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PETROGRAPHIC APPRAISAL OF COAL DEPOSITS FROM MALLAYYAPALLI AREA, MULUG COAL BELT, GODAVARI VALLEY, TELANGANA STATE, INDIA

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ABSTRACT

A detailed coal maceral and random vitrinite reflectance (R_o mean %) study of fourteen (14) coal seams, intersected in a deep (582.50 m) bore-hole No. ML-858 from Mallayyapalli region, Godavari Valley Coalfield is presented here. Quite low vitrinite reflectance variation between 0.48 % and 0.49 % is recorded from the upper parts of seams II Top, IIB and the entire IIC seam, indicating the attainment of sub-bituminous B stage. Whereas, the seams IIIA and III bottom, have shown higher reflectance of 0.69%, thus having reached high volatile bituminous B rank. However, the seams IB, Index below IB, IA Top, IA Bottom, I, basal parts of II Top and IIC and the entire IIB, Index above III, IIIB and III Top with vitrinite reflectance variation between 0.51 % and 0.59% have attained high volatile bituminous C stage.

The maceral study has revealed the existence of very high amount of mineral matter from the topmost Index above IB and III top seam. The ternary mineral matter free (m.m.f.) diagram suggest, that the Index below IB, IIIB and III bottom seams contain vitric type of coal. Index above III seam has fusic coal constitution whereas; the seams IA top and IIIA contain mixed type of coal. The seams IIB and IIC seams have been found associated with vitric and fusic coal types. Similarly, IB and II Top seams contain fusic and mixed type of coal and the IA bottom and I seam is characterized by vitric and mixed coal types.

The maceral and mineral matter constitution has indicated that, most of the coal seams in Mallayyapalli area have been deposited during the prevalence of alternate oxic and anoxic conditions, except the Index below IB seam, which has witnessed wet moor conditions with intermittent moderate to high flooding. A similar climatic change during deposition has also been noticed in I and IA bottom seams. However, a wide range of climatic alterations viz., existence of alternate oxic and anoxic moor conditions, invasion of moderate as well sudden high floods at the depositional site have been recorded for the IIB seam.

Keywords: Mallayyapalli, Mulug Coal belt, Godavari valley, Telangana State, Maceral, Reflectance, Depositional Environment etc.

INTRODUCTION

Godavari Valley Coalfield situated in the states of Telangana and Andhra Pradesh and cover nearly 17400 km^2 area, spread in Adilabad, Karimnagar, Warangal and Khammam districts. The Coalfield is marked between 16°38′ and 19°32′ latitudes and 79°12′ and 81°39′ longitudes. However, the coal bearing Gondwana deposits are confined to an aereal extent 11000 km^2. The gravity anomaly studies suggest that the Gondwana Sequence has been deposited in a rift valley, as well as in between the block faulted troughs and also in the regions of the boundary fault that were activated for prolong period as in the Ramagundam, Godavari Khani and the vast areas of the Chintalapudi coastal sub-basins, resulting in the deposition of thick pile of sedimentary sequences (Bhaskar Rao *et al.* 1971; Qureshi *et al.* 1968). However, there are also some regions, like Palauncha-Koyagudem area in Kothagudem sub-basin, where the fault remained active for a very short span and consequently the thickness of deposits is comparatively lesser. The pioneering geological work in the valley has been done by King (1872 and 1881), Blanford (1871) followed by Fox (1931 and 1934) and thereafter Raja Rao (1982) compiled the geological data of the different Indian Gondwana Basins, including the Godavari Valley Coalfield (Table 1).

The Gondwana deposits of Godavari Valley rest unconformably over Archaean Formation in the southern part; whereas; in the northern part they lie over the Proterozoic rocks of Pakhal and Sullavai Group. The Talchir Formation represents the oldest member of the Gondwana Sequence, which is observed in the form of small pockets. The basal part of the sequence is mostly occupied by a thick tillite bed, followed by cross-bedded medium-grained sandstones with alternate bands of clays and siltstone. The overlying Barakar Formation occupies marginal position in the valley and exists in linear patches with thickness variation between 220-300 m. Based on lithological variation the Barakar Formation is sub-divided into two parts. The basal arenaceous and non coal-bearing member, with thickness variation, between 70-120 m has predominance of coarse grained sandstones, interspersed with conglomeratic lenses. The overlying 150-200 m thick upper sequence includes cyclic sandstone, shale and coal seam succession. The overlying Barren Measures Formation has attained a maximum thickness of about 500 m in Godavari Khani area, Ramanamurthy, (1979), and is characterized by cross- bedded greenish to grey white, coarse-grained ferruginous as well as felspathic sandstone, along with variegated shale bands. The sediments have a lower dip of 6°-8° than the overlying Barakar Formation (15°-18°).

The stratigraphic sequence which exists between the Barren Measures Formation and the Maleri Formation is referred as the Kamthi Formation, which has attained maximum thickness in Chintalapudi sub-basin. The Kamthi Formation is further sub-divided into lower, middle and upper members. The lower member consists of calcareous; grey-white medium-grained sandstones along with the development of coal seams; whereas, the middle member with a maximum thickness of nearly 800 m is devoid of any coal seam. The basal part is characterized by the presence of coarse-grained, greenish sandstones along with greenish shale bands containing calcareous nodules, whereas the top part is occupied by siltstone sequence. The upper member of the Kamthi Formation includes ferruginous, coarse-grained

sandstones containing pebbles or conglomerates along and bands of yellow or violet clay-stones along with siltstone, displaying brick red colouration.

GEOLOGICAL FRAMEWORK

Mallayyapalli Block Mulug Coal belt is economically very significant horizon, which has shown the development of 20 persistent coal seams, which in descending order, include the seams namely, Index above IB, IB, Index below IB, IA top, IA Bottom, I, II top, II Bottom, IIIC, Index above IIIB, IIIB, IIIA, III top, III bottom, IVA, IV, Index below IV, Index above V, V and Index below V respectively. However, not much is known regarding petrographic constitution of the these recently found coal deposits from this area, Therefore, a systematic coal petrographic study has been undertaken of almost all the coal seams encountered in the bore-hole No. ML-858 to evaluate their economic credentials. The Mallayyapalli block has rectangular shape with strike length of 3.30 km and width measuring 1.20 km. The Gondwana deposits in this block are laid down unconformably over the Sullavai Formation. The Talchir Formation includes fine to medium grained siltstone, sandstone and shale with occasional existence of clay lenses and boulder beds. The overlying Barakar Formation displays gradational contact with Talchir. Barakar Formation in this area is divisible into the lower and upper members. The lower member includes the strata deposited above the Talchir/Barakar contact up to the floor of Index below V seam, which has predominance of medium grained grey white sandstones along with persistent thin coal bands. The upper member includes the sediments deposited over the floor of the Index below V seam up to the Barakar-Barren Measures contact. The unconformably overlying Barren Measures Formation has maximum thickness of 450 m, and comprises coarse grained greenish grey ferruginous sandstones along with variegated clay bands. There exists faulted contact between the Kamthi and its overlying Barren Measures and

Table 1. General geological succession of the Permian sediments exposed in the Godavari Valley Coalfield, Andhra Pradesh, India (after, Raja Rao, 1982).

Age	Group	Formation	Maximum Thickness (meters)	Lithology
			500	Upper Member : Coarse-grained, ferruginous sandstones with clay clasts and pebbles and subordinate violet cherty siltstones and pebble beds.
Upper Permian to Lower Triassic		Kamthi	600	Middle Member : Alternating sequence of medium grained white to greenish grey white sandstones and buff to greenish grey clays.
	L O W		200	Lower Member : Medium to coarse grained, grayish white calcareous sandstones with a few coal seams.
Upper Permian	E R	Barren Measures	500	Medium to coarse grained, greenish grey to grayish white felspathic sandstones with subordinate variegated and micaceous sandstones.
Upper part of Lower Permian	G O N D W A N A	Barakar	300	Upper Member : Coarse, white sandstones with subordinate shales and coal seams. Lower Member : Coarse-grained sandstones with lenses of conglomerates, subordinate shales/clays and a few thin bands of coal.
Lower Permian		Talchir	350	Fine-grained sandstones, splintery green clays/shales, chocolate coloured clays, pebble beds and tillite.
				----------Unconformity----------
? Upper Proterozoic		Sullavai	545	Medium to coarse grained, white to brick red sandstones, at places quartzitic and mottled shales.
				----------Unconformity----------
Lower Proterozoic		Pakhal	3335	Grayish white to buff quartzites, grey shales, phyllites and marble.
				----------Unconformity----------
Precambrian		-	-	Granites, banded gneisses, biotite gneisses, hornblende gneisses, quartz magnetite schists, biotite schists, quartz and pegmatite veins.

Barakar Formation. Kamthi Formation is further divided into the upper, middle and lower members, however, the lower member of the Kamthi Formation as well as the Barren Measures and Barakar Formation are found missing in some of the bore holes drilled in this area.

MATERIAL AND METHODS

The coal seam samples have been collected from Bore-hole No. ML-858 representing Mallayyapalli Block of the Mulug Coal Belt, Godavari Valley Coalfields, Telangana State. This bore-hole is located at a distance of nearly 2.5-3 km NE of Peddapalli Village and is about 7 km NE of Golapalli Village, Warangal District, Telangana. Samples representing 14 coal seams intersected between 423.78-582.50 m depth have been collected for coal petrographic studies (Table 2, Fig. 1).

For pellet preparation, maceral analysis, reflectance study and coal classification the recommendations and guidelines of ISO 7404-2 (2009), ISO 7404-3 (2009) ISO 7404-5 (2009), ISO-11760, 2005, ICCP (2001), Stach *et al.,* (1982) and Taylor et al. (1998) have been followed. Coal macerals were studied under Leica DM 4500P microscope and for random vitrinite reflectance (R_o mean %) analysis Microscopephotometry System (PMT III) and Software MSP 200 was used. Quantitative maceral study has been done by computerized point counter, using 2.35 version of Petroglite Software. For microphotography, Software tool Leica applications suit (LAS) has been utilized.

DESCRIPTION OF MACERALS

Vitrinite: This maceral group in general has shown predominance over the inertinite and liptinite macerals, barring a few occasional intervening coal bands, wherein inertinite and liptinite macerals have indicated preponderance. Telovitrinite sub-group, includes two macerals (1) telinite with low frequency distribution and show distinct cellular preservation whereas, (2) collotelinite (Plate I. Fig. 1) is commonly found as structureless constituent, which appears in the form of either bands or isolated bodies, displaying grey colour. At times, expulsion of exudatinite from the cracks and fissures is also observed (Plate I, Figs. 2 (normal mode) & 3. (fluorescence mode). Transitional stages from collotelinite to semifusinite are also seen (Plate I,

Table 2. Lithological details of the coal seam succession intersected in Bore-hole No. ML-858, Mallayyapalli Block, Bhupalpalli area, Godavari Valley basin, Telangana.

Sr. No.	Depth (in meter)	Coal Seam	Lithology
1.	411.21-411.49	Index above IB Seam	Shaly Coal
2.	423.78-424.26	IB Seam	Coal
3.	424.26-424.88	IB Seam	Shaly Coal
4.	434.25-434.50	Index below IB Seam	Shaly Coal
5.	441.33-441.68	I-A Top Seam	Coal
6.	443.14-443.77	I-A Bottom Seam	Coal
7.	443.77-444.32	--do--	Shaly Coal
8.	445.08-445.41	I Seam	Coal
9.	477.14-477.64	--do--	Shaly Coal
10.	478.06-478.65	--do--	Shaly Coal
11.	478.65-479.13	--do--	Coal
12.	479.26-479.72	--do--	Shaly Coal
13.	479.72-480.04	--do--	Coal
14.	491.55492.02	II Top Seam	Shaly Coal
15.	494.47-495.02	--do--	Coal
16.	508.70-509.74	II B Seam	Coal
17.	509.81-510.43	--do--	Coal
18.	511.20-511.70	--do--	Coal
19.	525.95-526.26	II C Seam	Shaly Coal
20.	526.26-526.60	--do--	Coal
21.	536.37-537.01	Index above III bottom Seam	Coal
22.	537.50-538.03	--do--	Shaly Coal
23.	546.57-547.27	III B Seam	Coal
24.	561.73-562.33	III A Seam	Coal
25.	574.00-575.34	III Top Seam	Coal
26.	581.95-582.50	III Bottom Seam	Coal

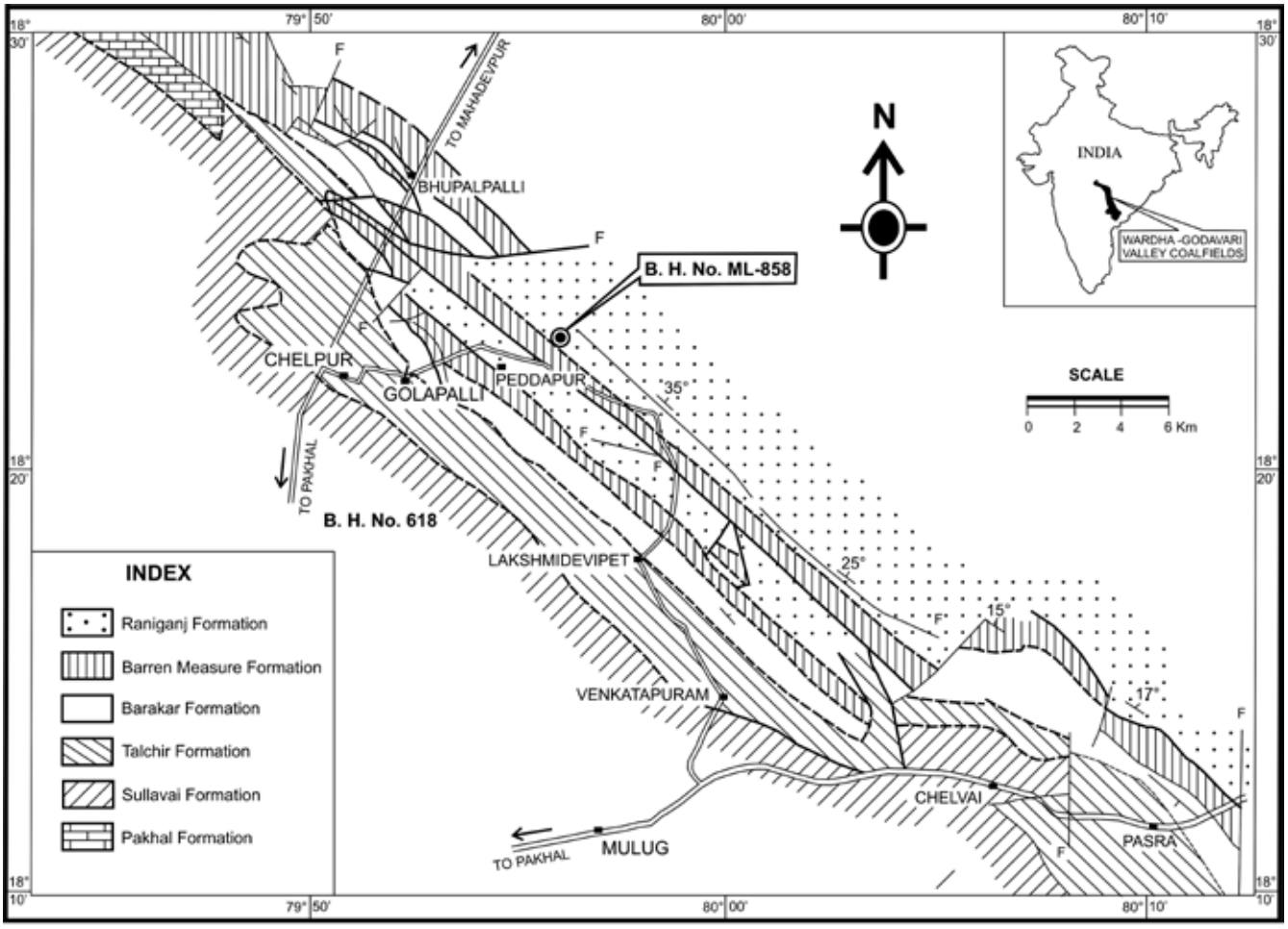


Fig. 1. Geological map showing location of Bore-hole No. ML-858, Mallayyapalli Block, Bhupalpalli area, Godavari Valley basin, Telangana.

Fig. 4). Detrovitrinite fragments are also frequently noticed. The intercellular spaces, cracks and fissures of the macerals are mostly occupied by mineral matter. Oval or round isolated bodies of corpogelinite are also frequently noticed.

Liptinite: All the coal seams in the study have shown the presence of spores which are mostly thin walled tenuispores (Plate I, Fig. 7). The spores assume thread like or spindle shaped appearance with dark grey colour in the form of , linear rows as well as with random distribution pattern mostly from the vitrinite bands, however, their association from inertinite or inertodetrinite fractions is also frequently recorded. Sometime spore masses are also observed (Plate I, Fig. 8). Similarly, cuticles are occasionally observed as thin (tenuicutinites) and thick-walled (Crassicutinite) forms, generally dispersed in the vitrinitic ground mass (Plate I, Fig. 9). Megaspores with varied shapes and ornamentation patterns display dark grey colouration. Similarly, broken sporangial remains containing spores (Plate I, Fig. 5, normal mode, Fig. 6, Fluorescence mode) are also noticed, however, their frequency is quite low. Dark grey coloured resin bodies with variety of shapes such as, spherical, oval or elongate are also observed dispersed in the vitrinitic and inertinitic ground mass. The wide range of variation recorded in morphographic features of microspores, cuticles and megaspores in fact display the existence of rich and diversified flora in the surrounding area of the depositional site.

Inertinite: Most of the coal seams have exhibited inertinite as the sub-dominance maceral group. Fusinite exists in two forms, pyrofusinites and degradofusinite, the former has well preserved cellular structures, strong relief and yellowish colouration, due to high carbon concentration its presence is generally related with events of forest fire (Plate I, Fig. 10). Due to compression, the fusinised cells assume bogen or star like appearance Degradofusinite display comparatively lower reflectivity than pyrofusinite, it has weak relief and less preserved cells with white colour. Amorphous, lenticular or oval structure less micrinites with high reflectivity and non-cellular, but highly reflecting secretinite with vesicular, oblong or sub-circular appearance have also been sparsely noticed with a wide range of variation in size and shape. Micrinites, however, are observed as amorphous bodies with light white to grey shade, whereas fuginite occur in the form of fungal spores and fungal hyphae, but represented in very in low proportion. Inertodetrinite, with white colour and high reflectance as distorted particles with uncertain affinity, were commonly found interspersed with other coal macerals.

Mineral Matter: The coals of Mallayyapalli have generally shown predominance of clay minerals, sulphides have comparatively lower concentration and exist as disseminates as well as cell lumen infillings, in the intercellular spaces, besides cracks and fissures. Carbonate minerals are also frequently noticed (Plate I, Fig. 11 and 12).

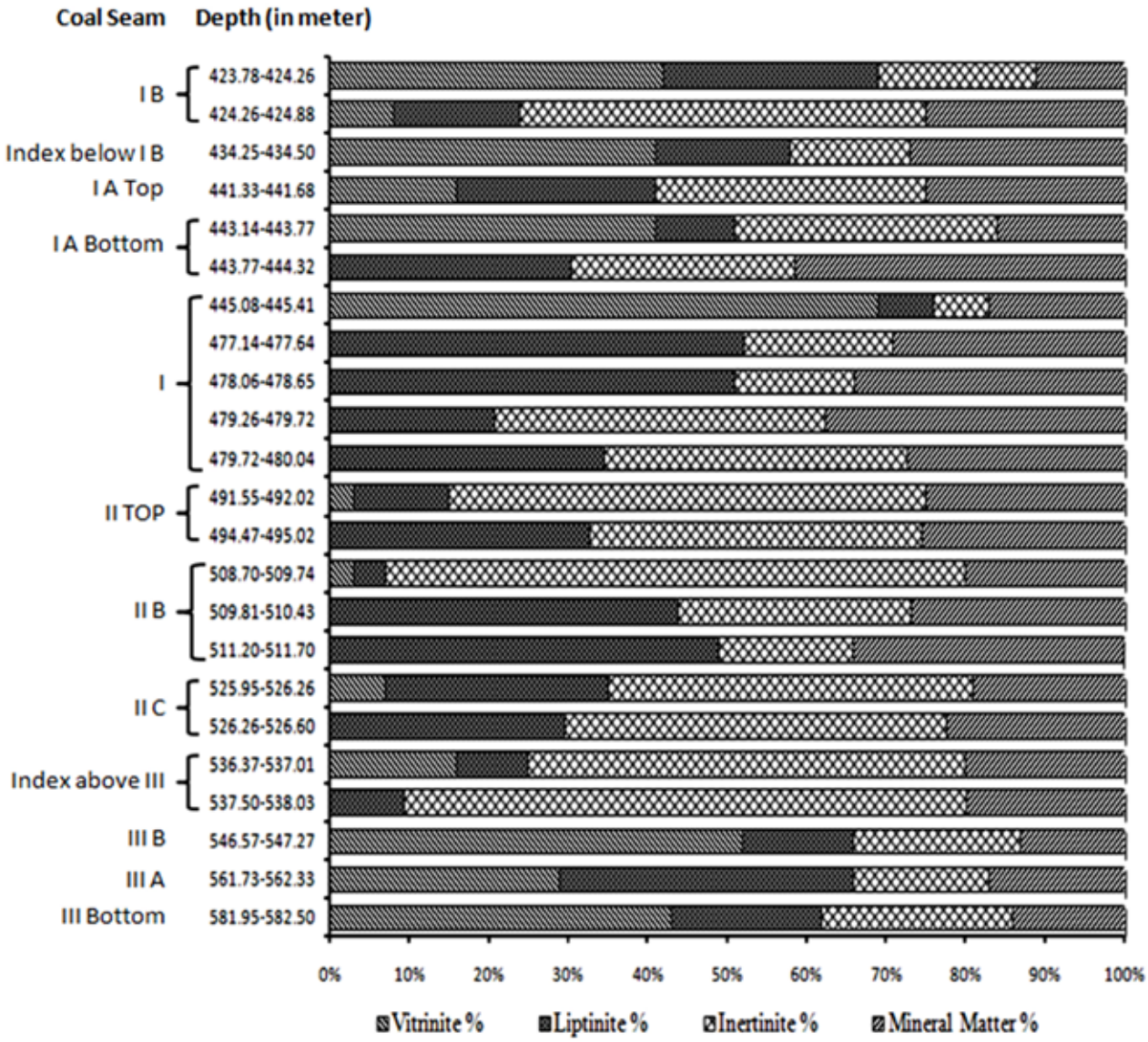


Fig. 2. Maceral constitution of the coal seams intersected in Bore-hole No. ML-858, Mallayyapalli Block, Bhupalpalli area, Godavari Valley basin, Telangana.

MACERAL CONSTITUTION

The maceral study of the entire 14 seams intersected in Bore-hole No. ML-858 has revealed that the topmost IB and the penultimate III top seams are shaly in nature. The coals of the rest 12 seams are distinctly divisible into four groups as vitric, fusic and vitric and Fusic (mixed) and liptinite rich, based upon their maceral configuration (Table 3, Fig. 2).

Vitric Coal: Five coal seams viz., Index below IB, IA bottom, I, IIIB and III bottom contain the dominant association of the vitrinite group of macerals (41-69 vol. %), except for a coal band recorded from I seam which contains almost equal representation of the vitrinite and internite fractions (28-30 vol. %). The liptinite macerals in all these seams range between 10-27 vol. %, besides, inertinite (7-33 vol. %) and mineral matter (13-16 vol. %) with maximum up to 27 vol. %) are recorded in some parts of Index below IB and I seams.

Vitric and Fusic coal (Mixed): Four seams, specifically IB, II top, IIB and IIC are represented by both the vitric and fusic type of coal. In all these seams the lower part of the seam is occupied by vitric coal whereas, fusic coal is recorded from the top part of the seams. The fusic coal bands in general contain sporadic (3-8 vol. %) representation of the vitrinite macerals along with liptinite (4-28 vol. %) with lowest frequency in IIB and higher representation in the IIC seam. Inertinite is the dominant maceral group with 46-73 vol. % distribution. The vitric coal is characterized by the predominance of vitrinite (33-59 vol. %), besides the presence of liptinite (18-27 vol. %), inertinite (12-28 vol. %) and mineral matter (11-17 vol. %).

Fusic coal: The seams IA Top and Index above III have shown the abundant association of inertinite group of macerals (34-61 vol. %) in association with liptinite (8-25 vol. %). In seam IA top seam liptinite (25 vol. %) has occupied sub-dominance. Vitrinite in both these seams has been recorded between 14-16 vol. % besides, mineral matter with 17-25 vol. % (Table 3,Fig. 2).

Liptinite rich: IIIA seam of this area has shown remarkably higher proportion of liptinite (37 vol. %) macerals with intimate association of vitrinite (29 vol. %) besides, inertinite and mineral matter (17 vol. %) each.

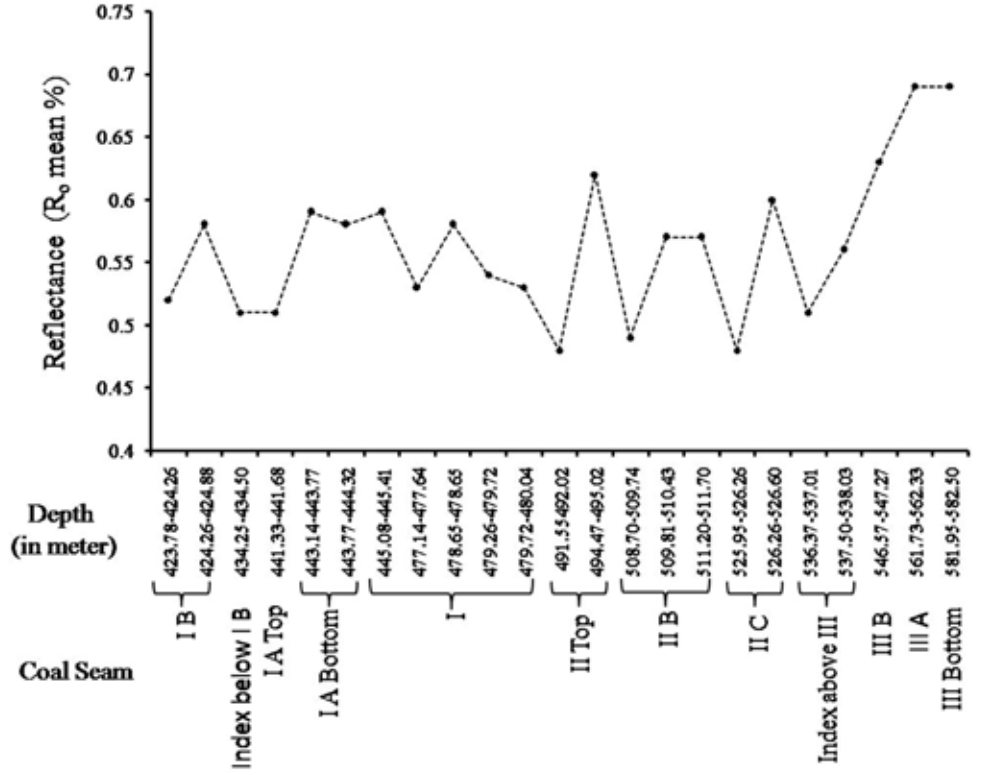


Fig. 3. Reflectance (R_o mean %) analysis of the coal seams intersected in Bore-hole No. ML-858, Mallayyapalli Block, Bhupalpalli area, Godavari Valley basin, Telangana.

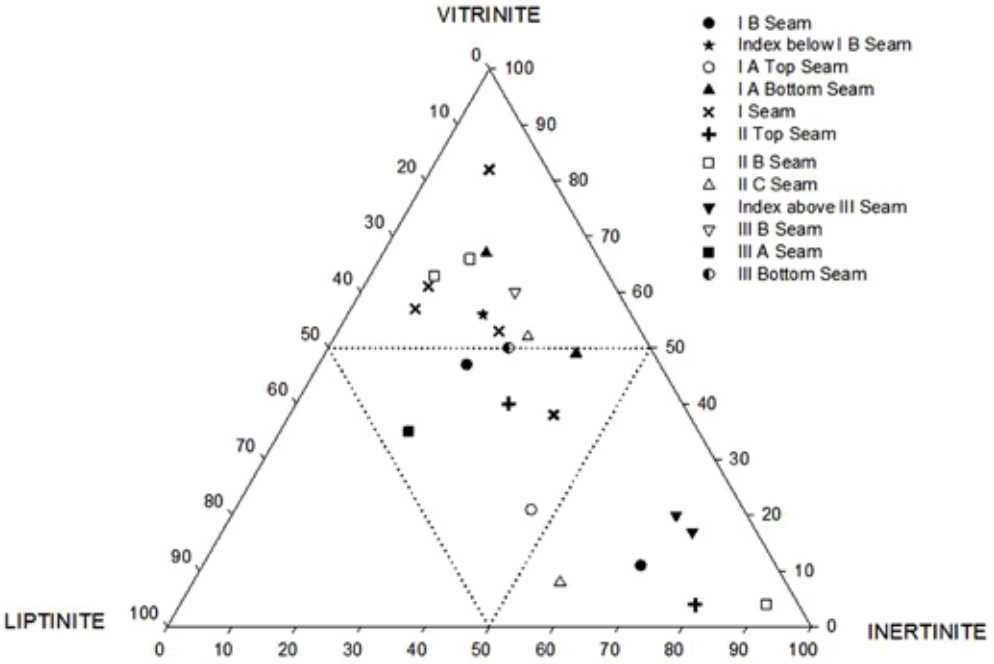
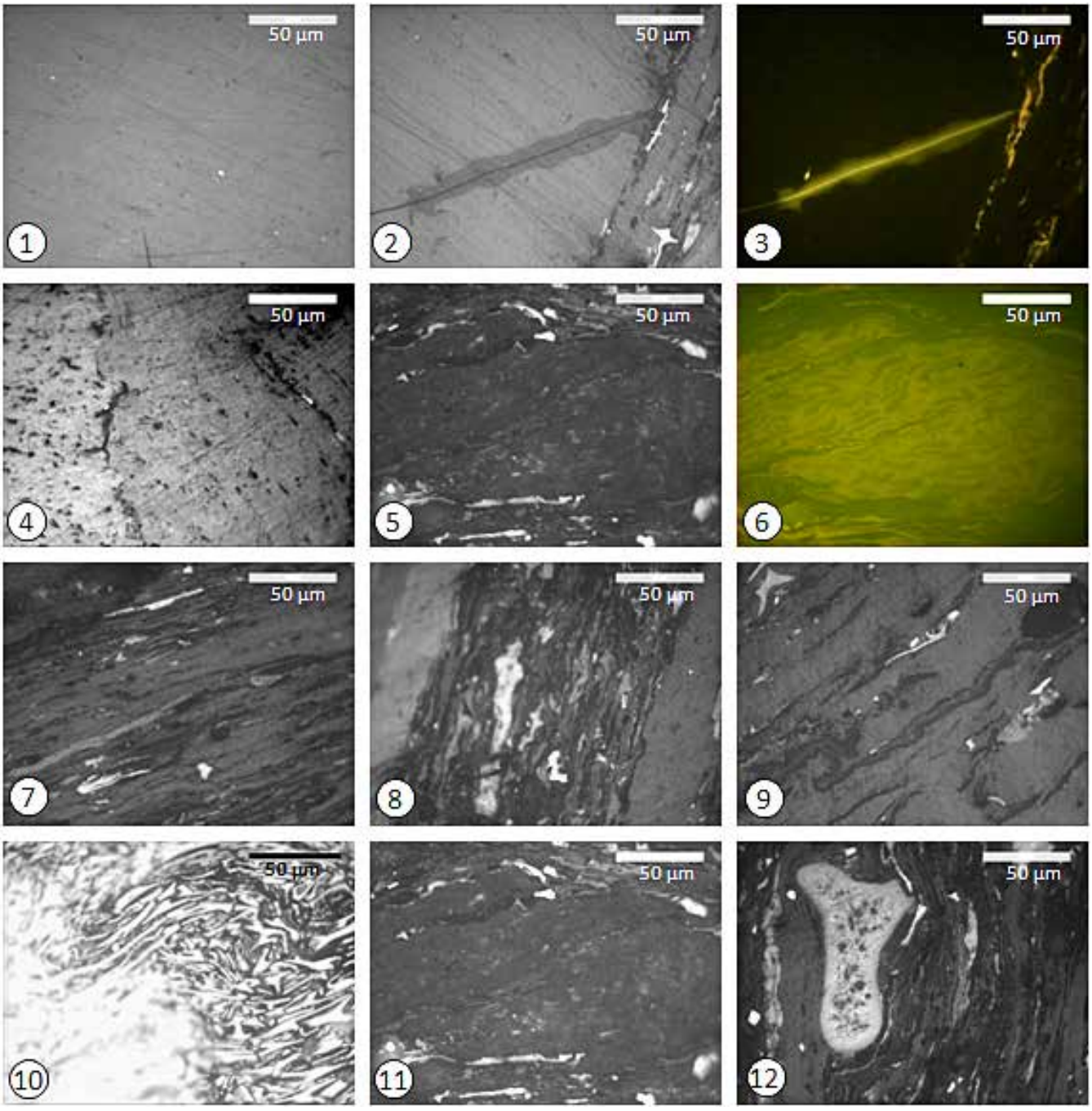


Fig. 4. Ternary diagram showing maceral (m.m.f.) configuration of the coal seams intersected in Bore-hole No. ML-858, Mallayyapalli Block, Bhupalpalli area, Godavari Valley basin, Telangana.

Plate I



EXPLANATION OF PLATE I

Fig. 1 Collotelinite 2. Collotelinite showing exudatinite (normal) 3. Fluorescence mode 4. Transition from collotelinite to semifusinite. 5. Sporangial remains with spores (normal) 6. Fluorescence mode 7. Microspores 8. Spore mass 9. Crassicutinite 10. Fusinite with cellular compression 11. and 12. Mineral matter infilling.

REFLECTANCE STUDY

The random vitrinite reflectance (R_o mean %) studies of different sub-surface seams of Mallayyapalli area suggests that upper coal horizones of the II Top, IIB and IIC seams have recorded low reflectance (R_o mean %) values which range between 0.48 % and 0.49 %. Thus the coal of these seams has attained sub-bituminous B stage of rank. Similarly, IIIA and III bottom the seams have recorded highest vitrinite reflectance of 0.69 %, indicating the attainment of high volatile bituminous B stage. All the other seams have shown a wide range of variation in their reflectance ranging from 0.51 % to 0.59 % which indicates that the coal has attained high volatile bituminous C stage of rank. The seams with reflectance variations between 0.51%-0.54% include the Top part of IB Seam, Index below IB Seam, IA Top Seam, middle and bottom parts of I Seam and

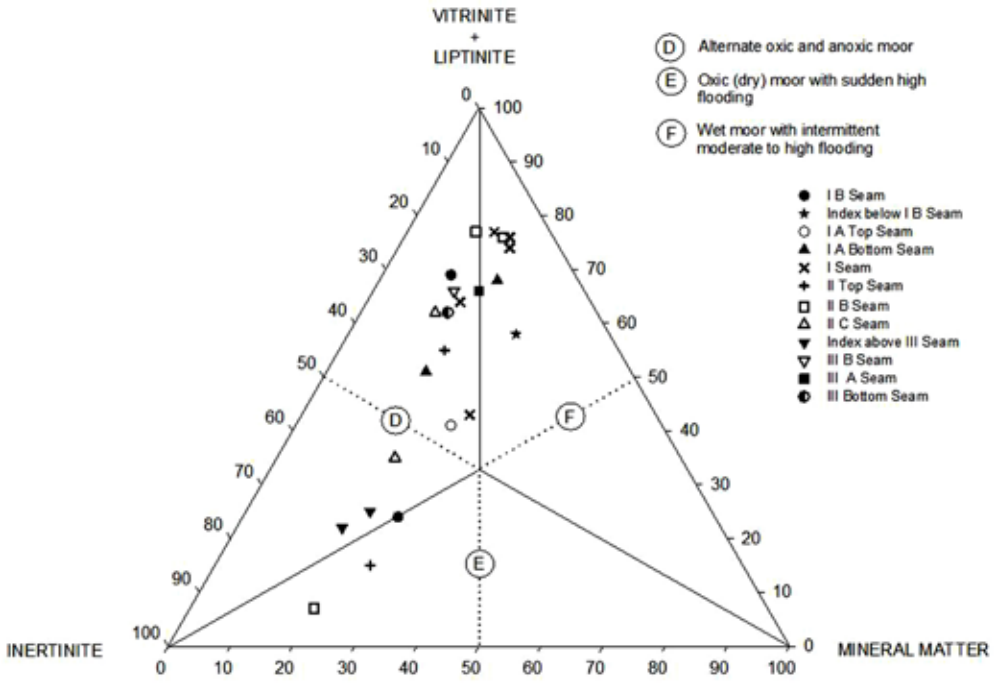


Fig. 5. Facies diagram dindicating the depositional environment of the coal seams intersected in Bore-hole No. ML-858, Mallayyapalli Block, Bhupalpalli area, Godavari Valley basin, Telangana (Singh and Singh, 1996).

Top part of Index above III Seam. The seams with reflectance variation between 0.56% and 0.59% incorporate the bottom part of IB Seam, IA Bottom Seam, top and middle parts of I Seam, middle and bottom parts of IIB Seam and bottom part of Index above III Seam. Whereas, the coal seams with reflectance ranging between 0.60-0.63% includes, the bottom part of II Top Seam, bottom part of IIC Seam and IIIB Seam. The seams IB and III top contain very high proportion of mineral matter association, indicating shaly nature (Fig. 3).

DISCUSSION

The ternary mineral matter free (m.m.f.) maceral composition has indicated that the coals in the study area, in general, have shown dominant association of the vitrinite group of macerals along with a few intervening shaly coal bands as suggested by the maceral study. Only one seam i.e. Index above III seam contain fusic type of coal constitution. Index below IB , IIIB and III bottom seams contain vitric type of coal, whereas, the coal of IA Top and IIIA seam is of mixed type. IIB and IIC seams however, contain both the vitric and fusic coal types. Similarly, IB and II top seams contain fusic and mixed type of coal constitution and the seams I A bottom and I are represented by vitric and mixed coal types (Fig. 4).

The facies diagram based upon the maceral and mineral matter association within the coal seams, Singh & Singh (1996) has indicated that out of 12 coal seams of the Mallayyaplli area 11 coal seams have been deposited during alternate oxic and anoxic moor conditions. During the deposition of seven coal seams, namely, IB, IA Top, IIC, Index above III, IIIB, IIIA and III Bottom, the climate remained unchanged. Similarly, the seam Index below IB has been deposited during the prevalence of uniform oxic (dry) moor with sudden high flooding. Whereas, change over to wet moor with intermittent moderate to high flooding is recorded for the seams I and IA. Similarly, climatic shift to oxic (dry) moor with sudden high flooding is recorded in the II Top seam. Wide range of climatic fluctuations, such as the prevalence of alternate oxic and anoxic moor conditions and moderate as well sudden high flood situations have been recorded during the deposition of seam IIB (Fig. 5).

Gondwanaland during the early Permian Period was located in subarctic region Stach et al. (1982) There are ample geological evidences recorded from the basal most Talchir sequence of the Indian Gondwana Sequence, which indicated that its deposition has been initiated during the prevalence of glacially influenced environment, with initially cold climatic conditions, which in later stages changed to warm humid and temperate conditions. Similarly, the megafloral evidences also suggests, that there existed dense and luxuriantly growing Glossopteris and Gangamopteris forests, along with Lepidophytes, Pteridosperms, Lepidodendron, Sigillaria etc. along with the aquatic members belonging to the family Calameriaceae that grew under marshy and swampy lacustrine or riverine conditions having occasional invasion and influx of marine incursions, Sing and Singh (1996). King (1958, 1961) Kräusel (1961), Plumstead (1961), Falcon (1986) and Chandra and Chandra (1987) have also observed the existence of cold and temperate humid climatic conditions with intervening dry and oxidizing spells during the deposition of Gondwana sediments.

CONCLUSIONS

Coal formation in the study area appears to have been initiated during the prevalence of prolonged cold climatic conditions, influenced by slowly sinking basinal configuration (Qureshi *et al*., 1968 and Bhaskar Rao *et al*., 1971).

Table 3. Maceral composition and reflectance (R_o mean %)of the coal seam succession intersected in Bore-hole No. ML-858, Mallayyapalli Block, Bhupalpalli area, Godavari Valley basin, Telangana.

Sr. No.	Pellet No.	Coal Seam	Vitrinite %	Liptinite %	Inertinite %	Mineral Matter %	Reflectance (R_o mean %)
1.	ML-858-1	Index above IB Seam	-	-	-	- Shale	0.53
2.	ML-858-2	IB Seam	42 (47)	27 (30)	20 (23)	11	0.52
3.	ML-858-3	IB Seam	8 (11)	16 (21)	51 (68)	25	0.58
4.	ML-858-4	Index below IB Seam	41 (56)	17 (23)	15 (21)	27	0.51
5.	ML-858-5	I-A Top Seam	16 (21)	25 (33)	34 (46)	25	0.51
6.	ML-858-6	I-A Bottom Seam	41 (49)	10 (12)	33 (39)	16	0.59
7.	ML-858-7	--do--	54 (67)	14 (17)	13 (16)	19	0.58
8.	ML-858-8	I Seam	69 (82)	7 (09)	7 (09)	17	0.59
9.	ML-858-9	--do--	52 (61)	25 (29)	9 (10)	14	0.53
10.	ML-858-10	--do--	47 (57)	27 (33)	8 (10)	18	0.58
11.	ML-858-11	--do--	-	-	-	-	Shale
12.	ML-858-12	--do--	28 (38)	15 (21)	30 (41)	27	0.54
13.	ML-858-13	--do--	45 (53)	19 (22)	21 (25)	15	0.53
14.	ML-858-14	II Top Seam	3 (04)	12 (16)	60 (80)	25	0.48
15.	ML-858-15	--do--	33 (40)	22 (27)	28 (33)	17	0.62
16	ML-858-16	II B Seam	3 (04)	4 (05)	73 (91)	20	0.49
17	ML-858-17	--do--	59 (66)	18 (20)	12 (14)	11	0.57
18	ML-858-18	--do--	53 (63)	23 (27)	8 (10)	16	0.57
19	ML-858-19	II C Seam	7 (08)	28 (35)	46 (57)	19	0.48
20	ML-858-20	--do--	46 (52)	16 (18)	26 (30)	12	0.60
21	ML-858-21	Index above III Seam	16 (20)	9 (11)	55 (69)	20	0.51
22	ML-858-22	--do--	14 (17)	8 (10)	61 (73)	17	0.56
23	ML-858-23	III B Seam	52 (60)	14 (16)	21 (24)	13	0.63
24	ML-858-24	III A Seam	29 (35)	37 (45)	17 (20)	17	0.69
25	ML-858-25	III Top Seam	-	-	-	-	0.66
26	ML-858-26	III Bottom Seam	43 (50)	19 (22)	24 (28)	14	0.69

Note: The values mentioned in the brackets indicate mineral matter free (m.m.f.) percentage

In general, predominance of vitrinite group of macerals i.e., vitric type of coal (seams, Index below IB, IIIB and III bottom) and mixed type (seams IIIA and IA top) and vitric and mixed type of coal (seams IA bottom and I) has been recorded, which indicates the prevalence of cold and moist (humid) climatic conditions during their deposition.

Inertinite rich (fusic) coal is recorded only from the Index above III Seam, which points to the prevalence of dry and oxidizing scenario of deposition with occasional instances of forest fire, Plumstead (1961), Holland et al. (1989) and Stach et al. (1982).

The seams II top and IB contain fusic and mixed type of coal, besides the seams IIB and IIC having vitric and fusic coal constitution which suggest the prevalence of alternating cold humid and dry oxidizing environment of deposition (Fig. 4).

The existence of the framboidal pyrites in these coals indicates stagnant swamp conditions with occasional invasion of marine incursions Singh and Singh (1996) whereas, the high incidence of mineral matter in the coals denote high water (flood-zone) influx at the depositional site.

Sarate (1996) carried out work from the sub-surface coal deposits from Golapalli area, which is located nearly 7 km south east of the present study area. The comparative coal petrographic study has revealed that there is a slight been in the vitrinite reflectance as we move from Golapalli to Peddapur i. e., from west to east of the Mulug coal belt. Similarly, there is a slight increase observed in the mineral matter in coal seam of the study area as compared to those which exists in Golapalli area. Vitrinite contents have also been recorded in slightly lower frequencies in Mallayyapalli area.

Thus, there has been a slight decrease in the quality of coal composition as we move from east to west of the Mulug coal belt.

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