THE MICRO-STRUCTURE OF COALS FROM THE JANGALGALI AND KALAKOT AREAS IN THE JAMMU PROVINCE

BY P. N. GANJU

(Department of Geology, University of Aligarh)

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INTRODUCTION

The economic importance of the Jammu coalfields first attracted attention about the year 1900. The nature and occurrence of these coals which are regarded as Lower Eocene in age has been studied from time to time by the officers of Mining Department of the Jammu and Kashmir State and also by other geologists. These coals have been generally described as semi-anthracitic with a low volatile content but a high percentage of ash, and some coals are known to exhibit coking properties. The coals generally appear to contain a high percentage of sulphur. Most of the coals are friable and show a foliated structure. The total output of coal recorded from Kashmir between 1940 and 1950 was 35,487 tons.

It is important that a systematic survey of the coal-bearing formations is made with a view to ascertain the economic value of these coals and their possible utilization.

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Micro-structure of Coals from the Jangalgali and Kalakot Areas

The present work includes a description of the nature of the microscopic constituents observed in coals of the widely separated areas of Jangalgali and Kalakot. A representative set of specimens from these localities was made available through the help of Mr. T. R. Bhatia, Lecturer in Geology, G. M. College, Jammu, who has visited these areas for geological fieldwork. I am thankful to Mr. Bhatia for sending me his collection for study.

Geology of the Area

The geological account of the area including the Sangarmarg and Mehogala coalfields was given by T. D. La Touche in 1888. Simpson (1904) published an account of the Jammu coalfields in the Memoirs of the Geological Survey of India. Middlemiss (1929) studied some of the coalfields in detail and his account of the Kalakot, Metka, Mahogala and other coalfields is published in the Mineral Survey Reports of Jammu and Kashmir Government.

The geological account which follows is based mainly on the works of Simpson and Middlemiss.

The coal measures of Jammu Province do not appear to have been formed in the same way as the Lower Gondwana coals, in gently inclined basins or troughs thrown down by faulting. These coals, like some other Tertiary coal deposits in the Salt Range, Baluchistan, Sind, etc., are closely associated with foraminifera-bearing shales and limestones suggesting that the coals were in many cases deposited very close to the seacoast probably in estuaries and marshes.

These coal measures occur on the north-east and south-west flanks of elongated domes or arches and are usually inclined at moderate to steep angles outwards from the dome areas. On the flanks of the domes the coal-bearing strata of Eocene age are overlain by the Murree series, while in the inner parts the underlying Great limestones crop out.

The upper Coal Measures which are about 120 feet thick are overlain by about 400 feet thick Nummulitic series of Eocene age and the Murree series of upper Tertiary age. They are underlain by the Bauxite series, 4 to over 24 feet thick, below which is first the Breccia 20 to 30 feet thick and then the Great limestone of unknown thickness. The Breccia has probably been formed by disintegration of the Great limestone. Its age is not definitely known. There is no definite evidence of age of the Great limestone, and it is probably older than Trias. The limestone over 1,500 feet thick was doubtfully referred to the Kioto limestone of Spiti. Sometimes the Great limestone is identified with the Sirban limestone of Kaghan valley and also
with the Krol limestone of the Simla-Chakrata area (Wadia, 1953). The Bauxite series which is probably of Lower Eocene age is known to pass laterally into hard coal. The coals associated with this series are known as the Lower Coal Measures as distinct from the coals occurring in the Upper Coal Measures.

The geological sequence (Middlemiss, 1929; Gee, 1945) is shown in the table below:—

<table>
<thead>
<tr>
<th>Nimadric beds (Murrees and Siwaliks)</th>
<th>Miocene and younger.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nummulitic limestones and shales</td>
<td>(unconformity)</td>
</tr>
<tr>
<td>Bauxite series with Lower Coal Measures</td>
<td>Carbonaceous shales with coal seams and ironstone bands. About 120 ft. thick.</td>
</tr>
<tr>
<td>Breccia</td>
<td>Chert fragments mainly in calcareous or siliceous cement; 20 to 30 feet thick. Age unknown.</td>
</tr>
<tr>
<td>Great (Riasi) Limestone</td>
<td>Massive grey limestone (probably Permian).</td>
</tr>
</tbody>
</table>

The principal areas where coal is known to occur lie in the Riasi (33° 05’: 74° 50’) District of Jammu Province. They are:—

1. The southern or main area, consisting of the large Riasi dome bisected by the Chenab river from north to south, and the three smaller domes of Mahogala, Metka and Kalakot.

2. The northern group of Dhansal-Sawalkot area.

3. The Dandli area in the extreme west.

The Ladda coalfield includes the Jangalgali and Anji valley areas. The south-eastern end of the Ladda coalfield is situated about 21 miles north-north-east of Jammu. The Sangarmarg field is geologically continuous with the Ladda field but the two are separated by the Chenab river. The Dhansal-Sawalkot field extends over a distance of about 12 miles to the east-south-east from Dhansal to Lodhra.

Specimens of coal from the Jangalgali area in the Ladda field and Kalakot area were examined in course of the present study.
The Ladda area

One coal seam of any significance is known to occur in this area. This seam varies in thickness up to 20 feet. In places it dies out entirely. According to Simpson (1913) the only workable portion lies between Ladda and the Anji valley. Here the average thickness of the seam is about 31 inches. About the year 1945 the Mining Department of Jammu and Kashmir State discovered a steeply dipping seam of good coal, 10 feet thick, at Jangalgali, about 42 miles north-north-east of Jammu. Mining by underground methods commenced at Jangalgali and Kalakot about the year 1945.

The Kalakot area

This coalfield is the most westerly of the southern group and its position is in Latitude 33° 13' and Longitude 74° 25'. The Lower Coal Measures include a seam 17 feet thick. There is another seam about 7 feet thick, but it may be a continuation of the 17-foot seam. Both these seams are hard anthracitic coals of good quality. In the upper part of the Upper Coal Measures, there is a coal seam from 4 to 7 feet thick. The coal of this seam is flaky and powdery with a high ash percentage. Another seam about 2 to 2½ feet thick is known to occur about 40 feet lower in the Upper Coal Measures. This seam is known to yield anthracitic coal of a good quality.

Specimens from Pits No. 1, 2 and 3 at Lain, Kund and Jangalgali top in the Jangalgali area were examined. In hand specimens these coals are very fragile and easily crumble to powder. The coal appears anthracitic in nature and often shows a bright lustre. Its fragile nature suggests that the coal seams were subjected to considerable compression and folding. No banding is seen in any specimen included in the collection.

Specimens of coal from Beragoa in the Kalakot coalfield are compact. It shows a bright silky lustre and a very fine lamination. The lamination tends to disappear in many samples which appear anthracitic. The specimens resemble some Assam coals of Tertiary age.

Microscopic Constituents

The microscopic examination was made on polished surfaces and in thin sections. A great difficulty is experienced in the preparation of thin and polished sections of the Jangalgali coals. These coals are fragile with the result that in the course of its preparation the section develops cracks in large numbers. In case of the Jangalgali coals particularly, it is not easy to make the section sufficiently thin so that only spore materials can be examined with advantage in transmitted light. These coals appear higher in rank as compared to those from Kalakot.
The nature of the microscopic constituents is described below:—

The Jangalgali coals

Examination of polished blocks reveals that they are composed almost entirely of woody tissues which do not show any well-preserved plant structures. A careful examination of thin sections also did not reveal any cellular structure.

Fungal bodies and fungal spores are, however, abundantly preserved and they have produced a widespread decomposition of the plant tissues. The fungi of the groups Ascomycetes and Basidiomycetes are regarded as important agents in the destruction of wood. Their hyphae absorb the cell contents of xylem and medullary rays. They penetrate the walls and destroy the middle lamella. In this way the whole material is ultimately disintegrated.

The fungal spores observed in these coals are shown in Plate I, Figs. 1–7.

Plate I, Figs. 6 and 7 show fungal bodies known as sclerotia. The nature of sclerotia found in some Indian coals of Permo-carboniferous age has been described by the author (1955 A) elsewhere. The sclerotia figured here resemble very closely Sclerotites brandonianus observed by the author in the Tertiary coals of Assam (Ganju, 1955 B). Stach (1934) has observed this species in the brown coals of Germany. The effect of compression is evident in Fig. 7 where the fungal body shows a number of cracks in its thick outer wall.

The spores shown in Plate I, Figs. 1, 3, 4 and 5 resemble teleutospores. The teleutospores are members of Ustilaginales and Uredinales of the group Basidiomycetes. They are parasites on the stems, sporophylls and leaves of vascular plants. The teleutospores may be unicellular or made up of two or more cells, each cell developing independently. They are thick-walled, usually dark coloured, resting spores and develop in considerable quantities either singly or in pairs or in clusters. They are commonly grouped in teleutosori. The spores may bear a stalk or they may be sessile. The generic identification is made on the characters of their shape and septation. The author has observed similar spores to occur in the Assam coals (loc. cit.).

Plate I, Fig. 1 shows a slipper-shaped spore having three chambers. The middle chamber is larger in size and is slightly curved and drawn out at one end. Plate I, Fig. 5 shows a spore with four chambers but the septa are much folded and crumpled. The spores in Plate I, Figs. 3 and 4 are three-chambered, and the walls show cracks here and there.
A type of spore which has been found to occur usually in large clusters is shown in Plate I, Fig. 2. These spores are rounded to oval in shape with an empty chamber surrounded by a moderately thick wall which shows in some cases a distinct opening at one end. In some spores the wall is produced into a small neck-like structure near the opening. This is clearly seen in two spores, one in the right-hand upper side and the other in the centre near the upper edge in this figure. These spores are no doubt fungal in origin and are probably teleutospores.

Sideritic matter is quite abundant in these coals and its presence causes much difficulty in obtaining a smooth polish altogether free from scratches. *The Kalakot coals*

In thin sections these coals appear distinctly clarainy in nature showing thin strips of vitrain in a ground mass which is largely composed of finely disseminated fusain material. Balls of fusain are conspicuous and constitute most of the macro-fragmentary material. Mineral matter comprising largely of siderite and ankerite is fairly abundant.

Plate I, Fig. 8 and Plate II, Fig. 1 show thin sections of these coals. An oval patch of fusain is observed in the upper left-hand side in Plate I, Fig. 8. A broad strip of vitrain is seen running across near the right-hand edge in this figure. It does not reveal any cellular structure. Plate II, Fig. 1 shows a typical coal exhibiting long narrow strips of vitrain placed almost parallel to one another, and finely granular fusain material and small mineral grains scattered in the ground mass. Dark oval or slightly compressed bodies seen occasionally are probably fungal in origin.

Plate II, Figs. 2–7 show polished surfaces of these coals in reflected light under oil immersion. Fig. 2 shows a band of wood in fusain with well-preserved rows of tracheids. An oval ball of fusain revealing clearly its woody nature appears in Fig. 4. A much decomposed woody tissue with fragments of cells scattered here and there is seen in Fig. 3.

Fungal spores are less abundant. The fungal bodies observed in polished sections appear in Plate II, Figs. 5–7 which show sclerotia in various forms. They have a carved outline and are very hard with the result that the surrounding tissues are closely compressed and folded, a fact clearly observed in Fig. 5. In their form and structure some of the sclerotia resemble those observed in the Jangalgali coals.

**SUMMARY AND CONCLUSIONS**

Representative specimens of coal from the Jangalgali area in the Ladda coalfield and from the Kalakot coalfield in Jammu Province have been examined for their microscopic constituents.
In its physical appearance the Jangalgali coal is anthracitic and often shows a bright lustre. It is fragile and easily crumbles to powder. The Kalakot coal is compact; it shows a bright silky lustre and a very fine lamination which tends to disappear in some anthracitic varieties.

The microscopic examination was made on thin sections and polished surfaces.

The Jangalgali coals are composed almost entirely of woody tissues which do not show any well-preserved plant structures. Fungal organisms have produced a widespread decay in these tissues. Sclerotia resembling *Sclerotites brandonianus* occur in large numbers. The teleutospores showing three or four chambers are found to occur in various forms. Small rounded or oval spores with a moderately thick wall and showing a distinct neck-like opening at one end are found to occur in large clusters. These are probably teleutospores. Sideritic matter is quite abundant.

The Kalakot coals appear distinctly clarainy showing thin strips of vitrain, often placed in parallel rows, in a ground mass which is largely composed of finely disseminated fusain material. Balls of fusain, usually revealing their structure clearly preserved, are conspicuous and constitute most of the macro-fragmentary material. Mineral matter comprising largely of siderite and ankerite is widely distributed in the ground mass. The fungal spores are less abundant, but sclerotia have been observed to occur commonly in these coals also.

The microscopic constituents reveal that the coals have generally undergone much compression and folding, the Jangalgali coals more so than those of Kalakot.

In the nature of their fungal organisms these coals appear to resemble some Tertiary coals of Assam.

**References**


.. *Geology of India*, 1953, Macmillan & Co.
EXPLANATION OF PLATES

PLATE I

(All Figures are from thin sections)

**Fig. 1.** A slipper shaped teleutospore showing three chambers. The middle chamber is larger in size and is slightly curved and drawn out at one end.

Pit. No. 3, Jangalgali coal \((\times 1200)\).

**Fig. 2.** A segregation of round and oval spores which are probably teleutospores. They show an empty chamber enclosed by a moderately thick wall. Two spores, one in the right-hand upper side and the other in the centre near the upper edge, show a small neck-like opening at one end.

Pit. No. 3, Jangalgali coal \((\times 740)\).

**Fig. 3.** Teleutospore showing three chambers. The thick septa shows a crack.

Pit. No. 3, Jangalgali coal \((\times 1,200)\).

**Fig. 4.** Teleutospore showing three chambers. The walls show cracks formed due to compression.

Pit. No. 3, Jangalgali coal \((\times 740)\).

**Fig. 5.** Teleutospore with four chambers showing much folded and crumpled septa.

Pit. No. 3, Jangalgali coal \((\times 1,200)\).

**Fig. 6.** Sclerotia resembling *Sclerotites brandonianus*.

Pit. No. 3, Jangalgali coal \((\times 1,200)\).

**Fig. 7.** Sclerotia resembling *Sclerotites brandonianus*. The thick outer wall shows a number of well-developed cracks formed due to compression.

Pit. No. 1, Jangalgali coal \((\times 1,200)\).

**Fig. 8.** Clarain-like coal showing an oval patch of fusain in the upper left-hand side. A broad strip of vitr ain is observed running across near the right-hand edge.

Kalakot coal \((\times 165)\).

PLATE II

(Fig. 1 is from a thin section; all other figures are from polished sections in reflected light under oil immersion.)

**Fig. 1.** Clarain-like coal exhibiting narrow strips of vitr ain placed in almost parallel rows. Finely granular fusain material and mineral grains are scattered in the ground mass. Small dark oval bodies are probably fungal in origin.

Kalakot coal \((\times 165)\).

**Fig. 2.** A band of wood in fusain with well-preserved rows of tracheids.

Kalakot coal \((\times 280)\).

**Fig. 3.** Much decomposed woody tissue with fragments of cells scattered here and there.

Kalakot coal \((\times 280)\).

**Fig. 4.** An oval ball of fusain revealing clearly its woody structure.

Kalakot coal \((\times 280)\).

**Fig. 5.** Sclerotia showing a carved outline. The surrounding tissue is clearly folded and compressed.

Kalakot coal \((\times 360)\).

**Fig. 6.** Sclerotia in a much decomposed woody tissue.

Kalakot coal \((\times 380)\).

**Fig. 7.** Same as in Fig. 6.

Kalakot coal \((\times 380)\).