"Geologists, in their all but closed conversation inhabit scenes that no one ever saw, scenes of global sweep, gone and gone again, including seas, mountains, rivers, forests and archipelagoes of aching beauty rising in volcanic violence to settle down quitely and then forever disappear - almost disappear."

JOHN McPHEE

4

FIELD CHARACTERISTICS AND LITHOLOGY

CHAPTER 4
FIELD CHARACTERS AND LITHOLOGY

GENERAL

The present chapter furnishes in detail the lithological characters and mode of occurrences of various Lower Gondwana litho-units in the study area (please refer Fig. 3.1 & 4.1). A very brief description of the Proterozoic sediments exposed in the study area is also dealt herewith.

PROTEROZOIC ROCKS

Rocks belonging to Pakhal and Sullavai formations of Middle to Upper Proterozoic age are exposed mainly in the western part of the study area. They also outcrop near Chinnur as faulted inlier. The Proterozoic rocks occur in the field as topographic high forming elongated hill ridges running for several kilometers in NW-SE trend.

In the field, the rocks of Sullavai Formation can be differentiated from those of Pakhal Formation by the former's predominant red colour and arenaceous composition.

Good exposures of the rocks of Pakhal Formation are occurring along River Devavagu near Devapur, NW of Kasipet. The limestones show excellent development of bedding planes (Plate 4.1) having orientation 5° due North. The limestones are micritic and black grey in colour.

The Sullavai Formation of Upper Proterozoic consists of pink laminated sandstones (Plate 4.2). Good exposures were encountered along Ralavagu, Devavagu and Peddavagu rivers near Bellampalli, Kasipet and Chinnur respectively. At places, the sandstones show blotches of white clay (Plate 4.3).

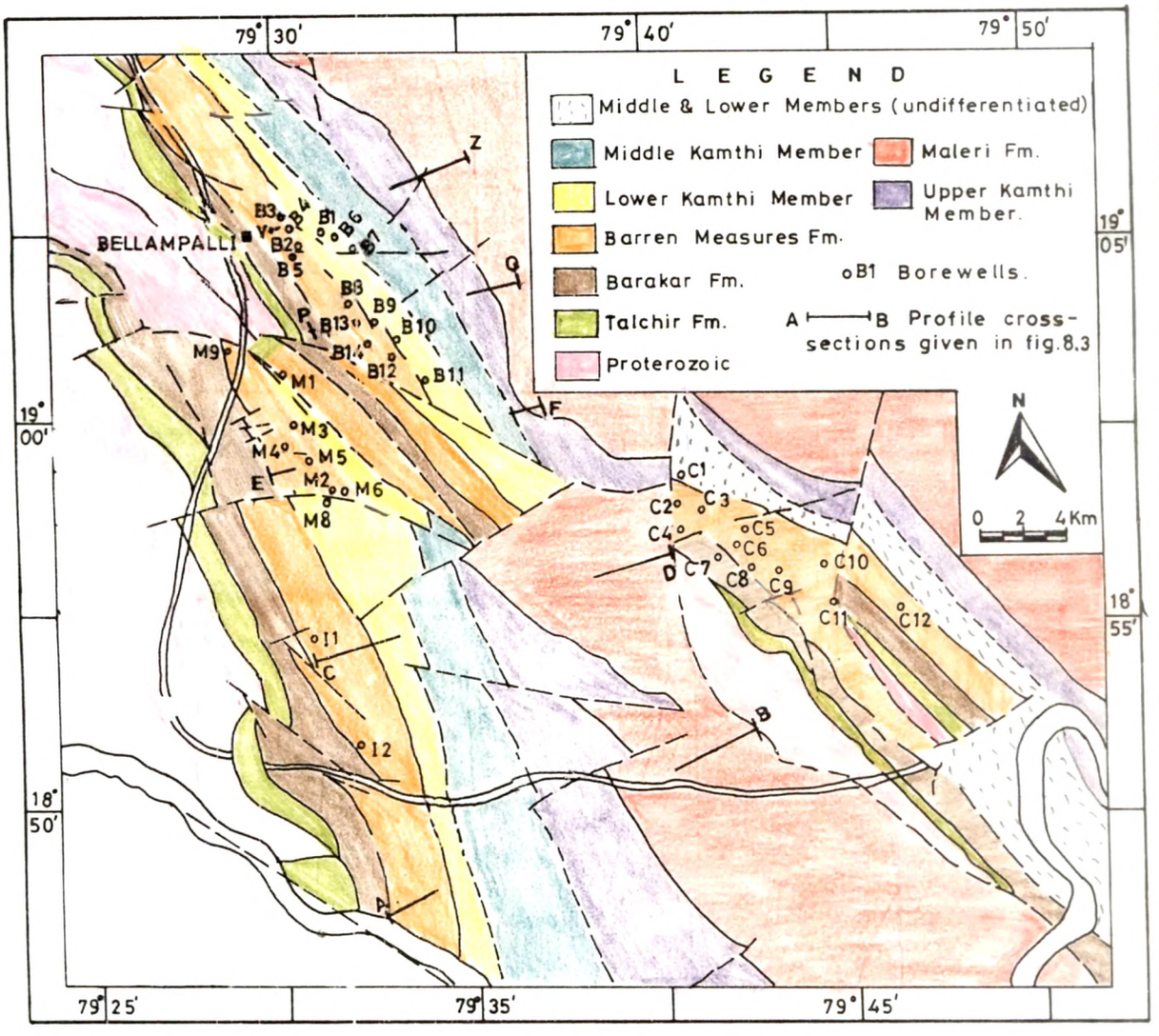

Fig. 4.1; Location of boreholes

Plate 4.1 Pakhal limestone showing development of bedding planes. Location : Devapur (near Kasipet).

Plate 4.2 Laminated Sullavai sandstone showing characteristic red colour. Location : Kasipet.

Plate 4.3 : Pockets of white clay within Sullavai sandstone.Location : Bellampalli.

Plate 4.4 : Talchir diamictite showing clasts of limestone granite and quartzite. Location : Bellampalli.

GONDWANA ROCKS

TALCHIR FORMATION

The rocks of Talchir Formation occur mainly along the western fringe of the study area from Tandur in the north to river Godavari in the south. They also occur as narrow strips within the faulted Chinnur block in the eastern part of the area.

Due to the predominant clay fraction, the rocks of Talchir Formation are prone to weathering and erosion and hence good occurrence of Talchir outcrops are encountered mainly along river and nala sections. The estimated maximum width and thickness of the Talchir outcrop recorded are of the order of 1400 m and 270 m respectively near Ravindrakhani - Mancherial region in the southern part of the study area. Near Bellampalli in the north and Chinnur in the east the width of the Talchir outcrop is much narrower of the order of 600 metres. The estimated exposed thickness is 130 metres. This is on account of the various faults that cut across the country.

The Talchir Formation exhibits wide spectrum of lithofacies assemblage. All the lithounits are not preserved in any one particular section. However, synthesizing all the examined sections, the composite litholog of Talchir Formation has been constructed (Fig. 4.2) which shows the presence of 3 broad lithofacies.

- Diamictite facies,
- Shale-Siltstone facies and
- Sandstone facies.

Diamictite facies

The basal part of Talchir Formation is composed of a diamictite member. It consists of red to greenish red silty clays with pebbles and clasts of granites, limestones and quartzites embedded in it (Plate 4.4). Poor sorting, high polymodality of size distribution and relative rounded nature of clasts characterize this diamictite unit. The clast (pebble) size ranges from less than one cm to 30 cms. They are oriented in a highly irregular and chaotic manner. The basal part of this diamictite is structureless and unstratified, whereas the

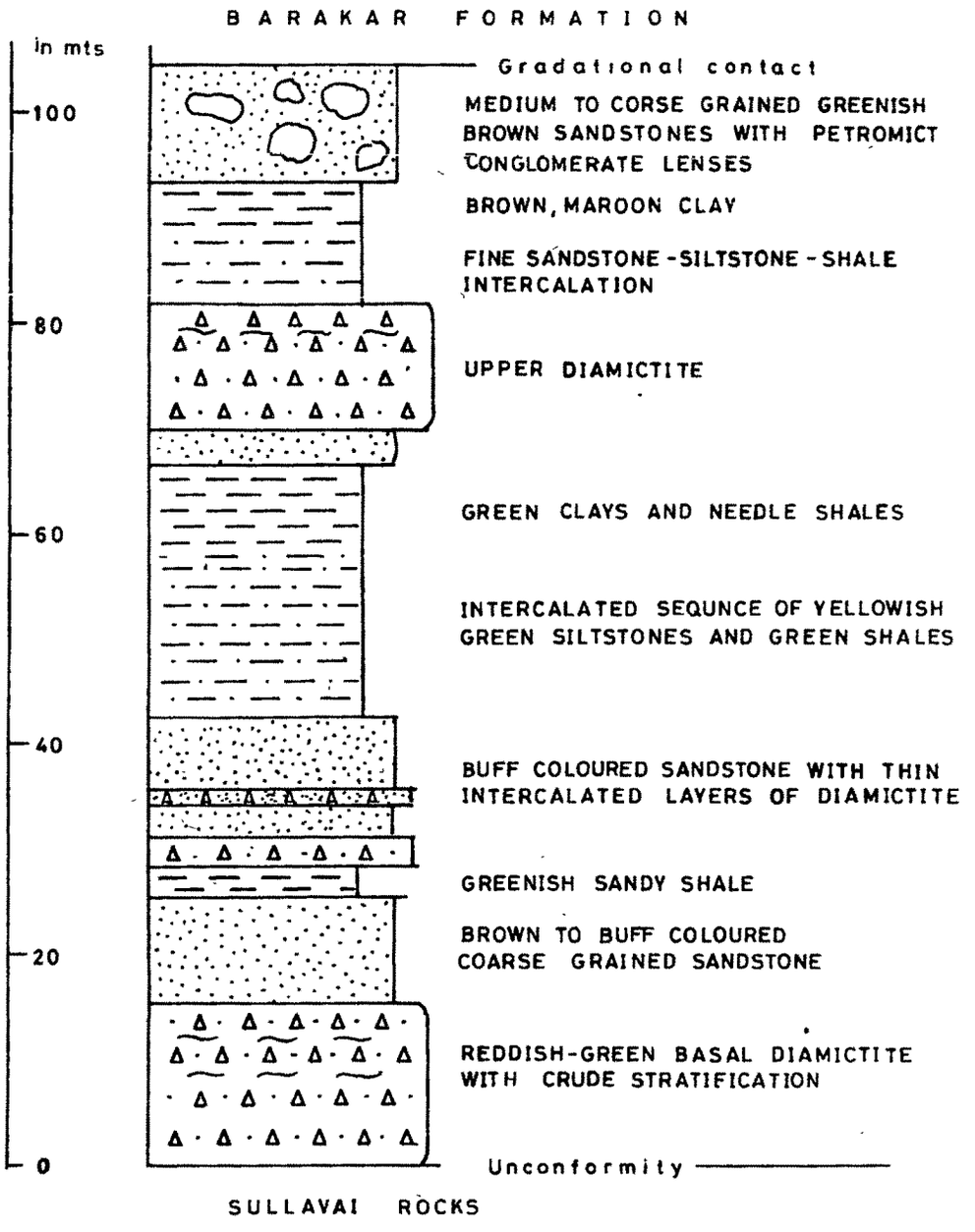

Fig. 4.2 : Composite section of lithostratigraphic sequence of Talchir Formation within the study area.

upper part shows crude stratification. Near Bellampalli, bands of green clays can be seen within the diamictite member (Plate 4.5). The diamictites occur at different stratigraphic layers within the Talchir Formation. In the upper part near the contact with Barakar Formation, there is an increase in the clast percentage and they include pebbles of limestones, granites, and quartzites. The matrix is much coarser falling in very fine sand size range.

Shale facies

The shale facies include needle shales, khaki and maroon clays and silty shales. The needle shales are highly characteristic of Talchir Formation and make a considerable portion of its lithic fill. The needle shales are generally olive green in colour and breaks into thin pencil like fragments due to the development of closely spaces joints. Layers of green clays are, at places, occurring within the khaki and maroon clays (Plate 4.6) overlying the diamictite member. The layers showing 10° dip towards NE. At places, khaki clay become consolidated showing fissility and joints. Due to this, at Kasipet, the Talchir Formation shows conspicuous camel hump like topographic expression where the consolidated claystone layers serve as a resistent cap to the more weatherable clays or diamictites underlying it (Plate 4.7). At places, the shales contain considerable silt percentage and shows dropstones and crude horizontal laminations (Plate 4.8).

Sandstone facies

This facies constitutes the uppermost of Talchir Formation. The sandstones are white to buff yellow in colour. Associated with the sandstones are the conglomeratic horizons. Conspicuously different from the diamictite. These conglomerates are orthoconglomeratic (Petromictic) in composition, comprising high population of grains and low content (less than 15%) of sandy matrix (Plate 4.9). Therefore, these are included with sandstone facies. Further, these sandstones do contain the reworked clast of lower shale unit.

BARAKAR FORMATION

Barakar Formation succeeds Talchir Formation with a gradational contact. Good exposures are seen in nala and river cuttings near Bellampalli,

Plate 4.5 : Layers of green clay within Talchir diamictite member.
Location : Bellampalli.

Plate 4.6 : Green clay layer within Khaki clay of Talchir Formation.
Location : Bellampalli.

Plate 4.7 : Diamictite (lower) overlain by hard claystone layer, Talchir Formation. Location : Kasipet.

Plate 4.8 : Silty shale of Talchir Formation showing development of horizontal lamination. Location : Near Mancherial.

Plate 4.9 : Petromict conglomerate showing high clast percentage in upper part of Talchir Formation. Location : Bellampalli.

Plate 4.10 : Weathered zones in form of calcareous ~~veems~~ veins within the Barakar sandstone. Location : Kasipet.

Kasipet and Ramakrishnapur. Measured outcrop thickness is of the order of 375 metres.

Barakar Formation consists predominantly of white sandstones, shales, carbonaceous shales, intercalations of fine grained sandstones and shales with coal seams. The exposures are mainly weathered. Among the sandstone exposures, white to greyish white, medium to pebbly coarse grained, feldspathic, loosely cemented variety is the most predominant type. The matrix is largely argillaceous and at places calcareous. Weathered zones in the form of calcareous veins are very common within the Barakar sandstones (Plate 4.10). Generally, the finer clastics like siltstones and shales constitute a small proportion of Barakar sequence and where present are seldom extensive laterally. The clays are mainly exposed along the cliffs of the nala-cutting.

Among the sedimentary structures observed in Barakar Formation, trough cross bedding, tabular cross-bedding and horizontal bedding are common. Due to the high weathering effect and paucity of fresh exposures, the structures are very poorly preserved within the outcrop. The cross-bedding are mainly exhibited by the coarse and medium sandstone varieties (Plate 4.11). The fine-grained sandstones and siltstones show cross and parallel laminations.

Owing to poor and weathered exposures, the borewell lithologs have been studied to understand their vertical variability and their cyclicity. Although a number of well logs have been collected from the Coal Company, selected representative into logs are given in Fig. 4.3. It has been recorded from those lithologs about six different sublithofacies which are :

- Coal, shaly coal (D),
- Carbonaceous shales and siltstones (C),
- Intercalation of fine grained sandstones, siltstones and shales (B),
- Fine to medium grained sandstones (A_3),
- Coarse to medium grained sandstones (A_2), and
- Pebbly very coarse grained sandstones (A_1).

Lithologs of the borewells reveal that the lower part of the Barakar (105 to 140 m) is composed of coarse grained pebbly sandstones and is devoid of coal seams. Thick workable coal seams are found in the upper part (160 to 200

Plate 4.11 : Barakar sandstone showing development of small scale trough cross stratification (cross-sectional view) Location : Near Indaram.

Plate 4.12 : Ferrugenous coarse grained sandstones of Measures Formation showing horizontal lamination. Location : Bellampalli.

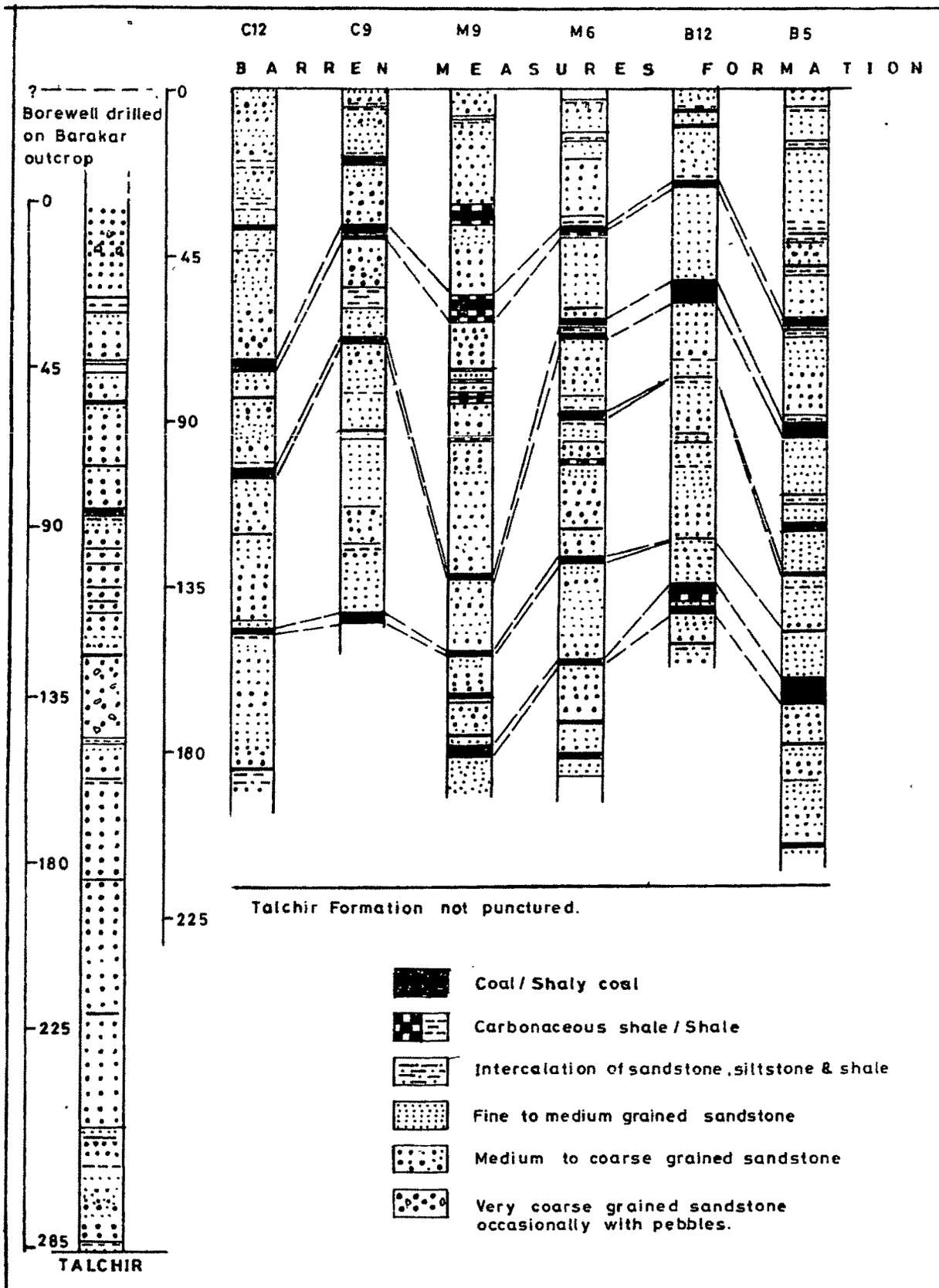

Fig.4.3: Reprsentative borehole sections of Barakar Formation

m) of the formation, which consists the first five lithounits mentioned above. The carbonaceous siltstones of some of the borewells show wavy and ripple drift lamination.

Closer examination of the lithologs reveal that they consist of a number of cycles of fining upward character, each beginning with coarse sandstone unit (facies A_1 and A_2) and ending with either fine sandstone, shale or coal unit (facies A_3, B, C, D) (Fig. 4.4 and 4.5). The vertical variation is mostly not systematic and all the facies are not represented at a time within a particular cycle. At the same time, within each cycle, there is repetition of facies A_3, B, C and D. Appearance of facies A_1 and A_2 has been taken as a start of a new cycle. The fining upward cycles, thus exhibit a truncated or incomplete and haphazard sequences comprising of two, three or four of the lithofacies described above in various combinations (Fig. 4.4 and 4.5). The upward part of Barakar Formation shows 12-16 cycles of irregular fining upward character. The vertical variation in cycles is similar to Allen's (1970) fluvial upward cycle.

BARREN MEASURES FORMATION

The rocks of Barren Measures Formation overlie those of Barakar Formation with a gradational contact. Good exposures are seen between Indaram and Mudikunta village in the southern part; and between Subhashnagar and Mallagurjala near Bellampalli in the northern part of the study area. In the eastern part near Chinnur, exposures are very scanty. Estimated thickness of Barren Measures Formation from outcrop sections ranges between 400 m near Bellampalli in the north to 500 metres near Indaram in the south. Near Chinnur the thickness is as low as 250 metres.

The Barren Measures Formation is represented by medium to coarse grained, grey to greenish grey ferrugenous sandstone with subordinate clays and grey to dark grey shales. On weathered surface, brown to reddish-brown colour and occassional presence of ferrugenous veins distinguished sandstones of Barren Measures from the underlying Barakar's sandstones (Plate 4.12). Shales and siltstones are subordinate to the proportion of sandstones and are variegated on the outcrop. Horizontal bedding, trough and tabular cross bedding (Plate 4.13) are some of the sedimentary structures present in the sandstones of Barren Measures. The structures, however, are very infrequent

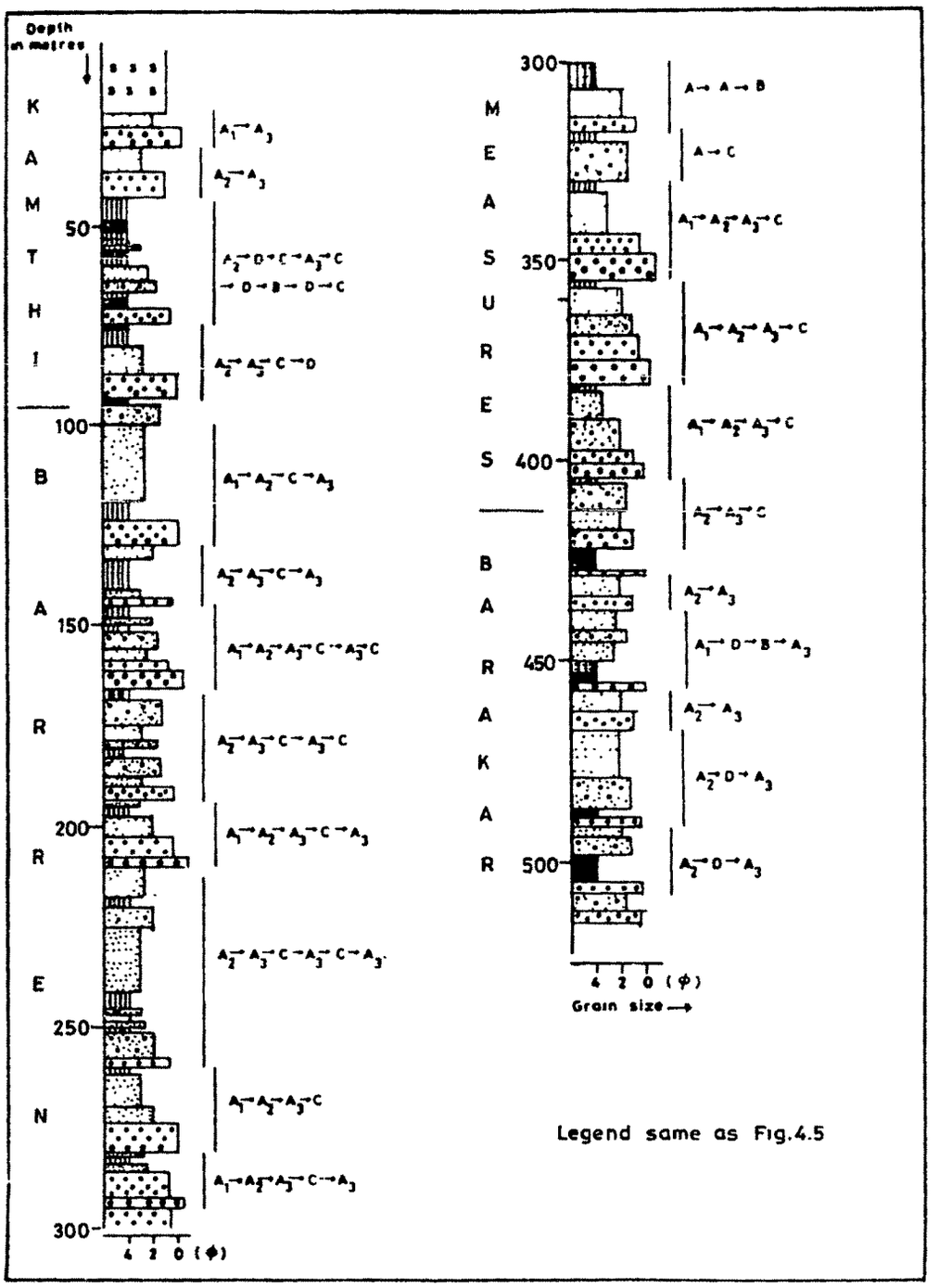

Fig.4.4: Litholog of borewell B1 showing truncated, haphazard cycles of fining upward character within Barakar, Barren Measures and Kamthi formations.

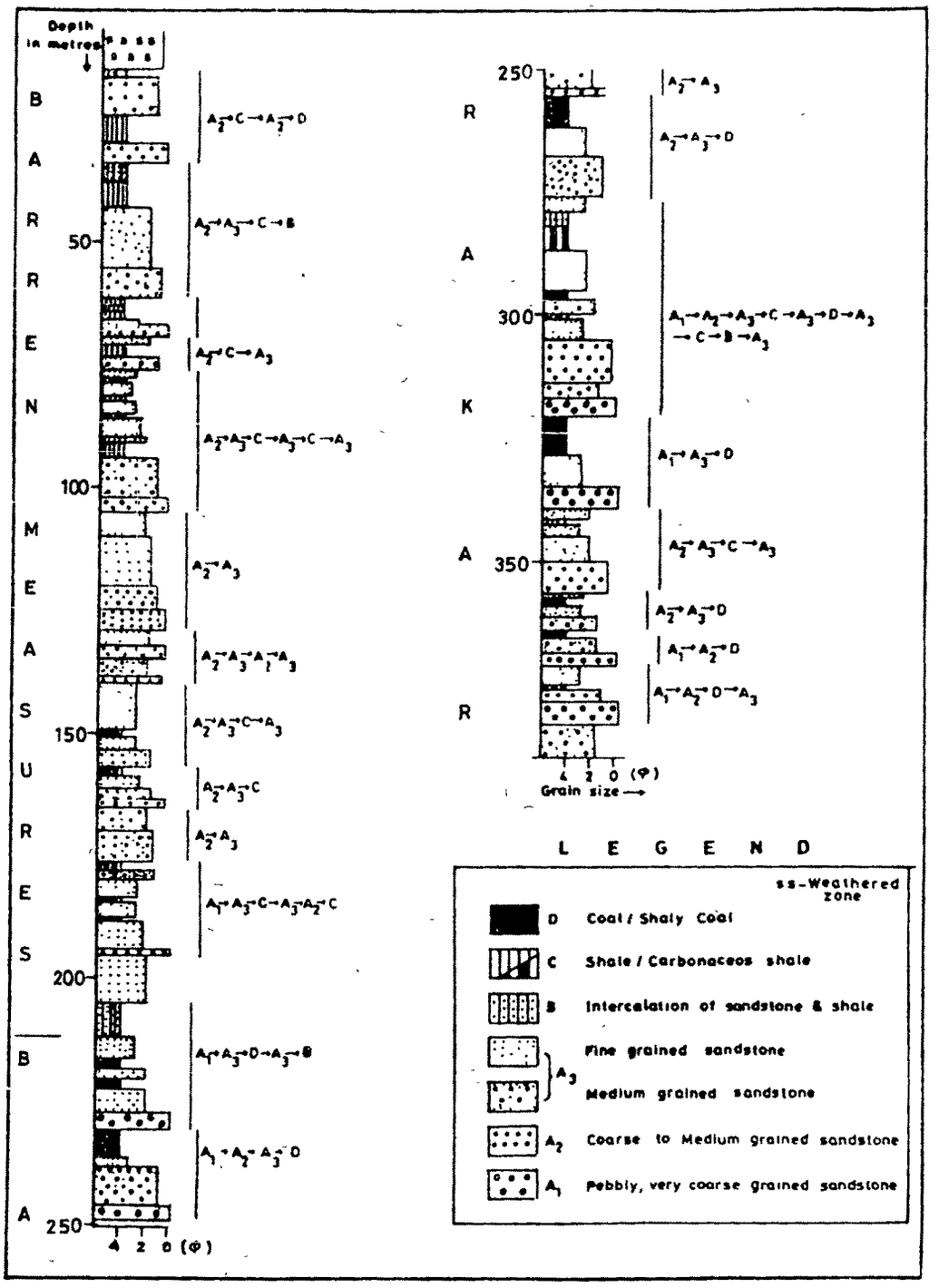

Fig 4.5: Litholog of borewell B2 showing truncated, haphazard cycles of fining upward character within Barakar and Barren Measures formations.

Plate 4.13 : Large scale trough cross stratification in Barren Measures sandstones. Location : Near Shantikhani.

Plate 4.14 : Variegated clay overlying medium grained sandstone in Middle Kamthi Member. Location : Near Jaipuram.

due to poor exposures. The current direction shown by the cross bedding varies between 310° to 325°. Coal seams are absent in the rocks of Barren Measures Formation. Streaks of carbonaceous matter are however encountered in the subsurface (Fig. 4.6). Most of the subsurface samples of Barren Measures show a conspicuous greenish tinge which is absent in the underlying and the overlying formations.

Decidedly, the onset of green colouration and absence of coal seams, in the sub-surface and prevalence of red colour with iron veins in the surface outcrop are the main criteria in differentiating the Barren Measures from Barakar and Lower Kamthi rocks.

The lithologs of Barren Measures show the presence of the following units :

* shale, siltstone and carbonaceous shale (C),
* intercalation of sandstone, siltstone and shales (B'),
* medium to fine grained sandstone (A_3),
* coarse to medium grained sandstone (A_2)
* and very coarse grained (occasionally pebbly) sandstone (A_1).

The unit exhibits cyclicity, like Barakar, is truncated and haphazard (Fig. 4.4 and 4.5). Number of cycles of fining upward character in the full sequence of Barren Measures (400 m) varies from 25 to 30. The thickness of the cycles varies from 1 m to 30 m. The sand-shale ratio within the Barren Measures is fairly constant and it varies from 5 to 7.

KAMTHI FORMATION

The Kamthi lithostratigraphic composite profile is presented (Fig. 4.7).

Lower Kamthi Member

The Lower Kamthi Member conformably succeeds the Barren Measures Formation with a gradational contact. This formation is mostly covered with soil. Outcrop of this formation, is observed at Mudikunta village, north of Mancherial-Chinnur road. The lithology of this member is grey-white, frequently calcareous to coarse grained sandstone with few coal seam and

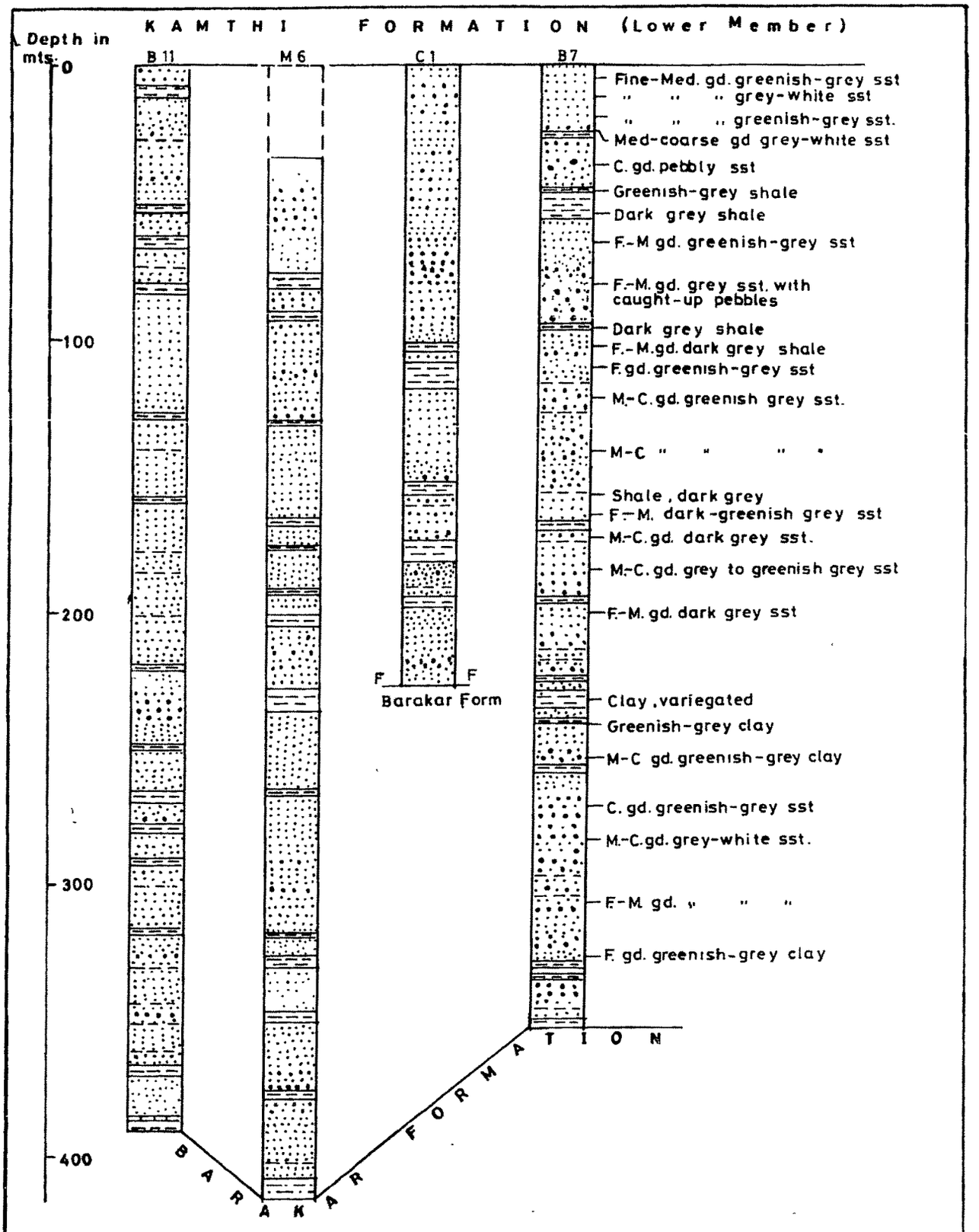

Fig. 4.6: Borewell lithosections of Barren Measures Formation.

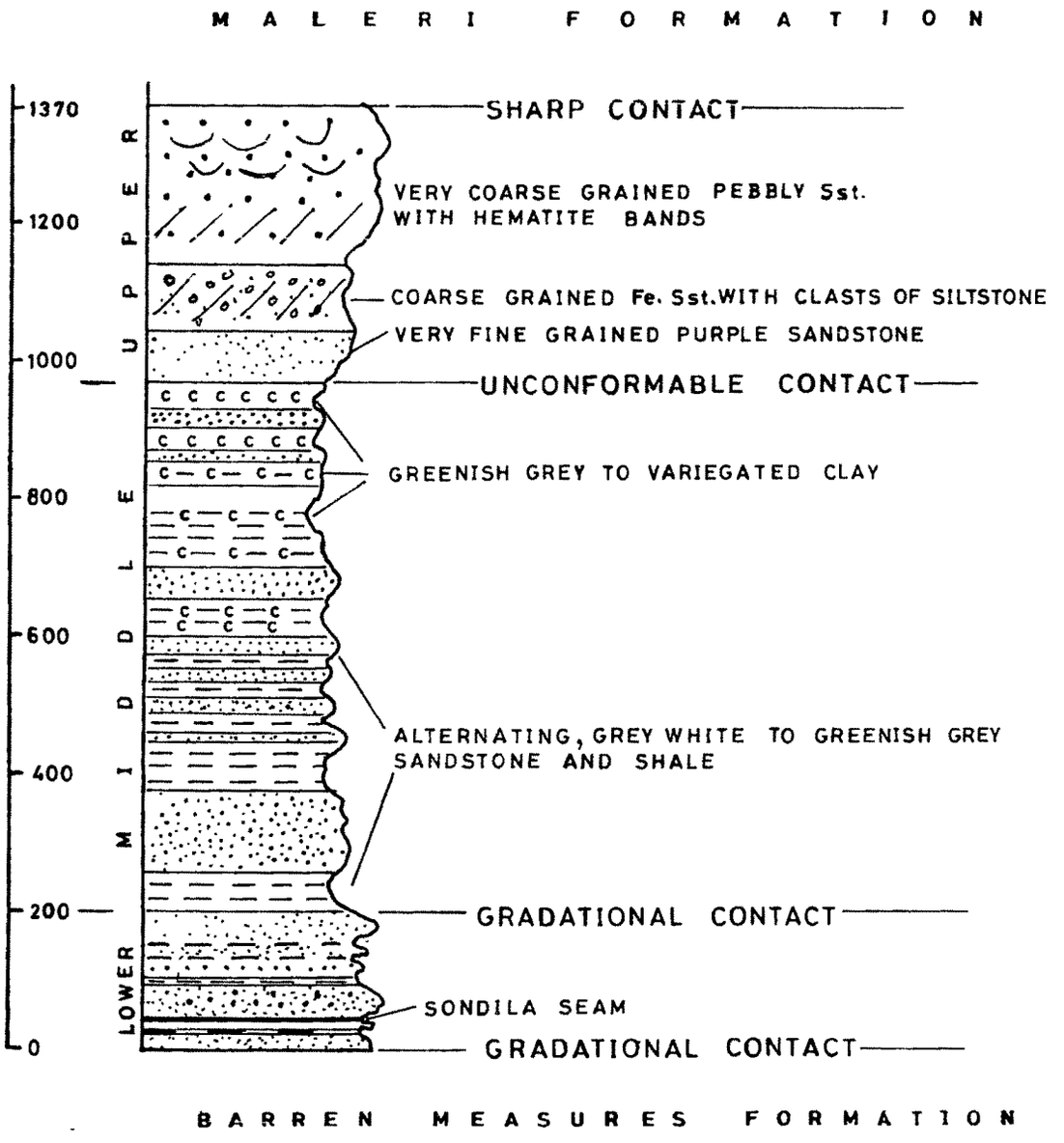

Fig.4.7: Generalised Lithostratigraphic section of Kamthi Formation within the study area.

subordinate shales.

The detailed sub-surface lithology of Lower Kamthi Member as examined in the borehole is presented (Fig. 4.8). The lower 100 metres consists of a few coal seams and layers of carbonaceous shales. Truncated fining upward cycles are also noticed within this member (Fig. 4.4). The fining upward cycles within the arenaceous Barakar, Barren Measures and Lower Kamthi units vary in thickness from 25 to 5 metres. Table 4.1 shows the percentage variation in thickness of bed of each facies within each of the different formations. Facies A_3 shows maximum variation in bed thickness within the different cycles and is thicker, on an average, than any other facies.

Middle Kamthi Member

The non-coal bearing middle member conformably succeeds the Lower coal bearing member with a gradational contact. Good exposures are observed near Jaipuram village on Mancherial-Chinnur road and near Mala Gurjala village near Bellampalli. Estimated exposed thickness is around 750 metres. This Middle Kamthi Member comprises of a monotonous sequence of alternating medium to coarse grained sandstones, shales and variegated clays (Plate 4.14). The sandstones and shales bear a conspicuous greenish tint (Plate 4.15). At places, the sandstone units exhibit within themselves fining upward cycles defined by pebbly to coarse sandstone at the base and very fine grained sandstones and siltstones at the top. At some places, the clays are characterized by nodules of calcareous material. Near the contact the Middle Kamthi Member wears a distinct red colour (Plate 4.16). Due to the predominance of shaly fraction and friable sandstone, this member occupies a low land topography which is mostly soil covered with rare exposures.

Upper Kamthi Member

The Upper Kamthi Member belonging to the Triassic, overlies the middle one with pronounced unconformity, resting on different units of the middle member. The maximum exposed thickness of this member is estimated to be around 425 m and it is prominently exposed in the Kundaram forest between Jaipuram and Pollampalli. Near Bellampalli good exposures of upper Kamthi are encountered at Tala Gurjala village where the estimated exposed thickness

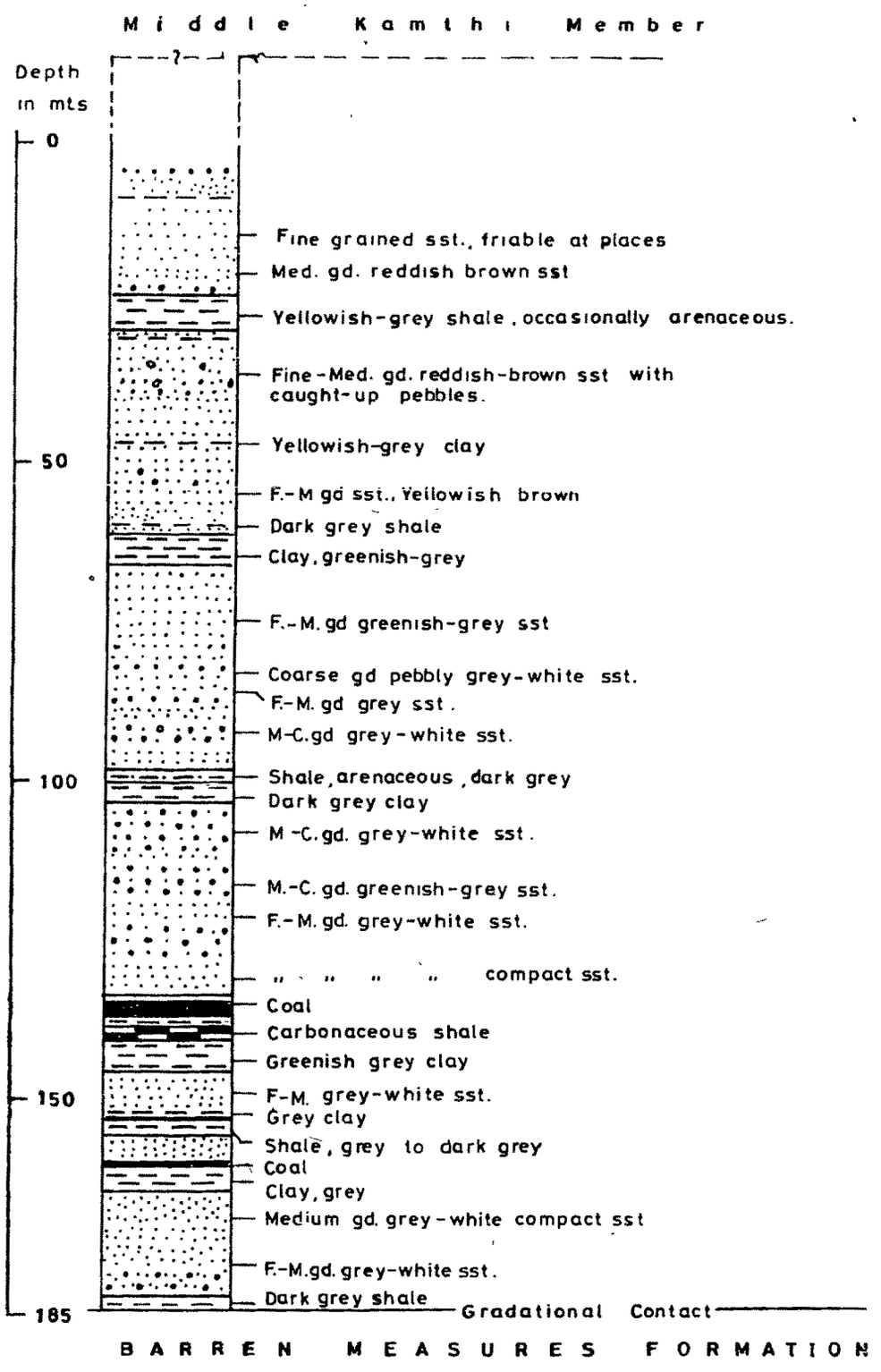

Fig.4.8: Borehole lithocolumn of Lower Kamthi member

TABLE 4.1 : PERCENTAGE VARIATION IN THICKNESS OF BED OF EACH GRAIN-SIZE FACIES WITHIN BARAKAR, BARREN MEASURES AND KAMTHI (LOWER) FORMATIONS OF THE STUDY AREA.

	Thickness in Metres						
	FACIES	1 - 2	2 - 4	4 - 6	6 - 8	8 - 10	Total
Kamthi Formation	A_1	0.0	100.0	0.0	0.0	0.0	2
	A_2	0.0	100.0	0.0	0.0	0.0	2
	A_3	20.0	40.0	40.0	0.0	0.0	5
	B	0.0	0.0	100.0	0.0	0.0	1
	C	50.0	33.3	16.7	0.0	0.0	6
	D	100.0	0.0	0.0	0.0	0.0	5
Barren Measures Formation	A_1	50.0	33.3	16.7	0.0	0.0	6
	A_2	17.8	39.3	28.6	7.1	7.1	28
	A_3	25.6	25.6	23.1	10.2	15.4	39
	B	33.3	33.3	33.3	0.0	0.0	3
	C	75.9	17.2	6.9	0.0	0.0	29
	D	-	-	-	-	-	-
Barakar Formation	A_1	28.6	42.8	28.6	0.0	0.0	7
	A_2	17.6	52.9	5.8	17.6	5.8	17
	A_3	22.7	31.8	18.2	18.2	9.1	22
	B	50.0	50.0	0.0	0.0	0.0	2
	C	100.0	0.0	0.0	0.0	0.0	1
	D	46.7	20.0	20.0	13.3	0.0	15

Plate 4.15 : Greenish coloured clay in Middle Kamthi Member.
Location : Near Jaipuram.

Plate 4.16 : Red coloured clay in upper part of Middle Kamthi Member
Location : Near Jaipuram.

is 275 m.

The upper member is predominantly an arenaceous facies with a prevalent red colour. The basal part of this member is characterized by brick red to purple coloured very fine grained sandstones (Plate 4.17). This grades upward into a poorly sorted, loosely cemented, argillaceous coarse-grained sandstone with abundant clasts of siltstones and quartz (Plate 4.18). The topmost part of this member is a poorly sorted, coarse, argillaceous yellowish brown sandstones with abundant quartz and quartzite pebbles. Dark brown layers of hematite, 1 to 2 cm thick are commonly found on bedding and joint planes of this sandstone unit (Plate 4.19). The coarse grained sandstone shows profuse large scale trough cross bedding, with a mean current azimuth towards NW - 325° (Plate 4.20).

Plate 4.17 : Brick red to purple coloured very fine grained sandstone at the basal part of Upper Kamthi Member. Location : Near Jaipuram.

Plate 4.18 : Loosely cemented coarse-grained sandstone of Middle part of Upper Kamthi Member showing clasts of siltstone and quartz. Location : Kundaram Forest.

Plate 4.19 : Bands of hematite along the bedding planes of coarse grained Upper Kamthi Member. Location : Kundaram Forest.

Plate 4.20 : Coarse grained pebbly sandstone of Upper Kamthi Member showing large scale trough cross-bedding.
Location : Kundaram Forest.