CHAPTER IV

GENERAL GEOLOGY OF MAHARASHTRA STATE WITH
PARTICULAR REFERENCE TO DIFFERENT
COALFIELDS IN NAGPUR DISTRICT
For the present paleopalynological studies coal samples collected from Kamptee Coalfield and Saoner Coalfield of Maharashtra State have been investigated. Hence the geology of Maharashtra State is given here.

The Maharashtra State extends over an area of 307,900 sq. kms., between latitudes 15°, 45' and 22° 00' and longitudes 73° 00' and 80° 59' along the western part of India. It has a long coast line and extends almost upto the middle part of the sub-continent.

The geological formations found in the State include those of the Precambrian, Palaeozoic, Tertiary and Quaternary periods. Most part of the state is covered with a thick pile of basalt flows. The South-Western corner, adjoining Goa, exposes Precambrian rocks over a small area. In the Eastern part are the Precambrian and Gondwana rocks, while the Quaternary deposits are confined to the courses of the major rivers like the Tapti, Wainganga etc.

The state constitutes a large part of the Deccan Plateau. In the Southern part of coastal terrain, a highly dissected terrain with flat topped hills raising to 150 to 200 metres (m) are seen. North, of Bombay, vast areas are covered by Coastal swamps. The Western Ghats, running parallel to the coast at a distance of 50 to 60 km. from the coast rise to great heights. The main part of the
State further to the East bears elongated flat topped trap hills with intervening valleys carved by numerous rivers flowing towards East or South-East. In the northern periphery of the state are the Satpura ranges running in almost east-west direction. In the eastern part of the State, particularly East and South of Nagpur, vast areas are penneiplained and bear a few low impersistent ridges.

The drainage along the coastal terrain is mainly towards west. East of the continental divide, the plateau is drained by the Godavari, Bhima, Krishna and their tributaries which have an easterly course. The Tapti, flowing in a westerly course, is a major river just south of the Satpura ranges. On the east, the Wainganga, Wardha and Kankan rivers, with a southerly or south-easterly course drain the highly penneiplained terrain.

The Gondwana Formations occur along a North-West to South-East belt in the Chandrapur area and in a W.N.W.-E.S.E. strip North-East of Nagpur. A few isolated patches are also found. At places, the Gondwana rocks are covered by Deccan Traps indicating their probable extension under them.

Three small patches of Talchir Formation consisting of conglomerate, (Upper Carboniferous) green shales and sandstones, occur as outliers in the area where Kamthi beds occur. A few, small, isolated patches of Barakar rocks
(Permian) trending N.W.S.E. are found in the Yeotmal and Chandrapur District. They occur also in Nagpur District. Besides these, minor outcrops of the Barakar rocks are present near Umrer (20° 13' : 79° 12' ). The Barakar Formation consists of sandstones, shales and coal seams. The Kamthi Formation, consisting of brownish to white folspathic sandstones, red to white shales and clays, are very extensive and overlap the older formations and also rest on the Archaeans, or at places, the Vindhyans.

There are fairly large coal bearing areas in the State. Coal occurs as sedimentary rock within "Coal Measures" as coal beds or coal seams. Sandstone, shale and clay mostly of fresh water origin alternate with coal beds. In thickness coal seams may range from a thin film upto 45 m. Thin bands of shale or clay called "Partings" interfere with mining clean coal. Thinner seams or "splits" are formed by partings of clay, shale or sandstone. Sandstone dykes, intrusions of volcanic rocks, "washouts" caused by erosion, during deposition disturb the coal seams and the quality of the coal seam is deteriorated. The coals in Maharashtra belong, geologically, to the Barakar series of Damuda system of Gondwana group.

Broadly speaking, coal bearing areas in Maharashtra state may be divided as follows:
<table>
<thead>
<tr>
<th>Nagpur District</th>
<th>Chandrapur District</th>
<th>Yavatmal District</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Kamptee Coalfield</td>
<td>a) Wardha valley Coalfield</td>
<td>a) Rajur Coalfield</td>
</tr>
<tr>
<td>b) Umrer Coalfield</td>
<td>i) Bandar</td>
<td></td>
</tr>
<tr>
<td>c) Bokhara Coalfield</td>
<td>ii) Warora</td>
<td></td>
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<tr>
<td>d) Saoner Coalfield</td>
<td>iii) Majri &amp;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>iv) Ghugus-Telwasa</td>
<td></td>
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<td></td>
<td>v) Chanda</td>
<td></td>
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<td></td>
<td>vi) Ballarpur</td>
<td></td>
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<td></td>
<td>vii) Sasti-Rajura</td>
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<td></td>
<td>xiii) Wirur-Chincholi</td>
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</tbody>
</table>

In the present study, Coal samples collected from bore holes drilled in Kamptee and Saoner Coalfields of Nagpur District have been analysed paleopalynologically. Hence the details of Coalfields occurring in Nagpur District are given here.

(a) **Kamptee Coalfield**

The Kamptee Coalfield, of late attracted much attention owing to the findings of five coal seams (by some private concerns and later by the Maharashtra Government) in certain parts of the area. The Upper inferior seams are already being worked in the Kamptee colliery. Apart from its key geographical location (being close to Nagpur), the super grade coal of the lower seams, as well as the existence of big potential consumers
like the thermal power station in the field near Khaperkheda and those in the neighbouring areas, viz., Ballarshah, Paras, Trombay and the needs of other existing and growing industries significantly contributed towards bringing the field in the threshold of industrialisation during the Third Plan period. Thus, the Kamptee Coalfield was assigned an annual target of 0.6 million tonnes of production, during the initial phase of the Third Plan. It is expected to have considerably larger share to the tune of 1.23 million tonnes per annum in the fourth plan. In order to prove adequate reserves to sustain the targeted production in the public sector, the Indian Bureau of Mines (IBM) undertook exploration for coal in a notified block comprising 98.42 sq. km., as indicated by the National Coal Development Corporation Limited (N.C.D.C.) in the northern belt of the Gondwanas of this field, which is reported to have at least three district belts extending over 129 sq.km.

This notified block, measuring 98.42 sq.km situated in the Nagpur district, is included in the Survey of India topo sheets No. 550/3 and 550/4. The area is bounded by latitudes 21° 14', 56" and 21° 21' 20" N and longitudes 79° 4' 5" and 79° 12' 17".

The exploration was taken up simultaneously, in the potential southern half of the block comprising the Gondwanas in three different apparently isolated sectors.
These sectors, Sillewara, Bina and Ghatrohan, occupy respectively the extreme western, central and eastern extremities of the notified block. The field extends in North-Westerly direction from Kanhan towards Saoner and covers an area of about 138 sq. kms.

Previous work: Existence of Lower Gondwana rocks in detached basins within 10-12 miles North-East of Nagpur and in the neighbourhood of Kamptee area was reported as early as 1867 by W.T. Blanford, who recognised Kamthi sandstones and Talchirs as forming part of these Lower Gondwanas and postulated possible presence of Barakar sandstones in between. He suggested at that time that drilling should be undertaken at different places in these detached belts (which are mostly covered by alluvium) for confirming his postulations.

During 1919 Dr. G. de P. Cotter of the Geological Survey of India (G.S.I.) mapped the area, West of Nagpur. Subsequently, discovery of fossils equivalent to that of Raniganj Series of Bengal and the Bijori beds of Satpura Coalfield confirmed according to Dr. Blanford, the age of these beds as equivalent to that of Raniganj Series. These three apparently detached belts extending approximately in WNW- ESE direction, constitute the present known limits of the Kamptee Coalfield and include the following:

1. Tekadi, Sillewara and Patansaongi belt,
2. The Bokara - Chakki Khapa belt.

3. The Bazargaon belt, 24-80 km. (15-20 miles) West of Nagpur.

During the year 1946, M/s. Brooke Bond Limited drilled a Bore hole to serve as a tube well, in the compound of their factory, located North of Kanhan Railway Station (near Kamptee). Incidental to this work, they discovered the existence of six coal seams in this bore hole within a depth of 122.23 m. One of the above seams which was about 6.4m (21 ft.) thick was encountered within a depth of 24.69 m from the surface.

The Kamptee Coalfield was also geologically investigated by M/s. Killick Nixon & Co., E.R. Goe and V.R. Khedkar. Shri P.K. Chatterjee of G.S.I. (1948), carried out geological investigations in the Katol Saoner area.

In recent years, Bore holes were drilled by Madhya Pradesh Government Board of Industries in Tekadi, June-Kamptee and Sillewara areas and also recently by the Department of Mines and Geology of Maharashtra State.

These investigations revealed that the block comprises different rock formations including the Archaeans within its northern limits and at the southern boundary, besides the various Lower Gondwana Formations including Talchirs at the base and successively overlain by coal bearing Barakars and the Moturs and Kamthis. The
Geological boundaries between the Gondwanas and the Archaeans and so also between the Barakars and Talchirs in particular, remain to be finally demarcated, in this largely soil covered area. Among the 5 groups of seams separated mainly by sandstone partings, the top 60-70 m section and the bottom 60-127m of the Barakars are barren of any economic seam, so also the overlying Moturs and Kamthis. They individually range from 0.40 to 23.56m in thickness and contain Grade I to Grade III quality coal. The lower two seams (seam I and II) are of better grade. The upper two inferior seams (IV & V) are of greater thickness.

**Physiography, Geomorphology and other general features:**

The coalcore samples collected from Kamptee Coalfield are analysed in the present study. The coal core samples collected from one Bore hole are compared with the other Bore holes. Hence the physiography, geomorphology and other general features of Kamptee coalfield are discussed in detail.

The Kamptee Coalfield as stated earlier is constituted by 3 district belts of Lower Gondwana trending approximately along WNW-ESE direction according to the present stage of knowledge. The district belts are-

1. Tekadi - Sillewara - Patansaongi belt,
2. Bokara- Chaki Khapa belt, and
3. Bazargaon belt, 24-80 km.(15-20 miles)
West of Nagpur. Apart from this, exposures of Kamthis are reported North of Shemda, which is 11 kms. (7 miles) North West of Nagpur. These 3 belts total about 134.68 sq. Km (52 sq. miles) and represent the so far known extensions of the field. However, since the geological formations in and around the field contain also such younger strata as Deccan Traps, Lametas, besides alluvial deposits, it is likely that on further investigation, the Lower Gondwanas may be found at depths under these varied mantles of younger formations, and in that case, the limit of the field will be correspondingly, extended over wider areas.

**Geology and Structure**

The geological sequence so far deciphered in this field is given below, in Table No. 2 (Hunday, et al. 1977).

**Table No. 2**

<table>
<thead>
<tr>
<th>Recent to sub-recent</th>
<th>Alluvium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cretaceous</td>
<td>Deccan Trap</td>
</tr>
<tr>
<td></td>
<td>............ Unconformity ............</td>
</tr>
<tr>
<td>Middle Cretaceous</td>
<td>Lametas</td>
</tr>
<tr>
<td>Upper Permian</td>
<td>Kamthi bed</td>
</tr>
<tr>
<td></td>
<td>............ Unconformity ............</td>
</tr>
</tbody>
</table>
Recent to Sub-recent  Alluvium

Lower Gondwanas  & overlap (?) postulated by earlier
Middle Permian  Moturs (?)  Clays & sandstones
          (Suggested) by GSI, &
          confirmed by IBM

Lower Permian  Barakar beds  White and grey sandstones
          and grits, fire clays,
          carbonaceous shales
          and coal seams.

Upper Carboniferous  Talchir beds  Green shales and
          sandstones and basal
          conglomerates.
          Unconformity.............

Archaean rocks Gneisses, mics-, and
hornblende schists, pegmatites,
crystalline, limestone (dolomite
quartzite, (occasionally cherty)
quartz veins.

The youngest beds of the Lower Gondwanas of the field
are the Kamthis, which comprise dominantly ferruginous
sandstones, shales and conglomerates in its upper horizon and
also argillaceous sandstones and shales below. These
ferruginous sandstones of the Kamthis are found to form low,
but conspicuous isolated ridges, elongated along WNW-SEE,
well inside the field and also along the bordering regions,
occupying the contours of 310-315m.

Apart from the Kamthis of the Gondwana sequence only
very small sporadic exposures of Barakar sandstones (?) are
seen in certain patches of the Kanhan river section. The
Motur clay beds and other weak strata, including shales
and coal seams are entirely capped by extensive and thick
alluvium.
The Barakars of the field were proved to be the only coal-bearing formation and contains at least five coal seams besides thin coal bands in its middle section. The remaining strata including the top and bottom sections of Barakars, the successive younger beds, viz., the Moturs and the Kamthis, as well as the older Talchir beds, are devoid of any coal seams. Establishing the presence of Motur beds (comprising dominantly clays and also thin shale bands) between the Kamthis and Barakars is a recent significant contribution to the geological knowledge of this field.

It is worth mentioning that small patchy exposures of southerly dipping Talchirs (including a few boulders of greenish calcareous shales and sandstones) are seen in the southern bordering regions of the Central Archaean Wedge in the Nagpur-Chindwara road side, in a nala section to the north-east of Bokhara and South-east of Mahadula villages. The presence of Talchirs in the Southern boundary marks a repetition of the Lower Gondwana sequence. As such, further South in relation to the southerly dip of the strata, the successive younger beds including the Barakars can be reasonably expected to continue below the alluvium. One of the few Bore holes near Bokara village recently drilled by the Geology and Mining Department, Maharashtra Government already confirmed the extension of
the coal bearing Barakars with four thin coal seams in the area located within a mile to the South-West of these Talchir exposures.

Geology of the area under investigation

Hence, the Gondwanas include Talchirs, Barakars, Moturs and Kamthis. The exposures, which are few and far between are mostly limited to those of the Kamthi formations in the isolated elongated low ridges in the South Central and extreme South-Eastern portions of the block. Besides, these only sporadic exposures of Barakar sandstone were so far noted in the river sections. There is remote possibility of finding exposure of weaker strata in this thickly soil covered country.

Kamthis: The youngest bed of the Lower Gondwana formations is represented by the Kamthis. This include dark brown coarse grained ferruginous sandstones, coarse felspathic grits and conglomerates in the upper horizons and compact argillaceous, yellow sandstones and red to brick red and yellow (limonitic) shales (resembling iron-stone shales).

The thickness of the Kamthis as encountered in the bore hole KMT-1 located near the central portion of the Chanakpur ridge is about 43 m. On projecting this data, it may be reasonably inferred that the thickness of the
Kamthis are found below the alluvium in the area to the South of this ridge and extend upto the Archaeans in relation to the southerly dip of the formations, the thickness of the Kamthis alone may as well be around 270 m in this field.

Previous workers indicated a distinct and great unconformity below the Kamthis. But the examination by the G.S.I. of the recent Maharashtra Government Bore holes drilled in the area and also later confirmation of the presence of mottled clays (Moturs) below the Kamthi sandstones in the I.B.M. Bore holes confirmed absence of such an unconformity at least in this area.

From a study of the Maharashtra Government Bore holes, the G.S.I. reported that the Kamthis unconformably overlie the Barakars at about 36 m depth in that area. On the evidence of plant fossils, the Kamthi beds were identified by previous workers as equivalent to the lowest portion of Raniganj beds. A few plant fossils (Glossopteris indica, G. communis, G. retifera, G. browniana, G. anagustifolia, Phyllotheca indica, Schizoneura sp. and fossil woods) were collected by the I.B.M. from some of the argillaceous sandstones and the charty and ferruginous shale beds of the Kamthis mainly from the exposures South of Patansaongi and some from the Chanskpyr and Juni-Kamptee exposures.
Moturs: In the available literature, the Moturs are suggested equivalent to the "Barren measures" of Raniganj Coalfield. In the relevant I.B.M. Bore holes, a minimum thickness of 250 to 270m may be attributed to the Moturs. Possibility of further increase to 300m in thickness can be inferred, which is to be confirmed by further bore holes. Moturs comprise mottled clays and chloritic sandstone. The mottled calcareous clays contribute the order of 64% of the Motur Formation while the typical chloritic micaceous sandstone comprises its 30%, the remaining portion being gray and carbonaceous shale bands.

Barakars: The Barakars contain at least 5 major groups of coal seams, viz., seams I to V, besides thin coal bands, shales and sandstones. The partings between the coal seams are usually of sandstones. In thickness, the Barakars were found to be approximately 270m. Barkaras are divided into three separate sections, designated as the top, middle and bottom section in relation to the presence of coal bearing horizons which constitute to middle section, which in turn is capped and underlain by the top and bottom sections of Barakars practically barren of any economic coal seams/bands.

The top section of Barakars is devoid of any workable coal seam in the entire notified area of Kamptea coalfield, so far explored. It ranges in thickness from 55m to 70 m.
**Middle Section:** This is the most important in that it contains the workable coal seams I, II, IV (Top and Bottom seams) and V. The total thickness of the middle section varies from 92.85 m to 105.07 m in the Ghatrohan sector while in Sillewara and Bina sectors it ranges from 101.89m to 132.48m.

**Bottom Section:** It ranges in thickness from 60m to 75m in Ghatrohan area, as against 50 m in Sillewara sector. A maximum thickness of 90m is observed in the Bina sector. The section of the Barakars is characterised by the development of thick argillaceous horizons of sandy/arenaceous shales.

**Talchirs:** In the Bore holes, the lithology of the Talchirs was found to include greenish, calcareous shales and sandstones often interbanded. The Talchir greenish shales and sandstones are exposed beyond the block to the South, on the Nagpur-Chhindwara road side, between 6th and 7th mile-stones from Nagpur and North-East of Bokara village, in a nala section. At this place also, a few stray boulder conglomerates with undecomposed feldspar were noticed. These may belong to the Talchir basal boulder bed. The Talchirs constitute the lowest horizon of the Lower Gondwanas in these areas and rest unconformably on the Archaeans.
Archaenses: These include the quartz, feldspathic gneisses, quartzites, cherty quartzites, horn blende and mica schists, crystalline and chloritic lime stones, pegmatites etc. The area occupied by the Archaean group of rocks is comparatively elevated.

Detrital Mantle: is the youngest geological formation that is ubiquitous and thickness varies from 21 to 47.66m. and is usually 25m to 35m. 3 distinct zones are represented. The top superficial area reveal the presence of black cotton soil ranging in thickness from 1m. to 11 m, this is followed by clayey soil of 2m to 23m thickness range. The sub-soil which is represented by coarse/very coarse sands and grits, ranges in thickness from 4m to 30m (usually 20m to 25m).

Sillewara area: During the period January 1962 to March 1964, the I.B.M. had drilled 116 Bore holes in Sillewara area with a total of 19,294 metres of drilling. The N.C.D.C. took into account the result of all the 116 Bore holes drilled by the I.B.M. and re-assessed the reserves of Sillewara area, comprising 5.5 sq. km area. According to them it contains 119.04 million tonnes of proved reserves and 73.80 million tonnes of indicated reserves of coal in the seams V, IV, III, II and I. In this area, the N.C.D.C. has opened a colliery which is under exploitation.
Kamptee Block-B-Extension: In this area during the year October 1968 to December 1969, the N.C.D.C. has drilled 30 Bore holes with a total of 4,973.29 m. of drilling in addition to 17 bore holes with 2,889.54 m. of drilling, drilled earlier by the I.B.M. The exploitation covered about 11 sq.km. area. As a result, the existence of 5 groups of seams, as in the adjoining Sillewara area has been proved.

In the subsequent years with a view to establish more coal bearing blocks in this coalfield towards West, the State Directorate of Geology and Mining (D.G.M.) undertook detailed prospecting operations in the Pipla-Patansaongi and Saonar area. The work proved the existence of coal seams in both the areas with barren zone devoid of coal in between. The details of work, blockwise, are indicated below:

1) Pipla-Patansaongi Block - The State Directorate of Geology and Mining undertook detailed prospecting for coal in the Pipla-Patansaongi block of - Kamptee Coalfield. Geological mapping around Pipla-Dahegaon, Walni, Patansaongi, Badulkheda was completed on 1: 63,360 scales. The Directorate has drilled 22 Bore holes in this area. 20 Bore holes proved to be coal bearing. 5 coal seams were encountered within the Barakar Strata. On the basis of the Bore holes drilled in Pipla-Patansaongi block the tentatively proved reserves of coal comes to 96.85 million tonnes.
(11) **Saoner Block**: The prospecting operations were continued in the NW direction towards Saoner where coal was encountered in the Bore hole drilled. The area lying between the Saoner and the Pipla-Patansaongi blocks however, proved to be barren of coal.

(b) **Umrer Coalfield**: This field is situated about 44 km South-East of Nagpur and covers an area of 4 sq.km. It was prospected by D.G.M., Government of Maharashtra. Umrer is a railway station on the Nagpur - Nagbhir-Chanda Fort (Narrow Guage) section of the South Eastern Railway and coal bearing rocks extend over an area of about 4 sq.km lying between latitude 20° 15' and 20° 53' and longitude 79° 19', included in Survey of India topo sheet No.55 P/S. The total thickness of Talchirs is over 50 m. and that of Barakars appears to be 200m in the central and deepest part of basin.

The Kamthis lie unconformably over the coal bearing Barakar rocks, while they in turn are unconformably overlain by the Lametas.

Lower Gondwana rocks were deposited in the form of a basin elongated along East-West of which the northern part and at present preserved, while the major portion of the southern part has been eroded away, being on the upthrown side of the fault.
The D.G.M. carried out exploration in this field and drilled 23 bore holes with a total of 2,619.37 m. drilling.

The total reserves of coal in the four seams are estimated to be of the order of 70 million tonnes. The quality of coal in the different seams varies in different sections ranging from selected grade I to grade III. The coal in seams I and II is of better quality than in seams III and IV.

(c) **Bokhara Coalfield**: Bokhara Coalfield is situated about 8 km north of Nagpur and is a small one. The area lies within latitude 21° 12' 40" and 21° 13' 52" and longitude 79° 3' 16" and 79° 5' 9". It is included in survey of India toposheet No.55 D/4. Coal bearing area has been found to cover 6 sq. km and 7 coal seams ranging in thickness from 0.17 m to 3.10 m have been met with.

The D.G.M. carried out exploration in this field and drilled 10 bore holes with a total drilling of 1,161.45m.

The available proved reserves of the Bokhara area are of the order of 3.5 million tonnes. The mineable reserves are only 2.95 million tonnes. Of the mineable reserves only 0.70 million tonnes would rank with class II (marginal) while the rest (2.25 million tonnes) would rank Class III.
Hingna area: Near Hingna, 16 km SW of Nagpur city the Gondwana Formations were encountered below the Deccan trap cover of about 50–70 m. thickness. 2 Bore holes were drilled in this area with a total drilling of 493 m. Prospecting was suspended in this area due to the non-availability of significant coal seam.

d) Saoner Coalfield: In the present study, coal core samples of 5 Bore holes drilled in Saoner Coalfield have been investigated palaeopalynologically. In order to meet the anticipated large requirement of coal for the proposed thermal power stations in Maharashtra an exploration programme for detailed prospecting of coal was undertaken by the Directorate of Geology and Mining, Government of Maharashtra, Nagpur. The prospecting operations for coal in Saoner-Saongi area in Saoner Tahsil of Nagpur District were initiated in the field season 1971–72. 5 coal seams have been encountered in the area. The average thickness of which is given below:

<table>
<thead>
<tr>
<th>Coal Seam</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>6 metres</td>
</tr>
<tr>
<td>VI</td>
<td>12 metres</td>
</tr>
<tr>
<td>III</td>
<td>1.0 metres</td>
</tr>
<tr>
<td>II</td>
<td>1.5 metres</td>
</tr>
<tr>
<td>I</td>
<td>1.0 metres</td>
</tr>
</tbody>
</table>
The Lower Gondwanas are concealed under the soil cover in this area except for some very small and weathering outcrops seen in Kolar river bed. The only exposures are that of Kamthi Sandstone exposed at a distance of 4 kms. South-South-East of Saoner town to the North of Borgaon village. The strike of this outcrop is WSW-ENE having a dip of 15° due south-west.

The area was surveyed on a grid of 1000 m, along and across the strike of the bed. In all 8.59 sq.km. area was covered under surveying.

Initially the bore holes were taken on a grid pattern at the distance of 1000 m, along and across the strike direction in view of deciphering the areal extent and behavior of coal seams. The bore holes revealed the presence of coal seams towards the southern part of the area. A detailed programme of drilling was 500m along and across the strike direction in order to estimate the coal reserves in the area.

The analysis reports of coal from central Fuel Research Institute's Nagpur Coal survey Laboratory at Nagpur reveals that the quality of coal ranges from grade II to Grade III in all the seams of IV and V and that of seam I to III is very poor owing to the presence of numerous partings of considerable thickness.
Stratigraphy

The stratigraphic sequence of the geological formations noticed while logging the bore holes in the area in order of increasing antiquity is given below: in Table No.3.

<table>
<thead>
<tr>
<th></th>
<th>Formations</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent to sub-recent</td>
<td>Detrital mantle</td>
<td>Medium to coarse grained sandy soil.</td>
</tr>
<tr>
<td>Eocene to upper cretaceous</td>
<td>Deccan trap</td>
<td>Greyish to blackish basalt.</td>
</tr>
<tr>
<td>Cretaceous</td>
<td>Lametas</td>
<td>Chirity limestones and white to greenish sandstone.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Unconformity</strong></td>
</tr>
<tr>
<td>Upper Permian</td>
<td>Kamthis</td>
<td>Dark brown and yellow sandstone, red clays.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Unconformity</strong></td>
</tr>
<tr>
<td>Middle Permian</td>
<td>Moturs</td>
<td>Red, purple, greenish clays, Greenish sandstone and Arenaceous shales.</td>
</tr>
<tr>
<td>Lower Permian</td>
<td>Barakars</td>
<td>Light grey to white coarse to medium sandstone, grey shales, carb shales and cal seams.</td>
</tr>
<tr>
<td>Upper Carboniferous</td>
<td>Talchirs</td>
<td>Greenish and dark grey shales of calcareous sandstone.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Unconformity</strong></td>
</tr>
<tr>
<td>Archaean</td>
<td>Metamorphic rocks</td>
<td>Gneissos</td>
</tr>
</tbody>
</table>