse grained sandstone interlaminated with siderite laminae. Bioturbation and biochurning at places.
331.20	354.50	23.30	23.30	Grey shale with sandy and silty bands at places. Three coal bands of 0.20m., 0.20m. and 0.15m. at depths of 342.00m., 345.20m. and 346.20m. respectively.
354.50	362.75	8.45	8.45	Granular sandstone grades upward to fine grained sandstone with shale and sideritic shale laminae.

362.75	367.40	4.65	4.65	Interbanded and interlaminated grey shale, fine to medium grained sandstone and siltstone with occasional coarse sandstone band towards bottom.
367.40	373.00	5.60	5.60	Granular to very coarse grained cross-bedded sandstone grades upward to grey shale with silty and sandy laminae.
373.00	375.95	2.95	2.95	Interlamination of grey shale and fine grained sandstone. Microfault and slickenside at places.
375.95	391.90	15.95	15.95	COAL. (Seam Zone - III)
391.90	392.90	1.00	1.00	Coarse to very coarse grained felspathic sandstone with grey shale laminae.
392.90	393.15	0.25	0.25	Carbonaceous shale.
393.15	401.00	7.85	7.85	COAL.
401.00	402.20	1.20	1.20	Medium grained sandstone with grey shale bands.
402.20	402.35	0.15	0.15	Carbonaceous shale.
402.35	402.90	0.55	0.55	COAL.
402.90	407.80	4.90	4.90	Interbanded medium to coarse grained cross-bedded sandstone, grey shale and fine grained sandstone.
407.80	408.75	0.95	0.95	COAL.
408.75	411.60	2.85	2.85	Coarse to very coarse grained cross-bedded sandstone with streaks of coal and carbonaceous material.
411.60	421.00	9.40	9.40	Very coarse grained cross-bedded sandstone grades upward to grey shale laminated with fine grained sandstone and siltstone.
421.00	421.95	0.95	0.95	COAL.
421.95	422.40	0.45	0.45	Carbonaceous shale with thin coal band.
422.40	435.70	13.30	13.30	Alternation and interlamination of very coarse, coarse to medium , fine grained sandstone and grey shale.
435.70	440.00	4.30	4.30	COAL. (Seam Zone - III)
440.00	447.45	7.45	7.45	Interlaminated unit of grey shale, fine to medium and medium to coarse grained sandstone with siderite shale bands and laminae.
447.45	448.35	0.90	0.90	COAL.
448.35	477.30	28.95	28.95	Coarse to very coarse grained cross-bedded sandstone. Top and bottom 2.00m. grey shale laminated with sandstone.

Borehole closed at 477.30 m. depth in Barakar Formation

Borehole No. : AB – 19

Location	:	**Lat. 23° 44′ 52″**	Drilling Unit	:	**267**
		Long. 84° 38′ 05″	Date of commencement	:	**01.03.1995**
R. L.	:	**427.475 m.**	Date of completion	:	**30.05.1995**
Final Depth	:	**423.50 m.**	Logged by	:	K. Mondal

Artesian at 296.0m. depth

From (m)	To (m)	Thick-ness (m)	Reco-very (m)	Lithology
1	2	3	4	5
0.00	9.00	9.00	0.20	Sludge of yellow medium sand.
9.00	18.50	9.50	9.50	Interbanded and interlaminated grey shale, fine to very fine grained sandstone. Sandstone is often ferruginous, Vertebraria, Glossopteris, Slickensided at places. Fault at 17.00m.
18.50	18.75	0.25	0.25	COAL.
18.75	21.90	3.15	3.15	Alternation and interlamination of coarse to very coarse grained sandstone and grey shale.
21.90	22.15	0.25	0.25	COAL.
22.15	24.30	2.15	2.15	Grey shale, top 0.40m. intercalated with coarse grained sandstone, sharp erosional upper contact.
24.30	24.55	0.25	0.25	COAL.
24.55	32.90	8.35	8.35	Coarse to very coarse grained sandstone grades upward to fine to very fine grained sandstone with grey shale intercalation.
32.90	33.10	0.20	0.20	COAL.
33.10	35.75	0.65	0.65	Grey shale with thin coal bands at places.
35.75	41.05	5.30	5.30	Coarse to very coarse grained cross-bedded sandstone interlaminated with grey shale.
41.05	48.55	7.50	7.50	Interbanded and interlaminated grey shale, fine to very fine grained cross-bedded sandstone, bottom carbonaceous shale.
48.55	48.62	0.07	0.07	Carbonaceous shale. (Seam Zone - VI)
48.62	51.25	2.63	2.43	COAL.
51.25	51.40	0.15	0.15	Carbonaceous shale.
51.40	53.60	2.20	2.20	Grey shale with carbonaceous laminae at places.

53.60	55.60	2.00	2.00	Grey shale with two 40cm. thick coal bands at 53.60m. and 54.45m. depth.
55.60	58.90	3.30	3.30	Coarse to very coarse grained cross-bedded sandstone, bottom carbonaceous.
58.90	77.20	18.30	18.30	Interbanded, interlaminated and intercalated grey shale, fine to very fine grained sandstone and siltstone with occasional carbonaceous shale laminae and medium to coarse sandstone bands.
77.20	81.85	4.65	4.65	Grey shale with coal bands of 0.20m., 0.30m. and 0.15m. thick occurred at depths of 77.20m., 79.45m. and 80.25m. respectively.
81.85	82.25	0.40	0.40	COAL. (Seam Zone - VI)
82.25	82.70	0.45	0.45	Grey shale.
82.70	104.75	22.05	22.05	Grey shale interbanded and interlaminated with fine to medium grained often cross-bedded sandstone, siltstone. Rootlet biochurning common.
104.75	109.00	4.25	4.25	Very coarse grained cross-bedded sandstone grades upward to grey shale.
109.00	110.00	1.00	1.00	Grey shale with sandy intercalation towards bottom.
110.00	115.50	5.50	5.50	COAL (Seam Zone - V + IV)
115.50	116.00	0.50	0.50	Grey shale.
116.00	116.65	0.65	0.65	COAL.
116.65	127.55	10.90	10.90	Grey shale interbanded with fine to very fine grained sandstone and siltstone. Coal bands of 0.20m. and 0.30m. at 124.55m. and 125.95m. depths respectively.
127.55	135.40	7.85	7.85	Alternation and interlamination of grey shale and fine to medium grained sandstone.
135.40	135.85	0.45	0.45	Carbonaceous shale.
135.85	139.05	3.20	3.20	Interbanded and intercalated grey shale, fine grained carbonaceous sandstone and three coal bands of 0.20m., 0.20m. and 0.30m. at depths of 137.90m., 138.35m. and 138.75m. respectively.
139.05	142.35	3.30	3.30	Very coarse grained sandstone with shale laminae grades upward to grey shale.
142.35	147.85	5.50	5.50	Grey shale with sandy laminae at places. Two coal seams of 0.25m. at 144.35m. and 0.30m. at 145.20m. depths. Bottom

carbonaceous shale.

147.85	148.17	0.32	0.32	Carbonaceous shale.
148.17	148.50	0.33	0.33	COAL.
148.50	152.20	3.70	3.70	Grey shale with coal bands of 0.20m. at 148.70m., 0.20m. at 149.50m., 0.30m. at 150.80m. and 0.40m. at 151.80m. depths.
152.20	162.85	10.65	10.65	Alternation and intercalation of grey shale and very coarse to coarse grained cross-bedded sandstone with occasional medium grained sandstone bands.
162.85	163.85	1.00	1.00	Gritty / granular sandstone.
163.85	168.90	5.05	5.05	Top 1.00m. fine grained carbonaceous sandstone and rest is grey shale with two 0.20m. Coal seams at 167.30m. and 167.70m. depths respectively. Occasional sandy laminae within grey shale. Bottom carbonaceous shale. Core dip-16°.
168.90	169.02	0.12	0.12	Carbonaceous shale.
169.02	171.36	2.34	2.26	COAL.
171.36	171.50	0.14	0.14	Carbonaceous shale.
171.50	172.95	1.45	1.45	Coarse grained cross-bedded sandstone grades upward to grey shale intercalated with carbonaceous shale, micro-fault at places.
172.95	174.15	1.20	1.20	Grey shale, slickensided.
174.15	177.35	3.20	2.60	COAL. (Seam Zone - V + IV)
177.35	184.30	6.95	6.95	Coarse grained sandstone grades upward to grey shale with sandy laminae.
184.30	190.90	6.60	6.60	Granular to very coarse grained cross-bedded sandstone grades upward to sandy shale and shale.
190.90	201.00	10.10	10.10	Alternation and intercalation of grey shale and fine to very fine grained sandstone .
201.00	210.40	9.40	9.40	Very coarse grained cross-bedded sandstone.
210.40	220.70	10.30	10.30	Heterolithic sequence of grey shale, coarse to medium grained cross-bedded sandstone, fine to very fine grained sandstone. Laminations at places biochurned and coal streaks and laminae towards top and middle.
220.70	232.40	11.70	11.70	Interbanded and interlaminated grey shale, very fine to fine grained and coarse grained cross-bedded sandstone. Laminae

				at places are biochurned.
232.40	237.70	5.30	5.30	Granular to very coarse grained sandstone grades upward to grey shale with fine grained sandstone laminae.
237.70	250.80	13.10	13.10	Interbanded and interlaminated grey shale, very fine to fine grained sandstone, siltstone with occasional medium to coarse grained sandstone bands, laminae biochurned at places. Thin coal seams at places.
250.80	256.80	6.00	6.00	Alternation of grey shale interlaminated with fine to coarse grained sandstone. Slumping towards bottom.
256.80	257.80	1.00	1.00	COAL.
257.80	260.00	2.20	2.20	Grey shale slickensided.
260.00	262.60	2.60	2.60	Granular sandstone, top carbonaceous.
262.60	267.85	5.25	5.25	Grey shale with fine grained sandstone laminae, bottom biochurned.
267.85	276.10	8.25	8.25	Heterolithic sequence of grey shale, fine to medium grained sandstone, very coarse grained sandstone with irregular shale laminae. Laminae biochurned.
276.10	287.10	11.00	11.00	Very coarse to granular sandstone of cross-bedded interbanded and interlaminated with grey shale.
287.10	293.30	6.20	6.20	Grey shale interbanded and interlaminated with fine to very fine grained cross-bedded sandstone. One 0.45m. coal band at 288.70m. depth.
293.30	321.00	27.70	27.70	COAL. (Seam Zone - III)
321.00	321.50	0.50	0.50	Coarse grained sandstone.
321.50	322.50	1.00	0.95	COAL.
322.50	327.10	4.60	4.60	Grey shale with bands of very coarse grained sandstone at middle.
327.10	330.35	3.25	3.25	COAL.
330.35	352.40	22.05	22.05	Very coarse grained cross-bedded sandstone with occasional grey shale laminae, bottom fine to medium grained sandstone with grey shale laminae.
352.40	357.65	5.25	5.25	COAL. (Seam Zone - III)
357.65	360.35	2.70	2.70	Fine grained sandstone with grey shale laminae.
360.35	367.10	6.75	6.75	Coarse to very coarse grained cross-bedded sandstone banded

				with grey shale and laminated with fine to very fine grained sandstone. Slickensided at places.
367.10	378.10	11.00	11.00	Grey shale interlaminated with fine to very fine grained sandstone with occasional coarse grained cross-bedded sandstone. Biochurning at places. 0.45m. coal at 367.95m. depth.
378.10	385.10	7.00	7.00	COAL. (Seam Zone - II)
385.10	390.25	5.15	5.15	Interlaminated grey shale and fine grained sandstone with a thin band of carbonaceous shale at middle.
390.25	401.30	11.05	11.05	COAL.
401.30	404.70	3.40	3.40	Grey shale with silty laminae.
404.70	410.20	5.50	5.50	COAL.
410.20	411.50	1.30	1.30	Fine grained silicified and slickensided sandstone with grey shale. Top sideritic shale.
411.50	418.90	7.40	7.40	COAL. (Seam Zone - II)
418.90	423.50	4.60	4.60	Grey shale, silty shale towards top and bottom. Micro-faulted. Slickensided, silicified at places. Intercalation of carbonaceous shale at places.

Borehole closed at 423.50m. depth in Barakar Formation.

APPENDIX – III A

BAND-BY-BAND ANALYSIS OF COAL SEAMS INTERSECTED IN BOREHOLES AB-1 TO AB-19
BANHARDI SECTOR, AURANGA COALFIELD, PALAMAU DISTRICT, BIHAR

(As received from Coal Survey Laboratory, Ranchi)

DETAILS SUPPLIED BY THE PARTY				DETAILS OBSERVED AT CSL			C.F.R.I.	AS ANALYSED BASIS		
B. H. No.	Run From (m.)	Run To (m.)	Thickness (m.)	Recovery (m.)	Lithology	Thickness (m.)	Sample No.	Moist %	Ash %	WEIGHT (Grms.)
AB - 1		RNC/90/BH-19								
					Roof – Coarse grained sandstone					
	75.15	76.29	1.14	1.14	Coal	0.18	A/C-1	8.7	21.1	1450
					Band	0.17	A/b-1	3.7	61.8	1850
					Coal	0.79	A/C-2	7.0	31.4	6000
					Floor – Coarse grained sandstone					
					Roof – Grey claystone					
	78.76	79.79	1.03	1.03	Shaly coal	0.16	B/b-1	5.5	43.0	1300
					Coal	0.75	B/C-1	8.7	24.0	6300
					Band	0.12	B/b-2	3.6	59.7	1150
					Floor – Grey claystone					
					Roof – Grey claystone					
	88.50	91.46	2.96	2.96	Band	0.28	C/b-1	3.0	65.1	3100
					Coal, CPB	0.48	C/C-1	7.8	29.5	3500
					Band	0.30	C/b-2	4.7	52.2	3250
					Coal, CPB	1.90	C/C-2	7.6	25.9	12000
					Floor – Grey claystone					
					Roof – Grey claystone					
	105.02	111.96	6.94	6.94	Coal, CPB	2.20	D/C-1	7.3	26.2	16000
					Band	0.35	D/b-1	4.6	56.0	3600
					Coal, CPB	4.39	D/C-2	7.5	24.2	29000
					Floor – Grey claystone					
					Roof – Grey shale					

DETAILS SUPPLIED BY THE PARTY				DETAILS OBSERVED AT CSL			C.F.R.I.	AS ANALYSED BASIS		
B.H. No.	Run		Thickness	Recovery	Lithology	Thickness	Sample No.	Moist	Ash	WEIGHT
	From (m.)	To (m.)	(m.)	(m.)		(m.)		%	%	(Grms.)
	120.78	121.65	0.87	0.87	Coal	0.52	E(In-b)	6.5	39.7	6850
					Shaly coal	0.35	,,			
					Floor – Grey shale					
					Roof – Grey shale					
	137.18	137.88	0.70	0.70	Shaly coal	0.40	F/b-1	6.1	47.0	4350
					Coal	0.30	F/C-1	7.9	35.2	2700
					Floor – Grey to black shale					
					Roof – Grey shale					
	142.18	143.90	1.72	1.72	Band, CB	0.64	G/b-1	4.6	60.6	6000
					Coal	0.40	G/C-1	7.6	36.7	3350
					Band, CB	0.29	G/b-2	3.6	64.3	2400
					Coal, CPB	0.24	G/C-2	7.9	27.6	1950
					Shaly coal, CB	0.15	G/b-3	5.3	48.0	1000
					Floor – Grey shale					
					Roof – Carbonaceous shale					
	236.90	241.55	4.65	4.65	Coal	0.15	H/C-1	6.8	30.7	1200
					Band	0.35	H/b-1	4.7	58.6	3400
					Coal, CPB	0.64	H/C-2	6.5	28.5	5000
					Band	0.14	H/b-2	5.2	53.3	1500
					Coal, slickensided	0.32	H/C-3	6.9	28.8	2600
					Band	0.16	H/b-3	4.8	53.8	1700
					Coal	0.28	H/C-4	6.3	29.3	2350
					Band, CPB	0.66	H/b-4	5.0	53.7	6150
					Coal, slickensided	0.38	H/C-5	6.9	28.3	2600
					Shaly coal	0.12	H/b-5	6.5	44.3	1150
					Coal, CB	0.35	H/C-6	7.0	27.3	1800
					Band, CPB	0.38	H/b-6	3.3	60.6	4000
					Coal, CPB	0.72	H/C-7	7.2	31.3	4750

DETAILS SUPPLIED BY THE PARTY				DETAILS OBSERVED AT CSL			C.F.R.I.	AS ANALYSED BASIS		
B.H. No.	Run From (m.)	Run To (m.)	Thickness (m.)	Recovery (m.)	Lithology	Thickness (m.)	Sample No.	Moist %	Ash %	WEIGHT (Grms.)
					Floor – Grey shale					
					Roof – Grey shale					
	308.87	309.72	0.85	0.85	Coal, CPB	0.54	I/C-1	6.7	21.1	3450
					Shaly coal, CPB	0.31	I/b-1	4.0	48.4	2750
					Floor – Carbonaceous shale					
					Roof – Grey shale					
	315.70	319.83	4.13	4.13	Coal	0.09	J/C-1	5.5	32.5	800
					Shlay coal	0.12	J/b-1	4.7	48.5	1000
					Coal	0.42	J/C-2	7.2	28.0	3400
					Band	0.14	J/b-2	4.6	57.0	1500
					Coal	0.35	J/C-3	6.9	27.2	2800
					Shaly coal	0.10	J/b-3	6.1	40.0	1100
					Coal, CPB	0.41	J/C-4	6.3	30.2	3400
					Shaly coal, CPB	0.13	J/b-4	5.2	48.9	1100
					Coal	0.26	J/C-5	6.7	30.3	2100
					Shaly coal	0.12	J/b-5	5.2	49.6	1200
					Coal	0.18	J/C-6	6.8	25.4	1300
					Band	0.09	J/b-6	4.6	53.8	850
					Coal	1.20	J/C-7	6.2	24.7	10000
					Shaly coal, CPB	0.15	J/b-7	4.6	49.6	1200
					Coal	0.24	J/C-8	6.6	27.3	1900
					Shaly coal	0.13	J/b-8	5.7	42.2	1300
					Floor – Carbonaceous shale					
AB – 2		RNC/90/BH-121								
					Roof – Silty shale					
	135.10	137.70	2.60	2.60	Band	0.10	A/b-1	6.6	55.0	800
					Coal	0.40	A/C-1	7.8	35.5	2650
					Shaly coal	0.11	A/b-2	7.7	43.0	700
					Coal	0.45	A/C-2	8.4	29.3	2950

DETAILS SUPPLIED BY THE PARTY				DETAILS OBSERVED AT CSL			C.F.R.I.	AS ANALYSED BASIS		
B.H. No.	Run		Thickness	Recovery	Lithology	Thickness	Sample No.	Moist	Ash	WEIGHT
	From (m.)	To (m.)	(m.)	(m.)		(m.)		%	%	(Grms.)
					Grey shale	0.12	Not sampled			1000
					Band	0.20	A/b-3	5.2	51.3	1550
					Coal	0.42	A/C-3	9.2	23.8	2400
					Band	0.21	A/b-4	5.3	61.2	2300
					Coal	0.34	A/C-4	8.2	31.8	2000
					Band, CPB	0.25	A/b-5	5.2	57.0	1800
					Floor – Carbonaceous shale					
					Roof – Carbonaceous shale					
	140.97	144.97	4.00	4.00	Shaly coal	0.08	B/b-1	6.2	46.8	450
					Coal	0.35	B/C-1	9.4	25.0	2250
					Band	0.08	B/b-2	4.3	62.8	550
					Coal	0.58	B/C-2	9.6	24.0	3700
					Band	0.16	B/b-3	4.7	65.0	1100
					Coal	0.25	B/C-3	9.6	24.5	1550
					Band	0.08	B/b-4	5.3	56.1	550
					Coal	1.40	B/C-4	9.5	24.4	7650
					Band	0.12	B/b-5	4.5	68.6	1150
					Coal	0.90	B/C-5	10.0	19.8	5400
					Floor – Carbonaceous shale					
					Roof - Shale					
	151.92	153.02	1.10	1.10	Coal, CPB	1.10	C/C-1	9.1	23.8	5300
					Floor – Sandy shale					
					Roof – Medium grained sandstone					
	160.74	161.88	1.14	1.14	Coal, CPB	0.20	D/C-1	9.2	20.2	900
					Shaly coal	0.16	D/b-1	7.0	46.2	1200
					Coal	0.21	D/C-2	8.8	26.2	1000
					Band	0.21	D/b-2	4.8	59.2	1400
					Coal	0.36	D/C-3	8.9	25.2	1700

DETAILS SUPPLIED BY THE PARTY				DETAILS OBSERVED AT CSL			C.F.R.I.	AS ANALYSED BASIS		
B.H. No.	Run		Thickness	Recovery	Lithology	Thickness	Sample No.	Moist	Ash	WEIGHT
	From (m.)	To (m.)	(m.)	(m.)		(m.)		%	%	(Grms.)
					Floor – Carbonaceous shale					
					Roof – Carbonaceous shale					
	162.08	166.48	4.40	4.40	Band	0.07	E/b-1	5.7	51.4	450
					Coal	0.59	E/C-1	9.0	25.9	3800
					Shaly coal	0.09	E/b-2	7.2	42.3	550
					Coal	0.29	E/C-2	10.5	21.5	1700
					Band	0.14	E/b-3	5.6	58.2	1200
					Coal, CPB	0.86	E/C-3	10.0	19.3	4600
					Band	0.15	E/b-4	5.7	59.2	1050
					Coal	0.55	E/C-4	9.8	20.8	5050
					Shaly coal, CPB	0.12	E/b-5	7.4	44.8	500
					Coal	0.11	E/C-5	9.3	21.0	500
					Band	0.12	E/b-6	6.5	50.7	800
					Coal	1.11	E/C-6	10.2	20.2	5000
					Band	0.10	E/b-7	6.5	51.7	650
					Coal, CPB	0.10	E/C-7	11.6	11.7	300
					Floor – Black shale					
					Roof – Carbonaceous shale					
	173.85	177.20	3.35	3.35	Coal	0.14	F/C-1	7.6	33.5	800
					Band	0.12	F/b-1	5.2	59.4	900
					Coal	0.12	F/C-2	8.8	27.8	750
					Band	0.12	F/b-2	6.1	50.1	1000
					Coal	0.14	F/C-3	8.0	35.6	800
					Band	0.19	F/b-3	6.7	50.1	800
					Coal	0.22	F/C-4	8.5	26.5	1500
					Shaly coal	0.12	F/b-4	6.1	44.5	800
					Coal	0.28	F/C-5	8.8	27.5	1900
					Band	0.30	F/b-5	5.3	54.1	2250
					Coal	0.21	F/C-6	9.9	19.3	1200

DETAILS SUPPLIED BY THE PARTY				DETAILS OBSERVED AT CSL			C.F.R.I.	AS ANALYSED BASIS		
B.H. No.	Run From (m.)	Run To (m.)	Thickness (m.)	Recovery (m.)	Lithology	Thickness (m.)	Sample No.	Moist %	Ash %	WEIGHT (Grms.)
					Sideritic shale	0.11	Not sampled			750
					Coal	0.55	F/C-7	8.2	31.4	3250
					Shaly coal	0.39	F/b-6	6.4	45.9	2950
					Coal	0.29	F/C-8	9.0	28.7	1850
					Band	0.05	F/b-7	5.8	52.5	450
					Floor – Siltstone					
					Roof - Shale					
	219.10	220.00	0.90	0.90	Band	0.37	G/b-1	5.6	58.7	2950
					Coal	0.07	G/C-1	8.9	29.9	350
					Band	0.30	G/b-2	6.0	53.6	2500
					Coal	0.16	G/C-2	9.6	28.4	950
					Floor – Carbonaceous shale					
					Roof – Black shale					
	279.40	280.20	0.80	0.80	Shaly coal	0.37	H/b-1	7.7	42.9	1800
					Coal	0.15	H/C-1	8.9	28.6	650
					Band	0.11	H/b-2	8.1	38.4	550
					Coal	0.17	H/C-2	9.1	27.5	600
					Floor – Medium grained sandstone					
					Roof – Grey shale					
	290.15	303.40	13.25	12.45	Shaly coal, CB	0.10	I/b-1	6.7	47.1	300
					Coal, CPB	0.24	I/C-1	8.0	28.3	850
					Band, CB	0.25	I/b-2	4.8	51.8	800
					Coal, CB	0.14	I/C-2	7.4	29.6	350
					Shaly coal	0.30	I/b-3	7.5	45.0	1700
					Coal	0.26	I/C-3	8.6	26.7	1050
					Band, CPB	0.30	I/b-4	5.9	49.2	1400
					Coal	0.43	I/C-4	9.1	21.7	1750
					Shaly coal	0.30	I/b-5	6.8	41.8	1400
					Coal, CPB	0.24	I/C-5	7.1	30.4	750

DETAILS SUPPLIED BY THE PARTY				DETAILS OBSERVED AT CSL			C.F.R.I.	AS ANALYSED BASIS		
B.H. No.	Run		Thickness	Recovery	Lithology	Thickness	Sample No.	Moist	Ash	WEIGHT
	From (m.)	To (m.)	(m.)	(m.)		(m.)		%	%	(Grms.)
					Shaly coal, CB	0.42	I/b-6	6.6	45.3	1200
					Coal	0.43	I/C-6	8.8	26.3	1750
					Shaly coal	0.09	I/b-7	6.0	43.4	350
					Coal, CPB	0.29	I/C-7	8.6	27.8	1000
					Band, CPB	0.72	I/b-8	5.4	55.9	2550
					Coal, CPB	0.42	I/C-8	9.2	22.2	1600
					Band	0.26	I/b-9	5.5	53.1	1400
					Coal, CPB	0.60	I/C-9	9.1	25.4	2300
					Band	0.28	I/b-10	5.8	51.2	1550
					Coal, CPB	0.34	I/C-10	8.2	32.8	1300
					Shaly coal, CPB	0.26	I/b-11	7.0	44.2	1250
					Coal, CB	0.33	I/C-11	9.6	21.8	800
					Shaly coal, CPB	0.56	I/b-12	7.1	45.6	2150
					Coal, CPB	0.16	I/C-12	8.2	29.1	600
					Band, CB	0.32	I/b-13	6.4	51.1	1150
					Coal, CB	0.45	I/C-13	8.2	25.3	1700
					Band, CB	0.19	I/b-14	6.9	52.8	550
					Coal, CPB	0.16	I/C-14	7.0	32.3	500
					Band	0.28	I/b-15	6.1	54.2	1550
					Coal	0.59	I/C-15	8.0	26.7	2450
					Band	0.20	I/b-16	6.0	53.7	1100
					Coal	0.16	I/C-16	8.1	25.3	600
					Shaly coal, CPB	0.32	I/b-17	6.0	45.7	1500
					Coal	0.32	I/C-17	7.6	31.4	1450
					Shaly coal, CPB	0.13	I/b-18	6.1	46.3	500
					Coal, CPB	0.27	I/C-18	7.5	37.2	1050
					Shaly coal, CPB	0.16	I/b-19	6.0	47.0	800
					Coal, CB	0.14	I/C-19	8.1	30.9	400
					Band	0.42	I/b-20	5.7	53.0	2200

DETAILS SUPPLIED BY THE PARTY				DETAILS OBSERVED AT CSL			C.F.R.I.	AS ANALYSED BASIS		
B.H. No.	Run From (m.)	Run To (m.)	Thickness (m.)	Recovery (m.)	Lithology	Thickness (m.)	Sample No.	Moist %	Ash %	WEIGHT (Grms.)
					Coal	0.30	I/C-20	9.0	31.5	1350
					Band	0.32	I/b-21	5.2	56.7	1800
					Floor – Silty shale					
					Roof – Silty shale					
	304.10	304.85	0.75	0.75	Coal, CPB	0.24	J/C-1	8.6	30.0	500
					Shaly coal, CB	0.31	J/b-1	5.1	49.4	850
					Coal, CPB	0.20	J/C-2	11.5	19.0	500
					Floor – Silty shale					
					Roof – Carbonaceous shale					
	306.20	307.10	0.90	0.90	Band, CPB	0.58	K/b-1	5.1	53.5	2600
					Sideritic shale, CPB	0.25	Not Sampled			1700
					Coal, CPB	0.07	K/C-1	8.8	24.6	300
					Floor – Siltstone					
					Roof – Carbonaceous shale					
	317.50	320.80	3.30	3.30	Coal, CPB	0.30	L/C-1	9.9	24.8	1450
					Band, CB	0.76	L/b-1	7.0	48.7	4050
					Coal	0.08	L/C-2	7.7	34.5	350
					Band	0.90	L/b-2	6.1	54.0	5700
					Coal, CB	0.33	L/C-3	9.2	31.0	850
					Coal & shale, CB & mixed cut at 1.60 sp.gr. — Float	0.45	L/C-4	9.2	25.5	650
					Sink		L/b-3	4.6	57.9	700
					Band, CB	0.48	L/b-4	6.2	56.2	1800
					Floor – Carbonaceous shale					
		RNC/91/BH-121			Roof - Siltstone					
	362.65	367.14	4.49	4.49	Band, CPB	0.30	M/b-1	5.8	52.4	1500
					Coal, CPB	0.35	M/C-1	8.9	25.2	1250
					Band	0.20	M/b-2	6.6	49.0	1100

DETAILS SUPPLIED BY THE PARTY				DETAILS OBSERVED AT CSL			C.F.R.I.	AS ANALYSED BASIS		
B.H. No.	Run From (m.)	Run To (m.)	Thickness (m.)	Recovery (m.)	Lithology	Thickness (m.)	Sample No.	Moist %	Ash %	WEIGHT (Grms.)
					Coal, CPB	0.62	M/C-2	8.9	27.6	2150
					Band	0.20	M/b-3	6.1	51.4	800
					Coal	1.25	M/C-3	8.8	26.9	4900
					Band	0.19	M/b-4	5.6	53.0	1050
					Coal	0.70	M/C-4	8.3	28.1	2650
					Band, CPB	0.40	M/b-5	5.9	52.3	1200
					Coal, CB	0.28	M/C-5	9.7	21.2	700
					Floor – Fine grained sandstone					
					Roof – Fine grained sandstone					
	367.60	370.85	3.25	3.25	Band	0.25	N/b-1	4.2	69.7	1400
					Coal, CPB	0.43	N/C-1	8.5	30.1	1600
					Band	0.44	N/b-2	6.5	48.9	2450
					Coal & shale, CB & mixed, cut at 1.60	0.45				
					sp. gr. — Float		N/C-2	9.2	25.5	800
					Sink		N/b-3	5.7	59.2	750
					Band	0.18	N/b-4	5.6	63.0	1250
					Coal, CB	0.15	N/C-3	10.7	18.4	400
					Band, CPB	0.46	N/b-5	6.7	52.6	1500
					Coal, CPB	0.43	N/C-4	8.9	26.7	1500
					Band, CPB	0.18	N/b-6	5.9	54.3	700
					Coal	0.28	N/C-5	9.4	24.6	1000
					Floor – Fine grained sandstone					
					Roof – Silty shale					
	375.83	376.63	0.80	0.80	Coal, CPB	0.31	O/C-1	9.7	21.9	1000
					Band, CPB	0.49	O/b-1	5.6	61.0	1800
					Floor – Siltstone					
					Roof – Very coarse grained sandstone					
	386.85	389.45	2.60	2.40	Band, CPB	1.10	P/b-1	6.8	49.0	4100

DETAILS SUPPLIED BY THE PARTY				DETAILS OBSERVED AT CSL			C.F.R.I.	AS ANALYSED BASIS		
B.H. No.	Run		Thickness	Recovery	Lithology	Thickness	Sample No.	Moist	Ash	WEIGHT
	From (m.)	To (m.)	(m.)	(m.)		(m.)		%	%	(Grms.)
					Coal, CPB	0.34	P/C-1	8.5	30.3	1000
					Band	0.24	P/b-2	6.4	52.5	1000
					Coal, CB	0.24	P/C-2	9.2	29.5	600
					Band, CPB	0.48	P/b-3	5.8	56.6	2000
					Floor – Black shale					
					Roof – Grey shale					
	399.26	400.21	0.95	0.95	Band, CB	0.25	Q/b-1	5.2	55.8	1000
					Coal, CB	0.25	Q/C-1	7.6	29.5	700
					Shaly coal	0.20	Q/b-2	6.5	43.4	750
					Coal	0.25	Q/C-2	7.1	39.3	750
					Floor – Grey shale					
					Roof – Medium grained sandstone					
	439.15	440.85	1.70	1.70	Shaly coal	1.00	R/b-1	6.3	44.1	3200
					Coal	0.20	R/C-1	8.4	27.7	500
					Band, CPB	0.50	R/b-2	5.8	49.6	1350
					Floor – Grey shale / Siltstone					
AB – 3		RNC/91/BH-71								
					Roof – Black shale					
	262.15	263.25	1.10	1.10	Band	0.38	A/b-1	8.1	55.7	3550
					Coal, CPB	0.50	A/C-1	10.1	35.4	2200
					Shaly coal, CPB	0.22	A/b-2	9.5	45.5	1100
					Floor – Black shale					
					Roof – Carbonaceous shale					
	330.30	331.60	1.30	1.30	Band	0.18	B/b-1	7.7	52.2	2000
					Coal, CPB	0.18	B/C-1	10.6	33.3	1150
					Band	0.59	B/b-2	7.1	54.6	5200
					Coal	0.35	B/C-2	12.3	27.3	2200
					Floor – Carbonaceous shale					
					Roof – Carbonaceous shale					

DETAILS SUPPLIED BY THE PARTY				DETAILS OBSERVED AT CSL			C.F.R.I.	AS ANALYSED BASIS		
B.H. No.	Run From (m.)	Run To (m.)	Thickness (m.)	Recovery (m.)	Lithology	Thickness (m.)	Sample No.	Moist %	Ash %	WEIGHT (Grms.)
	363.55	364.82	1.27	1.27	Band	0.12	C/b-1	6.1	56.8	1200
					Coal	1.02	C/C-1	10.1	27.2	6200
					Shaly coal, CPB	0.13	C/b-2	8.1	40.7	750
					Floor – Siltstone					
					Roof – Carbonaceous shale					
	376.60	377.24	0.64	0.64	Coal	0.64	D/C-1	9.0	30.8	5200
					Floor – Grey shale					
					Roof – Black shale					
	546.70	548.60	1.90	1.90	Band	0.20	E/b-1	3.9	72.6	1600
					Coal	1.40	E/C-1	10.4	23.8	8200
					Band	0.30	E/b-2	6.5	50.1	2150
					Floor – Fine grained sandstone					
					Roof – Black shale					
	562.46	562.96	0.50	0.50	Band	0.13	F/b-1	4.6	64.9	1050
					Coal	0.37	F/C-1	9.8	21.0	2200
					Floor – Carbonaceous / Grey shale					
					Roof – Grey shale					
	601.40	613.00	7.90	7.90	Shaly coal	0.16	G/b-1	6.1	46.9	1100
					Coal	0.90	G/C-1	8.8	21.8	5700
					Shaly coal, CPB	0.22	G/b-2	6.7	45.2	1100
					Coal, CPB	1.30	G/C-2	9.4	19.2	6500
					Band	0.38	G/b-3	5.4	58.9	3200
					Coal	1.93	G/C-3	9.2	17.8	11400
					Shaly coal	0.18	G/b-4	6.4	47.0	1050
					Coal	2.76	G/C-4	8.9	23.2	14750
					Shaly coal	0.07	G/b-5	6.4	40.2	500
					Floor – Shale / Carbonaceous shale					
					Roof – Dark grey shale					
	616.26	617.50	1.24	1.24	Shaly coal	0.25	H/b-1	6.0	43.8	2000

DETAILS SUPPLIED BY THE PARTY				DETAILS OBSERVED AT CSL			C.F.R.I.	AS ANALYSED BASIS		
B.H. No.	Run From (m.)	Run To (m.)	Thickness (m.)	Recovery (m.)	Lithology	Thickness (m.)	Sample No.	Moist %	Ash %	WEIGHT (Grms.)
					Coal	0.23	H/C-1	7.7	28.7	1400
					Shaly coal	0.14	H/b-2	5.4	49.0	1000
					Coal, CPB	0.45	H/C-2	7.5	32.1	2700
					Band	0.07	H/b-3	4.8	55.1	550
					Coal	0.10	H/C-3	10.1	19.8	600
					Floor – Carbonaceous shale					
AB – 4		RNC/91/BH – 72								
					Roof – Carbonaceous shale					
	21.85	28.00	6.15	6.15	Band, CPB	0.36	A/b-1	6.4	59.9	2300
					Coal	0.11	A/C-1	12.1	28.8	550
					Band	0.17	A/b-2	8.1	50.2	1000
					Coal, CPB	0.32	A/C-2	12.2	31.3	1700
					Band, CPB	0.52	A/b-3	7.2	54.8	3700
					Coal	0.17	A/C-3	10.7	38.4	1050
					Band	0.11	A/b-4	7.4	54.2	900
					Coal	0.10	A/C-4	11.0	38.0	750
					Band	0.28	A/b-5	8.6	50.8	2300
					Sideritic shale	0.14	Not sampled			1400
					Band	0.10	A/b-6	6.0	63.3	750
					Coal, CPB	0.21	A/C-5	14.6	23.4	1000
					Band, CPB	0.50	A/b-7	7.3	54.2	3600
					Coal, CPB	0.17	A/C-6	9.8	34.8	950
					Band	0.11	A/b-8	9.7	45.6	900
					Coal, CPB	0.38	A/C-7	13.1	31.7	2000
					Band	0.16	A/b-9	5.0	70.4	1300
					Coal	0.24	A/C-8	13.5	24.9	1400
					Band	0.18	A/b-10	5.4	67.3	1600
					Coal, CPB	0.32	A/C-9	11.0	34.4	1700
					Band	0.13	A/b-11	8.4	49.4	1100

DETAILS SUPPLIED BY THE PARTY				DETAILS OBSERVED AT CSL			C.F.R.I.	AS ANALYSED BASIS		
B.H. No.	Run		Thickness	Recovery	Lithology	Thickness	Sample No.	Moist	Ash	WEIGHT
	From (m.)	To (m.)	(m.)	(m.)		(m.)		%	%	(Grms.)
					Coal, CPB	0.09	A/C-10	12.7	33.8	500
					Band	0.16	A/b-12	9.8	45.3	1200
					Coal, CPB	0.13	A/C-11	10.8	40.1	700
					Band	0.38	A/b-13	7.0	59.5	3100
					Coal, CPB	0.39	A/C-12	12.5	27.1	2100
					Shaly coal	0.10	A/b-14	9.4	40.1	750
					Coal	0.12	A/C-13	13.6	19.8	550
					Floor – Carbonaceous shale					
					Roof – Very coarse grained sandstone					
	42.05	43.20	1.15	1.15	Band	0.22	B/b-1	4.4	69.6	2000
					Coal	0.12	B/C-1	9.1	36.2	650
					Band	0.31	B/b-2	4.5	68.2	2750
					Coal	0.50	B/C-2	12.9	22.4	2300
					Floor – Medium grained sandstone					
					Roof – Grey shale					
	47.05	49.50	2.45	2.45	Coal	1.07	C/C-1	10.1	30.7	7000
					Band	0.27	C/b-1	6.9	53.8	1900
					Coal	0.26	C/C-2	11.7	24.4	1500
					Band	0.20	C/b-2	7.2	52.4	2000
					Coal	0.65	C/C-3	10.6	30.3	4300
					Floor – Siltstone					
					Roof - Siltstone					
	100.40	101.15	0.75	0.75	Band	0.12	D/b-1	6.6	57.6	1050
					Coal	0.63	D/C-1	11.1	27.2	3600
					Floor – Siltstone					
					Roof - Siltstone					
	102.55	103.00	0.45	0.45	Band, CPB	0.29	E/b-1	6.2	55.7	1600
					Sideritic shale, CPB	0.16	Not sampled			1300