The Palaeobotanist, **34**: 281-293, 1985.

THE FOSSIL FLORAS OF KACHCHH. V — NATURE, COMPOSITION AND RANK (MATURATION) OF MESOZOIC COALS

ANAND-PRAKASH
Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India

ABSTRACT

The petrographic and rank studies of Mesozoic coals have been carried out from Trambau, Rukmawati, Chawad and Guneri areas of Kachchh Basin. The vitrinite group of macerals and mineral matter form the dominant constituents of these coals and on the basis of their quantitative representation, three coal types, viz. (i) vitrinite/vitrite dominant type, (ii) mineral matter/carbominerite dominant type, and (iii) intermediate type have been suggested. The richness of mineral matter with the presence of pyrite and sulphur in appreciable amount has been related with the deposition of the vegetal matter by shallow rapidly shifting channels of delta regime under the possible influence of marine conditions. The reflectance (rank) study has indicated a progressive increase in the maturation of coal towards the western part of the basin. This trend of maturation seems to have been resulted due to the intense tectonic activity in the north-western parts of the area. The rank study of coals also indicates that some of the sediments in the area have attained to a level of organic maturity corresponding to the oil generation zone.

Key-words — Coal-microconstituents, Maturation, Palaeoenvironment, Mesozoic, Kachchh (India).

साराँश

कच्छ के अश्मित वनस्पतिजात . 5 — मध्यजीवी कोयलों की प्रकृति, संरचना एवं कोटि (परिपक्वन) – आनन्द प्रकाश

कच्छ द्रोणी के ट्राम्बो, रुकमावती, च्वाड़ एवं गुनेरी नामक क्षेत्रों से प्राप्त मध्यजीवी कोयलों का कोटिकीय एवं शैलिकीय अध्ययन किया गया है। मेसीरलों के विट्रीनाइट समूह एवं खनिज पदार्थ इन कोयलों के प्रभावी अवयव हैं तथा इनके परिमाणात्मक निरूपण के आधार पर तीन प्रकार के कोयले अर्थात् (अ) विट्रीनाटइ/विट्राइट प्रभावी प्ररूप, (आ) खनिज पदार्थ/कार्बोमिनराइट प्रभावी प्ररूप, तथा (इ) मध्यवर्ती प्ररूप प्रस्तावित किये गये हैं। पाइराइट एवं गंधक की पर्याप्त मात्रा के साथ-साथ खनिज पदार्थ की प्रचुरता सम्भावित समुद्री परिस्थितियों के प्रभाव के समय डेल्टा प्रदेश के छिछले जलप्रवाहों द्वारा वनस्पतिक पदार्थ के निक्षेपण से सम्बद्ध की गई है। परावर्तकता अध्ययन (कोटि) से द्रोणी के पश्चिमी भाग की ओर वाले कोयले की पक्वता में उत्तरोत्तर वृद्धि इंगित होती है। इस क्षेत्र के उत्तर-पश्चिमी भागों में हुई अत्याधिक विवर्तनिक गतिविधी के फलस्वरूप ही परिपक्वता की यह प्रवृत्ति प्रतीत होती है। कोयलों के कोटिकीय अध्ययन से भी यह प्रदर्शित होता है कि इस क्षेत्र के अवसादों में से कुछ का कार्बनिक पक्वता स्तर तेल-धारक मंडल के तदनुरूप है।

INTRODUCTION

ABOUT two decades ago the science of coal petrology was only confined to the study of coal constituents. Slowly, the investigations on coal micro-constituents, macerals and microlithotypes became more and more popular for describing the coal composition mainly due to its utilization in quality assessment for technological purposes. During the course of detailed microscopic examinations, it was established that the reflectance property of some macerals can be effectively utilized for determining the rank or maturity of coal sequences. Maceral vitrinite was selected for reflectivity measurements mainly because of its sensitiveness and availability in almost all types of coals. Soon, the reflectance studies gained significance as a measure of rank which is an important factor in determining the coking and other technological properties of coal.

Realising the usefulness of rank (maturation) studies, the coal petrologists started using these techniques in almost all types of sedimentary rocks as a measure of the degree of chemical alteration/degradation of the dispersed organic matter. Further, it was also demonstrated that the maturity index of dispersed organic matter can be successfully utilized in unravelling the tectonic history of sedimentary basins, estimating palaeogeothermal gradients and assessing the degree of diagenesis or metamorphism. The microscopic techniques, particulary for the determination of rank, gained special value in the exploration of fossil fuels as the reflectance of vitrinite is accepted to be the best measure of the maturity of source rocks. In addition to this, the fluorescence microscopy has also become indispensible to petroleum industry as it helps in the recognition of oil generating macerals and in estimating their abundance. Therefore, in recent years remarkable progress has been made in the field of coal petrology which is now regarded as a much broader pursuit of organic petrology.

In India, so far the coal petrographic studies have been carried out mostly from the productive Lower Gondwana and Tertiary coalfields; the unproductive coals found associated with the Mesozoic sediments remained neglected by the coal petrologists. So far, only Pareek (1980) and Navale and Misra (1980) have carried out the petrological study of Guneri coals and Panandhro and Akri lignites from the Mesozoic and Tertiary sediments of Kachchh respectively.

In Kachchh Basin, the coal occurs in the form of very thin seams, streaks and small lenses associated with the Mesozoic sediments which is commercially unexploitable. Only near Guneri a coal seam of about 0.4 m thickness is present which is intermittently quarried for local consumption.

The present investigations were undertaken mainly to study the nature, petrological characteristics and maturity of coal, in order to understand the changes which have taken place in the plant matter and its level of maturation.

GENERAL GEOLOGY

Kachchh is one of the most important areas for the study of Mesozoic sediments in India. The Mesozoic succession here has been divided into four lithological units (formations) by Biswas (1971) which are as follows:

4. Bhuj Formation
3. Jhuran Formation
2. Jhumara Formation
1. Jhurio Formation

The basal two formations, viz., Jhurio and Jhumara are barren of coal, while the upper two formations, viz., Jhuran and Bhuj contain thin seams, lenses and pockets of coal.

COAL OCCURRENCES

JHURAN FORMATION

In Jhuran Formation the presence of coal has been recorded only in Chawad River Section (Map 1). The coal is exposed in this section mainly at the following places.

1. At about 1 km (23°28′8″N: 69°12′ 55″ E) upstream from Dhamai Charkhara Road crossing on right bank of the Chawad River a 5 to 13 cm thick coal band is seen interbedded with sandstones. The beds here are folded and highly disturbed due to the presence of a number of local faults.

2. At about 2 km (23°26′44″ N: 69°10′ 31″ E) downstream from the Mathal Dam a 15 cm thick coal band is exposed on the left bank of Chawad River interbedded with sandstones forming escarp.

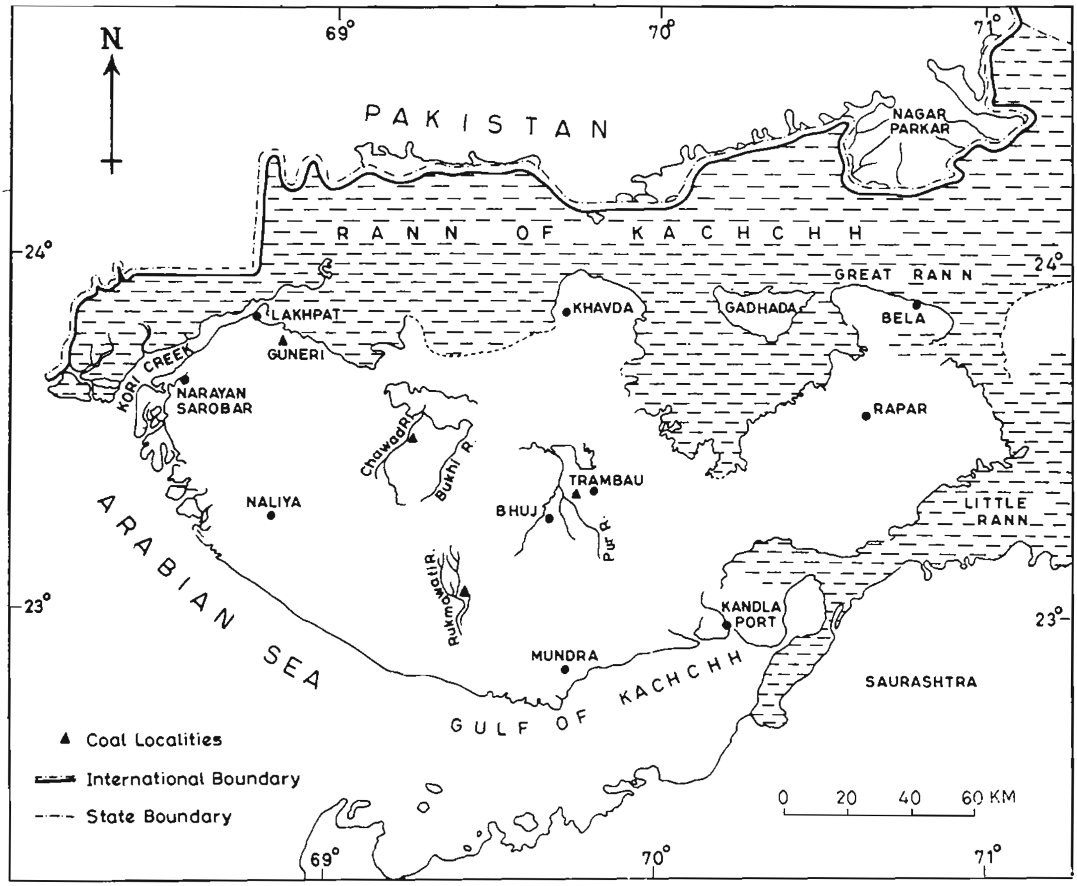
It seems that the same coal band is exposed at both the places as the nature and thickness of the coal and associated sandstones are closely comparable to each other.

BHUJ FORMATION

The coal in this formation is present at numerous places. The locations studied here are described below:

1. At Guneri (Map 1, 23°28′8″ N: 69° 12′55″ E) the most important coal exposure of Kachchh Basin is present. The coal seam is about 30 to 45 cm in thickness and it is mined in a quarry near Guneri Village. The seam is interbedded between creamish white, fine to medium grained current-bedded sandstones dipping 10° due west.

2. At Trambau (Map 1, 23°19′5″ N: 69°44′ E) a 15 to 20 cm thick coal band is exposed on the left bank of Pur River



MAP 1 — Location map of Kachchh showing coal occurrences.

near Trambau Village about 1 km upstream from its confluence with Pat River. The coal band is present almost in the middle of a 1.5 m thick grey shale interbedded with sandstones. The beds here are locally folded forming a small anticline which is affected by a fault. Along the weak fault plane a dyke has also been intruded.

3. At Jamthara (Map 1, 23°6′20″ N: 69°25′49″ E) a thin coal band of about 5-10 cm thickness is exposed on the right bank of Rukmawati River. It is overlain by a highly current bedded and bioturbated sandstone and underlain by the carbonaceous shale. Another very thin coal layer is present in the sandstones about 400 m downstream from the above coal exposure.

MATERIAL AND METHODS

The samples were crushed to ± 18 mesh size and particulate pellets were prepared in araldite. Pellets were polished using standard methods. Maceral and microlithotype analyses were carried out according to the I.C.C.P. (1963, 1971) recommendations under incident light, using low power oil immersion objective (20) on Leitz MPV-1 microscope. In case of rank evaluation, reflectance measurements (max. reflectance with polarizer) were taken at 548 nm wave band on vitrinite fractions in accordance with the I.C.C.P. recommendations.

It has been observed in the field that at many places the coal exposed is very soft

DETAILS OF THE COAL SAMPLES FROM MESOZOIC SUCCESSION OF KACHCHH

Serial No.	Sample No.	Location	Stratigraphic position
8.	Guneri	Guneri coal quarry	Bhuj Formation
7.	Pur River Section	Trambau	Bhuj Formation
6.	RRJ/33	Jamthara Village	Bhuj Formation
5.	RRJ/29B	Rukmawati River Section	Bhuj Formation
4.	CRS/34 Chawad River Section	Chawad River Section 1 km from Dhamai-Charkhara Road crossing	Jhuran Formation
3.	Chawad River Section 6″ coal band	Chawad River Section Dhamai-Charkhara Road crossing	Jhuran Formation
2.	CRS/38 Chawad River Section	Chawad River Section 2 km down stream from Mathal Dam	Jhuran Formation
1.	CRD/2 Chawad River Section	Chawad River Section 2 km down stream from Mathal Dam	Jhuran Formation

in nature which seems to have developed due to intense weathering and, therefore, such samples were not considered for the present investigations.

MACROSCOPIC CHARACTERISTICS

Chawad Coal (Jhuran Formation)

The coal is hard and dull in lustre as usually seen in low grade shaly coals. It is mainly composed of durain and very thin bands of vitrain (1-2 mm). Pyrite is present as crack fillings.

Rukmawati Coal (Bhuj Formation)

The Rukmawati coal is thinly banded unlike Chawad coal. Vitrain bands are thin but more persistently present. It breaks easily along the bedding plane.

Trambau Coal (Bhuj Formation)

Like Chawad coal Trambau coal is also dominantly composed of dull constituents with only occasional thin vitrain streaks. Vitrain is prominent near the fault and is friable in nature.

Guneri Coal (Bhuj Formation)

This coal is dark grey to black in colour having rough hard surface and dull lustre. It is dominantly composed of durain with very thin bands of vitrain. Occasionally, pyrite is seen along the fissures and cracks.

MICROSCOPIC CHARACTERISTICS

Maceral

All the coals investigated mainly consist of two maceral groups, vitrinite and inertinite. The exinite (Liptinite) group is very poorly represented. Besides these maceral groups, the coals are very rich in mineral matter.

Vitrinite Group — This group forms a dominant constituent of the coals from almost all the localities. A major part of vitrinite occurs as irregular bands, shreds, fragments and sheets associated with the mineral matter (Pl. 1, fig. 3; Pl. 2, figs 2, 6, 8). However, thick vitrinite bands are also present (Pl. 1, fig. 3). Individual vitrinite bands (Pl. 1, figs 1, 2, 6, 7) are mainly present in Trambau and Guneri coals. In Chawad and Rukmawati coals individual bands of vitrinite are rarely seen.

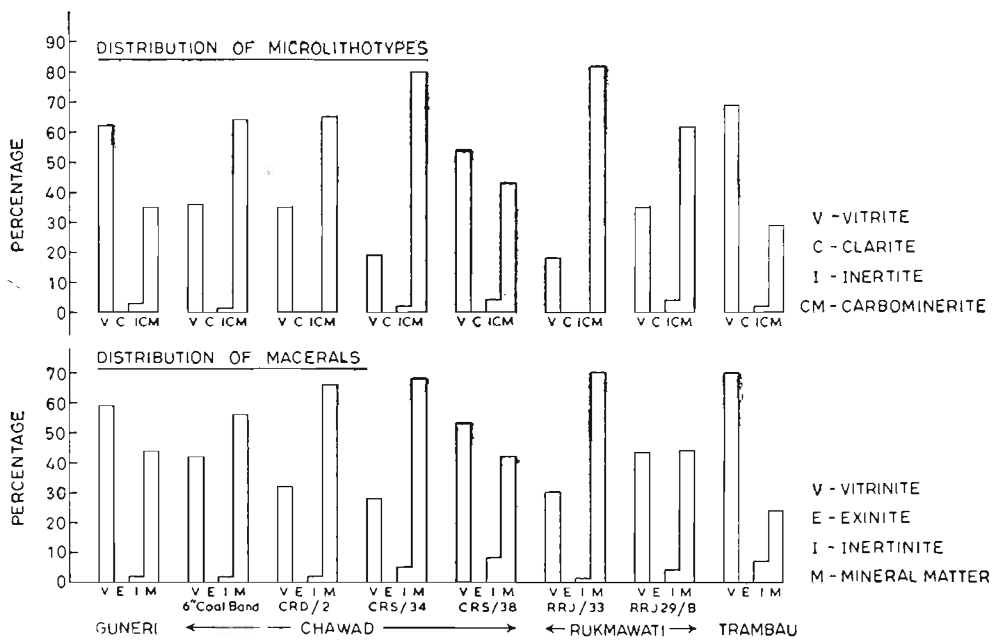
The vitrinite present in the coals comprises collinite and tellinite. The collinite represents the common variety and chiefly consists of telocollinite (Pl. 1, fig. 6) and carpocollinite (Pl. 2, fig. 7). The desmocollinite variety is rarely observed. The tellinite generally shows wood tissues and medullary rays with vitrinitic cell walls (Pl. 1, figs 2, 7). Wood tissues with thick- or thin-walled cells have been observed frequently. Besides, the small fragments of vitrinites are also observed in these coals which possibly indicate that the source material was fragmental in nature.

The vitrinites are generally dark grey to light grey in colour. However, the bright grey vitrinites are also seen. The individual vitrinite bands are usually uniform in nature but in some of the bands strips of different shades of grey colour having varying reflectance were observed (Pl. 1, fig. 6). This feature is normally less common in the vitrinites and might have developed due to differential coalification of the vegetal source material.

Finely dispersed mineral matter is associated with almost every vitrinite particle in varying amount. The mineral matter is often present as crack and fissure fillings in the vitrinites. But the main fissure and crack filling minerals are pyrite and siderite (Pl. 1, fig. 8). The quartz grains are also associated with the vitrinites.

The Kachchh coals show a large variation in their vitrinite content (Text-fig. 1) which ranges from very small amount (27.4% to 34.5%) to a high proportion (42% to 69%). In Chawad River Section the vitrinite content ranges from 27.4% to 50.3%. In Rukmawati River Section it ranges from 29.3% to 42.5%. In Guneri, the vitrinite content becomes 54%. While in Trambau vitrinite attains its maximum representation of 69%. These percentages represent only coal bands and may not be of regional significance.

Exinite (*Liptinite*) *Group* — The exinite group of macerals is rarely seen (Text-fig. 1) and represented mainly by macerals sporinite (Pl. 2, fig. 3), cutinite (Pl. 2, fig. 9) and resinite. In maceral sporinite, the microspores are found associated with some vitrinite bands as small thread-like bodies. Only one doubtful megaspore exine has



TEXT-FIG. 1 — Histogram showing the distribution of macerals and microlithotypes in Kachchh coals.

been observed as elongated streak-like structure with a lumen and indistinct sculptural features. The cutinites are long and slender, sometimes also folded with serrated margins on one side (Pl. 2, fig. 9). Resinite sometimes occurs as infillings in cell cavities of telocollinite, rendering discernible cellular structure to the tissues. The exinite percentage is less than 1% in every coal sample.

Inertinite Group — Fusinite and semifusinite are the most common macerals of the inertinite group. The other macerals of this group like — fusinised resin, inertodetrinite, sclerotinite and micrinite have also been observed, though they are rarely represented in the coals.

Semifusinite is dominant to subdominant in the total fraction of intertinite macerals. It occurs as isolated fragments, in thick to thin microbands associated generally with fusinite and vitrinite. The cell structures in semifusinite are generally not well-preserved (Pl. 2, fig. 5). However, sometimes well-preserved cell structures have also been observed. The compressional effect on semifusinite has been observed in the form of broken cell walls and folded structures. The cell cavities, tissues and cracks in semifusinite are usually filled with carbonate or shaly mineral matter. Most of the semifusinite observed in the coals seem to be degrado-semifusinite. The rank semifusinite is rare and observed only in Guneri and Trambau coals. In general, it is characterized by shining whitish grey to white colour. Occasionally, transitional forms between semifusinite and vitrinite were also seen. These transitional forms were critically observed for the assessment of their nature and distribution in the coal. Semifusinite is not a dominant maceral, but it is present in all the coals investigated. The percentage varies from less than 1% to 6.3%. Its maximum representation has been recorded from Trambau (5.5%) and Chawad (6.3%) coals.

Fusinite is the next dominant maceral after vitrinite. It is present both in the form of irregular isolated fragments (Pl. 2, figs 1, 6) and thin to thick microbands (Pl. 1, figs 4, 5, 9, 10). Like semifusinite most of the fusinite seem to be of degrado-fusinite, while the rank fusinite is rarely seen. The walls of the fusinised tissue are poorly preserved. They often form boggen structures. The compressional effect is also present in fusinite in the form of folded tissues (Pl. 1, fig. 5). The cell cavities of the tissues are mostly filled with black shaly matter and carbonate minerals (Pl. 1, figs 4, 9). Besides these features, the fusinite is characterized by a shining white to yellowish white colour. The fusinite percentage varies between 0.5% and 2.5%. The maximum representation of this maceral has been recorded from Chawad coal.

Micrinite is a rare maceral in Kachchh coals. Only occasionally it is found either as dispersed fine grained material in the cavities of tellinite or as irregular bodies associated with vitrinite and mineral matter bands (Pl. 2, figs 2, 7). It is characterized by bright white colour.

Inertodetrinite is only occasionally present as dispersed inert material in the vitrinite and mineral matter bands. It is characterized by white, bright white to yellow in colour and variable reflectivity. Sclerotinite bodies are often seen associated with fusinite, semifusinite and mineral matter (Pl. 2, figs 1, 6). These are quite common in Guneri coal in comparison to the coals of other areas. They occur as small isolated bodies rounded to subrounded and oval in shape. The occurrence of sclerotinite is well known from Gondwana coals. These are regarded fungal in origin, as Snyman (1961) has shown a hyhpa attached with a sclerotinite body supporting the view of stach (1952). In case of the Mesozoic coals of Kachchh these bodies are referred to as sclerotinite maceral according to the suggestions of Taylor and Cook (1962).

After vitrinite, inertinite maceral forms the next dominant maceral group. It is present in all the coals of the area in varying percentages. The inertinite content varies between 0.5% and 7.7% in the coals (Text-fig. 1). Its significant representation has been recorded from Trambau (6.5%) and Chawad (7.7%) coals.

Mineral Matter — The mineral matter is a dominant constituent. It has not only influenced the quality of the coal, but also reflects upon the depositional conditions prevailed during the accumulation of the source material in the basin.

In general, the coals are characterized by very high proportions of mineral matter, which can be separated into four groups, viz., (i) clay minerals, (ii) silica minerals,

(iii) carbonate minerals, and (iv) sulphide and other minerals.

Clay Minerals — Clay minerals form the most dominant mineral group. They are associated with almost every maceral and microlithotype. Usually it is present as fine dispersed matter in the groundmass (Pl. 2, figs 1, 2, 3, 6) of various coal constituents and as thin and thick bands of black opaque matter (Pl. 1, fig. 3; Pl. 2, fig. 8) forming shaly coal or Carbargillite. Occasionally, clay minerals also form infillings of telinitic and fusinitic cell cavities (Pl. 1, figs 2, 5, 7, 9).

Silica Minerals — Small quartz grains are often found embedded in various macerals. These are generally clastic in origin and recognized as angular to subangular shining grains under the microscope. At places fine quartz grains were also recorded in cracks and fissures of the vitrinite maceral.

Carbonate Minerals — Siderite is the most common carbonate mineral observed in the coals. It commonly occurs as linear acicular crystals associated with vitrinite and inertinite macerals. Occasionally, it also occurs intergrown with sulphide minerals mainly pyrite (Pl. 2, fig. 10). The maximum proportions of siderite are recorded from Trambau coal.

Sulphide Minerals — Pyrite is the most common sulphide mineral recognized in the coals. It is usually present as crack fillings in vitrinites as shining yellowish white matter in irregular shapes. It is also present at places as thin to thick bands in vitrinites (Pl. 1, fig. 8).

The mineral matter is the most dominant part of the coals (fig. 1). It varies between 24% and 70% in various samples. The maximum representation of mineral matter has been recorded from Rukmawati, while the minimum is from Trambau.

MICROLITHOTYPE

The vitrite and carbominerite are the two dominant microlithotype groups. The inertite group is impersistently present in low amount. The clarite microlithotype is absent with the result the durite and trimacerite groups are not represented in these coals.

Vitrite Group — The vitrite generally occurs as thin to thick microlayers alternating with the carbominerite (Pl. 1, figs 3, 8). Occasionally, individual vitrite fragments were observed specially in Trambau and Guneri coals (Pl. 1, figs 1, 2, 6, 7, 8). It is also present in association with semifusinite and fusite bands. The transition between semifusite and vitrite has also been recorded at some places. Further, the clastic quartz grains are often seen in the vitrite. The vitrite is characterized by the intimate association of dispersed carbonate and clay minerals.

The percentage of vitrite varies from sample to sample. It is maximum (69%) in Trambau followed by Guneri (62%). In Rukmawati and Chawad coals it ranges between 18.6% and 53.5%.

Inertite Group — The inertite microlithotype group is mainly represented by semifusite and fusite microlithotypes (Pl. 1, figs 4, 5, 9, 10). Semifusite and fusite occur as thin or thick microbands and fragments. Quantitatively, it is represented in much low percentages from less than 1% to 4%. It is 4% in Chawad and 3.5% in Rukmawati. In Trambau and Guneri it is between 1.33% and 2.5%. It is absent in some of the samples.

Carbominerite — Carbominerite is a dominant microlithotype and occurs in the form of irregularly dispersed argillaceous matter. It is also present as thin and thick bands and crack fillings in various microlithotypes particularly in vitrite (Pl. 1, fig. 3; Pl. 2, fig. 8). In carbominerite the carbargillite represents the most common variety followed by carbopyrite.

Quantitatively, the carbominerite percentage varies significantly from sample to sample. The minimum (29%) and maximum (82%) carbominerite has been recorded from Trambau and sample no. RRJ/33 from Rukmawati sections respectively. In rest of the samples it is represented between 35% and 80%.

Rank (Maturity) — The Kachchh coals show a reflectance range in oil (Ro max.) between 0.41% and 1.15%. The maximum reflectance value recorded is 1.15% from Guneri and minimum 0.41% from Trambau. In Chawad and Rukmawati the Ro max. ranges between 0.52% to 0.63% and 0.50% to 0.55% respectively. According to the American (ASTM) classification these frequencies fall in three distinct groups, viz. (i) sub-bituminous-C having reflectance 0.41% from Trambau, (ii) sub-bituminous-A having reflectance between 0.5% to 0.63% from Rukmawati and 0.5% to 0.63% from

Chawad areas, and (iii) high volatile, bituminous-A having reflectance 1.15% from Guneri.

The critical evaluation of rank values indicates that Trambau, Rukmawati and Chawad coals are of normal maturity, whereas the Guneri coal shows abrupt increase in reflectance. It is also to be noted that the rank values increase from east to west as they are minimum in Trambau and maximum in Guneri. These localities represent the eastern and western limits of the coal bearing areas under investigation respectively. The higher rank of Guneri coal seems to be due to the intense tectonic activity and lower rank of Trambau coal may be due to comparatively less tectonic activity. However, an igneous intrusion along a fault plane is present in Trambau area which seems to be of only local importance.

PETROLOGICAL CHARACTERISTICS

The petrological examination of Kachchh coals indicates that in general these coals are composed of thin vitrinite layers and black shaly mineral matter. Such nature of coal from all the four localities investigated suggests a similarity with the sub-bituminous type coal present in some of the Gondwana basins of India.

Vitrinite group, mainly represented by collinite and telocollinite, is a dominant microconstituent. Telocollinite often exhibits well-preserved cell structures of secondary wood, bark tissues, medullary rays, and tracheids represent the recognizable microstructures indicating that the source material was dominated by the woody material in the basin.

Inertinite group, represented mainly by the fusinite and semifusinite macerals, also indicates the dominance of woody constituents in the source material. Fusinised woody tissues with cell lumens filled with dark opaque material forming boggen structure are common. Folded fusinised tissues were also observed exhibiting the affect of compressional forces on the coal forming material. Transitional stages between semifusinite and fusinite are present showing progressive increase in coalification process. Similarly, transitional forms between semifusinite and vitrinite have also been recorded. These are classified as semivitrinite (Ammosov, 1964) maceral, characterized by slight increase in the reflectance as compared to the vitrinite. However, the number of such forms is much less and, therefore, have not been included in the quantitative analysis. Besides, sclerotinite also represents a characteristic maceral of inertinite group. A number of well-preserved sclerotia have been observed indicating considerable fungal activity during the formation of the coals. The sclerotia are characterized by a thin outer layer and thicker inner cells, closely comparable with the *Sclerotites ghuneriensis* (Pareek, 1980) described from Guneri area.

Apart from the organic microconstituents, the inorganic mineral matter also forms a characteristic and sizeable portion of the coals. The mineral matter is present mainly in the form of fine dispersed material intimately associated with the various macerals and microlithotypes, especially its association with vitrinites is most common. It seems that the clastic mineral matter got mixed up with the vitrinitic material during gelification in plastic stage as the vitrinite is often found forming the matrix. The other important minerals observed are pyrite and siderite usually forming concretions. Sulphur efflorescence is also associated with these coals on exposed surface of the coal. The significant representation of these minerals might be indicative of the formation of the coals in shallow paralic basins under the influence of marine conditions (Stach, 1982).

Statistical evaluation of macerals and microlithotypes (Table 1) has also confirmed the dominance of vitrinitic constituents and mineral matter in these coals. From all the four localities investigated, the coals are characterized either by the prominence of vitrinitic contents or mineral matter. However, in some of the samples these constituents are evenly represented. Thus, the above distribution pattern of coal microconstituents suggests that broadly these coals can be grouped into three types, viz. (i) the vitrinite/vitrite dominant type, (ii) the mineral matter/carbominerite dominant type, and (iii) the intermediate type.

The vitrinite/vitrite dominant type coal is present in Trambau and Guneri areas. The mineral matter/carbominerite dominant type coal is present in Chawad area (sample nos. CRD/2 & CRS/34) and

TABLE 1 — SHOWING COMPOSITE PICTURE OF MACERAL GROUPS, MICROLITHOTYPES AND REFLECTANCE VALUES OF KACHCHH COALS

SAMPLE NO.	GUNERI	CHAWAD 6″ COAL	CRD/2	CRS/34	CRS/38	RUKMAWATI RRJ/33	RRJ/29B	TRAMBAU
				MACERAL				
Vitrinite	54%	42%	32·0%	27.4%	50.33%	29.33%	42.45%	69.5%
Exinite	—	—	—	0.3%	—	—	—	—
Inertinite	1.5%	1.66%	2.0%	4.57%	8.00%	0.66%	3.41%	6.5%
Mineral matter	44.50%	56.33%	66.0%	67.71%	41.67%	70.0%	54.13%	24.0%
				MICROLITHOTYPE				
Vitrite	62.0%	36.0%	34.50%	18.67%	53.5%	18.0%	34.5%	69.0%
Clarite	—	—	—	—	—	—	—	—
Inertite	3.00%	0.5%	—	1.33%	4.0%	—	3.5%	2.0%
Carbominerite	35.0%	63.5%	65.50%	80.00	42.50%	82.0%	62.0%	29.0%
Reflectance in oil (Ro max.)	1.152%	0.632%	0.525%	0.548%	0.60%	0.556%	0.502%	0.417%

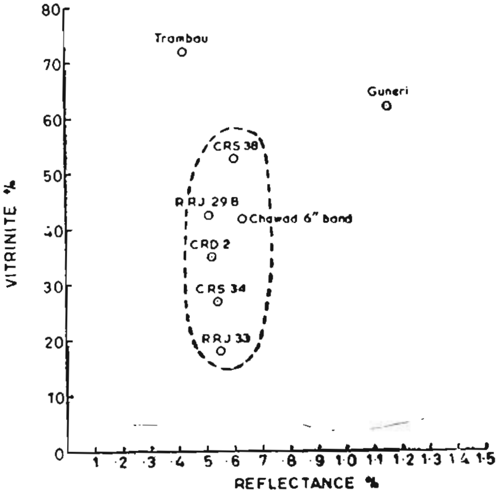
Rukmawati area (sample no. RRJ/33). While the intermediate type (between vitrinite and mineral matter dominant types) coal is represented by sample nos. 6″ coal band and CRS/38 of Chawad and sample no. RRJ/29B of Rukmawati sections. The other microconstituents are not considered for classifying these coal types due to their poor representation in over all maceral and microlithotype assemblages. However, the coals contain small amount of inertinite. Exinite is rarely present and, therefore, the coals are almost devoid of trimacerite and durite groups.

DEPOSITIONAL CONDITIONS

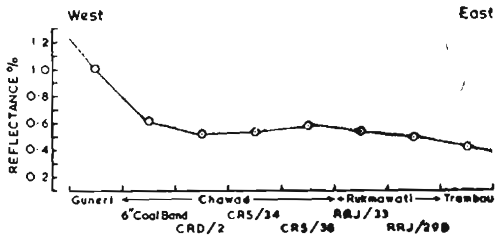
A critical assessment of the various petrological entities observed in the Kachchh coals indicates that the plant matter, mainly woody tissues, formed the bulk of coal forming source material deposited in the basin alongwith clastic sediments. The nature of sediments and field studies suggests that the basin seems to be a shallow river valley characterized by a flat flood plain with rapidly shifting channels. Such a condition appears to have developed over a coastal plain modified by the delta system with numerous distributaries. In this environment the plant matter was deposited mainly in the deeper parts of the basin. But the conducive coal forming conditions were limited for a very short time, as the coal is present only in the form of very thin seams, pockets and lenses. The shallow nature of the basin is also reflected by the quick burial of the plant matter below the sediments under fluctuating water levels. Till water was available in small depressions vitrinization has taken place under reducing conditions. Bacterial activity has also played an important role in vitrinization and resulted into the formation of pyrite and sulphur found associated with coal. The association of pyrite, siderite and sulphur in appreciable amounts with the coals may also indicate the influence of marine conditions (Stach, 1982) in the basin. In the absence of water the plant matter was exposed to atmospheric decay, resulting in the formation of various inertinite macerals. It appears that during the exposure of the plant matter the fungal activity has also taken place as reflected by the presence of well-preserved sclerotia alongwith other macerals of inertinite group.

TREND OF MATURATION

As described earlier, the Mesozoic coals of Kachchh have been divided into three groups on the basis of rank. Similarly, three coal types were designated on the basis of maceral and microlithotype ana-



TEXT-FIG. 2 — Showing relation between rank and vitrinite content in Kachchh coals.



TEXT-FIG. 3 — Showing trend of maturation in Kachchh coals.

lyses. The vitrinite versus reflectance plot (Text-fig. 2) shows that Trambau coal is characterized by rich vitrinite content and low maturation values; Chawad and Rukmawati coal is characterized by medium vitrinite content and medium maturation values, while Guneri coal is characterized by high vitrinite content and high maturation values. Thus the maturation increases progressively from east to west (Text-fig. 3) as the eastern and western limits of coal occurrences are represented by Trambau and Guneri areas respectively. Such a condition seems to have been developed mainly due to the intense tectonic activity recorded in the western part of Kachchh around Guneri where the beds are folded forming a dome.

UTILIZATION PROSPECTS

As regards the utilization of coal, the area is of little importance in the absence of economically workable coal seams. Only at Guneri some coal is being querried for local consumption. However, the maturity of coal increases from east to west, from Chawad and Rukmawati areas up to Guneri, the sediments seem to be mature enough to fall in the oil generation zone. The maturity of coal in these areas ranges between 0.5% and 1.15% indicating the presence of suitable maturation level for petroleum generation (Stach, 1982; figs 24, 70). Now a detailed study of the dispersed organic matter (DOM) is essential for a better understanding of the organic matter present in the Mesozoic sediments of the Kachchh Basin.

REFERENCES

AMMOSOV, I. I. (1964). Composition petrographique des charbons, humiques de l' USSR-C.r. 5. *Cong. int. stratigr. Geol. Carbonifere*, **3**: 909-916. Paris.

BISWAS, S. K. (1971). Note on the geology of Kutch. *Jl geol. Min. metal. Soc. India*, **43** (4): 223-235.

BISWAS, S. K. (1983). Cretaceous of Kachchh-Kathiawar region, pp. 40-65 in Maheshwari, H. K. (Ed.) *Cretaceous of India*. Indian Assoc. Palynostratigraphers, Lucknow.

International Hand Book of Coal Petrography (1963). International Committee for Coal Petrology, 2nd ed. C.N.R.S., Paris.

International Hand Book of Coal Petrography (1971 & 1975). International Committee for Coal Petrology Suppl. to 2nd ed., C.N.R.S., Paris.

NAVALE, G. K. B. & MISRA, B. K. (1980). Maturation studies of some Indian coals and lignites and their bearing on oil and gas prospecting. *IV int. palynol. Conf., Lucknow (1976-1977)*, **2**: 551-564.

PAREEK, H. S. (1980). Petrological study of Guneri lignite-bituminous coal, district Kutch, Gujarat, India. *J. geol. Soc. India*, **21**: 343-347.

SNYMAN, (1961). Die Petrographie Sudafrikanischer Gondwanakohlen. Ein verglich zwischen Gondwana und Euramerischen Kohlen. *Diss. uni Bonn*, **135**.

STACH, E. (1952). Heutiger stand der genetischen Dentung der Kohlengefügebestandteile'. c.r. 3. *Cong. int. stratigr. Geol. Carbonifere, Heerlen, 1951*: **2**: 585-590. Maastricht.

STACH, E. (1982). *Text Book of Coal Petrology*. Gebruder Borntraeger, Berlin, Stuttgart.

TAYLOR, G. H. & COOK, A. C. (1962). Sclerotinite in coal — its petrology and classification. *Geol. Mag.*, **99**: 41-52.

EXPLANATION OF PLATES

(All the photomicrographs magnified × 180)

PLATE 1

1. Telocollinite (vitrite).
2. Woody tissue showing telinitic structure.
3. Collinite (vitrite) bands alternating with mineral matter.
4. Fusinite (fusite) showing well-preserved cellular structure.
5. Folded fusinite (fusite) band.
6. Collinite with different grey colour bands.
7. Telinite showing cell structures and fissures filled with mineral matter.
8. Vitrinite (vitrite) and a broad fissure filled with pyrite.
9. A structured fusinite band associated with mineral matter and thin vitrinite bands.
10. A fusinite (fusite) band.

PLATE 2

1. A fungal sclerotia with mineral matter.
2. Mineral matter (carbominerite) with thin vitrinite bands associated with macrinite, micrinite and inertodetrinite.
3. Vitrinerite with mineral matter.
4. Vitrinite associated with pyrite.
5. Semifusinite associated with pyrite.
6. A sclerotinite associated with thin vitrinite band and mineral matter.
7. Vitrinite band with micrinite and carpocollinite.
8. Vitrinite with thick mineral matter bands.
9. Cutinite with mineral matter.
10. Carbominerite, dispersed siderite grains.

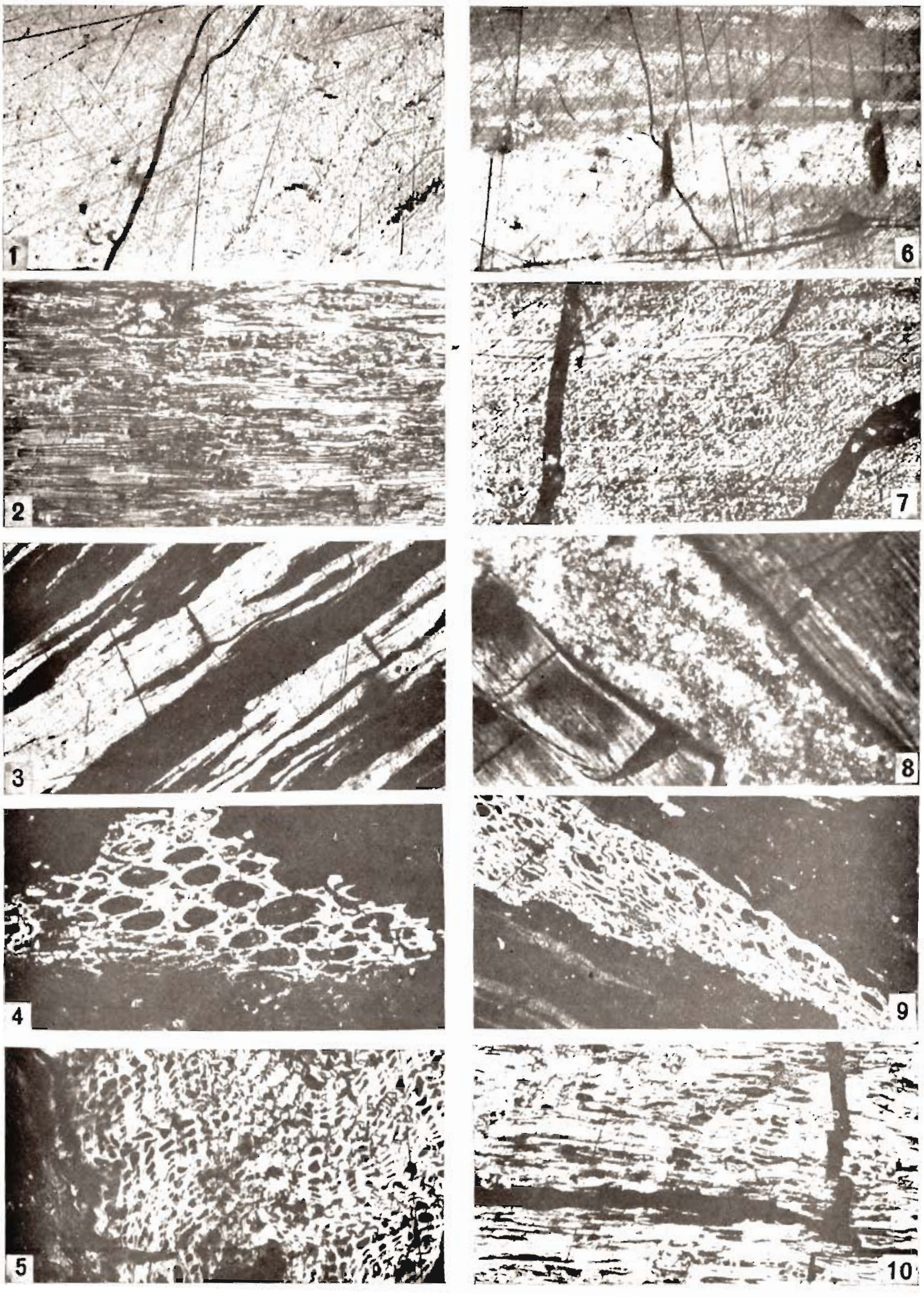


PLATE 1

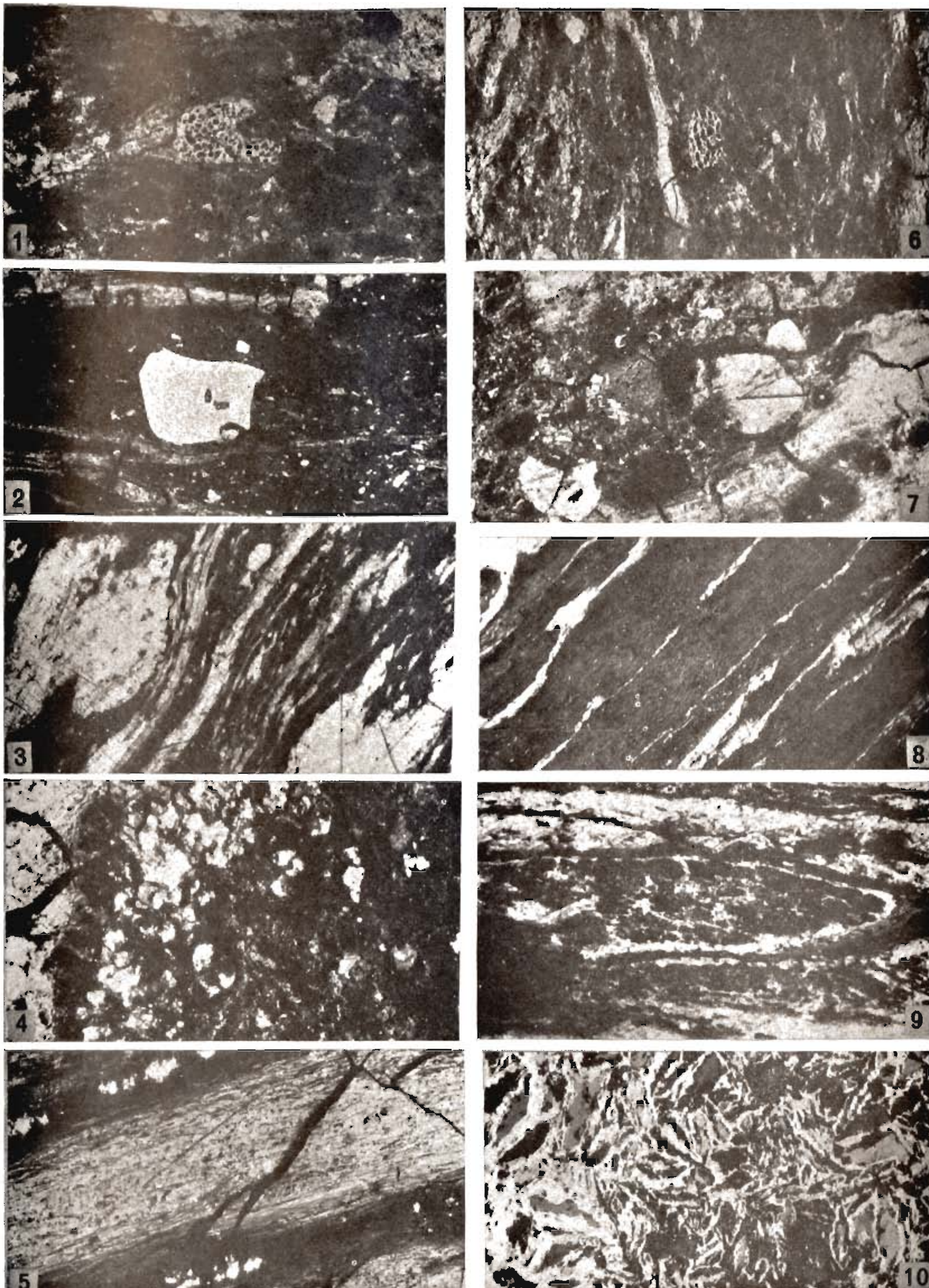


PLATE 2