INTERNATIONAL HANDBOOK OF COAL PETROGRAPHY

INTERNATIONAL COMMITTEE FOR COAL PETROLOGY

SECOND EDITION
1963

PART I : *Nomenclature.*
PART II : *Methods of analysis.*

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To the memory of
M. C. STOPES, †
on whose work the nomenclature
of coal petrography is based.

M. C. Stopes died on 2nd October, 1958 at Dorking, England.

PREFACE

The first edition of the INTERNATIONAL HANDBOOK OF COAL PETROGRAPHY was published in 1957 *essentially as a glossary in three languages, German, French and English.*

The second edition, 1963, *consists of two parts. Part* I *deals with nomenclature, Part* II *with methods of analysis. Descriptions of these methods of analysis appeared essential to better definition of the petrographic constituents.*

In addition to the German, French and English versions published in Paris, a Russian version of the 1963 *edition will be published in Moscow.*

Liège, January 1963.

Nomenclature Sub-Committee,
International Committee for
Coal Petrology.

Foreword to the 2001 CD ROM Reprint of International Handbook of Coal Petrography
Second Edition 1963

The second edition of the International Handbook of Coal Petrography marked a significant milestone in the standardisation of coal petrographic nomenclature. Many of the definitions have been current for nearly 40 years and have only recently undergone revision, especially those belonging to the Stopes - Heerlen system. This long period of usage tell us something of the quality of the original work. The second edition of the Handbook was initially made available in English, French, German and Russian but has been out of print in any language for a number of years.

Some terms defined in the handbook have fallen largely into disuse, some have been superseded, some are difficult to access (e.g. the Russian system of genetic nomenclature) while others remain current. Since many of the maceral, and microlithotype and lithotype definitions (including the word "maceral" itself) are still current, as well as some of the analytical and preparation techniques, a decision has been made to make a reprint available to a new generation of coal petrologists. The reprint is not only of historic interest but will also be a valuable working volume for many people.

The format of the reprint as Adobe Acrobat files on CD ROM should greatly enhance its usability. A common criticism of the second edition was that it was difficult to locate items, partly due to a lack of pagination and partly due to the organisation. For example, the Table of Contents lists the items that may be found but not the order in which they occur; the Alphabetical Index gives the order for most items but despite the general alphabetical organisation, a number of inconsistencies occur e.g. the Introductions and General Notes appear immediately after the alphabetical index; the entry for "Kaolin - Coal Tonstein" (in the English editions) was invariably placed under "T" for tonstein; Fusite sheets were placed before the Fusinito-collinite coal sheets; both Carbonification and Coalification occur in the alphabetical index but only a single sheet exists; and so on.

The arrangement on the CD ROM places all the sheets up to and including the abbreviations as part of the introduction and contents. All items are then extensively linked between the table of contents, the alphabetical index and the sheets. All individual sheets are bookmarked back to the Contents and Alphabetical Index. In addition, an effort has been made to link items between sheets. For example, in the Alginite sheet, references are made to both Boghead and Sapropelic coals - both of these words are linked to the appropriate sheet which may be brought up by mouse clicking on them; the Acrobat 'go to previous view' button (a large left arrow on the menu bar) then returns the reader to the Alginite sheet or the user may return to the Table of Contents or Alphabetical Index. These links are not highlighted but can be seen when the Acrobat open hand changes to a pointing finger.

It should be noted that linking of a term to a sheet does not always imply a direct correlation. For example, in the TBM System, many references are made to algae, resins, cuticles spores etc which have been linked to the respective sheets of alginite, resinite, cutinite and sporinite. Alginite etc. do not occur in the TBM System and belong to the Stopes-Heerlen System. The link is merely designed to give the reader additional information if required and may be particularly useful as descriptions in transmitted light are also usually given.

Some minor editing of the sheets has occurred, mostly to correct specific spelling mistakes. Changes made are as follows and are annotated on the appropriate sheets :

1. Correction of the title of the anthraxylon plate to read "ANTHRAXYLON" instead of the spelling mistake "ANTRAXYLON"

2. On the Clarodurite sheets under II - Description, the line commencing "rank and more than..." has been repeated. The repeated line has been deleted.

3. On the Correlation of Nomenclature Sheets, change of "antraxylon" to "anthraxylon" in the Semi-splint coal - Quantitative Statements.

4. Rotation of Fig 2 of the Degradinite Sheet by 180° so that it is in the same orientation as Fig 1

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7. Replacement of "exinite" by "inertinite" on Vitrinertite Sheet - I Origin of Term last word, third sentence.

8. Correction of palaeozoic to Palaeozoic on the sporinite sheet

In addition, some pages have been rotated 90° to make the text run horizontally across a computer screen for ease of reading.

Since the plates have no scale bars, it will be useful to note that the original image area scanned was width = 5.50 inches (13.97 cm) and height = 9.42 inches (23.93 cm). All pages are scanned images which have been digitally edited if necessary to remove extraneous markings or to enhance quality.

Details on how to obtain additional copies can be found on the ICCP web site http://www.iccop.org

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1st August, 2001

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1. (SH) = STOPES-Heerlen System.
2. (TBM) = THIESSEN-Bureau of Mines System.
3. (IGM) = System of the Geological Institute of the Academy of Sciences of the U. S. S. R., Moscow.

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1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

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1. (SH) = Stopes-Heerlen System.
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INTRODUCTION

(to the first edition: 1957)

The need for an international glossary of coal petrography was expressed at the 3rd Congress for the Advancement of Studies in Stratigraphy and Geology of the Carboniferous held at Heerlen (Netherlands) in 1951.

Marked developments in this branch of science and a rapid increase in the number of its industrial applications led the International Committee for Coal Petrology inaugurated in 1953 to include in its programme the project of preparing and publishing an international glossary.

On the initiative of its president, Professor Dr. R. Potonie, the Committee established a Nomenclature Sub-Committee composed of a number of its members. This Sub-Committee meets twice a year. It discusses the definitions proposed by members for each term, and drafts an agreed text. An editorial group is charged with preparing the final text and, after approval by the full Sub-Committee, with publishing the glossary.

The first part of the glossary is concerned exclusively with solid fuels, generally described in Europe as «hard coals», in North America as bituminous coal and anthracite. Consideration of terms of the petrography of less mature fuels is contemplated later.

There exist at present two principal systems of nomenclature, that introduced by Stopes (Heerlen) employed chiefly in Europe, and that introduced by Thiessen and employed chiefly in U.S.A. The nomenclature used in each of these two systems has been defined by two separate groups of experts. Furthermore, some members of the Nomenclature Sub-Committee have been entrusted with the task of correlating the two systems. The results of their work will be reproduced in the form of special sheets.

The glossary is published as a loose leaf system. Each term is detailed on loose leaves with the name of the author, and the corresponding reference in the literature, a list of synonyms, analogous terms, description, properties, occurrence, and practical importance.

The texts in the glossary are tentative but correspond with the present state of knowledge. Proposals for amendments shoud be submitted to the Secretary[1] not less than four months before the meetings of the International Committee for Coal Petrology held every two years.

List of Members of the Nomenclature Sub-Committee [2]

B. Alpern (France) [3].
I. Ammosov (U.S.S.R.) [3].
K. Asai (Japan).
G.H. Cady (U.S.A.).
D. Chandra (United Kingdom).
S.J. Dijkstra (Netherlands) succeeded by O. Kuyl in January 1957.
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G.W. Fenton (United Kingdom) [3].
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P.A. Hacquebard (Canada) [3].
V. Hevia (Spain).
R.M. Kosanke (U.S.A.).
M. Legraye (Belgium).
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B. Ch. Mukherjee (India).
R. Noel (Belgium) [3].
B.C. Parks (U.S.A.).
R. Potonie (Germany).
J.M. Schopf (U.S.A.) [3].
C.A.Seyler (United Kingdom).
A.H.V. Smith (United Kingdom).
E. Stach (Germany) [3].
G.H. Taylor (Australia).
M. Teichmuller (Germany).

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1. Steinstrasse 137, KREFELD, Germany.
2. All the members in this list have contributed to the preparation of the Glossary. The statements expressed are often the result of compromise between different views, and do not necessarily represent the opinion of every member.
3. Member of Editorial Group.

PART I.
NOMENCLATURE — INTRODUCTION

Part I of the Handbook extends the first edition of the Glossary of Coal Petrography by adding 48 further terms. At the same time the text of the original glossary has been revised and brought up-to-date. The additions include, on the one hand, further terms in the Stopes-Heerlen system (reflected light), and on the other, terms of the Thiessen-Bureau of Mines system of nomenclature (transmitted light) of which only four terms appeared in the first edition. The correlation which has been established between the Stopes-Heerlen system and that of the Thiessen-Bureau of Mines is shown by means of two tables.

In view of the importance which the nomenclature of W. Spackman has attained during recent years in the U.S.A. it appeared necessary to make a brief reference to the principles of this system in the new edition of the glossary and to provide a summary table of its major subdivisions.

Eleven of the more important terms of the genetic terminology of the Geological Institute of the Academy of Sciences of the U.S.S.R., Moscow have been included together with a schematic summary of this system. The terms have not been discussed by the Nomenclature Sub-Committee, however, because of the members' insufficient practical knowledge of Russian coals.

Again, definitions of a further number of general terms which are used in coal petrology have been added. Definitions of purely botanical terms such as spore, algae, etc. have been omitted from the second edition, on the grounds that definitions of such terms rightly belong to text books and glossaries of botany, and are outside the scope of coal petrology.

Terms relating specifically to the petrography of brown coals have not been included, and remain to be considered by the Nomenclature Sub-Committee. The nomenclature of the Geological Institute of the Academy of Sciences of the U.S.S.R., Moscow, however, can be applied to brown coals.

The decimal system of classifying and indexing the terms in the glossary has been abandoned, because of continuing developments in the nomenclature of coal petrography and the difficulty in including new terms.

In the second edition the terms are arranged in alphabetical order. A subject index has also been added with indications of how the individual terms fall into the different systems of nomenclature. Furthermore, at the top of each page dealing with particular terms, reference is made to the system of nomenclature to which the term belongs, and to the method of examination used (polished surface or thin section).

The Nomenclature Sub-Committee has met seven times since the first edition of the glossary was published in 1957 (Paris 1957, Liège 1958, Heerlen 1958, London 1959, Madrid 1960, Krefeld 1961, Liège 1962). The number of members has risen from 24 to 34. The Committee regrets the decease of A. Duparque, M. Legraye and C.A. Seyler during this period, and the resignation from the Committee of G.W. Fenton, A.A. Luber and O. Kuyl. The chairmanship of the Committee has changed several times since 1957; it has been held successively by M. Legraye (1957), G.W. Fenton (1958-60), E. Stach (1960-61) and by M. Teichmuller. The editing of the second edition was undertaken by B. Alpern, G.H. Cady, G.W. Fenton, V. Hevia, M. Th. Mackowsky, R. Noel, A.H.V. Smith, and M. Teichmuller.

Members of the Nomenclature Sub-Committee in 1963.

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International Committee for Coal Petrology
Nomenclature Sub-Committee

GENERAL NOTES

1 — "1935 Heerlen Congress" refers to the 2nd Congress for the Advancement of Studies in Stratigraphy and Geology of the Carboniferous, held at Heerlen (Netherlands) in 1935.

2 — The descriptions given of petrographic constituents examined by reflected light refer to the appearance in polished surfaces using oil immersion objectives. With dry objectives the general appearance is similar but contrast is weaker and the relief is stronger.

The appearance of each constituent examined in thin section by transmitted light is also described. The colour, and the intensity of anisotropy exhibited depend on the thickness of the section. Those given in the descriptions relate to thin sections of normal thickness (5 to 10 microns).

3 — The statements on relief are always given on the basis of comparison with vitrinite (collinite).

4 — The micro-hardness HV_{100} in kg/mm^2 is the Vickers micro-hardness for a load of 100 g.

The strength HV_{1000} in kg/mm^2 is the Vickers macro-hardness for a load of 1000 g.

5 — The statement of volatile matter content always refers to the dry ash free state (d.a.f.).

6 — It is agreed to describe constituents as:

- rare: where they occur in proportions less than 5 per cent.
- common: where they occur in proportions between 5 and 10 per cent.
- very common: where they occur in proportions between 10 and 30 per cent.
- abundant: where they occur in proportions between 30 and 60 per cent.
- dominant: where they exceed 60 per cent.

7 — The correlations between the terms of the Stopes-Heerlen nomenclature and those of the Thiessen-Bureau of Mines system are based on the examination of polished thin sections.

8 — A note in the top right-hand corner of each sheet describing the petrographic constituents indicates whether the term is applicable to brown coal, hard coal or both, and whether the description relates to observation by reflected or transmitted light. In addition, where a term is associated with a particular system of nomenclature, this system is indicated in the centre heading (see *Abbreviations*).

9 — The numbering of the figures on the various plates of illustrations is from left to right and from top to bottom.

1963
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International Committee for Coal Petrology
Nomenclature Sub-Committee

ABBREVIATIONS

French	German	English
Matières volatiles	Flüchtige Bestandteile	Volatile Matter
M. V.	Fl. Best.	**V. M.**
Lumière réfléchie	Auffallendes Licht	Reflected Light
L. R.	Auflicht	R. L.
Lumière transmise	Durchfallendes Licht	Transmitted Light
L. T.	Durchlicht	T. L.
Pouvoir réflecteur	Reflexionsvermögen	Reflectance
P. R.	R.	R.

(SH) = Stopes-Heerlen System.

(TBM) = Thiessen-Bureau of Mines System.

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ALGINITE

(Stopes-Heerlen System)

Hard coal
R. L.
T. L.

I — ORIGIN OF TERM

The term was introduced by Hevia [1] in 1953.

Analogous terms: algite (Cady, 1942), algal remains.

II — DESCRIPTION

The term alginite designates the characteristic maceral of boghead coal.

In reflected light it is very difficult to recognise the cellular structure of the algae. The reflecting power of the maceral is much weaker than that of vitrinite and weaker also than that of sporinite in coals of low rank.

In transmitted light, alginite sometimes shows structure (of colonies of algae). The colour is yellow to orange.

Alginite is best recognized by luminescent microscopy; it shows marked luminescence of varying colour—silvery blue, green, yellowish brown. The humic constituents are either not luminescent or show a different kind of luminescence to the alginite.

III — OCCURRENCE

See sapropelic coal.

IV — PRACTICAL IMPORTANCE

See sapropelic coal.

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[1] Hevia (V.). El estudio microscopico del carbon. Bol. Inform. Inst. Nac. Carbon, *9*, (1953), p. 5.

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Nomenclature Sub-Committee

ALLOCHTHONY

(in the terminology of solid fuel)

General
Term

I — ORIGIN OF TERM

The term allochthony was introduced by C. F. NAUMANN[1] in 1849.

II — DEFINITION

Accumulation of plant remains in a region which does not correspond to that in which the plants grew (primary allochthony). One also speaks of secondary allochthony associated with erosion and postgenetic transport of fragments of a coal seam (see autochthony).

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[1] NAUMANN (C. F.). Lehrbuch der Geognosie, Leipzig, *I*, (1849), p. 692.

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee	Brown coal Hard coal T. L.

ANTHRAXYLON

(THIESSEN-Bureau of Mines System)

I — ORIGIN OF TERM

Term introduced by R. THIESSEN[1] in 1920.

II — DESCRIPTION

Viewed microscopically anthraxylon generally reveals some of the original plant structure.

Cellular inclusions indigenous to the original plant tissue are assigned to the anthraxylon when present.

Conventionally anthraxylon must be more than 14 microns thick perpendicular to the bedding plane.

Microscopic material resembling anthraxylon in colour and translucency but less than 14 microns wide is included with translucent humic degradation matter (q.v.).

Colour: orange to red to brownish red; the depth of colour increasing with rank and the thickness of the thin section. Cellular inclusions may vary in colour from reddish brown to light yellow. In general plant structure is revealed by slight differences in the tint of cell walls and cell fillings. Anthraxylon that is transitional into semifusain shows a darker tint than normal anthraxylon of the same rank, and cell structure is more clearly shown.

Anisotropy: anisotropic even in low rank coals.

III — CORRELATION WITH TERMS OF THE STOPES-HEERLEN SYSTEM

All vitrinite greater than 14 microns in thickness, perpendicular to the bedding plane is anthraxylon. Vitrite is in the main anthraxylon.

IV — OCCURRENCE

Present in quantities exceeding 5% in all varieties of common banded coal. Bright banded bituminous coal frequently contains 50-70% of anthraxylon; banded bituminous coal of dull lustre contains lesser amounts of anthraxylon.

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[1] THIESSEN (R.). Compilation and composition of bituminous coals. J. Geol., *28*, (1920), p. 185-209.

V — PRACTICAL IMPORTANCE

1. *Preparation.*

Because of the relative greater brittleness of anthraxylon, it tends to concentrate in small sizes of broken coal in the preparation plant, chiefly in sizes between 1/10 in. (2mm) to 1/100 in. (0.2mm). Consequently nut sizes of coal (3/4-2 in.). (18-50mm) are likely to have lower content of anthraxylon than is found in the bed as a whole. In some mining operations, accordingly, small size coal is less satisfactory for use in domestic-type stokers than nut coal crushed to the same size.

2. *High—and low—temperature carbonization.*

Although in bituminous coal it is chiefly the anthraxylon that contributes to the coking properties it may not always do so favourably because of undesirable shrinkage properties.

3. *Hydrogenation.*

Anthraxylon has primary value for hydrogenation when considered in relation to rank.

4. *Oxidizability.*

Anthraxylon is probably the most readily oxidizable of the four constituents, particularly in coals with more than 30% V.M.

5. *Tendency to form dust.*

Anthraxylon forms less dust than fusain but more than either translucent or opaque attritus.

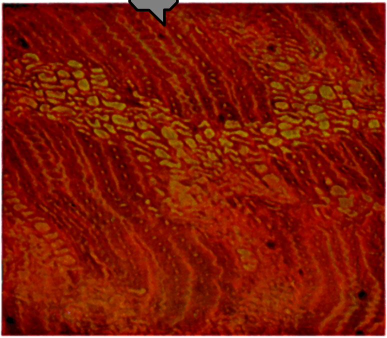
Fig. 1.

Anthraxylon from an English coal (37 % V.M.).
Polished thin section in transmitted light, 250 ×.

Fig. 2.

The same in reflected light, oil immersion, 250 ×.

RAXYLON



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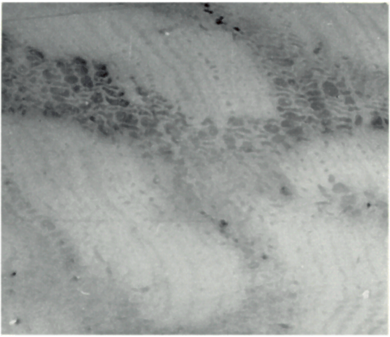

2

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **ATTRITUS** (Thiessen-Bureau of Mines System)	Brown coal Hard coal T. L.

I — ORIGIN OF TERM

The term was introduced by R. Thiessen[1] in 1919 to designate the thin bands of dull coal interlaminated with the bright, glossy coal bands that he called anthraxylon.

II — DESCRIPTION

Macroscopic appearance: dull with granular surface texture.

Microscopically consists of intimately mixed, tightly compacted remains of varied morphological form and origin. For the various kinds of organic matter comprising attritus see translucent and opaque attritus.

III — CORRELATION WITH TERMS OF THE STOPES-HEERLEN NOMENCLATURE

Attritus consists of an intimate association of varying proportions of macerals of the vitrinite, exinite and inertinite groups.

Attritus is a collective term, not directly comparable with any one of the microlithotypes of the Stopes-Heerlen nomenclature.

IV — OCCURRENCE

Attritus is present in practically all types of coal. In bright banded coal it is secondary in importance to anthraxylon, but in splint it is the dominant component, and nonbanded attrital coals consist wholly of attritus.

V — PRACTICAL IMPORTANCE

1. *Preparation.*

Attritus, in the form of dull attrital coal, by virtue of its higher density and greater hardness than bright coal, can be concentrated from normal heterogeneous banded coal by preparation methods involving gravity separation or by differential crushing and screening techniques.

---

[1] Thiessen (R.). Constituents of coal through a microscope: Proc. Coal Mining Inst. Amer. (1919), p. 34-45.

2. *Carbonization.*

In caking coals the caking power of attritus is determined by the relative proportions of translucent matter and opaque matter. A predominance of yellow translucent constituents appears to enhance the coking properties.

3. *Hydrogenation.*

All translucent constituents of attritus apparently are amenable to hydrogenation, but brown humic matter and opaque matter are more or less non-reactive and difficult to hydrogenate.

4. *Oxidizability.*

The oxidation properties of the constituents of attritus are generally intermediate between those of anthraxylon and fusain.

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

AUTOCHTHONY

(in the terminology of solid fuel)

General
Term

I — ORIGIN OF TERM

The term was introduced by G. Grote[1] in the middle of the last century.

II — DEFINITION

Accumulation of plant remains in the place of their growth. Within the term autochthony R. Potonie[2] distinguishes between autochthonous elements of growth (eu-autochthony) and autochthonous elements of sedimentation (hypautochthony).

Eu-autochthony applies to plant remains which are now found in the exact place and more or less in the correct relative positions in which they grow, for instance roots, stumps and even entire trunks.

Hypautochthony applies to remains of plants which no longer occur in the exact place, but still lie within the same general region of their growth (for instance in a peat bog, lying within the limits of a wider territory in which they grew).

Others include hypautochthony with allochthony (q.v.).

A large part of the plant material of coal seams is hypautochthonous. Autochthonous seams may contain allochthonous layers or constituents.

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1. Grote (G.). History of Greece, London. (1846-1856), p. 146.
2. Potonie (R.). Synopsis der Gattungen der Sporse dispersae. Part 2, Beiheft Geol. Jb. 31, (1958), p. 11.

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

General
Term

BOGHEAD COAL

I — ORIGIN OF TERM

The term boghead coal was introduced in 1953 by J. QUECKET [1].

Synonym: torbanite.

Analogous terms: parrot coal, boghead-cannel (RENAULT [2]), algal coal.

II — DESCRIPTION

Boghead coal is a sapropelic coal of brownish-black to black colour which on macroscopic examination appears unstratified. It resembles cannel coal in its physical properties, but at low levels of rank it is somewhat browner and tougher: it fractures conchoidally.

Microscopic observation shows that boghead coal consists of alginite and very finely dispersed inertinite and vitrinite. The proportion of algae can vary very widely. There is a continous range of transitional stages between typical boghead coal and typical cannel coal, designated cannel-boghead or boghead-cannel coal depending on whether alginite or sporinite predominates.

III — OCCURRENCE

Pure boghead coals are rare: cannel-boghead or boghead-cannel coals are more frequent. Seams composed entirely of boghead coal or boghead-cannel transitions are extremely rare.

IV — PRACTICAL IMPORTANCE

See sapropelic coal.

---

[1] QUECKET (J.). On the minute structure of a peculiar combustible mineral from coal measures of Torbane Hill near Bathgate, Linlithgowshire, known in commerce as Boghead Cannel Coal. Trans. Micros. Soc. London, *2*, (1853), p. 34-66.

[2] RENAULT (B.). Communication faite sur le Boghead. Bull. Soc. hist. nat., Autun., *5*, (1892).

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

BRIGHT COAL

(Thiessen-Bureau of Mines System)

Hard coal
T. L.

I — ORIGIN OF TERM

‘Bright coal’ is an old mining term for lustrous coal. Thiessen [1] (1931) defined ‘bright’ coal as coal “composed of anthraxylon and attritus in which the translucent matter predominates” and thereby established the concept of ‘bright coal’ on a microscopic basis. In 1948 Parks and O’Donnell [2] provided a quantitative definition based on microscopical examination (see below).

II — DESCRIPTION

According to the definition of Parks and O’Donnell [3] (1948) ’bright coal’ is a type of banded coal composed microscopically of more than 5 per cent of anthraxylon and less than 20 per cent of opaque matter, the measurements being made perpendicular to the bedding across the entire thin section (2-3 cm. in width). ‘Bright coal’ can consist entirely or in greater part of anthraxylon; it can also be attrital providing the content of opaque attritus remains below 20 per cent and the content of translucent attritus may amount to 95 per cent (vide. ‘Type of Coal’ TBM). The protobitumens (spores, cuticles, waxes) occasionally predominate over THDM in the translucent attritus.

III — CORRELATION WITH TERMS OF THE STOPES-HEERLEN NOMENCLATURE

‘Bright coal’ corresponds to the microlithotypes vitrite, clarite and in part to duroclarite and vitrinertite.

IV — OCCURRENCE

‘Bright coal’ is the most abundant of the three types of coal. It occurs in all banded coals.

---

[1] Thiessen (R.) in Fieldner (A. C.), Davis (J. D.), Thiessen (R.), Kestner (E. B.) and Selvig (W. A.). Methods and apparatus used for determining the gas-coke and by-product-making properties of American coals. U. S. Bureau Mines Bull. *344*, (1931), p. 64.

[2] Parks (B. C.) and O’Donnell (H. J.). Petrography of American coals, Bureau of Mines Bull., *550* (1956), p. 17.

V — PRACTICAL IMPORTANCE

1. *Preparation.*

The behaviour of 'bright coal' in preparation processes depends on its content of anthraxylon and the type of attritus of which it is composed. The fine particle sizes are enriched in bright coal with a high content of anthraxylon or of attritus consisting predominantly of humic degradation matter. This is usually the case. 'Bright coal' containing proportions of spore-rich translucent attritus tends to concentrate in nut-size coal.

2. *Carbonization.*

Since bright coal consists predominantly of anthraxylon and humic degradation matter which plasticise the coal it provides in general a better caking and swelling coal than splint coal and semi-splint coal of the same rank.

3. *Hydrogenation.*

In coals with more than 25 per cent V. M. 'bright coal' is the most easily hydrogenated type of banded coal.

4. *Oxidizability.*

'Bright coal' is in general more easily oxidized than splint and semi-splint since it usually contains more humic constituents (anthraxylon and THDM).

5. *Formation of dust.*

On account of its brittleness and tendency to fissure 'bright coal' tends to produce dust more than other types of coal.

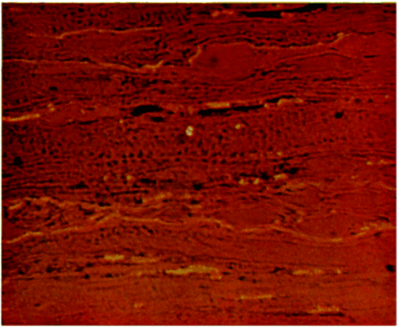
Fig. 1.

Bright coal in an English coal (37 % V. M.)
Polished thin section in transmitted light, 250 ×.

Fig. 2.

The same in reflected light, oil immersion, 250 ×.

BRIGHT COAL



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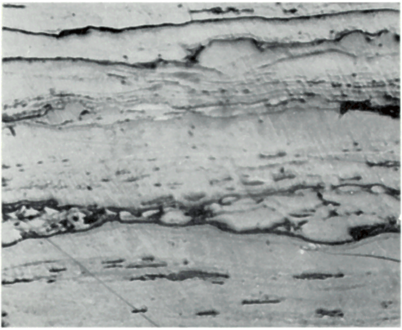

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1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **BROWN MATTER** (THIESSEN-Bureau of Mines System)	Brown coal Hard coal T. L.

I — ORIGIN OF TERM

R. THIESSEN [1], 1932.

Synonyms: semi-opaque matter, semi-translucent matter, brown cell wall degradation matter.

II — DESCRIPTION

Cell-wall degradation matter and the contents of cells which in thin section are brown and semi-translucent.

III — CORRELATION WITH TERMS OF THE STOPES-HEERLEN NOMENCLATURE

The term brown matter has no exact equivalent in the STOPES-Heerlen nomenclature. Constituents with a reflectance between that of vitrinite and fusinite may correspond in part to brown matter. Some brown matter is identical with semifusinite and massive micrinite.

IV — OCCURRENCE

Brown matter is found in varying amounts in the attrital matter of all splint and semisplint coals; it is occasionally present in the attritus of bright coals.

V — PRACTICAL IMPORTANCE

Not yet studied.

---

[1] THIESSEN (R.) in FIELDNER (A. C.), DAVIS (J. D.), THIESSEN (R.), KESTNER (E. B.), SELVIG (W. A.), REYNOLDS (R. A.) JUNG (F. W.) & SPRUNK (G. C.). Carbonizing properties and constitution of No. 6 Bed coal from West Frankfort, Franklin County, Ill. U.S. Bur. Mines. Tech. Paper, *524*, (1932), p. 21.

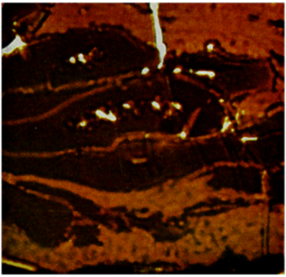
Fig. 1

Brown matter in an English coal (37% V.M.)
Polished thin section in transmitted light, 500 ×.

Fig. 2.

The same in reflected light, oil immersion, 500 ×.

BROWN MATTER



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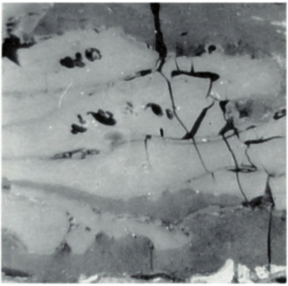

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1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

CANNEL COAL

General
Term

I — ORIGIN OF TERM

Cannel coal is an old term used by LELAND [1] in 1538 for a coal burning with a steady luminous flame. The sapropelic origin of cannel coal was recognized at the beginning of the present century (see sapropelic coal). The term cannel coal is now used for sapropelic coal containing spores, in contrast to sapropelic coal containing algae, which is termed boghead coal (see boghead coal).

Synonym: Gayet.

Analogous term: parrot coal.

II — DESCRIPTION

Viewed macroscopically cannel coal shows no stratification. It is generally dull and has a more or less pronounced waxy lustre. It is very compact and fractures conchoidally. There are transitions between cannel coal and boghead coal.

It is not possible always to distinguish macroscopically between cannel coal and boghead coal. Such a distinction can, however, be easily made with the microscope except in high rank coals.

Microscopic examination of cannel coal shows that its composition can vary very considerably. Compared with humic coal, the macerals are more intimately mixed and at the same time are finer and more uniformly grained. Moreover, cannel coal frequently shows a uniform micro-stratification and is more homogeneous in structure than humic coal. These characteristics make it possible to identify cannel coal in polished section. Quantitative determination of the proportion of cannel coal in polished sections of crushed coal in distinction to lump coal is difficult. In typical cannel coal, ultra-fine fragments of inertinite and exinite are generally found in a vitrinitic groundmass. Transitions to clarite, duroclarite and clarodurite also exist.

In American nomenclature, cannel coal must contain less than 5% anthraxylon.

---

[1] LELAND (J.). Itinerary of John Leland the Antiquary, 1st edition, (1710).

III — OCCURRENCE

Cannel coal occurs in layers or lenses up to several centimetres in thickness. Thin seams consisting entirely of cannel coal are known. It occurs widely but in limited amounts.

IV — PRACTICAL IMPORTANCE

See sapropelic coal.

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

CARBANKERITE

Hard coal
R. L.

I — ORIGIN OF TERM

The term carbankerite was introduced by HEVIA[1] in 1960 to designate a microithotype containing 20-60% by volume of carbonate minerals (calcite, siderite, dolomite and ankerite), and was adopted in 1962 by the International Nomenclature Sub-Committee.

II — DESCRIPTION

An intimate association of various microlithotypes with carbonate minerals of which the particle size does not exceed 30 μ. Larger accretions or single crystals exceeding 30 μ of the minerals, occurring for example in cleat partings and breaks, are regarded as "rock" since a band of material 50 μ wide containing 30 μ of carbonate mineral would have a density greater than 2.0.

Carbonate mineral generally appears medium grey in a polished surface and shows slight relief against vitrite.

Positive identification of the different carbonate minerals is not possible by R.L. and is even difficult in T.L.

In polarised light carbonate minerals shown medium to strong anisotropy; certain types of siderite accretions display Brewster's cross in median section.

Any microlithotype containing the appropriate amount of carbonate mineral constitutes carbankerite. In microscopic analysis only bands of carbankerite greater than 50 μ are recorded.

In addition to mineral carbonate, carbankerite may contain up to 5 % by volume of pyrites and up to 20 % by volume of clay minerals and quartz.

Intergrown coal and mineral carbonate containing more than 60 % by volume of mineral carbonate is classified as "rock" since the density of such material is more than 2.0.

The purer forms of carbankerite have between 15 and 30 % of ash.

The density varies generally between 1.5 and 2.0 depending on the content of mineral carbonate, but is rather higher when siderite is the intergrown mineral.

---

[1] HEVIA (V.). Reuniones Internationales sobre petrografia del carbon. Bol-Inform. Inst. Nac.-Carbon. *9*, 48, 1960), p. 90-91.

III — OCCURRENCE

Widely distributed although in amounts which vary considerably. Massive accretions of carbankerite are sometimes useful in seam identification and correlation.

IV — PRACTICAL IMPORTANCE

In coal preparation practice carbankerite, like carbopyrite and carbargilite falls into the category of "true intergrown coal" in as much as the mineral carbonate is so intimately associated with the coal that it is not possible to free it by crushing. It appears therefore in "middlings". It is usually possible to free the mineral carbonate deposits occurring in cleat partings and fissures by crushing.

When carbankerite occurs in appreciable proportions in cleaned coal it has its effect as an inert material on coking and swelling properties, hydrogenation and gasification, but without giving rise to any special trouble or difficulty.

Carbankerite shows no tendency to spontaneous combustion or to produce dust.

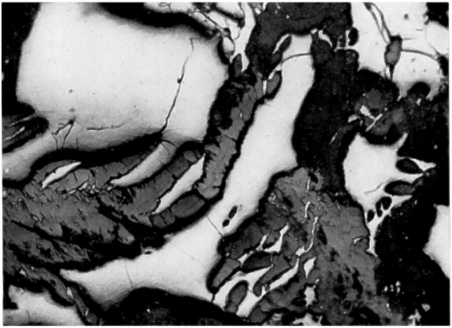
Fig. 1.

Carbankerite with siderite accretions. German coal (Ruhr 18 % V.M.)
Thin section in reflected light, oil immersion, 250 ×.

Fig. 2.

Carbankerite with ankerite deposits in fissures.
German coal (Ruhr, 25 % V.M.)
Thin section in reflected light, oil immersion ,220 ×.

CARBANKERITE - CARBANKERIT



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1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **CARBARGILITE** (STOPES-Heerlen System)	Hard coal R. L.

I — ORIGIN OF TERM

In 1955 the Nomenclature Sub-Committee resolved to use this term for the microlithotype containing 20—60 % by volume of clay minerals, mica, and, in lesser proportions, quartz.

The terms carbonaceous shale, Brandschiefer, schiste charbonneux, and bone coal, are restricted to macroscopic description and are therefore not synonyms of carbargilite.

II — DESCRIPTION

Intimate association of various microlithotypes with argillaceous minerals and micas (small amounts of quartz), of average particle size 1-3 microns. The finer microstructure is sometimes distinct and regular; in other cases diffuse and turbostratic. The mineral constituents appear black in reflected light and, with the exception of quartz (viewed in air) show no relief.

Distinctions can be made between carbargilites based on each of the various microlithotypes.

In petrographic analysis it is conventional to record only bands of carbargilite which are more than 50 microns wide.

The ash usually varies between 20 and 60 %.

Density varies between 1.5 and 2.0 depending on the mineral content.

The strength is generally less than that of the mineral free microlithotypes (except fusite).

III — OCCURRENCE

Widely distributed, in very variable quantities.

IV — PRACTICAL IMPORTANCE

In coal preparation practice carbargilite corresponds to true "intergrown" coal. The mineral is so intimately associated with the coal that it is impossible to free it by crushing. Carbargilite therefore appears in "middlings" and may be a common constituent of steam-raising coals. If the proportion of carbargilite in a coal is too high, it will prove troublesome in carbonization, hydrogenation and gasification. It has no special tendency to form dust or to spontaneous combustion.

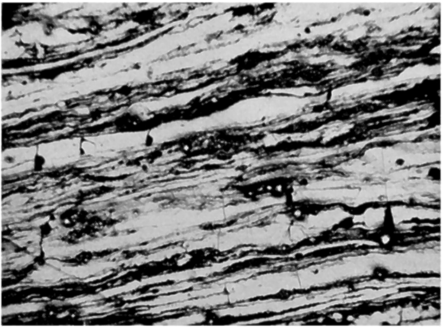
Fig. 1.

Carbargilite of vitrite in banded form.
German coal (Ruhr, 25 % V.M.)
Thin section in reflected light, oil immersion, 250 ×.

Fig. 2.

Carbargilite of duroclarite. German coal (Ruhr, 27 % V.M.)
Thin section in reflected light, oil immersion, 200 ×.

CARBARGILITE - CARBARGILIT



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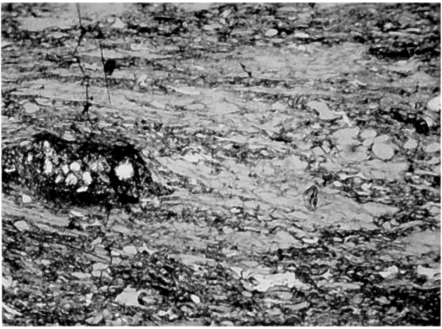

2

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **CARBONIFICATION — COALIFICATION**	General Term

I — ORIGIN OF TERM

The term carbonification was used in 1883 in the newspaper Standard [1] and was reintroduced in 1955 by the Nomenclature Sub-Committee to designate the processes of transformation of peat to hard coal including anthracite.

Some authors would include peat formation under carbonification.

Synonyms: houillification — Inkohlung.

II — DESCRIPTION

Carbonification is the process by which the vegetable substances of peat were transformed in the partial absence of air, and under the influence of temperature and pressure throughout geological time into lignite and subsequently into coal.

The process is characterized essentially by enrichment of the carbon content.

If peat formation is included, two principal mechanisms are distinguished:

1. Diagenesis including biochemical processes;
2. Metamorphism or geochemical carbonification.

Diagenesis takes place under normal conditions of temperature and pressure, and ends at the soft lignite stage.

Metamorphism occurs under the influence of higher temperature and pressure after burial and leads to the formation of bright lignite and subsequently of hard coal, the final stage of which is anthracite.

During metamorphism, the principal chemical transformations are as follows:

— increase in carbon content and diminution of oxygen and hydrogen content;

— diminution (in general) of volatile matter content;

— increase of calorific value to a maximum in coals with about 20 per cent. volatile matter.

While increase of temperature modifies the chemical composition of coal, increase of pressure (depth of burial and tectonic movements) affects primarily the physical properties of the coal, e.g. hardness, strength, optical anisotropy, porosity.

Rank (q.v.) is the stage reached by a coal in the course of its carbonification.

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[1] STANDARD, Edition of 31 st January, 1883, London, p. 5, column 3.

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

CARBOPYRITE

Hard coal
R. L.

I — ORIGIN OF TERM

The term carbopyrite was introduced by Hevia [1] in 1960 to designate a microlithotype containing 5-20 % by volume of iron disulphide (pyrite, marcasite and melnikovite) and was adopted in 1962 by the International Nomenclature Sub-Committee.

II — DESCRIPTION

An intimate association of various microlithotypes with 5-20% by volume of finely accreted pyrites—or less commonly of pyrite deposited in fine hair cracks—generally less than 10 μ in grain size. The pyrites has usually a golden-yellow colour by reflected light, and exhibits distinct relief. Excluding pressure-induced anisotropy (undulant extinction), inclusions of pyrites and melnikovite are isotropic, whereas marcasite in conformity with its crystal structure is anisotropic. Some accretions of pyrites may be found arranged in a manner of linked beads.

Any microlithotype containing the appropriate amount of pyrite constitutes carbopyrite. In microscopic analysis only bands of carbopyrite greater than 50 μ are recorded.

In addition to pyrites, carbopyrite may contain clay minerals, quartz or mineral carbonate in amounts up to 20 % by volume (cf. carbargilite and carbankerite).

Intergrown coal and pyrites containing more than 20 % by volume of pyrites is classified as "rock" since the density of such material is more than 2.0.

Carbopyrite has between 5 and 25 % of ash if there are no other mineral inclusions.

The density varies between 1.5 and 2.0 depending on the pyrites content.

III — OCCURRENCE

Widely distributed in quantities which vary considerable. It is generally particularly abundant in seams having a marine roof and such occurrences are sometimes useful in seam identification and correlation.

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[1] Hevia (V.). Reuniones Internationales sobre petrografia del carbon. Bol-Inform. Inst. Nac.-Carbon. 9, 48, (1960), p. 90-91.

IV — PRACTICAL IMPORTANCE

In coal preparation practice carbopyrite, like carbargilite and carbankerite, falls into the category of "true intergrown coal", the pyrites being so intimately associated with the coal that it is generally impossible to free it by crushing. As an exception to this, pyrite occurring in fine hair cracks is freed to some extent by crushing and appears in the prepared coal as minute spangles. In the normal course of coal preparation carbopyrite remains in "middlings", and, as a result, is a common constituent of steam raising coals. High sulphur in such coals furthers both the formation of deposits on, as well as corrosion of, the heating surfaces. In addition it raises the SO_2 and the SO_3 content of the flue gases.

When carbopyrite occurs in appreciable proportions in washed coal, the sulphur content of the coke and the carbonization by-products may be raised to an undesirable level. Carbopyrite is also undesirable in hydrogenation and gasification processes. It is possible that carbopyrite increases the liability of spontaneous combustion in a coal, especially if the iron sulphide is in the form of melnikovite or marcasite.

Carbopyrite shows no tendency to form dust.

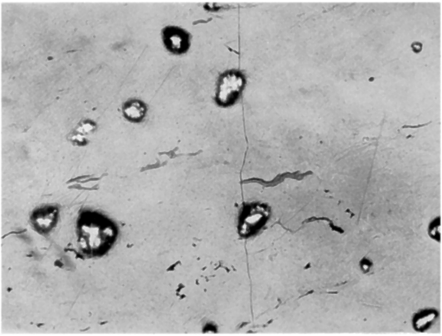
Fig. 1.

Carbopyrite with finely accreted pyrites.
German coal (Ruhr, 31 % V.M.)
Thin section in reflected light, oil immersion, 250 ×.

Fig. 2.

Carbopyrite with pyrite deposited in fissures.
German coal (Ruhr, 32 % V.M.)
Thin section in reflected light oil immersion, 180 ×.

CARBOPYRITE - CARBOPYRIT



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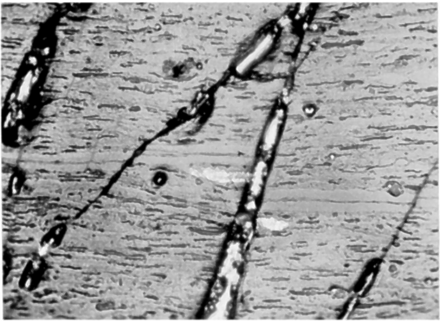

2

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

CAUSTOBIOLITH

General
Term

In 1908 H. Potonie[1] described caustobioliths as “die flussigen oder festen, brennbaren, kohlenstoffhaltigen fossilen, subfossilen oder nach ihrem Absterben gebildeten rezenten Produkte der Lebewesen” (liquid, or solid, carbon containing fossil or semi-fossil combustible matter, or recent products deriving from formerly live organisms). The following definition was given at the Nomenclature Colloquium of the Prussian State Geol. Dept. (vol. 58, p. 428) : —

“The term caustobiolith designates a rock with a fairly high content of organic carbon compounds or even pure carbon where the latter is, like the carbon compounds, of organic origin.”

The caustobioliths comprise the humoliths, saproliths and liptobioliths.

The term was first used in 1906 in p. 3 of the “Protokoll uber die Versammlung der Direktoren der Geologischen Landesanstalt der Deuschen Bundesstaaten” (Minutes of the Sept. 1906 Directors’ Meeting of the Federal German Geological Institute at Eisenach), and subsequently appeared in p. 154 of the 1908 Edition of the “Prussian Acad. of Sciences Conference Minutes[1]”

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[1] Potonie (H.). Eine Klassifikation der Kaustobiolithe. Sitzber. Königl. Preuss. Ak. Wiss. phys. math. Cl., *6*, (1908), p. 154-165.

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **CLARAIN** (Stopes-Heerlen System)	Hard coal

I — ORIGIN OF TERM

The term clarain was introduced by M.C. Stopes [1] in 1919 to designate the *macroscopically* recognizable bright lustrous constituent of coal, which, in contrast to vitrain, is intrinsically striated by dull intercalations. Nowadays the term is used to describe all finely striated bands of coal which have an appearance intermediate between vitrain and durain.

Synonyms: charbon semibrillant, Halbglanzkohle.

II — DESCRIPTION

Bands of variable thickness having a lustre between that of vitrain and durain.

Conventionally the thicknesses of the fine, bright and dull striations must be less than 3 mm; — if greater than this they should be considered as thicknesses of separate lithotypes:

In macroscopic descriptions of seams, only bands having a thickness of several mm. are usually recorded as clarain [2].

Examination with the microscope shows clarain may have very variable composition of macerals from the three groups, vitrinite, exinite and inertinite.

III — OCCURRENCE

Clarain is, as a general rule, the most widely distributed and common macroscopic constituent of all humic coals.

---

[1] Stopes (M. C.). On the four visible ingredients in banded bituminous coals. Proc. Roy. Soc., Series B, *90*, (1919), p. 470.

[2] The minimum thickness varies from 3 to 10 mm. in different countries.

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

CLARITE

(Stopes-Heerlen System)

Hard coal
R. L.

I — ORIGIN OF TERM

R. Potonie[1], 1924.

In 1955 the Nomenclature Sub-Committee resolved to use this term for the microlithotype consisting principally of vitrinite and exinite.

II — DESCRIPTION

Contains at least 95 % of vitrinite and exinite. The proportions of these two macerals may vary widely but each must be greater than the proportion of inertinite, and neither must exceed 95 %. Distinction may be made between spore clarite, cuticular clarite, and resinous clarite. Clarite V. and clarite E. connote clarains rich in vitrinite and exinite respectively.

In petrographic analysis it is conventional to record only bands of clarite more than 50 microns wide.

The density of clarite with average maceral composition varies between 1.2 and 1.7 according to the rank of the coal: in any given coal of low rank (with more than 25 % V.M.) it varies inversely with the exinite content.

The strength varies between 26 and 85 kg/mm^2: it is generally greater than that of vitrite, but this difference diminishes with increasing rank.

May contain inorganic impurities, principally clay minerals, pyrites, and carbonates.

III — OCCURRENCE

Widely distributed and very common, particularly in clarain type coals. Occurs in fairly thick bands.

IV — PRACTICAL IMPORTANCE

1. *Preparation.*

Exinite confers on clarite a tendency to fissure less than, and a strength greater than vitrite.

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[1] Potonie (R.). Einführung in die allgemeine Kohlenpetrographie. Berlin, Verlag Borntraeger, (1924), p. 34.

Particle size and the breaking characteristics depend on the exinite content of the clarite and also on the thickness of the bands occurring naturally in the seam. Clarite tends to concentrate in grain sizes greater than 1 mm.

2. *Carbonization.*

In caking coals, clarite contributes outstandingly to coking ability by reason of its high swelling properties and good plasticity. The yield of by-products varies with the exinite content.

3. *Hydrogenation.*

In coals with more than 25 % V.M. the clarite is readily hydrogenated. This seems related to the high hydrogen content of the contained exinite. No data are available regarding the hydrogenation of clarite in higher rank coals.

4. *Oxidizability.*

In coals with more than 14 % V.M. is less oxidizable than vitrite, irrespective of the type of oxidizing agent. Shows some tendency to spontaneous combustion.

5. *Formation of dust.*

Because of its strength clarite generally does not tend to form dust.

Fig. 1.

Spore clarite. Megaspore and microspores with vitrinite.
High-Volatile American coal. Polished thin section
in reflected light, oil immersion. 200 ×.

Fig. 2.

The same in transmitted light.

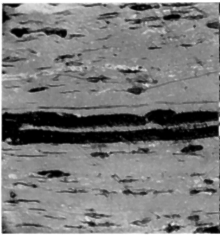
Fig. 3.

Resinous clarite (French coal 37 % V.M.). Polished section
in reflected light, oil immersion. 350 ×.

Fig. 4.

Cuticular clarite (French coal 37 % V.M.). Polished section
in reflected light, oil immersion. 180 ×.

CLARITE - CLARIT



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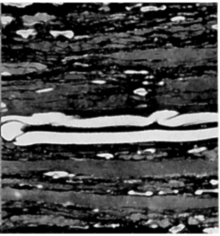

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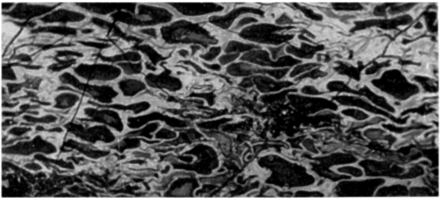

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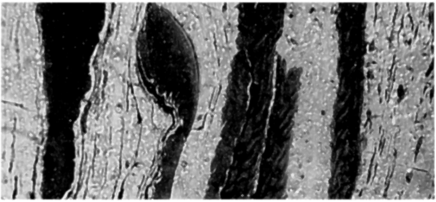

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1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee	Hard coal R. L.
	CLARODURITE (Stopes-Heerlen System)	

I — ORIGIN OF TERM

The term "clarodurain" was introduced by G.H. Cady [1] in 1942, and in the modified form clarodurite was adopted by the Nomenclature Sub-Committee in 1956 to designate the microlithotype with maceral composition between that of clarite and durite but closer to durite than to clarite.

II — DESCRIPTION

Maceral composition :

- vitrinite > 5 per cent;
- exinite > 5 per cent;
- inertinite > 5 per cent.

The further specification is that the proportion of inertinite must exceed that of vitrinite.

In petrographic analysis only bands more than 50 microns wide are recorded.

The density varies, depending on rank, between 1.25 and 1.7. For a coal of given rank and more than 25 % V.M. the density depends on the exinite and inertinite contents.

[illegible] strength varies between 30 and 80 kg/mm². It is generally greater than that of clarite, but the difference decreases with increasing rank.

May include various mineral impurities (clay minerals, pyrites, siderite, etc.).

III — OCCURRENCE

Occurs in fairly thick bands.

Widely distributed and, like duroclarite, is a common constituent of most humic coals.

---

[1] Cady (G. H.). Modern concepts of the physical constitution of Coal. J. Geol., *50*, (1942), p. 341.

IV — PRACTICAL IMPORTANCE

The technological properties of clarodurite are intermediate between those of durite and those of clarite, but because of the predominance of inertinite over vitrinite they resemble those of durite more closely than those of clarite.

Fig. 1.

Clarodurite from an American coal (35 % V.M.).
Polished thin section in reflected light,
oil immersion. 500 ×.

Fig. 2.

The same in transmitted light. 500 ×.

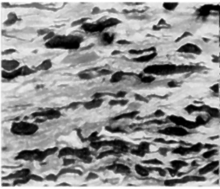
Fig. 3.

Clarodurite from a Belgian coal (33.5 % V.M.).
Horizontal plane.
Polished section, oil immersion. 180 ×.

Fig. 4.

Clarodurite from a French coal (Jura, 37 % V.M.).
Polished section in reflected light,
oil immersion. 600 ×.

CLARODURITE - CLARODURIT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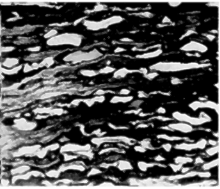
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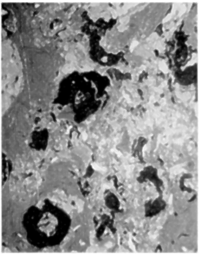
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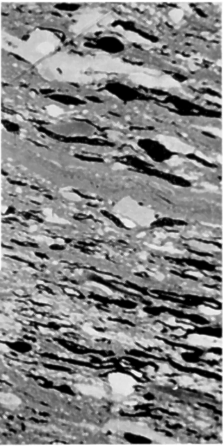
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1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

General
Term

COAL BALL

I — ORIGIN OF TERM

First described from English coal seams by Binney[1] in 1841.

Synonyms: Torf dolomite.

Analogous terms: seam nodules, plant bullion, nodule calcaire, nodule dolomitique, ugolnaja potschka.

II — DESCRIPTION

Coal balls are nodules of sphaeroidal, lenticular or irregular shape containing "petrified" plant remains and in some cases animal remains[2].

They vary in size from about 1 cm to 40 cm or more: occasional specimens weigh more than 1 ton. Infrequently an entire seam in a restricted area consists largely of coal balls.

Coal balls consist mainly of calcareous, dolomitic, sideritic, pyritic or siliceous material surrounding or impregnating plant and animal remains.

Anatomical detail of the plant structures is best preserved in calcareous and siliceous coal balls. Plant structures have occasionally been seen to continue from one coal ball to another (Stopes and Watson, 1909)[2].

Calcium and magnesium carbonate are the predominant components of the dolomitic or calcareous balls, but small amounts of manganese and iron carbonate also occur. In some balls iron pyrites may be considerable. The amount of carbonaceous matter is in general slight.

IV — OCCURRENCE

They occur in brown coals (mainly sideritic balls) as well as in coals of higher rank generally lying within the coal seam but occasionally in the roof. Calcareous, dolomitic and pyritic coal balls are commonly found in seams having marine strata in the roof. The distribution in seams is variable: they may occur in a broad zone running through the coal bed or be distributed irregularly in "nests".

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1. Binney (E. W.). Remarks on the marine shells found in the Lancashire coalfield. Trans. Manch. Geol. Soc., *1*, (1841), p. 80-89.

2. Mamay (S. H.) and Yochelsen (E. L.). Floral-faunal associations in America coal balls. Science, 118 (1953), p. 240-41.

3. Stopes (M. C.) and Watson (D.M.S.). On the present distribution and origin of the calcareous concretions in coal seams known as "coal balls". Phil. Trans. Roy. Soc. Lond. Series B., 200, (1909), p. 167-218.

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **COAL CONSTITUENT CLASSIFICATION** (Spackman System)	Brown coal Hard coal R. L.

In the United States it is generally agreed that the maceral concept of the nomenclature Stopes-Heerlen System, fails to comprehend the effect of the stage of coalification on the nature of coal constituents.

Spackman's [1] interpretation of the maceral concept incorporates the ideas of variable coalification (as described by Schopf [2]) in suggesting a skeletal framework upon which a systematic classification can be built. The maceral concept, as interpreted by Spackman, implements the classification of the products of coalification. In this scheme, macerals possessing similar chemical and physical properties are assembled into maceral groups which can, in turn, be characterized by a comparatively restricted set of properties. Maceral groups possessing similar characteristics can be classified into maceral suites.

Chapiro and Gray[3] have developed a descriptive procedure that is consistent with the concepts of Schopf[2] and one that renders the concept of Spackman useful in quantitative terms. This has been done by arbitrarily dividing the now poorly differentiated maceral materials into "entity types" that can be identified with a high degree of precision. Each entity type represents a particular level in the coalification of a certain material, thus rendering the expression of petrographic composition meaningful in terms of utilization as well as geologic history. The final differentation of entities is achieved by reflectance measurements made on the material in question. The method of instrumentation used in the accumulation of coal-reflectance data is basically that of McCartney[4].

It is apparent that the classification described herein is not new in the sense of ideas but is new in terms of its organization and quantification and offers the opportunity to accumulate comparable data in many laboratories. It is, in fact, simply a refinement and amplification of the classification Stopes-Heerlen.

In the classification of Spackman presentend in the accompanying table the *Maceral Suites* reflect a particular source material or mode of preservation of a particular source material. The relative proportions of the various suites or assemblages

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[1] Spackman (W.). The maceral concept and the study of modern environments as a means of understanding the nature of coal. Trans. New York Ac. Sci., ser. II, *20*, No. 5, (1958), p. 411-423.

[2] Schopf (J. M.). Variable coalification, the processes involved in coal formation. Econ. Geol., *43*, No. 3, (1948), p. 207-225.

[3] Schapiro (N.) and Gray (R.J.). Petrographic classification applicable to coals of all ranks. Proc. Illinois Min. Inst., 68th Year, (1960), p. 83-97.

[4] McCartney (J. T.). A study of the Seyler theory of coal reflectance. Econ. Geol., *47*, No. 2, (1952), p. 202-219.

of suites determine the varieties of coal (bright, semi-splint, splint, or cannel) and the sizes and degree of concentration of the suites of materials determine the banded nature of the coal.

For more specific descriptions, the suites are subdivided into *Maceral Groups* that are broadly analogous to mineral or chemical groups. The subdivision into groups is based on the thermal behavior and texture. For instance, the vitrinite suite is subdivided into three groups: the reactive vitrinoids, which soften and resolidify during carbonization; the inert anthrinoids, which remain relatively unaltered during carbonization; and the xylinoids, which form only a char and do not exhibit plastic properties when carbonized.

Each group is subdivided into *Entity Types.* The entity types are specific stages in the maturation of the maceral materials. The entity types are the most detailed working units in the classification. The maceral groups are subdivided into entity types on the basis of arbitrary reflectance categories, each of which represents 0.1 per cent maximum reflectance in oil. Thus the entity subdivisions are sufficiently small to permit detailed descriptions of coals. For less critical analysis, the entities can be presented in groups or in reflectance ranges that encompass several entity types within a group. For convenience in interpretation of analysis, the letter and number designation of the entity type can be translated directly into reflectance; for example, in the vitrinoid group, a reflectance range of 0.60 to 0.69 per cent in oil has been designated as Vitrinoid Type 6 (V6) and a reflectance range of 0.70 to 0.79 per cent in oil has been designated as Vitrinoid Type 7 (V7), etc.

Coal constituent classification, 2.

STOPES-HEERLEN SYSTEM	CLASSIFICATION IN U.S.A. (SPACKMAN/SYSTEM)				
Maceral-Group	*Maceral-Suite*	*Maceral-Group*	*Range of maximum reflectance (per cent.) under oil*	*Other distinguishing characteristics* [1]	*Macerals* [2]
Vinitrite	Vitrinite suite	Anthrinoid Group	2.50-10.00	Opaque in transmitted light. Greyish-white in reflected light.	A_{25}-A_{100}
		Vitrinoid Group	0.40- 2.40	Translucent in transmitted light — usually yellow, red or brown. Grey in reflected light.	V_4-V_{24}
		Xylinoid Group	0.10- 0.39	Translucent in transmitted light — usually buff, whitish-yellow to yellowish-brown. Dark grey in reflected light.	X_1-X_3
Exinite	Liptinite suite	Exinoid Group	0.05- 1.50	Coalified spore, pollen, cuticular or endodermal materials. Translucent in transmitted light — whitish-yellow, yellow, golden yellow or red. Black, dark grey to light grey in reflected light.	E_0-E_{15}
		Resinoid Group	0.05- 1.50	Coalified resins or other plant secretions or exudates. Translucent in transmitted light — whitish-yellow, yellow to red. Black, dark grey to light grey in reflected light.	R_0-R_{15}
Inertinite	Inertinite suite	Fusinoid Group	4.00- 10.00	Characteristics essentially those of fusinite (STOPES-Heerlen System).	F_{40}-F_{100}
		Semi-Fusinoid Group	0.20- 3.99	Characteristics essentially those of semifusinite (STOPES-Heerlen System).	SF_2-SF_{39}
		Micrinoid Group	0.20- 8.00	Characteristics essentially those of micrinite (STOPES-Heerlen-System).	M_2 M_{80}

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1. Descriptions for transmitted light refer to thin sections of standard thickness.
2. Provisionally differentiated into "Entity Types" and designated by type numbers (when adequately circumscribed names will be assigned ending in "-inite").

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **COAL**	General Term

I — ORIGIN OF TERM

Uncertain—carrying back a long way into history.

II — DEFINITION

1. Coal is a combustible sedimentary rock formed from plant remains in various stages of preservation by processes which involved the compaction of the material buried in basins, initially of moderate depth.

These basins are broadly divided into limnic (or intra-continental) basins, and paralic basins which were open to marine incursions. As the underlying strata subsided progressively, and more or less regularly but sometimes to great depths, the vegetable debris was subjected to the classical factors of general metamorphism, in particular those of temperature and pressure.

2. Coals are characterised:

— by their *Type*, determined by the nature of the plant remains, and the conditions of deposition;

— by their *Rank* (q.v.).

The variations in rank are of greatest importance in the classification of coals. Increasing metamorphism results in important changes in all the properties of coal.

3. Under the microscope, almost all coal appears heterogeneous. The various constituents, called *macerals*, occur in characteristic associations, *microlithotypes*, which may include in more or less intimate mixture 0-20% by volume of mineral matter.

The amount of mineral matter which coal can contain and still retain its name depends on commercial considerations which vary from one country to another.

The different bands recognized by the unaided eye in humic coals are called *lithotypes*.

The physico-chemical properties of the maceral vitrinite (q.v.) are commonly used to characterize and classify scientifically coals of the higher levels of rank i.e. the *hard coals*, or those designated *houilles* in French.

III — DESCRIPTION (not applicable to peat)

Solid and opaque, except in thin section; non-crystalline; varies in colour from light brown to black. Humic coals (q.v.) are banded whilst sapropelic coals, cannel, and boghead are of unstratified appearance; of dull to glossy lustre according to rank, petrographic composition (inclusive of minerals) and tectonic factors.

Density: 1.0 — 1.8.

Strength: fairly weak, 0.5 — 2.5 kg/cm^2.

The fragility of coal varies with rank and may be quite marked especially when it has a very high fusain content or when it has been subject to pressure from surrounding strata. Coal usually fractures irregularly and raggedly, but sometimes conchoidally. The fracture surfaces vary according to the lithotype, being smooth in vitrain, granular in durain and fibrous in fusain. Vitrain breaks very readily, and coal containing large bands of fusain also disintegrates easily. Banded coals frequently exhibit systems of cracks normal to the stratification (endogenous cracks). Other fissuring attributable to tectonic conditions (exogenous cracks) may run in various directions.

Other properties: see under RANK and the various petrographic constituents.

IV — OCCURRENCE

Certain coalfields contain no more than one single, thick seam of coal; others contain a large number (sometimes several hundred). The seams are separated by beds of shale or sandstone of varying thickness. In certain coalfields some seams extend laterally for considerable distances with a relatively uniform thickness. Other seams vary considerably in thickness. Seams may split into two or more beds (dichotomy).

Coal is chiefly won from Permian and Carboniferous strata, although it occurs from the Devonian to the Tertiary. The distribution of reserves in the different geological formations were estimated in 1937 to be :

Tertiary:	54 %
Cretaceous:	0.3 %
Jurassic:	4 %
Triassic:	0.5 %
Permian:	17 %
Carboniferous:	22 %

In 1958 [1] estimates of the solid fuel reserves of the world—including probable as well as established reserves at all depths were as shown in the table below.

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[1] LARDINOIS (P.). Les réserves mondiales de combustibles minéraux solides. Annales des Mines de Belgique, 2, (1958), p. 93-153.

Coal Reserves in Millions of Tons (Metric, long or short)

COUNTRY	COALS		LIGNITES	
	Minimum	Maximum	Minimum	Maximum
North America	1.324.400	2.051.200	501.080	2.054.301
South America	15.705	38.688	27.986	70.586
Africa	73.226	221.468	200	300
U.S.S.R.	902.000	1.350.000	199.000	301.000
Europe	257.503	704.142	138.022	175.390
Oceania	36.015	42.400	13.719	170.410
Asia	264.536	4.107.057	2.729	8.196
Total	2.873.385	8.514.935	882.736	2.780.183

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee	Hard coal R. L.
	COLLINITE [1] (STOPES-Heerlen System)	

I — ORIGIN OF TERM

M.C. STOPES [2], 1935.

Synonyms: ciment amorphe, pâte, gelée, or substance fondamentale (A. DUPARQUE and E. BERTRAND), collit (W.J. JONGMANS), desmit (I. AMMOSOV).

Analogous term: anthraxylon = collinite in bands more than 14 microns in thickness.

II — DESCRIPTION

Without visible botanical structure (see III). Frequently, however, material defined as collinite on this basis by reflected light shows cellular structure by transmitted light.

Colour: in R.L. grey, becoming yellowish white in coals of increasing rank; in T.L. orange to dark red.

R: ca. 0.5 to 7 % in oil immersion; ca. 6 to 15 % in air.

Large areas show anisotropy. The degree of anisotropy is a function of rank.

In R.L. and in sections perpendicular to stratification, the anisotropy is measurable generally in coals with more than 90% carbon, $\frac{\text{R min.}}{\text{R max.}}$ changing from 0.96 to 0.30 with increase in rank above this.

In T.L. anisotropy can be detected from the first stages of carbonification; it is always more intense than in R.L.

The density (by displacement of liquid) varies between 1.2 and 1.7 depending on rank.

The true density (determined in helium) has a minimum value in coals with about 89 % C.

The micro-hardness varies, depending on rank, from 30 to more than 100 kg/mm^2 with a minimum value in coals with about 89 % C.

Relief is less pronounced than that of most other macerals; for this reason collinite is chosen as the basis of reference.

---

[1] See vitrinite.

[2] STOPES (M. C.). On the petrology of banded bituminous coal, Fuel, *14*, (1935), p. 4.

III — OCCURRENCE

Constitutes a matrix, cement, or impregnating material for fragments of all other macerals and associated minerals.

Very generally the cell-filling of telinite.

Is sometimes intimately mixed with resinite.

Infrequently it forms a secondary filling of fissures (see Fig. 2).

With telinite, widely distributed in vitrite and clarite in discrete bands of varying thickness.

IV — PRACTICAL IMPORTANCE

See vitrite.

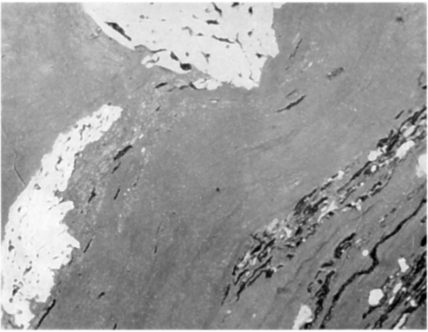
Fig. 1.

Collinite cement in a French coal (Lorraine, 37% V. M.).
Polished section in reflected light, oil immersion. 300 ×.

Fig. 2.

Collinite forming the matrix of clarite and secondary filling of fissure in a Turkish coal (Zonguldak).
Polished section in reflected light, oil immersion. 250 ×.

COLLINITE - COLLINIT



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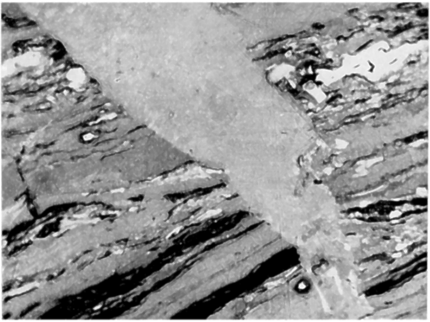

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1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **COMPONENT OF COAL** (Thiessen-Bureau of Mines System)	Brown coal Hard coal T. L.

I — ORIGIN OF TERM

The term component was introduced in 1920 by R. Thiessen [1]. In discussing the various petrographic layers or bands of banded bituminous coal, he refers to these layers or bands as components of coal.

II — DEFINITION

In the sense used by Thiessen components of coal are petrographic entities, recognizable visually as bands or layers of coal that have distinctive physical appearance and characteristic *microstructural* features from coal to coal. Thus the component anthraxylon is described as representing bright, glossy bands of coal that under the microscope always show traces of more or less well preserved cellular tissues indicating its derivation from woody plant material. Thiessen recognized three components of banded bituminous coals: *anthraxylon, attritus and fusain.*

III — CORRELATION WITH TERMS OF THE STOPES-HEERLEN NOMENCLATURE

The term component is somewhat comparable with the term microlithotype.

---

[1] Thiessen (R.). Compilation and composition of bituminous coals. J. Geol., *28*, 3, (1920), p. 185-200.

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

CONSTITUENT OF ATTRITUS

(Thiessen-Bureau of Mines System)

Brown coal
Hard coal
T. L.

I — ORIGIN OF TERM

The word constituent, although it has its prevailing general usage, has been commonly, and more or less consistently, used by the Bureau of Mines, since this conventional usage was adopted by Thiessen in 1931 [1].

II — DEFINITION

Constituents are the petrographic entities of the attritus which are recognizable in thin sections only by the microscope. According to Thiessen [2] and Parks & O'Donnel [3] the following constituents may be distinguished in coals:

- translucent humic degradation matter.
- brown or semitranslucent matter.
- opaque matter
  - granular opaque matter.
  - massive opaque matter.
- resins and resinous matter.
- spores and pollen.
- cuticles and cuticular matter.
- algae and algae matter.

III — CORRELATION WITH TERMS OF THE STOPES-HEERLEN NOMENCLATURE

The term *constituent*, which applies mainly to the microscopic entities composing the attritus in the Bureau of Mines terminology, is equally applicable to the macerals of the Stopes-Heerlen system although its use has not been so definitely restricted.

---

[1] Thiessen (R.) in Fieldner (A. A.), Davis (J. D.), Thiessen (R.), Kestner (E. B.) & Selvig (W. A.). Methods and apparatus used in determining the gas-coke and by-product making properties of American coals. U.S. Bur. Mines Bull., 344, (1931), p. 64.

[2] Thiessen (R.). What is coal ? Paper pres. Fuel Eng. Conf. spons. by Appalach. Coals Incorp. Detroit, June 15, (1937).

[3] Parks (B. C.) & O'donnell (H. J.). Petrography of American coals. Bur. Mines Bull., 550, (1956), p. 5-6.

Correlation of the nomenclature THIESSEN-Bureau of Mines (thin section method) with the nomenclature STOPES-Heerlen [1] (polished block method).

TRANSMITTED LIGHT			REFLECTED LIGHT	
SYSTEM THIESSEN-BUREAU OF MINES			SYSTEM STOPES-HEERLEN	
Banded components	*Constituents of attritus* [2]		*Macerals*	*Groups of macerals*
Anthraxylon (translucent)			Vitrinite more than 14 μ in width.	Vitrinite.
Attritus	Translucent attritus	Translucent. Humic matter.	Vitrinite lees than 14 μ in width.	Exinite.
		Spores, pollen. Cuticles, algae.	Sporinite, cutinite, alginite.	
		Resinous and waxy subst.	Resinite.	Inertinite.
		Brown matter. (semitranslucent).	Weakly reflecting semifusinite. Weakly reflecting massive micrinite. Weakly reflecting sclerotinite.	
	Opaque attritus	Granular opaque matter.	Granular micrinite.	
		Amorphous (massive) opaque matter. Finely divided fusain, sclerotia.	Fusinite less than 37 μ in width. Strongly reflecting massive micrinite. Strongly reflecting sclerotinite.	
Fusain (opaque)			Fusinite and semifusinite more than 37 μ in width.	

Transmitted light			Reflected light	
System thiessen-bureau of mines			System stopes-heerlen	
	Types of coal	*Quantitative statements :*	*Microlithotypes*	
Banded coals	Bright coal	More than 5 per cent. anthraxylon.	Vitrite.	
		Less than 20 per cent. opaque attritus.	Clarite.	
	Semisplint coal	More than 5 per cent. anthraxylon. 20-30 per cent. opaque attritus.	Duroclarite. Vitrinertite.	
	Splint coal	More than 5 per cent. anthraxylon. More than 30 per cent. opaque attritus.	Clarodurite.	
Non-banded coals	Cannel coal	Less than 5 per cent. anthraxylon.	Durite [3].	Cannel.
	Boghead coal	Less than 5 per cent. anthraxylon.		Boghead.

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1. An exact correlation of the two systems is not possible (see the sheets concerned).

2. For the recognizable botanical entities (for instance "spores", "cuticles") the term "phyteral" may be employed.

3. Durite is part of banded coals with less than 5% vitrinite that would be placed by definitions in the nonbanded coals in the Thiessen-Bureau of Mines system.

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

CUTINITE COAL

(System of Geol. Inst. Acad. Sci. U.S.S.R. Moscow)

Brown coal
Hard coal
T. L.

I — ORIGIN OF TERM

The term was introduced in 1956 by KRYLOVA, WALZ, GINSBURG and LUBER [1].

II — DESCRIPTION

Cutinite coal consists of more than 50% of cuticle. The fragments of cuticle occur embedded in gelito-collinite, fusinito-collinite and collinite of fusinitic nature.

In addition to cuticle, spores, resin bodies and fragments of finely fusinised and gelified tissue are present. Leaf parenchyme and stem tissue, bordered by cuticle, may also be seen.

Hand specimens of this type of coal are greyish-black, matt or semi-matt, finely striated or sometimes even banded. It breaks angularly, and generally has high ash.

III — OCCURRENCE

Cutinite coal occurs as thin bands in seams of different geological age.

V — PRACTICAL SIGNIFICANCE

The use of cutinite coal is largely determined by the other forms of coal with which it is associated.

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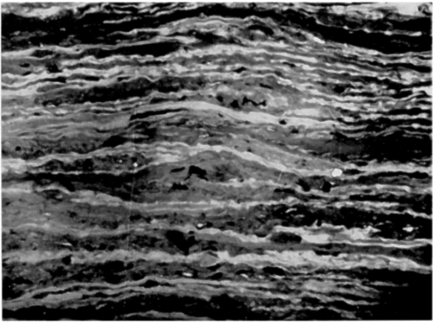
[1] KRYLOVA (N. M.), WALZ (I. E.), GINSBURG (A. I.) and LUBER (A. A.). The terminology and fundamental classification of the petrographic constituents of humic coals. Akad. Nauk SSSR, Trudy Labor. coal Geol., *6*, (1956), p. 42-53.

Fig. 1.
Cutinite coal (cutinite and gelito-collinite) from a Russian seam.
Transmitted light, 200 ×.

Fig. 2.
Cutinite coal (cutinite and gelito-collinite) from a Russian seam (Irkoutsk).
Transmitted light, 200 ×.

CHARBON DE CUTINIT
KUTINIT KOHLE
CUTINITE COAL



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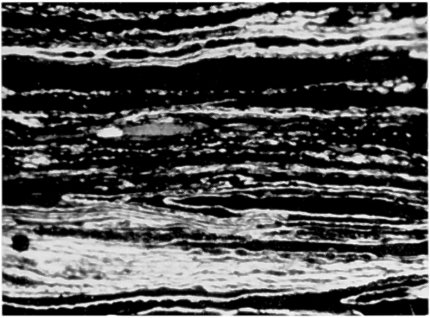


2

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

CUTINITE

(Stopes-Heerlen System)

Hard coal
R. L.

I — ORIGIN OF TERM

M.C. Stopes [1], 1935.
Synonym: Cuticular substance.

II — DESCRIPTION

Constituent formed from cuticles.

Perpendicular to stratification, cuticles appear in the form of more or less narrow bands, one edge of which is often serrated; in other planes of section cuticles may sometimes be confused with macrospores.

Colour: by R.L. cutinite is dark grey to black, (slightly lighter than the corresponding sporinite) in coals with more than 29 % V.M.: the colour lightens with increasing rank, and in coals with less than 20 % V.M. it is rarely distinguishable from vitrinite; however, it can sometimes be recognized again in coals with less than 12 % V.M. by using polarised light.

In T.L. the colour of cutinite varies with rank, being orange yellow in coals with more than 35 % V.M., and brownish red in those with 20-35 % V.M.: it has the same colour as vitrinite in coals with less than about 20 % V.M.

R : no precise figures are available as yet.

Density : similar to that of sporinite.

Micro-hardness and relief : similar to those of sporinite.

III — OCCURRENCE

Important constituent of certain clarites. Present in nearly all coals, but rarely abundant.

IV — PRACTICAL IMPORTANCE

1-5. *See exinite.*

6. *Stratigraphy.*

Morphographic studies of cuticles have been used in stratigraphy. (K.A. Jurasky)[2].

---

[1] Stopes (M. C.). On the petrology of banded bituminous coal. Fuel, *14*, (1935), p. 4.

[2] Jurasky (K. A.). Kutikular-Analyse, Biologia Generalis, *10*, (1934)p. 383-402; *11*, (1935), p. 227-244; *11*, 2 part, p. 1-26.

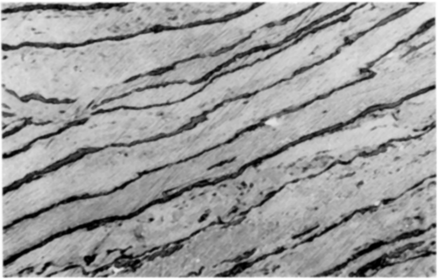
Fig. 1.

Tine cuticles in a French coal (Lorraine, 37 % V.M.)
Polished section in reflected light,
oil immersion. 300 ×

Fig. 2.

Thick cuticles in a high-volatile German coal
(Ruhr, 41 % V.M.)
Polished section in reflected light,
oil immersion. 110 ×

CUTINITE - KUTINIT



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1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

DEGRADINITE

Brown coal
Hard coal
R. L.

I — ORIGIN OF TERM

The term *degradinite* was introduced at the "Seminar for Coal Petrology" held in Japan in 1952. In 1955 K. ASAI proposed to the International Nomenclature Sub-Committee that this term should be accepted to describe the most common constituent of the Tertiary coals of Japan.

Analogous term: degradinite is part of the "translucent humic degradation matter" of R. THIESSEN.

II — DESCRIPTION

Degradinite resembles vitrinite and has no definite form.

Colour : in R. L., varies with increasing rank from dark grey to whitish grey; in general it is darker than the colour of vitrinite, but lighter than that of exinite of the same coal.

In T.L., varies with increasing rank from yellowish brown to reddish brown and is brighter than that of the corresponding vitrinite.

R: not yet exactly determined, but lower than that of vitrinite.

Relief: practically none as against vitrinite.

III — OCCURRENCE

Degradinite forms the groundmass of the hydrite of Japanese Tertiary coals and encloses exinite, resinite and sclerotinite. Micrinite, fusinite and semifusinite are less commonly associated with it.

IV — PRACTICAL IMPORTANCE

See hydrite,

Fig. 1.

Degradinite (medium grey) and vitrinite (light grey) in a bright lignite from the Oligocene of Upper Bavaria.
Polished thin section in reflected light, oil immersion, 600 ×.

Fig. 2.

The same in transmitted light, 600 ×.
(The degradinite is lighter than the vitrinite).

DEGRADINITE - DEGRADINIT

1

2

1963
EDITION

International Committee for Coal Petrology

DOPPLERITE

Brown coal

I — ORIGIN OF TERM

The term dopplerite was introduced by W. Haidinger[1] in 1849. It is applicable only to material occuring in *peat* and *soft brown coal*. Collinite would be used for analogous material in *hard brown coal*, which resembles hard coal. According to R. Potonie[2], distinction should be made between secondary "*true dopplerite*", recently formed in fissures in soft brown coal, and "fossil dopplerite" (Zittavite) originating at the peat stage of soft brown coal.

Synonyms: Torf-Dopplerit, Weichbraunkohlen-Dopplerit.

Analogous terms: peat gel, brown coal gel.

II — DESCRIPTION

A black gelatinous material, solidifying as a result of loss of water to a black lustrous solid.

Colour: by R.L. dark grey to grey. In T.L. yellow-red to dark red.

Reflectance: usually stronger than the associated humic material.

Anistropy: isotropic.

Relief: slight.

Dopplerite chemically consists principally of free humic acids or as humic acid salts such as calcium humate.

III — OCCURRENCE

First described in the peat deposit at Kaimish near Mark Aussee in Styria (true dopplerite). Fills cracks and dry fissures in peat and brown coal, and also occurs as secreted masses or "nests" (fossil dopplerite). May occur in veins (Hummel's lustrous veins in brown coal[3]). Widely disseminated in microscopic form in soft brown coal. Sometimes associated with sand beds (Vogelsberg, Rhön).

---

1. Haidinger (W.). Sitzber. Akad. Wiss., Vienna, *2*, (1849), p. 287.
2. Potonie (R.) and Stockfisch (K.). Ueber Oxyhumodile. Mitt. Lab. preuss. geol. Landesanst., *16*, (1932), p. 1-37.
3. Hummel (K.). Glanzkohlengänge in der Braunkohle des Habichtwaldes. Z. deutsch. geol. Ges., *82*, (1930), p. 489-497.

IV — PRACTICAL IMPORTANCE

The properties of dopplerite are valueless for coal upgrading. Appreciable proportions of dopplerite have a detrimental effect on the strength of brown coal briquettes and brown coal coke. Dopplerite can be used as pigment in paints or colouring materials.

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **DURAIN** (Stopes-Heerlen System)	Hard coal

I — ORIGIN OF TERM

The term durain was introduced by M.C. Stopes [1] in 1919 to designate the *macroscopically* recognizable dull bands in coals.

Synonyms: charbon mat, Mattkohle.

Analogous terms: splint coal, dull coal.

II — DESCRIPTION

Bands of durain are characterised by their grey to brownish black colour and rough surface with dull or faintly greasy lustre: reflection is diffuse: they are markedly less fissured than bands of vitrain, and generally show granular fracture.

Wandless and Macrae [2] (1934) distinguished two types of durain, — grey durain and black durain.

In macroscopic descriptions of seams, only bands having a thickness of several mm. are usually recorded [3]. Examined under the microscope, durain is shown to consist of microlithotypes rich in exinite or inertinite.

By macroscopic examinations alone durain may sometimes be confused with carbonaceous shale and dirty coal.

III — OCCURRENCE

In humic coals, durain occurs in bands up to many cms. in thickness. Widely distributed, but with exceptions not abundant.

---

[1] Stopes (M. C.). On the four visible ingredients in banded bituminous coals. Proc. Roy. Soc., Series B, *90*, (1919), p. 470.

[2] Wandless (A. M.) and Macrae (J. C.). The banded constituents of coals. Fuel, *13*, (1934), p. 4-15.

[3] The minimum thickness varies from 3 to 10 mm. in different countries.

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **DURITE** (STOPES-Heerlen System)	Hard coal R. L.

I — ORIGIN OF TERM

R. POTONIE [1], 1924.

In 1955 the Nomenclature Sub-Committee resolved to use this term for the microlithotype consisting principally of the following groups of macerals: inertinite (micrinite, fusinite, semifusinite, sclerotinite) and exinite, (particularly sporinite).

II — DESCRIPTION

Contains at least 95 % inertinite and exinite. The proportions of these two groups of macerals may vary widely, but each must be greater than the proportions of vitrinite and neither must exceed 95 %. Durite E. and durite I. connote durites rich in exinite and inertinite respectively.

In petrographic analysis only bands more than 50 microns wide are recorded.

The density of durite with average maceral composition varies between 1.3 and 1.7 according to the rank of the coal. In any given coal of low rank (with more than 25 % V.M.) it varies inversely with the exinite content.

The strength varies between 28 and 85 kg/mm^2; it is generally greater than that of the corresponding vitrite and clarite but the difference decreases with increase in the rank of the coal.

May contain inorganic impurities, principally clay minerals.

III — OCCURRENCE

Is found in many coals, in fairly thick bands, principally in durains and the duller types of clarain: generally common.

IV — PRACTICAL IMPORTANCE

1. *Preparation.*

Exinite confers on durite a tendency to fissure less than vitrite and clarite and correspondingly greater strength.

---

[1] POTONIE (R.). Einführung in die allgemeine Kohlenpetrographie. Berlin, Verlag Borntraeger, (1924), p. 34.

Particle size and the breaking characteristics of durite depend on the exinite content of the durite, and also on the thickness of the bands occurring naturally in the seam. Durite tends to concentrate in grain sizes greater than 1 mm.

Sometimes it contains less syngenetic minerals than vitrite, but it may have a high content of inherent plant mineral matter; in the preparation of very clean coal it is therefore necessary to exclude it.

2. *Carbonization.*

In caking coals the caking power of durite is weaker than that of vitrite, clarite and duroclarite; it depends on the relative proportions of exinite and inertinite.

Durite I. can act as a diluent in the coking process, and, used in suitable proportions and particle size, may improve the quality of the coke.

3. *Hydrogenation.*

Durite E., in coals with more than 25 % V.M., is readily hydrogenated; durite I. is not. No data are available for higher rank coals.

4. *Oxidizability.*

Generally not readily oxidised.

5. *Formation of dust.*

No tendency to form dust.

6. *Stratigraphy.*

Certain durites, particularly those rich in thick-walled spores (crassidurites), may serve as an aid in seam correlation.

Fig. 1.

Durite in a high-volatile German coal (Ruhr, 36 % V.M.).
Polished thin section in reflected light,
oil immersion. 200 ×.

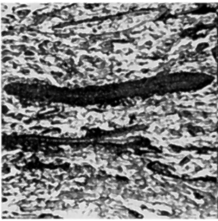
Fig. 2.

The same in transmitted light.

Fig. 3.

Megaspore, microspores and micrinite in a durite of a French coal
(Jura, 37 % V.M.). Polished section in reflected light
oil immersion. 300 ×.

DURITE - DURIT



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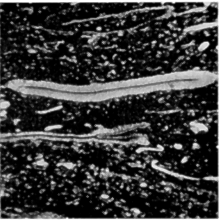

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1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **DUROCLARITE** (STOPES-Heerlen System)	Hard coal R. L.

I — ORIGIN OF TERM

The term duroclarite was introduced in 1956 by the Nomenclature Sub-Committee to designate the microlithotype with maceral composition between those of clarite and durite but closer to clarite than durite.

II — DESCRIPTION

Maceral composition :

— vitrinite $>$ 5 per cent;
— exinite $>$ 5 per cent;
— inertinite $>$ 5 per cent.

The further specification is that the proportion of vitrinite must exceed that of inertinite.

In petrographic analysis only bands more than 50 microns wide are recorded.

The density varies, depending on rank, between 1.25 and 1.7. For a coal of given rank and more than 25 % V.M. the density varies inversely with the exinite content.

The strength varies between 30 and 80 kg/mm^2. It is generally greater than that of clarite, but markedly lower than that of durite.

May include various mineral impurities (clay minerals, pyrites, siderite, etc...).

III — OCCURRENCE

Occurs in fairly thick bands.

Widely distributed and, like clarodurite, is a common constituent of most humic coals.

IV — PRACTICAL IMPORTANCE

The technological properties of duroclarite are intermediate between those of clarite and durite, but because of the predominance of vitrinite over inertinite they resemble those of clarite more closely than those of durite.

Fig. 1.
Duroclarite in a high-volatile American coal (35 % V.M.).
Polished thin section in reflected light,
oil immersion. 200 ×.

Fig. 2.
The same in transmitted light.

Fig. 3.
Duroclarite with vitrinite, fine and massive micrinite in a French coal
(Lorraine 40 % V.M.).
Polished surfaces in reflected light,
oil immersion. 300 ×.

DUROCLARITE - DUROCLARIT

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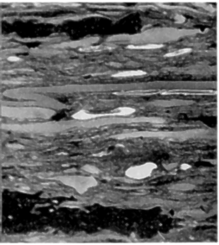

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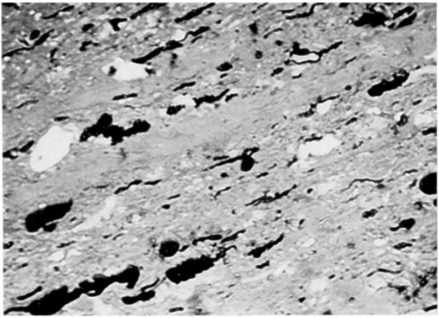


3

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

EXINITE — LIPTINITE

(STOPES-Heerlen System)

Hard coal
R. L.

I — ORIGIN OF TERM

M.C. STOPES[1] (1935) used the term exinite for the constituent represented by the exines of spores in coal, (exinite sense stricto). C.A. SEYLER[2] in 1932, however, used the term with its present meaning designating the following group of macerals: sporinite, cutinite, alginite, resinite.

The macerals grouped under the term exinite are not necessarily exines but appear to have similar technical properties.

The term liptinite was introduced by AMMOSOV[3] in 1956.

Synonym: Stabilprotobitumina (R. POTONIE 1925).

II — DESCRIPTION

See each of the constituent macerals.

III — OCCURRENCE

See each of the constituent macerals.

IV — PRACTICAL IMPORTANCE

Little information is so far available on the technological behaviour of pure exinite. By comparison and extrapolation it has proved possible, however, to deduce that in coals with more than 35 % V.M. exinite is the maceral group richest in volatile matter and in hydrogen (about 80 % and about 9 % respectively).

1. *Preparation.*

In coals with 18-25 % V.M. exinite is more resilient than the vitrinite; in coals with more than 25 % V.M., it has even greater resilience than micrinite. Exinite therefore increases the strength of bands in which it occurs and in broken coal concentrates in particles greater than 1 mm.

---

[1] STOPES (M. C.). On the petrology of banded bituminous coal, Fuel, *14*, (1935), p. 4.

[2] SEYLER (C. A.). Petrology and classification of coal. Proc. S. Wales Inst. Engrs., *53*, (1932), p. 270.

[3] AMMOSOV (I.). Letter to the Nomenclature Sub-Committee, (1956).

2. *Carbonization.*

In the carbonization of coals with more than 25% V.M., exinite is the element from which the highest yields of by-products are derived.

3. *Hydrogenation.*

By reason of its high hydrogen content, exinite in coals with more than 25 % V.M. is particularly suitable for hydrogenation. No practical data are available concerning the hydrogenation of the exinite of high rank coals.

4. *Oxidizability.*

In coals with more than 25 % V.M. exinite oxidizes less readily than vitrinite: it has no particular tendency to spontaneous combustion.

5. *Formation of dust.*

Exinite, by reason of its toughness, restricts the fissuring of beds of coal in which it occurs, and correspondingly, the formation of dust when such beds of coals are worked.

6. *Stratigraphy.*

See sporinite and cutinite.

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **FUSAIN** (STOPES-Heerlen System)	Hard coal

I — ORIGIN OF TERM

The term fusain was introduced by GRAND'EURY[1] in 1882 to designate the black silky, lustrous bands, recognised *macroscopically* in coal.

Synonyms: Faserkohle — charbon fibreux.

Analogous terms: mineral charcoal — mother of coal — Russkohle.

II — DESCRIPTION

Fusain is recognized macroscopically by its black or grey-black colour, its silky lustre, its fibrous structure and its extreme friability. It is the only constituent of coal which marks and blackens objects with which it comes in contact. Fusain may include a high proportion of mineral material, which strengthens it and reduces its friability; it retains, however, its silky lustre. In macroscopic descriptions of seams, only those bands having a thickness of several mm[2] are recorded.

Microscopic examination shows that fusain consists in the main of fusite.

III — OCCURRENCE

As fine bands and lenses in almost all humic coals.

Widely distributed, but not abundant.

---

[1] GRAND'EURY. Mémoire sur la formation de la houille. Ann. Mines. 8e série, I, (1882), p. 99-290.

[2] The minimum thickness varies from 3 to 10 mm. in different countries.

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

FUSAIN

(Thiessen-Bureau of Mines System)

Brown coal
Hard coal
T. L.

I — ORIGIN OF TERM

The term fusain was introduced by Grand'Eury [1] in 1882 to denote the black silky-lustre bands visible to the naked eye in coal. The term was first used in the U.S.A. in 1911 by J.J. Stevenson [2] as a synonym for "mineral charcoal". In the Thiessen-Bureau of Mines system fusain is a "component" with a minimum band width of 37 microns (Parks and O'Donnell) [3]. In the Stopes-Heerlen system on the other hand, "fusain" is a macroscopic constituent.

II — DESCRIPTION

Macroscopically, fusain closely resembles wood charcoal, usually being soft, friable, and black, and disintegrating readily into a black powder when roughly handled. A hard variety exists, impregnated with mineral matter.

Examined microscopically in thin sections fusain is usually opaque (black) although in very thin sections it may be slightly translucent and dark red in colour. It frequently shows well preserved plant cell structure in which the lumens may be empty or may be filled with mineral matter.

As by definition fusain (TBM) must have a minimum thickness of 37 microns, fragments of fusinite less than 37 microns are counted as opaque attritus.

III — CORRELATION WITH TERMS OF THE STOPES-HEERLEN SYSTEM

Fusain (TBM) represents bands and lenticles of fusinite and semifusinite greater than 37 microns in thickness. Bands of fusain more than 50 microns in thickness correspond to the microlithotype fusite.

IV — OCCURRENCE

Fusain (TBM) occurs as microscopically fine inclusions, but also in much grosser form as bands and lenses up to 15-20 cm. thick and 3-4 metres or more long (lenses). It is widely distributed in the humic coals of the Carboniferous, but only in small quantities.

---

1. Grand'Eury (F. C.). Mémoire sur la formation de la houille. Ann. Mines, *1*, ser. 8, (1882), p. 106.
2. Stevenson (J. J.). The formation of coal. Proc. Amer. phil. Soc., *50*, (1911), p. 55.
3. Parks (B. C.) and O'Donnell (H. J.). Petrography of American coals. Bur. Mines Bull, 550, p. 6.

V — PRACTICAL IMPORTANCE

1. *Preparation.*

Friable fusain concentrates in the very fine particle sizes. Hard fusain distributes itself in the different sizes of coal (see fusite) other than the fines and dust. The majority of the fusain which concentrates in the fine particle sizes is generally derived from the grosser bands visible to the naked eye.

2. *High—and low—temperature carbonization.*

Fusain has no caking power and acts as a diluent. It gives very low yields of by-products.

3. *Hydrogenation.*

Fusain does not lend itself to hydrogenation.

4. *Oxidizability.*

Fusain is not readily oxidised and has no tendency to spontaneous combustion.

5. *Tendency to form dust.*

Fusain contributes disproportionately to the fine coal dust.

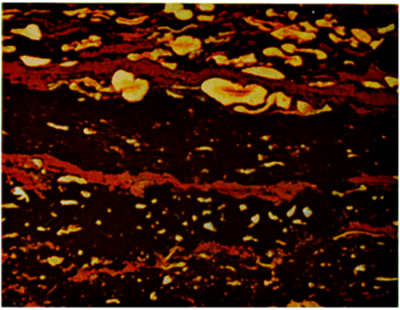
Fig. 1.

Fusain (Thiessen-Bureau of Mines) in an English coal (37 % V.M.)
Polished thin section in transmitted light, 250 ×.

Fig. 2.

The same in reflected light, oil immersion, 250 ×.

FUSAIN (TBM)



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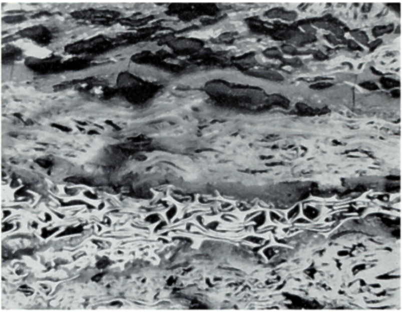

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1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee	Hard coal R. L.
	FUSINITE (STOPES-Heerlen System)	

I — ORIGIN OF TERM

M.C. STOPES[1], 1935.

II — DESCRIPTION

Constituent showing well defined cellular structure of wood or sclerenchyma. The cell cavities vary in size and shape,—round, oval or elongated. Bogen-structure is common.

Colour: in R.L. yellowish white; in T.L. opaque.

R: high, irrespective of the rank of the coal in which it occurs.

Generally isotropic.

Density: ca. 1.5—that is higher than that of the other macerals and almost independent of the rank of the coal in which it occurs.

Micro-hardness: very high.

Relief: very strong, and especially noticeable when dry objectives are used.

III — OCCURRENCE

As discrete lenses, thin partings or bands, and as small dispersed fragments.

Widely distributed, common.

IV — PRACTICAL IMPORTANCE

The physical and chemical properties of funisite vary only slightly in coals of different rank, and consequently its technological properties are fairly constant.

1. *Preparation.*

By reason of its friability, fusinite—despite its high intrinsic hardness—concentrates in the very fine particle sizes.

---

[1] STOPES (M. C.). On the petrology of banded bituminous coal. Fuel, *14*, (1935), p. 4.

2. *Carbonization.*

Without caking power and acts as a diluent. Gives very low yields of by products.

3. *Hydrogenation.*

By reason of its high carbon and low hydrogen content, fusinite dœs not lend itself to hydrogenation.

4. *Oxidizability.*

Oxidized with difficulty: has no tendency to spontaneous combustion.

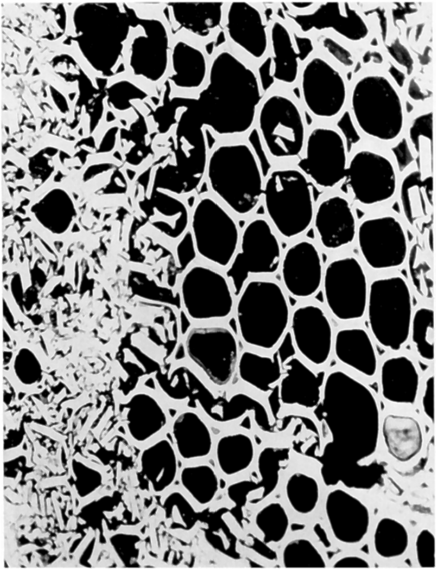
5. *Formation of dust.*

Concentrates in the finest dust.

Fig. 1.

Fusinite showing Bogen-structure at the top, in a high-volatile German (Ruhr) coal. Polished section in reflected light, oil immersion. 500 ×.

FUSINITE - FUSINIT



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1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **FUSINITO - COLLINITE COAL** (System of Geol. Inst. Acad. Sci. U.S.S.R. Moscow)	Brown coal Hard coal T. L.

I — ORIGIN OF TERM

The term was introduced in 1962 by Timofeev, Bogoliubova and Yablokov [1, 2].

II — DESCRIPTION

Fusinito-collinite coal consists of more than 50% of material (micrinite) which is opaque or only semi-translucent in transmitted light. Gelified micro-components are present in only small quantities. Components with recognizable form are mainly microspores and occasional megaspores. Fusinised tissue is rare.

Hand specimens of this type of coal are black, homogeneous in appearance, and break with a block fracture. The coal has low ash.

III — OCCURRENCE

Fusinito-collinite coal occurs as thin bands in seams of different geological age.

IV — PRACTICAL SIGNIFICANCE

Fusinito-collinite coals are non-caking. They are used, like other fusinitic types of coal, as fuel.

Fig. 1.

Fusinito-collinite coal from a Russian seam (Ekibastus).
Transmitted light, 200 ×.

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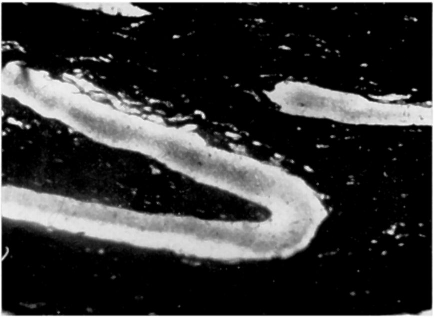
[1] Timofeev (P. P.), Bogoliubova (L. I.) and Yablokov (V. S.). Principles of a genetic classification of humic coals. Akad. Nauk SSSR, Izvest., Geol. Ser., No. 2, (1962).

[2] Timofeev (P. P.), Yablokov (V. S.) and Bogoliubova (L. I.). Die Enstehung und die genetische Klassifikation von Humuskohlen in den Hauptbecken der USSR. Brennst Chemie, *43*, (1962), p. 97-105.

CHARBON DE FUSINITO - COLLINITE
FUSINITO - COLLINIT - KOHLE
FUSINITO - COLLINITE COAL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1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **FUSINITO - POSTTELINITE COAL** (System of Geol. Inst. Acad. Sci. U.S.S.R. Moscow)	Brown coal Hard coal T. L.

I — ORIGIN OF TERM

The term was introduced in 1962 by Timofeev, Bogoliubova and Yablokov[1,2].

II — DESCRIPTION

Fusinito-posttelinite coal consists of more than 50% of relatively fine, more or less fusinised fragments of tissue exhibiting weakly defined cell structure or complete lack of structure. It may also contain subordinate micro-components of the vitrinite and liptinite groups.

Hand specimens are black and matt, very friable and of fibrous structure. The ash is always low.

III — OCCURRENCE

Fusinito-posttelinite coal occurs in seams of different geological age, and is particularly common in the Lower Jurassic in beds up to one metre or more thick.

IV — PRACTICAL SIGNIFICANCE

Fusinito-posstelinite coals are non-caking and are chiefly used as fuels in briquette form.

Fig. 1.

Fusinito-posttelinite coal from a Russian seam (Ulugchemsk).
Transmitted light, 200 ×.

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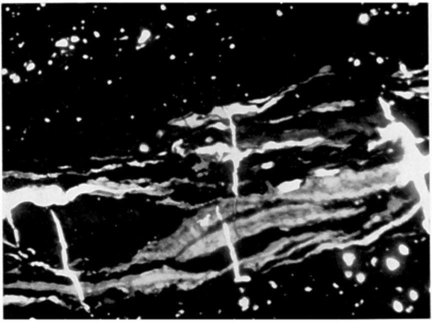
[1] Timofeev (P. P.), Bogoliubova (L. I.) and Yablokov (V. S.). Principles of a genetic classification of humic coals. Akad. Nauk SSSR, Izvest., Geol. Ser., No. 2, (1962).

[2] Timofeev (P. P.), Yablokov (V. S.) and Bogoliubova (L. I.). Die Entstehung und die genetische Klassifikation von Humuskohlen in den Hauptbecken der U.S.S.R. Brennst Chemie, *43*, (1962), p. 97-105.

CHARBON DE FUSINITO - POSTTÉLINITE
FUSINITO - POSTTELINIT - KOHLE
FUSINITO - POSTTELINITE COAL



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1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **FUSINITO - PRECOLLINITE COAL** (System of Geol. Inst. Acad. Sci. U.S.S.R. Moscow)	Brown coal Hard coal T. L.

I — ORIGIN OF TERM

The term was introduced in 1962 by TIMOFEEV, BOGOLIUBOVA and YABLOKOV [1, 2].

II — DESCRIPTION

Fusinito-precollinite coal consists of more than 50% of an accumulation of very fine, virtually structureless, fragments of tissue more or less fusinised which appear in transmitted light as a semitranslucent or opaque micrinite groundmass. Coarse fragments of tissue are rare. Because they are closely packed the more or less opaque micro-components form a dark background, when viewed in thin section. Numerous microspores and cuticles, as well as scattered resin bodies, plate-like cells from cortical tissue, streaks of translucent collinite and fine inclusions of gelified structured components show up well against the dark background. Hand specimens of this type of coal are black and matt or semi-matt, homogeneous or finely striated with a fibrous structure. The ash is low.

III — OCCURRENCE

Fusinito-precollinite coal occurs in seams of different geological age, and is particularly common in the Lower Jurassic as beds up to 1 metre thick.

IV — PRACTICAL SIGNIFICANCE

Fusinito-precollinite coals are non-caking and are chiefly used as fuel in briquette form.

Fig. 1.

Fusinito-precollinite coal from a Russian seam (Moscow)
Transmitted light, 200×.

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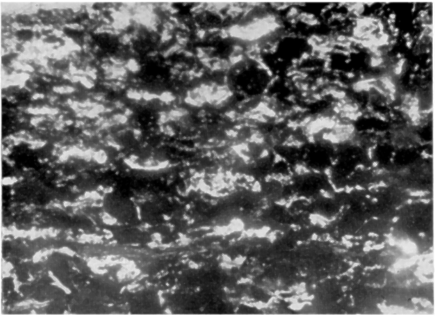
[1] TIMOFEEV (P. P.), BOGOLIUBOVA (L. I.) and YABLOKOV (V. S.). Principles of a genetic classification of humic coals. Akad. Nauk S.S.S.R., Izvest., No. 2, (1962).

[2] TIMOFEEV (P. P.), YABLOKOV (V.S.) and BOGOLIUBOVA (L. I.), Die Entstehung und die genetische Klassifikation von Humuskohlen in den Hauptbecken der USSR. Brennst Chemie, *43*, (1962), p. 97-105.

CHARBON DE FUSINITO - PRÉCOLLINITE
FUSINITO - PRÄCOLLINIT - KOHLE
FUSINITO - PRECOLLINITE COAL



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1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **FUSINITO - TELINITE COAL** (System of Geol. Inst. Acad. Sci. U.S.S.R. Moscow)	Brown coal Hard coal T. L.

I — ORIGIN OF TERM

The term was introduced in 1960 by Yablokov and Bogoliubova [1].

II — DESCRIPTION

Fusinito-telinite coal consists of more than 50% of coarse stem and rhizome tissues which have been metamorphosed into fusinite and semifusinite, and show well defined cell structure. By transmitted light it is reddish brown to dark brown or black. The fragments of stem tissue are generally closely packed forming, as it were, aggregates. In a number of instances fusinitotelinite is bounded by bands of vitrite; occasionally it is embedded in a homogeneous groundmass (collinite). Isolated microspores, cuticles and resin bodies also occur in this type of coal. The parent material of this type of coal was wood tissue.

Hand specimens are black and matt, rather friable and soft, with a distinctive fibrous structure. Fusinito-telinite coals invariably have low ash.

III — OCCURRENCE

Fusinito-telinite coal occurs in seams of any geological age, being particularly common in the Lower Jurassic in seams up to 100 metres thick.

IV — PRACTICAL SIGNIFICANCE

Fusinito-telinite coals are non-caking and are used chiefly as fuels in briquette form.

Fig. 1.

Fusinito-telinite coal from a Russian seam.
Transmitted light, 110×.

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[1] Yablokov (V. S.) and Bogoliubova (L. I.). On humic coals and structure types of certain thickcoal seams of Mesozoic age. Akad. Nauk. SSSR, Izvest., Geol. Ser., No. 5, (1960), p. 49-59.

CHARBON DE FUSINITO - TÉLINITE
FUSINITO - TELINIT - KOHLE
FUSINITO - TELINITE COAL

1

1963	**International Committee for Coal Petrology** Nomenclature Sub-Committee	Hard coal
EDITION	**FUSITE** (STOPES-Heerlen System)	R. L.

I — ORIGIN OF TERM

R. POTONIE [1], 1924.

In 1955 the Nomenclature Sub-Committee resolved to use this term for the microlithotype consisting principally of the macerals fusinite, semifusinite and sclerotinite.

II — DESCRIPTION

See fusinite, semifusinite, and sclerotinite.

Contains at least 95% of these three macerals.

Two varieties of fusite may be distinguished, —a fragile and powdery fusite and hard consolidated fusite in which the cavities are filled by various minerals, carbonates, sulphides, kaolin and other clay minerals.

In petrographic analysis only bands or lenses of fusite which are more than 50 microns wide are recorded.

Density:?

The strength of the soft variety of fusite is much less than that of vitrite : on the other hand that of the hard variety is greater.

Mineral impurities:?

III — OCCURRENCE

Widely distributed, but in general not abundant. Occurs in fine bands and lenses of varying thickness.

IV — PRACTICAL IMPORTANCE

See fusinite, semifusinite and sclerotinite.

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[1] POTONIE (R.). Einführung in die allgemeine Kohlenpetrographie. Berlin, Verlag, Borntraeger, (1924), p. 24.

1. *Preparation.*

The soft variety of fusite concentrates in the very fine particle sizes. Hard fusite distributes itself in various sizes (depending on the thickness of the original bands or lenticles in the seam), but not in the fines. This form of fusite is usually discarded in the middlings and refuse.

2-6. See fusinite, semifusinite and sclerotinite.

Fig. 1.

Folded fusite from a French coal (Lorraine).
Polished section in reflected light, oil immersion, 60 ×.

Fig. 2.

Fusite cousisting of semi-fusinite in a French coal
(Lottaine, 40% V. M.)
Polished section in reflected light, oil immersion, 300 ×.

FUSITE - FUSIT

1

2

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **GELITO - COLLINITE COAL** (System of Geol. Inst. Acad. Sci. U.S.S.R. Moscow)	Brown coal Hard coal T. L.

I — ORIGIN OF TERM

The term was introduced in 1960 by Yablokov and Bogoliubova [1]

II — DESCRIPTION

Gelito-collinite coal is characterised by a predominance (over 50%) of a groundmass (collinite) translucent in thin sections, resulting from complete decomposition in the process of gelification of the original plant material. As a rule the collinite material occurs as homogeneous floccular masses. Gelified components showing structure are only rarely represented in the form of lenses and thin strips of vitrinised wood fibres, gelified fragments of bark and leaf parenchyme tissue. Fusinised inclusions are rare. There may be occasional concentrations of homogeneous, opaque particles and fine fragments of fusinised tissue, sometimes also coarse lenses of semifusinite and fusinite. The proportion of lipoid micro-components varies from a single inclusion to the maximum concentration permitted in these gelito-coals. Occasionally this type of coal may contain algae of the pila type.

Hand specimens are generally semi-lustrous with a uniform coarsely banded structure, and break with a typical, slightly conchoidal fracture. This type of coal may have low or high ash.

III — OCCURRENCE

Gelito-collinite coals occur in seams of different geological age as distinctive bands within a seam or as entire seams of varying thickness.

IV — PRACTICAL SIGNIFICANCE

Medium rank gelito-collinite coals are valuable for coking.

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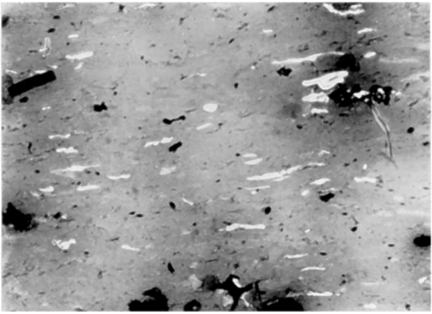
[1] Yablokov (V. S.) and Bogoliubova (L. I.). On humic coals and structure types of certain thick coal seams of Mesozoic age. Akad. Nauk. SSSR, Izvest., Geol. Ser., No. 5, (1960), p. 49-50.

Fig. 1

Gelito-collinite coal from a Russian seam.
Transmitted light. 200×.

CHARBON DE GÉLITO - COLLINITE
GELITO - COLLINIT - KOHLE
GELITO - COLLINITE COAL



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1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **GELITO - POSTTELINITE COAL** (System of Geol. Inst. Acad. Sci. U.S.S.R. Moscow)	Brown coal Hard coal T. L.

I — ORIGIN OF TERM

The term was introduced in 1961 by Timofeev [1].

II — DESCRIPTION

Gelito-posttelinite coal is characterised by a preponderance (more than 50%) of fragments of gelified tissue less than 0.2 mm. in size. The individual fragments take different form - lenticular, ribbon-like, angularly-round and round. Their outline may also occur in gelito-posttelinite coals in minor amounts. All the structured components are distinct by reason of their somewhat darker colouring and are embedded in a transparent groundmass, varying in amount in different cases.

Gelito-posttelinite coal is distinguished from gelito-telinite coal by more marked fragmentation of the plant material and a higher degree of gelification.

In hard coals gelito-posttelinite coal is generally lustrous or semi-lustrous and in brown coals semi-matt or sometimes even matt. It is usually finely striated. Gelito-posttelinite coal may have high or low ash.

III — OCCURRENCE

Gelito-posttelinite coal occurs in seams of different geological age, as bands within seams or as entire seams several metres thinck.

IV — PRACTICAL SIGNIFICANCE

Gelito-posttelinite coals of medium rank are valuable for coking.

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[1] Timofeev (P. P.). Genesis and genetic classification of Middle Jurassic coals of the Turwinsk depression. Akad. Nauk SSSR, Doklady, *193*, No. 4, (1961).

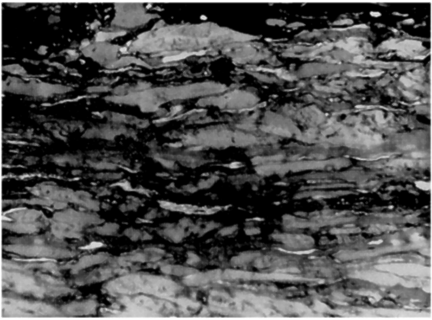
Fig. 1.

Gelito-posttelinite coal from a Russian seam (Donetz).
Transmitted light, 200 X.

Fig. 2.

Gelito-posttelinite coal from a Russian seam (Irkoutsk).
Transmitted light, 200×.

CHARBON DE GÉLITO - POSTTÉLINITE
GELITO - POSTTELINIT - KOHLE
GELITO - POSTTELINITE COAL



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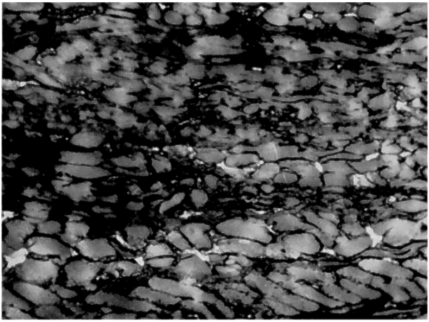

2

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **GELITO - PRECOLLINITE COAL** (System of Geol. Inst. Acad. Sci. U.S.S.R. Moscow)	Brown coal Hard coal T. L.

I — ORIGIN OF TERM

The term was introduced in 1961 by TIMOFEEV [1].

II — DESCRIPTION

Gelito-precollinite coal consists of more than 50% of very fine gelified fragments of tissue, which, although having lost their original cell structure, have more or less retained their shape. The outline of the fragments is rather indistinct, and where decomposition has been sufficiently marked, individual fragments overlap and form a gelified mass with honeycomb structure. Minor amounts of lipoid and fusinised micro-components as well as some opaque matter also occur in this type of coal.

Gelito-precollinite coal is lustrous or semi-lustrous in hard coals and semi-matt to matt in brown coals. It is finely striated or homogeneous to the unaided eye and breaks with a slightly conchoidal fracture. It may have high or low ash.

III — OCCURRENCE

Gelito-precollinite coal occurs in seams of different geological age as bands within seams or as entire seams several metres thick.

IV — PRACTICAL SIGNIFICANCE

Medium rank gelito-precollinite coals are valuable for coking.

Fig. 1.

Gelito-precollinite coal from a Russian seam of Jurassic Age.
(Irkoutsk.)
Transmitted light, 200×.

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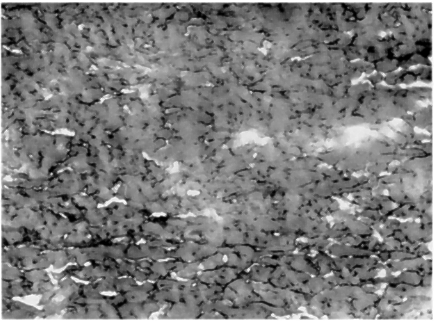
[1] TIMOFEEV (P. P.). Genesis and genetic classification of Middle Jurassic coals of the Turwinsk depression. Akad. Nauk. SSSR, Doklady, *139*, No. 4, (1961).

CHARBON DE GÉLITO - PRÉCOLLINITE
GELITO - PRÄCOLLINIT - KOHLE
GELITO - PRECOLLINITE COAL



1

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **GELITO - TELINITE COAL** (System of Geol. Inst. Acad. Sci. U.S.S.R. Moscow)	Brown coal Hard coal T. L.

I — ORIGIN OF TERM

The term was introduced in 1960 by Yablokov and Bogoliubova [1].

II — DESCRIPTION

Gelito-telinite coal contains 50% or more of gelified, vitrinitic components. The size of the constituent entities generally varies between 0.2 and 1.0 mm. although coarser forms (1.5 to 2.0 mm) are also seen. Fusinised tissue is not common, and liptinite is insignificant. Gelito-collinitic material is present in greater or lesser amounts. Wood-gelito-telinite coals and parenchyme-gelito-telinite coals are distinguished according to the preponderance of the type of original plant tissue.

Wood-gelito-telinite coal consists largely of individual fragments of stems and rhizomes, wood tissue predominating. They are invariably low in ash.

Parenchyme-gelito-telinite coals consist chiefly of cuticle-bordered leafy material; the parenchyme tissue is markedly gelified. Here and there the leafy material may be closely packed forming aggregates; at other times it is found in varying quantities embedded in a transparent groundmass. Parenchyme-gelito-telinite coals may have high or low ash.

In hand specimens gelito-telinite coal is black and in hard coals lustrous or semi-lustrous; in brown coal it is matt or semi-matt. Gelito-telinite coal shows sharp-edged, stepped fracture.

III — OCCURRENCE

Gelito-telinite coals occur in seams of different geological age, both as bands within seams or as entire seams up to several metres thick.

IV — PRACTICAL SIGNIFICANCE

Compared with other gelitic types of coal, gelito-telinite coals of medium rank are characterised by very high caking power and because of this are valued for coke making.

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[1] Yablokov (V. S.) and Bogoliubova (L. I.). On humic coals and structure types of certain thick coal seams of Mesozoic age. Akad. Nauk SSSR, Izvest., Geol. Ser., No. 5, (1960), p. 49-59.

Fig. 1.

Gelito-telinite coal from a Russian seam of Mesozoic Age (Irkoutsk). Transmitted light, 200 ×.

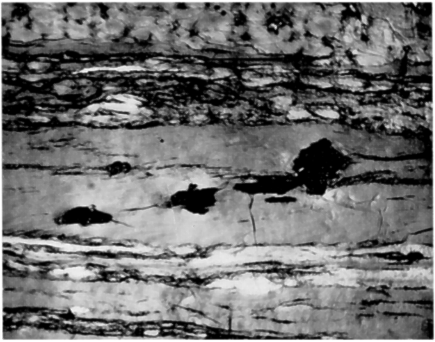
Fig. 2.

Gelito-telinite coal from a Russian seam of Mesozoic Age (Irkoutsk). Transmitted light, 200 ×.

Fig. 3.

Gelito-telinite coal (with parenchyme tissues) from the U.S.S.R. Transmitted light, 200 ×.

CHARBON DE GÉLITO - TÉLINITE
GELITO - TELINIT - KOHLE
GELITO - TELINITE COAL



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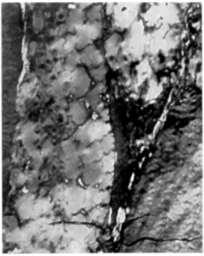

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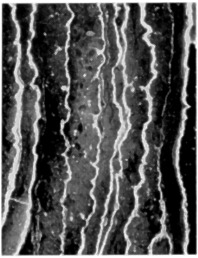

3

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

HUMIC COAL

General
Term

I — ORIGIN OF TERM

The term was introduced in 1906 by H. Potonie [1] to describe coals the original organic matter of which underwent change chiefly by humifaction, that is through the process of peat formation in the presence of oxygen.

II — DESCRIPTION

Macroscopic: amongst the hard coals of the Palaeozoic, Mesozoic and Tertiary the humic coals, in contrast to the sapropelic coals, are stratified; in transverse section bright bands alternate with semi-lustrous bands and dull bands. The bright bands are fairly markedly fissured or cleated, the dull bands rather less so. (Brown coals which are mainly humic coals are not included in this description).

Microscopic: The microlithotypes (q.v.) are clearly distinguishable under the microscope in the humic coals.

III — OCCURRENCE

Most seams of coal consist principally of humic coal.

IV — PRACTICAL IMPORTANCE

The technological properties of humic coals vary with their rank, with their petrographic composition, and with the manner of distribution of mineral inclusions.

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1. Potonie (H.). Klassifikation und Terminologie der rezenten brennbaren Biolithe und ihrer Lagerstätten. Abh. preuss. geol. Landesanstalt, *19*, (1906), p. 1-94.

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

HYDRITE

Brown coal
Hard coal
R. L.

I — ORIGN OF TERM

The term was proposed by K. Asai at the 1955 meeting of the International Committee for Coal Petrology to denote a very common microlithotype in Japanese Tertiary coal.

Analogous term: clarite.

II — DESCRIPTION

Hydrite consists of macerals vitrinite, degradinite and exinite. The proportions of these macerals may vary very considerably. The greater part of the exinite is generally resinite, associated with sporinite and cutinite in varying amounts. Sclerotinite may be present in small amounts: micrinite, semifusinite and fusinite are extremely rare.

On the basis of the maceral content it is possible to distinguish between degradinite-rich hydrite (hydrite D) and exinite-rich hydrite (hydrite E). In microscopic analysis only bands having a width of more than 50μ are recorded as hydrite.

The density increases with increasing coalfication. In hydrites of more than 25 % V.M. the specific gravity is the lower, the higher the exinite content. The density of hydrite is only slightly different from that of vitrite: that of pure hydrite is somewhat lower than that of the corresponding vitrite. However, because of high ash content hydrite is commonly heavier than vitrite.

The strength varies according to the rank, and is generally higher than that of vitrite (26 to 85 kg/mm^2).

III — OCCURRENCE

The dull bands of many Japanese Tertiary humic coals consist largely of hydrite. It generally occurs alternating with vitrite as micro-fine bands, one or the other predominating.

IV — PRACTICAL IMPORTANCE

1. *Preparation.*

After breaking or crushing hydrite tends to concentrate in particle sizes greater than 1 mm.

2. *Carbonization.*

In general hydrite softens well and more readily than the vitrite from the same seam. However, it yields a poorer coke than vitrite. Otherwise, the coking properties of hydrite vary according to rank. Hydrite, in accordance with its high content of degradinite and exinite, gives greater yields of tar and gas than the corresponding vitrite.

3. *Hydrogenation.*

Because of its high content of exinite and degradinite, hydrite has a relatively high hydrogen content. Hydrite with more than 25 % volatile matter is particularly readily hydrogenated.

4. *Oxidizability.*

Hydrite oxidizes less readily than vitrite.

5. *Formation of dust.*

In general hydrite does not tend to form dust because of its high strength.

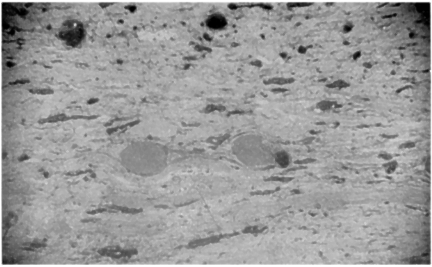
Fig 1.

Hydrite in a Japanese Tertiary coal, with a small amount of sporinite. Polished thin section in reflected light, oil immersion, 250 ×.

Fig. 2.

Hydrite in a Japanese Tertiary coal with a large amount of sporinite. Polished thin section in reflected light, oil immersion, 250 ×.

HYDRITE - HYDRIT



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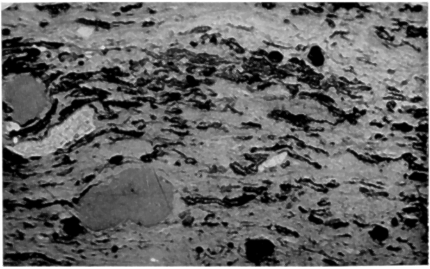

2

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **INERTINITE** (STOPES-Heerlen System)	Hard coal R. L.

I — ORIGIN OF TERM

E. STACH [1], 1952.

The term inertinite was proposed to simplify the nomenclature of coal petrography by combining, in a single term, the group of the following macerals: micrinite, semifusinite, fusinite, sclerotinite. This grouping is based on certain similarities in the technological properties of the four macerals. The term inertinite does not imply that the constituents are totally inert, but only that they are more inert than the macerals of the other two groups, particularly in carbonization processes in which they behave as diluents.

II, III, IV.

See under each of the constituent macerals.

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[1] STACH (E.). *Die Vitrit-Durit Mischungen in der petrographischen Kohlenanalyse.* Brennst Chemie, *33*, 1952), p. 368.

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

KAOLIN - COAL TONSTEIN

General
Term

I — ORIGIN OF TERM

The term tonstein was introduced by G. Bischof (1863/66) [1] to designate certain argillaceous bands in the hard coal seams of the Carboniferous. The term Kohlentonstein was used by Hoehne [2] in 1954 and Kaolin-Kohlentonstein by Burger, Eckhard and Stadler (1962) [3].

II — DESCRIPTION

The following data are based principally on the examination of German coal measures and are therefore only provisional.

Kaolin-coal tonstein is difficult to distinguish with the unaided eye from ordinary dirt bands occuring in hard coal. Its colour ranges from a yellowish-white to black. The lighter coloured varieties generally occur as the immediate roof, or floor of seams or in the associated strata, whereas tonstein bands occurring within the coal are generally dark-grey to black. Kaolin-coal tonstein has a dense, fine-grained texture, and is not generally stratified.

Unmistakable identification of kaolin-coal tonstein is only possible by use of the microscope and by X-ray diffraction. The characteristic and predominant mineral is kaolinite or a mineral belonging to the kaolinite group.

According to Schuller (1956) [4] the following types of tonstein may be distinguished, between which there are full ranges of intermediates. Bouroz [5], in 1962, put forward an alternative classification of tonsteins based on their origin. This has not yet been examined by the Nomenclature Sub-Committee but will be mentioned in the next edition of the Handbook.

1. *Crystalline tonstein:* contains vermicular, prismatic or tabular kaolinite crystals, may be either light or dark in colour according to the proportion of contained carbonaceous matter. Occasionally granular kaolinite may also be recognised. The crystals lie embedded in either a finely-crystalline or cryptocrystalline kaolinite ground mass.

2. *Granular (Graupen) tonstein:* consists predominantly of kaolinite grains of lighter or darker shades, often surrounded by collinite. These grains show a cryptocrystalline to finely-crystalline structure; the cryptocrystalline material is isotropic.

3. *Dense non-crystalline tonstein:* consists almost entirely of a fine-grained kaolin ground mass, showing weak aggregate-polarisation, containing here and there isolated corroded crystals of kaolinite. Such bands are commonly more than 100 mm. thick, and light in colour.

4. *Pseudomorphous Tonstein:* characterised by numerous pseudomorphs of kaolinite-feldspar or kaolinite-mica within a kaolinite groundmass.

The following secondary minerals are found in tonstein: illite, muscovite-illite ("leverrierite") and chlorite of the clay minerals; quartz (in abundance), apatite, siderite, pyrite, crandallite, as syngenetic minerals originating from solution; feldspar, mica and zircon representing clastic components. In tonsteins containing components of volcanic origin the following further minerals may be recognised: — montmorillonite-illite, halloysite and potassium feldspar (sanidine).

Furthermore, most tonstein bands contain carbonaceous material generally vitrinitic, which surrounds the kaolinite crystals or grains as a fine film. Characteristic also is kaolinised cell tissue in which the cell walls are telimitic and the lumens are filled with kaolinite indicating that the kaolinite was deposited from solution.

III — OCCURRENCE

Kaolin-coal tonstein occurs almost invariably within coal seams, usually close to the roof or floor; more rarely it is associated with different forms of carbonaceous shale and black band ironstone. In isolated instances it is also found in pure shale or sandstone. The frequency and thickness of tonstein bands vary in different coalfields and different parts of the sequence of seams. The thickness is generally only one to a few centimetres. Their lateral persistance is often considerable.

IV — PRACTICAL SIGNIFICANCE

Because of their wide lateral persistence and extensive vertical range tonsteins are valuable in seam correlation and regional stratigraphy. A coal seam may sometimes be traced over an entire coalfield by means of a tonstein band only a few centimetres thick. For example several tonsteins which occur in the Ruhr coals are also found in the corresponding seams or groups of seams around Aachen [6]. Fig. 1 shows the lateral extent of certain tonsteins in various European coalfields [7]. Fig. 2 shows the vertical distribution of tonstein bands known to date in the Ruhr coalfields.

Tonsteins can be used for the manufacture or refractory products if the thickness of the beds justifies their development, and provided that they do not contain too much secondary mineral or coaly material.

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1. Bischof (G.). Lehrbuch der chemischen und physikalischen Geologie. 2nd Edit., 3, Bonn, p. 1863-1866.

2. Hoehne (K.). Zur Ausbildung und Genese der Kohlentonsteine im Ruhrkarbon. Chemie der Erde, 17, 1, Jena, (1954), p. 6-28.

3. Burger (K.), Eckhard (F. J.) and Stadler (G.). Zur Nomenklatur und Verbreitung der Kaolin-Kohlentonsteine im Ruhrkarbon — Fortschr. Geol. Rheinl. Wesf. 3, Krefeld, (1962), 2, p. 525-540.

4. Schuller (A.), Guthorl (P.) and Hoehne (K.). Monographie der Saartonsteine. — Geologie 5, Berlin, (1956), 8, p. 695-755.

5. Bouroz (A.). Sur la pluralite d'origine des tonstein. Ann. Soc. Geol. Nord., 82, (1962), p. 77.

6. Herbst (G.), Koerner (K.) and Stadler (G.). Kaolin-Kohlentonsteine im Oberkarbon des Aachener Reviers. Fortschr. Geol. Rheinl. Westf. *3*, 2, (1962), S. p. 591-604.

7. Scheere (J.). Nouvelle contribution à l'étude du tonstein du terrain houiller belge. Publ. Ass. Etud. Paleont. Bruxelles, n° 26, (1956), p. 53.

Fig. 1.

The lateral extent of several tonsteins in various European coalfields (after Scheere [7]).

Key

–·–·– *Marine horizon*
——— *named tonstein*
(name or number of seam or depth of bore)
– – – *tonstein correlation*
– ? – *very localised or valueless tonstein.*

Fig. 2.

The vertical distribution of tonstein bands in the central part of the Ruhr coalfield, (after Burger, Eckhardt & Stadler [3] (1962).

Di.T. = *Dense non-crystalline tonstein.*
Kr.T. = *Crystalline tonstein.*
Gr.T. = *Granular (Graupen) tonstein.*
Ps.T. = *Pseudomorphous tonstein.*

Fig. 3.

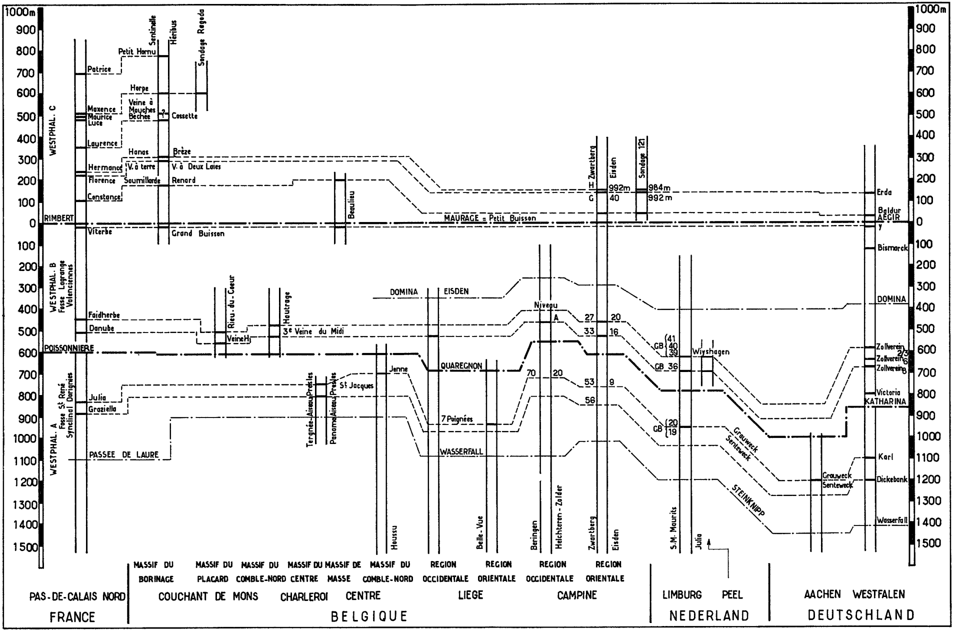
3*a*. *Crystalline tonstein from the Zollverein 7/8 seam, (Ruhr).*
Reflected light, oil immersion, 250 ×.

3*b*. *Granular (Graupen) tonstein from the N_1 seam, (Aix-la-Chapelle).*
Shreds of collinite in the lower half.
Reflected light, oil immersion, 250 ×.

3*c*. *Dense non-crystalline tonstein with thin streaks of collinite from the Erda seam, (Ruhr).*
Reflected light, oil immersion, 250 ×.

3*d*. *Pseudomorphous tonstein (pseudomorphs of kaolinite-mica) from the Zollverein 7/8 seam, (Ruhr).*
Transmitted light, 55 ×.

TONSTEIN
KAOLIN-KOHLENTONSTEIN



TONSTEIN

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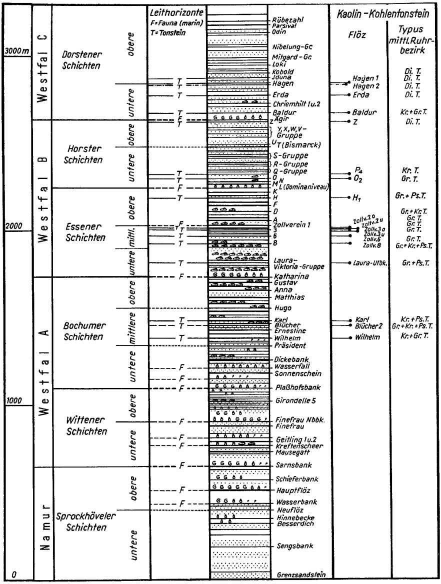

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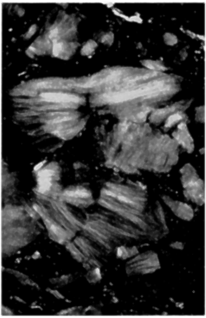

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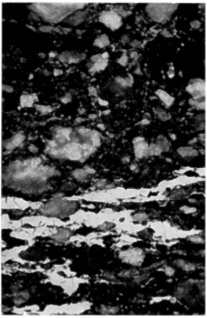

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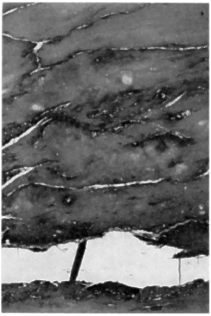

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3d

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee	Hard coal R. L.
	LIPTITE or SPORITE (STOPES-Heerlen System)	

I — ORIGIN OF TERM

The term liptite was introduced by AMMOSOV[1] in 1956, the term sporite by H. POTONIE[2] in 1910. The Nomenclature Sub-Committee agreed in 1962 to adopt these terms to describe a microlithotype consisting mainly of the exinite group of macerals and especially of sporinite.

II — DESCRIPTION

Contains not less than 95 per cent of exinite (liptinite).

Thickness (bands) of exinite greater than 50 microns are recorded as liptite (sporite).

Density: see the constituent macerals, especially sporinite.

Strength: actual values are not known.

III — OCCURRENCE

Liptite (sporite) is a rare constituent of hard coal.

Fig. 1.

Liptite with megaspores in a Belgian hard coal (33 % V.M.).
Reflected light, oil immersion.

Fig. 2.

Liptite with microspores in a Belgian hard coal (33 % V..M).
Reflected light, oil immersion.

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[1] AMMOSOV (I.). Proposal to the U.S.S.R. Conference on Coal Petrology, (1956).

[2] POTONIE (R.). Die Entstehring der Steinkohle und des Kanstobiolith überhaupt. Verlag Borntraeger, 5th Edition, Berlin, (1910).

LIPTITE - LIPTIT

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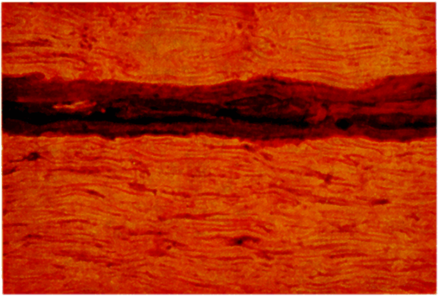

2

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

LITHOTYPE

(STOPES-Heerlen System)

Hard coal

The term lithotype was proposed by C.A. SEYLER [1] in 1954 in a communication to the Nomenclature Sub-Committee to designate the different macroscopically recognizable bands of humic coals. These bands were described by M.C. STOPES [2] in 1919 as "the four visible ingredients in banded bituminous coal".

Synonyms: ingredient — rock type — banded ingredient — banded constituent — Kohlentype — zone type.

The following macroscopic bands are distinguished in humic coals :

ENGLISH	GERMAN	FRENCH
Vitrain	Glanzkohle	Vitrain or charbon brillant
Clarain	Glanzstreifenkohle Streifenkohle Mattstreifenkohle	Clarain or charbon semibrillant
Durain	Mattkohle	Durain or charbon mat
Fusain	Faserkohle	Fusain or charbon fibreux

The pattern of the glossary sheets for lithotypes is as follows :

I — Origin of term.

II — Description.

III — Occurrence.

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[1] SEYLER (C. A.). 1954. Letter to the Nomenclature Sub-Committee.

[2] STOPES (M. C.). On the four visible ingredients in banded bituminous coals. Proc. Roy. Soc., Series B, *90*, (1919), p. 470.

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

Hard coal
R. L.

MACERAL

(STOPES-Heerlen System)

The term was introduced by M.C. STOPES [1] in 1935 to designate the elementary microscopic constituents of coals, by analogy with the minerals of rocks. The different individual macerals are grouped according to their various petrographic properties (see under II). The names of the macerals are all given the suffix "ites". This suffix is also used in terms designating groups of similar macerals.

The properties of most macerals change in the course of carbonification.

Synonyms: Gefügebestandteil—Gemengteil c.f. phyteral.

Table of macerals and groups of macerals

DETAILED NOMENCLATURE	SIMPLIFIED NOMENCLATURE (for technical use)	
Maceral [2]	*Group*	*Symbol*
Collinite Telinite	Vitrinite	V
Sporinite Cutinite Alginite Resinite	Exinite or Liptinite	E
Micrinite { fine-grained micrinite Micrinite { massive micrinite Sclerotinite Semifusinite Fusinite	Inertinite	I

The system of three groups of macerals, vitrinite, exinite (liptinite) and inertinite, is conventional and represents a simplification or compounding which is particularly convenient. Each group includes macerals which, although not identical, may appear similar under the microscope.

The pattern of the glossary sheets for the macerals is as follows:

---

[1] STOPES (M. C.). On the petrology of banded bituminous coal. Fuel, *14*, (1935), p. 4.

[2] This list is not exclusive and can be augmented.

I — ORIGIN OF TERM

Name of author and date when the term was first used in its present meaning and the appropriate reference in the literature.

Synonyms and analogous terms.

II — DESCRIPTION

Morphography.

Colour: in reflected light (R.L.); in transmitted light (T.L.).

Reflectance: (R.).

Anisotropy: in reflected light; in transmitted light.

Density.

Micro-hardness.

Relief.

III — OCCURRENCE

Occurrence.

Distribution — Abundance.

Associations.

IV — PRACTICAL IMPORTANCE

1. Preparation.
2. Carbonization.
3. Hydrogenation.
4. Oxidizability.
5. Formation of dust.
6. Stratigraphy.

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **MICRINITE**	Hard coal R. L.

I — ORIGIN OF TERM

The word "micronite" was used by M.C. Stopes in 1935 [1], and was modified to "micrinite" in the same year at the Heerlen Congress at the suggestion of C.A. Seyler.

Analogous terms: opaque matter (opaque attritus) in part (Thiessen and Sprunk 1931), residuum (Kellett, 1928).

II — DESCRIPTION

Of variable form, finely or coarsely granular but showing no cellular structure,

Wide differences in size and form have led to distinction being made between fine micrinite—granules of the order of 1 or more microns in size, and with rather indefinite outline—and massive micrinite, with well defined outline, generally 10 to 100 microns, rarely more than 100 microns in size.

Colour: R. L., light grey to white with sometimes a yellowish tinge; [illegible]erally opaque, except in very thin sections of low-rank coals, when it is dark r[illegible]rown.

Massive micrinite is slightly anisotropic in T.L. when the section is sufficiently thin.

Density: 1.4 to 1.5 and always higher than that of the corresponding vitrinite.

The micro-hardness is always greater than that of the corresponding vitrinite.

Relief: nil for fine micrinite, moderate for massive micrinite.

III — OCCURRENCE

Particularly common in durite.

Fine micrinite is often associated with microspores, but in small quantities: occasionally it is found in the cell cavities of telinite, and sometimes associated with collinite.

IV — PRACTICAL IMPORTANCE

Little information is available on the technological behaviour of pure micrinite. By comparison and extrapolation, however, it is deduced that massive micrinite behaves as follows:

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[1] Stopes (M. C.). On the petrology of banded bituminous coal. Fuel, *14*, (1935), p. 4.

1. *Preparation.*

Confers high strength on the microlithotypes which contain it by reducing their fissuring.

2. *Carbonization.*

Caking ability weaker than that of the corresponding vitrinite: acts as a diluent in coals with more than 18 % V.M.

3. *Hydrogenation.*

Is not hydrogenated by reason of its low hydrogen content.

4. *Oxidizability.*

Not readily oxidizable (less than vitrinite).

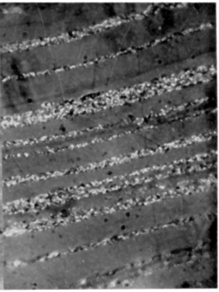
Fig. 1.
Fine micrinite in a French coal (Jura, 36 % V.M.)
Polished section in reflected light,
oil immersion. 110 ×

Fig. 2.
Fine micrinite in a coal from Upper Silesia.
Polished section in reflected light,
oil immersion. 1.000 ×

Fig. 3.
Massive micrinite in a durite (crassidurite) of German coal (Ruhr, 30 % V.M.)
Polished section in reflected light,
oil immersion. 300 ×

MICRINITE - MIKRINIT

1



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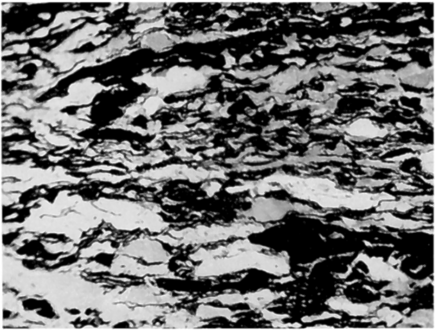

3

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **MICROITE**	Hard coal R. L.

I — ORIGIN OF TERM

The term microite[1] was proposed in 1961 by H. R. Brown, A.C. Cook and G.H. Taylor[2] for a microlithotype composed principally of inertinite in which micrinite[3] is the most abundant form.

Synonym: Inertite, (Snyman)[4].

Analogous terms: fusinito-collinite coal (Timofeev); pulpe végétale (Duparque).

II — DESCRIPTION

See : micrinite.

Contains at least 95% inertinite. The further specification is that the proportion of micrinite must exceed that of fusinite,semifusinite and sclerotinite combined. The micrinite occurs mainly in the massive form.

In petrographic analysis only bands more than 50 microns wide are recorded.

Density: no information.

The strength of microite is generally similar to that of durite and greater than that of other microlithotypes.

May contain inorganic impurities, principally clay minerals.

III — OCCURRENCE

Microite is found in many coals and occurs in large quantities in Gondwana coals and Permo-Carboniferous coals of U.S.S.R. It is most abundant in coals with little exinite, or coals of high rank in which exinite cannot be recognized, and may occur in very persistent thick bands. It is present in small amounts in Carboniferous coals of the Northern Hemisphere.

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[1] The term micrite is already in use as an international term in the petrography of limestone rocks (see: Murchison (D. G.) and Bathurst (R.G.C.). Fuel, *41*, (1962), p. 403-407.

[2] Letter to the Nomenclature Sub-Committee.

[3] The introduction of this term in the list of microlithotypes of the Stopes-Heerlen system is still under discussion.

[4] Snyman (C. P.). A comparison between the petrography of South African and some other palaeozoic coals. Publ. Univ. Pretoria, N. R., *15*, (1961), p. 59, Pretoria 1961.

IV — PRACTICAL IMPORTANCE

1. *Preparation.*

Microite, like durite, tends to break less easily than vitrinite or clarite, and to concentrate in grain sizes of greater than 1 mm.

2. *Carbonization.*

In caking coals, the caking power of microite is even weaker than that of durite I. Acts as a diluent in the coking process and is undesirable in large amounts or in coarse grains.

3. *Hydrogenation.*

No data available, but probably behaves as durite I.

4. *Oxidizability.*

Not readily oxidized.

5. *Formation of dust.*

No tendency to form dust.

6. *Stratigraphy.*

Certain bands of microite are remarkably persistent and may help in seam correlation.

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **MICROLITHOTYPE** (STOPES-Heerlen System)	Hard coal R. L.

I — ORIGIN OF TERM

The term was introduced by C.A. SEYLER[1] in 1954. It designates in the microscopy of humic coals the typical associations of macerals, the minimum band width of which has been fixed at 50 microns. The microlithotypes bear the suffix "ite". Their delimitation although arbitrary and conventional appears to agree well with technological behaviour.

Synonyms: Streifenart, subtype.

Analogous term: Type of coal (TBM).

Table of Microlithotypes[2]

MICROLITHOTYPE	PRINCIPAL GROUPS OF CONSTITUENT MACERALS	[3]
Vitrite	Vitrinite	Monomaceral
Liptite	Exinite or Liptinite	Monomaceral
Fusite	Inertinite (except micrinite)	Monomaceral
Clarite	Vitrinite + Exinite	Bimaceral
Durite	Inertinite + Exinite	Bimaceral
Vitrinertite	Vitrinite + Inertinite	Bimaceral
Duroclarite	Vitrinite + Exinite + Inertinite	Trimaceral
Clarodurite	Inertinite + Exinite + Vitrinite	Trimaceral

The pattern of the glossary sheets for the microlithotypes is as follows :

I — ORIGIN OF TERM

Name of author and date when the term was used in its present sense, with the appropriate reference in the literature.

Synonyms and analogous terms.

---

[1] SEYLER (C. A.). Letter to the Nomenclature Sub-Committee, (1954).

[2] This list is not exhaustive and may be extended later.

[3] These names indicate the number of maceral groups represented as principal constituents in the microlithotypes.

II — DESCRIPTION

Maceral composition.
Minimum band width.
Density.
Strength.
Mineral impurities.

III — OCCURRENCE

Occurrence — distribution — abundance — associations.

IV — PRACTICAL IMPORTANCE

1. *Preparation.*

2. *Carbonization.*

3. *Hydrogenation.*

4. *Oxidizability.*

5. *Formation of dust.*

6. *Stratigraphy.*

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

MINERAL INCLUSIONS IN COAL

General
Term

II — DESCRIPTION

The term "mineral inclusions in coal" is applied to the mineral matter which has become associated with coal by various processes during the various stages of coalification: the inorganic constituents of the original plant material (i.e. plant ash), discrete bands of dirt within the seam, and rock from strata above and below the seam are not included in the term.

The following are microscopically and macroscopically distinguished:

1. Minerals intimately intergrown with the coal.
2. Minerals deposited in cleats and other fissures in the coal.

III — OCCURRENCE

Mineral inclusions can occur in all lithotypes or microlithotypes of coal.

The amount and form of the mineral inclusions which are intergrown with the coal depend largely on the conditions of formation in the bog (water cover, water movement, pH value, chemical composition, Redox potential). The amount varies within wide limits (0-60 % by volume of the whole). The terms carbargilite, carbopyrite and carbankerite are used to designate coal intimately intergrown with other minerals (see these terms).

The amount of mineral matter found in cleats and other natural breaks in coal also varies within wide limits and depends largely on the extent to which fissuring in the seam has facilitated the penetration of ascendant and descendant solutions. The chemical composition of the solutions which circulated through the coal has determined the nature of these minerals.

IV — PRACTICAL IMPORTANCE

1. *Preparation.* The breakage characteristics of freshly mined coal depend primarily on its mechanical strength which is often increased by mineral inclusions, particularly the intergrown forms. The effectiveness of coal preparation—in particular the level of ash achievable in washed coal—also depends largely on the nature of the mineral matter in the coal.

Mineral matter which is intimately mixed with the coal, e.g. finely intergrown pyrites and siderite, fine-grained quartz, and intercalations of clay minerals, is the principal source of the ash of washed coal grades. The minerals deposited in the cleats and other natural fissures are largely freed in the breakage which occurs during mining operations and are subsequently readily removed by reason of their high density (> 1.8—2.0) in washing.

The possibility of preparing ultra clean coal with around 0.5 % ash by normal preparation techniques depends far more on the form in which the mineral matter exists in the original coal, than on the maceral and microlithotype composition.

2. *Carbonization* and low temperature carbonization: in small amounts (up to about 10 % ash) the mineral matter of washed small coal does not usually impair the quality of coke. How far ash constituents exert a favourable influence on coke strength as well as their, so often alleged, effect on the reactivity of coke have yet to be fully proved. Excessive pyrite leads to unfavourable high sulphur contents in the carbonization products: excessive chlorine may lead to corrosion of the oven walls.

3. *Hydrogenation:* Mineral inclusions in coal are undesirable and should therefore be removed as far as possible.

4. *Oxidizability:* Very finely disseminated minerals can increase the oxidizability of coal, and thereby perhaps its tendency to spontaneous combustion; finely intergrown pyrite is suspect in this respect.

5. *Formation of dust:* Finely intergrown mineral matter lessens the tendency of coal to form dust.

6. *Stratigraphy:* In cases where the mineral inclusions in a seam or a certain band of a seam have a high concentration of particular minerals and have extensive lateral persistence, they afford valuable indications to the identity of the seam and thereby to seam correlation. Bands of quartz, tonstein and siderite, and fine accretions of pyrites provide examples. The last mentioned are particularly frequent in seams having overlying marine bands.

7. *Steam-raising:* On combustion the greater part of the mineral matter in coal appears as a residue of fused or partly fused clinker, consisting principally of a silicate glass (half being SiO_2, and $\frac{1}{3}$ to $\frac{1}{4}$ as Al_2O_3). This clinker is largely derived from the decomposition of the clay minerals. CaO and MgO, both originating from carbonate minerals and Fe_2O_3 from pyrite in the coal modify the fusibility of the clinker. Part of the mineral matter is carried forward in the combustion gases either as solid particles, or in a fused or gaseous form—minute hollow spheres (cenospheres) of silicate glass and also SiO from the clay minerals [1] and quartz, water vapour and alkalis from the clay minerals, SO_2 and SO_3 from iron di-sulphides (pyrites, and marcasite), CO_2 from the carbonate minerals, and phosphorous oxides possibly from either phosphorite

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[1] SiO is produced by the very strong reducing action of carbon at temperatures around 1 500-1 800°C. The existence of unburnt carbon at temperatures within this range may be attributed to extremely high firing rates. The SiO is re-oxidised to SiO_2 immediately on contact with oxygen.

or apatite. If the coal contains salt, then in addition to alkalis quantities of Cl will be freed. Fused ash tends to corrode the iron parts and the refractory linings of the combustion chamber, whilst the solids carried in the combustion gases cause deposits on the heating surfaces of the boiler as well as polluting the atmosphere. Alkalis, SO_2 and SO_3 and possibly the phosphorous oxides are then main constituents of the binding agents in these deposits.

Principal mineral inclusions in coal

	INTIMATELY INTERGROWN WITH THE COAL		
	Deposited by water or windblown	Originally formed in the peat	Deposited in cleats and other fissures (coarsely intergrown)
Clay minerals	Illite, sericite, kaolinite, leverrierite, montmorillonite, etc...		
Carbonate minerals (spars)		Accretions of siderite, dolomite, (ankerite), and calcite. $FeCO_3$ and $CaCO_3$ in fusite.	Calcite. Ankerite.
Sulphide minerals		Accretions of FeS_2. Accretions of FeS_2-$CuFeS_2$-ZnS Melnikovite.	Pyrites Marcasite Zinc blende Copper pyrites Galena
Oxides		Limonite. Hematite.	Göthite (needle iron ore)
Quartz	Granular quartz.	Chalcedony and quartz produced by decomposition of aluminium silicates.	Quartz Chalcedony
Salts (chlorides, sulphates, etc...)	Rock salt, thenardite, gypsum		

Fig. 1.

Intimate intergrowth of argillaceous minerals and coal.
Polished thin section in reflected light, oil immersion, 125 ×.

Fig. 2.

Intimate intergrowth of concretionary pyrite and coal.
Polished thin section in reflected light, oil immersion, 125 ×.

Fig. 3.

Intimate intergrowth of siderite accretions and coal.
Polished thin section in reflected light, oil immersion, 125 ×.

Fig. 4.

Intimate intergrowth of quartz and coal (accessory argillaceous minerals).
Polished thin section in reflected light, glycerine immersion, 125 ×.

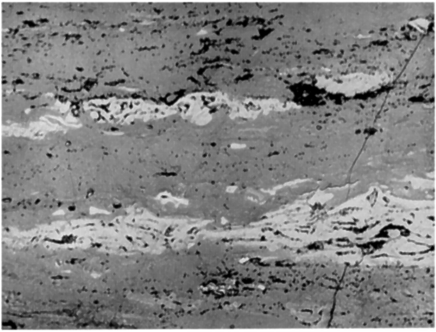
Fig. 5.

Iron pyrites deposits in cleats and fissures.
Polished thin section in reflected light, oil immersion, 125 ×.

Fig. 6.

Calcite deposits in cleats and fissures.
Polished thin section in reflected light, oil immersion, 125 ×.

INCLUSIONS MINÉRALES DANS LES HOUILLES
MINERALISCHE EINLAGERUNGEN IN DEN KOHLEN
MINERAL INCLUSIONS IN COAL



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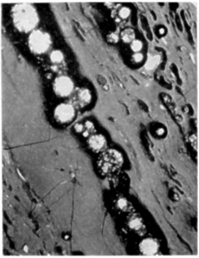

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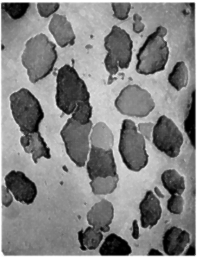

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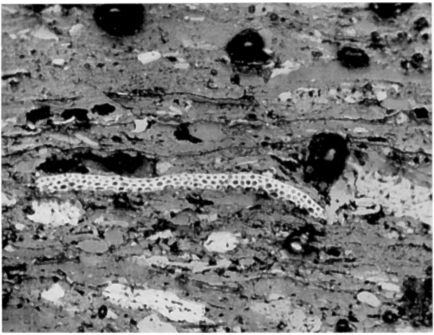
INCLUSIONS MINÉRALES DANS LES HOUILLES
MINERALISCHE EINLAGERUNGEN IN DEN KOHLEN
MINERAL INCLUSIONS IN COAL



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5

6

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **OPAQUE ATTRITUS** (Thiessen-Bureau of Mines System)	Brown coal Hard coal T. L.

I — ORIGIN OF TERM

Term first used by R. Thiessen [1] in 1930 referring to coal material of which the "most prominent and important constituent is opaque matter, also referred to as opaque matrix, black fundamental matter or matrix and residuum [2]. "

II — DESCRIPTION

Opaque attritus consists of three common types of organic matter all of which are opaque to transmitted light in thin section:

1. Opaque matter consisting of fusain less than 30 microns thick.

2. Amorphous opaque matter equivalent in general to dispersed humic degradation matter in form but suggesting a fusinized mode of preservation (cf. micrinite, massive micrinite).

3. Granular opaque matter consisting of discrete granules, 0.5 to 1.5 microns in diameter, opaque when aggregated but showing greyish to faintly brownish translucency in extremely thin section or when sufficiently dispersed in translucent humic material. Occasionally granular opaque matter impregnates cellular cavities of well decayed plant tissue. (cf. micrinite, granular micrinite).

III — CORRELATION WITH TERMS OF THE STOPES-HEERLEN SYSTEM

The following macerals of the Stopes-Heerlen nomenclature are included in opaque attritus: fusinite, and sclerotinite, micrinite and semifusinite when these are strongly reflecting, i.e. opaque.

Opaque attritus is a collective term and not comparable with any of the micro-lithotypes of the Stopes-Heerlen nomenclature.

IV — OCCURRENCE

Present, at least in minor amounts in most banded and non-banded coals. It is the characteristic component of splint and many dull coals.

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1. Thiessen (R.). Splint coal; Trans. A.I.M.E. Coal Division, (1930), p. 644-672.
2. Kellett (J. G.). The physical constitution of bituminous coal and coal seams. Colliery Guard., *137*, (1928), p. 240-2.

V — PRACTICAL IMPORTANCE

1. *Preparation.*

Opaque attritus does not separate as a pure constituent but always tends to be associated with tough, blocky, attrital dull coal and thus to concentrate in coarse sizes of commercial coal.

2. *High — and low — temperature carbonization.*

Opaque attritus lacks swelling and agglutinating properties on carbonization, but may increase the agglutinating index of a coal in which it occurs.

3. *Hydrogenation.*

Opaque attritus contributes to the non-liquified residue.

4. *Oxidizability.*

It is relatively inert to oxidation.

5. *Tendency to form dust.*

Opaque attritus contributes less to dust formation than fusain, anthraxylon and translucent attritus.

Fig. 1.

Opaque attritus (amorphous opaque matter) in an English coal (37% V.M.)
Polished thin section in transmitted light, 500 ×.

Fig. 2.

The same in reflected light, oil immersion, 500 ×.

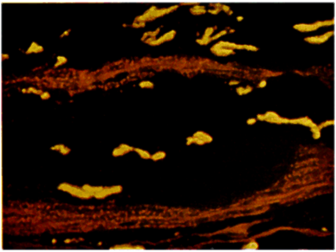
Fig. 3.

Opaque attritus (granular opaque matter) in an English coal (37% V.M.)
Polished thin section in transmitted light, 500 ×.

Fig. 4.

The same in reflected light, oil immersion, 500 ×.

OPAQUE ATTRITUS



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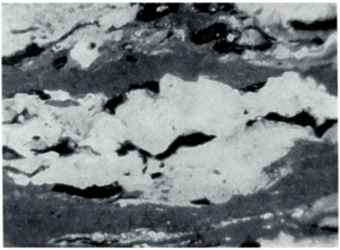

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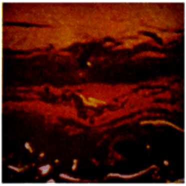

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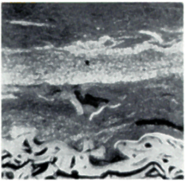

4

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

General
Term

PEAT

There are two types of peat, low moor (Flachmoor) and high moor (Hochmoor) peat. Low moor peat is the most common starting material in coal genesis. It therefore constitutes a caustobiolith of low diagenetic degree. Peat is formed in marshes and swamps from the dead, and partly decomposed remains of the marsh vegetation. Stagnant ground water is necessary for peat formation to protect the residual plant material from decay.

Peat has a yellowish brown to brownish black colour, is generally of a fibrous consistency, and can be either plastic or friable; in its natural state it can be cut; further, it has a very high moisture content ($> 75\%$, generally $> 90\%$). It can be distinguished from brown coal by the fact that the greater part of its moisture content can be squeezed out by pressure (e.g. in the hand). Peat also contains more plant material in a reasonably good state of preservation than brown coal. Individual plant elements, such as roots, stems, leaves, seeds, etc. can commonly be seen in it with the unaided eye. Failing that, treatment of peat with dilute alkali will make visible many of these plant tissues. Further, peat is richer in cellulose than brown coal (reaction with Fehling's solution). Unlike brown coal, peat still contains cellulose, protected by lignin or cutin, which gives a reaction with chlor zinc iodide (POTONIE[1], 1929). Correspondingly peat shows under the microscope tissues which have not undergone either lignification, suberinisation or cutinisation; this is not the case in brown coal. The reflectance of peat is low (about 0.3%). Microscopic examination is best undertaken with transmitted light.

STRACHE & LANT[2], state that the inorganic matter content of peat should be under 40% on a dry basis.

The carbon content of peat varies generally between 50% and 60% (d.a.f.) (LISSNER-THAU[3], 1956).

According to KAYSER, SCHARAU & MUNDERLOCH[4], (1953), peat and brown coal are readily distinguished in practice as follows.

Peat: Moisture content $> 75\%$; can be cut with peat-cutting tools; rich in free cellulose.

Brown coal: Moisture content $< 75\%$; usually impossible to cut with peat-cutting tools; free cellulose absent.

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[1] POTONIE (R.). Petrographische Hilsmittel zur eineutigen Bezeichnung der Kohlenarten. Bergtechnik, N. F. Braunk. Brikett Ind., *20*, (1927), p. 109-110.

[2] STRACHE (H.) & LANT (R.). Kohlenchemie. Verlag Akad. Verlagsges. m. b. H., Leipzig, (1924).

[3] LISSNER (A.) & THAU (A.). Die Chemie der Braunkohle. VEB Vilhelm Knapp Verlag, Halle/Saale, (1956).

[4] KAYSER (H. G.), SCHARLAU (A.) & MUNDERLOCH (H.). In WINNACKER-WEINGAERTNER. Chemische Technologie. Organische Technologie L. München, (1952), p. 123-124.

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **PHYTERAL**	Brown coal Hard coal T. L. R. L.

The term phyteral was introduced by G.H. Cady[1] in 1942, "to designate plant forms or fossils in coal as distinguished from the material of which the fossils may be composed".

Phyterals are identified in general botanical terms which are usually morphological such as spore coat, sporangium, cuticle, resin, wax, wood substance, bark, etc. The initial composition of the phyterals differed; these or other differences produced during diagensis may or may not be perpetuated by and during carbonification (coalification). Phyterals are recognized with increasing difficulty in high rank coals. In contrast to macerals which represent a purely petrographical concept, the concept phyteral demands strict correlation with certain organs of the initial plant material.

---

[1] Cady (G. H.). **Modern concepts of the** physical constitution of coal. J. Geol., *50*, No. 4, (1944), p. 337-356.

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

PROTOBITUMEN

General
Term

I — ORIGIN OF TERM

A generic term introduced in 1926 by R. Potonie[1] for petrographic constituents, from which bitumen is derived.

II — DESCRIPTION

The protobitumens include sporinite, cutinite, resinite, pollinite, alginite. Chemically the protobitumens are composed mainly of sporinites, pollenines, cutines, suberins, resins, waxes, fats and oils of plant and animal origin.

Relative to vitrinite they have high hydrogen and low oxygen contents.

In coals of low rank (in general those with more than 30% V.M.) the protobitumens have properties which are more or less similar to those of the corresponding entities in recent plant and animal material. But in coals with 20-30% V.M. the properties change fairly rapidly with increasing rank. In polished surfaces of low rank coals they exhibit a much weaker reflectance than vitrinite and are dark brown to dark grey in colour—in transmitted light, golden-yellow.

In coals of higher rank the optical characteristics gradually approach those of the associated vitrinite, from which constituent the protobitumens are generally indistinguishable in coals with less than 20% V.M. The properties of some protobitumens change more rapidly with rank than others.

The following distinctions are made:

1. *Stable protobitumens.*

Include spore and pollen exines, cuticle, cork tissue, primary resins, waxes, and cell walls of algae. Also included are products derived from non-bituminous matter and unstable protobitumens, amongst others, as a result of changes brought about by saprophytic agents. Such products are termed secondary bitumen or stable metabitumen, and are usually structureless. Stable protobitumens only show marked changes in coals with less than 30% V.M.

2. *Unstable protobitumens.*

These originate from certain plant and animal fats and oils and, in contrast to stable protobitumens, show changes in their properties at an early stage of coalification.

---

[1] Potonie (R.). Beziehungen zwischen bituminösen Gesteinen und Erdöl. Minutes of the Meeting of the Geol. Landesamt, Berlin, *1*, (1926), p. 10-24.

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

General
Term

RANK

I — ORIGIN OF TERM

The Nomenclature Sub-Committee agreed that the term "rank", which has long been used in several countries to designate the degree of carbonification should be accepted as an international scientific term.

Synonyms: Inkohlungsgrad, degré de houillification, degree of coalification.

II — DEFINITION

"Rank" describes the stage of carbonification attained by a given coal.

III — DETERMINATION OF RANK

1. *General.*

The rank of a coal is not a directly measurable quantity. To define it, it is necessary to refer to a specific physical or chemical property which exhibits adequate change in the course of coalification. Such properties are numerous but, unfortunately, they do not all change conformably with carbonification and, therefore, many are not reliable indices of rank.

Moreover, the properties of the different coal constituents do not change to the same pattern. It is necessary, therefore, in strict comparisons to determine rank on one particular maceral. This presents some difficulties in the case of peat and soft brown coal which, unlike more highly coalified material, can only be examined as a whole. In determining the rank of hard brown coal and bituminous coals, as well as of anthracite, vitrinite is the best reference maceral for the following reasons.

a) it is the most abundant and, therefore, the most representative maceral;

b) its characteristics change fairly continuously and commensurately with the course of coalification;

c) it is relatively easy to isolate.

However, even vitrinite is not a completely homogeneous substance. In consequence it is difficult to prepare truly comparable vitrinite samples for chemical analysis. Nonetheless, in the light of current knowledge, the differences between telinite and collinite may be disregarded when considering rank in the range of hard coals.

Within certain ranges of rank, changes in the exinite are more marked than those in the vitrinite of the coal and, therefore, the exinite can be used for rank determination in these coals particularly in microscopic analysis.

With increasing coalification the various macerals become less differentiated, and consequently the rank of anthracite is usually determined on the whole of the specimen without particular reference to the vitrinite therein.

A straightforward determination of rank is not possible where the coals are weathered, oxidised or affected by radio-activity.

Rank is determinable by various methods.

2. *Physical Methods of Determining Rank.*

a) Microscopy.

As Figs. 1 and 5 indicate, major differences in coalification can be recognised under the microscope without recourse to special measurement; the degree of compaction and homogenisation (gelification) of the plant remains as well as the differences in the colour and brightness of the macerals—are important criteria.

The rank of hard coals can be determined by microscopy, in conjunction with reflectance measurement, on either pure vitrinite or equally well on the vitrinite as it occurs in any average sample of coal. Isolation of the vitrinite by hand-picking or flotation is unnecessary. Reflecting power increases with coalification.

As the reflectance of the vitrinite within a given seam at any particular locality may show some variation, in accurate determinations of rank sufficient individual measurements should be made to satisfy statistical requirements, and the average value and the variance calculated from these. Rank determination of this kind can be undertaken on column samples of seam profiles or on strip samples. In critical investigations rank should be determined on polished blocks orientated to provide identical conditions of measurement on all occasions independent of the plane of the section. This is particularly important when dealing with anthracite.

Reflectance measurements can be plotted against other parameters commonly used in defining the degree of coalification, for example, volatile matter or carbon content (both measured on a d.a.f. basis). Two examples of graphs of this kind are shown in Figs. 3 and 4. Using these, it is possible to give an approximate estimate of both the volatile matter and carbon content of the coal, from its reflectance.

The only method of determining the rank of different coals in a mixture of coals is reflectance measurement, since chemical, physico-chemical or technological tests conducted on a blend only give values representing the average for the mixture.

b) The true density and Micro-Vickers hardness of the pure vitrinite may both be used with some reservations to indicate rank. These two parameters exhibit a minimum in the 87-90% carbon range.

c) X-ray diffraction may be employed to distinguish between high rank anthracite and graphite, the latter giving the interference bands of a three-dimensional ordered lattice.

3. *Chemical and Physico-Chemical methods.*

a) Volatile matter of d.a.f. vitrinite.

The volatile matter of coals decreases generally with increasing rank and is particularly rapid below 30% V. M.

b) Ultimate analysis of vitrinite (C, H, N, O, org. S).

Carbon content increases with increasing rank whilst oxygen decreases. In coals of more than 90% C the hydrogen content is a very satisfactory indicator of rank. N and S are uncertain measures of coalification. Reference to more than one element, e.g. the molecular ratios O/C and N/C, instead of a single element like carbon has much to commend it.

c) Moisture content and calorific value of the ash-free vitrinite.

Both the moisture content (bed moisture) of the freshly mined undried vitrinite and its calorific value referred to on an ash-free basis are satisfactory measures of coalification in the lower rank coals [1].

The different methods used to establish rank are summarised and compared in Fig. 5 (cf. PATTEISKY and M. TEICHMÜLLER 1960 [2]).

A number of countries have established systems of coal classification for practical purposes based on coal rank.

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[1] *Solubility in KOH.* Peat and brown coal may be distinguished from hard coal by the solubility of the humic substance and the vitrinite respectively in KOH. Peat and brown coal dissolve for the greater part in KOH solution; hard coals on the other hand are insoluble or only slightly soluble.

[2] PATTEISKY (K.) and TEICHMÜLLER (M.). Inkohlungs-Verlauf, Inkohlungs-Massstabe und Klassifikation der Kohlen auf Grund von Vitrit-Analysen. Brennst Chemie, *41*, (1960), p. 79-84, p. 98-104 and p. 133-137.

[3] KOTTER (K.). Die mikroskopische Reflexionsmessung mit dem Photomultiplier und ihre Anwendung auf die Kohlenuntersuchung. Brennst Chemie, *41*, (1960), p. 263-272.

CAPTIONS TO FIGURES ON RANK SHEET

Fig. 1 and 2.

Changes in microscopic structure at different ranks.

1a. *Peat of the Quarternary (approx. 90 % H_2O).*

1b. *Soft brown coal of the Tertiary (60 % H_2O).*

1c. *Hard brown coal of the Tertiary (30 % H_2O).*

2a. *High-volatile coal of the Carboniferous (38 % volatile matter d.a.f.).*

2b. *Medium-volatile coal of the Carboniferous (24 % volatile matter d.a.f.).*

2c. *Anthracite of the Carboniferous (3% volatile matter d.a.f.) under polarised light and with crossed nicols.*

1a. *Thin section, transmitted light, 250×.*

1b, 1c, 2a, 2b, 2c. *Polished section, reflected light, oil immersion, 250×.*

Fig. 3

Correlation between reflectance (oil immersion, green light) and volatile matter and carbon content of vitrinite (Kotter, 1960 [3]).

Fig. 4.

Maximum and minimum reflectances (oil immersion) of vitrinite and the relationship with carbon content (results of various authors, collated by Huntjens*)*

1. Broadbent (S. R.), & Shaw (A. J.). *Reflectance of coal. Fuel, 34, (1955), p. 385-403.*

2. Murchison (D. G.). *Reflectance of vitrinite. Brenns Chemie, special issue 39, (1958) p. 47-51.*

3. Mc Cartney (J. T.) & Ergun (S.). *Written communication.*

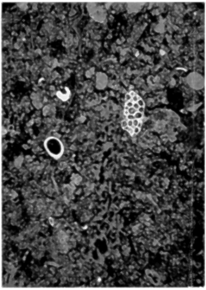
4. Huntjens (F. J.) & Van Krevelen (D. W.). *Chemical structure and properties of coal II. Reflectance. Fuel, 33, (1954), p. 88-103, as well as unpublished data.*

Fig. 5.

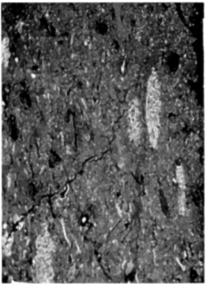
Distinctions between the broad stages of coalification based on microscopic and chemical characteristics—the applicability of various measures of rank (after Patteisky & M. Teichmüller, 1960[2]).

RANG - RANK

1a



1b

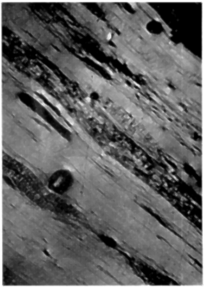


1c

RANG - RANK

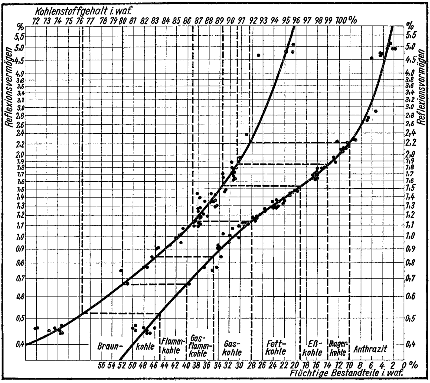
2a

2b



2c

RANG-RANK


Kohlenstoffgehalt i. waf.
72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 %
Reflexionsvermögen
%
5,5
5,0
4,5
4,0
3,8
3,6
3,4
3,2
3,0
2,8
2,6
2,4
2,2
2,0
1,9
1,8
1,7
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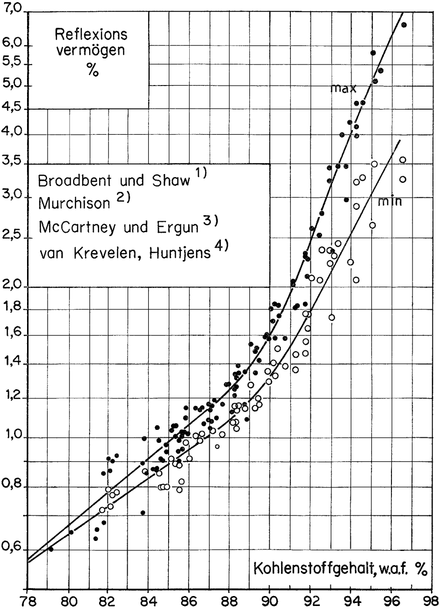
1,5
1,4
1,3
1,2
1,1
1,0
0,9
0,8
0,7
0,6
0,5
0,4
Braun- kohle
Flamm- kohle
Gas- flamm- kohle
Gas- kohle
Fett- kohle
Eß- kohle
Mager- kohle
Anthrazit
56 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2 0 %
Flüchtige Bestandteile i. waf.


Reflexions vermögen %
Broadbent und Shaw 1)
Murchison 2)
McCartney und Ergun 3)
van Krevelen, Huntjens 4)
max
min
Kohlenstoffgehalt, w.a.f. %
7,0
6,0
5,5
5,0
4,5
4,0
3,5
3,0
2,5
2,0
1,8
1,6
1,4
1,2
1,0
0,8
0,6
78
80
82
84
86
88
90
92
94
96
98

Rank increasing

		Rank Stages	% reflectance of vitrinite	Important microscopic characteristics	% C in vitrinite	Volatile matter % d.a.f. in vitrite	% H_2O in situ	Calorific value of vitrite (a.f.)	Applicability of the different parameters for the determination of rank
		Peat		Large pores Details of initial plant material still recognizable Free cellulose	50				Calorific value (a.f.) or moisture in situ (moisture-holding capacity)
							75		
Brown coal		Soft brown coal		No free cellulose Plant structures still recognizable (cell cavities frequently empty)	60				
			ca. 0.3	Marked gelification and compaction takes places		ca. 53	35	7,200 B.t.u./lb (4,000 kcal/kg)	
	Hard brown coal	Dull brown coal		Plant structures still partly recognizable	70	ca. 49	25	9,900 B.t.u./lb (5,500 kcal/kg)	Carbon (d.a.f.) Reflectance of the vitrinites
		Bright brown coal		(cell cavities filled with collinite)					Volatile matter (d.a.f.)
			ca. 0.5			ca. 45	8-10	12,600 B.t.u./lb (7,000 kcal/kg)	
Hard coal		Bituminous hard coal		Exinite becomes markedly lighter in coulour ("Coalification jump")	80	30			X-ray diffraction (graphite lattice)
			ca. 2.5	Exinite no longer distinguishable from vitrinite in reflected light	90	10		15,500 B.t.u./lb (8,650 kcal/kg)	H. (d.a.f.)
		Anthracite		Reflectance anisotropy					
		Graphite	11.0		100	0			

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee	Brown coal Hard coal
	RESIN RODLETS (Resinous bodies)	R. L. T. L.

I — ORIGIN OF TERM

White and Thiessen [1] described and illustrated resin rodlets in 1913.

Synonyms: resin rods, resin fibrils, resin needles, resin casts, resin canal casts.

Analogous terms: Harzkosper, resinous constituents or components or bodies. Certain resin rodlets in bituminous coals have been called sclerotia [2].

II — DEFINITION

Constituent representing resinous secretion of plants; most resin rodlets have been formed by the secretion of resin into canals or ducts by the surrounding epithelial cells. Many of the rodlets were formed in the petioles of the Medullosans, although may have been contributed from the stems of other gymnosperms.

III — DESCRIPTION

As the name implies resin rodlets are cylindrical and rod shaped. They may occasionally be hollow but are usually solid except that they may be traversed by small vesicles or canals. They have infrequently been observed split lengthwise with an inner pattern of disc-like forms inclined from either end toward a central flat-lying disc. When the rodlet is hollow the space is commonly mineralized, kaolinite being a common filling.

Anisotropy: probably variable depending on rank and the degree of fusinization.

Density: no information.

Microhardness: no information.

Relief: from slightly greater to considerably greater than that of the associated vitrinite depending on the degree of fusinization.

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[1] White (D.) and Thiessen (R.). The origin of coal: U. S. Bur. Mines. Bull., *38*, (1913).

[2] Kosanke (R. M.) and Harrison (J. A.). Microscopy of the resin rodlets of *Illinois coal*: Ill. State. Geol. Surv. Circular, *234*, (1957), p. 14.

IV — OCCURRENCE

Common, but in relatively small quantity in banded bituminous coals. Rare in non-banded coals. May occur genetically associated with anthraxylon or fusain, or be scattered and mixed at random with other constituents in the attritus, and in bands of highly mineralised coal.

V — PRACTICAL IMPORTANCE

The technological properties of resin rodlets are not yet known in detail. They probably vary considerably with the rank of the coal, and their degree of fusinization. Unfusinised resin rodlets may be assumed to behave as exinite (q.v.) and fusinised rodlets as inertinite (q.v.).

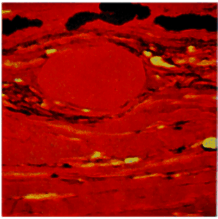
Fig. 1.
Resin rodlets from an American coal (30 % V.M.)
Polished thin section
Transmitted light, 300 ×.

Fig. 2.
As fig. 1.
Reflected light, oil immersion, 300 ×.

Fig. 3.
Resin rodlet extracted from coal by maceration.
The rodlet split longitudinally is ornamented along its length with a pattern of stacked discs inclined from each end towards a central flat-lying disc. 10 ×.

Fig. 4.
Two translucent resin rodlets, one showing numerous vesicles, the other none.
Transmitted light, 300 ×.

RESIN RODLETS



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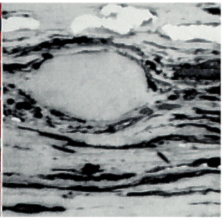

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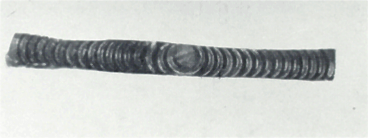

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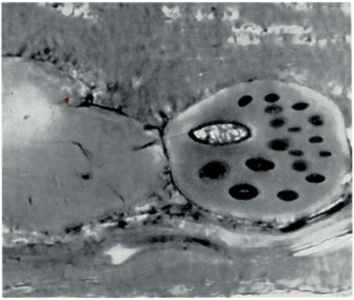

4

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

RESINITE COAL

(System of Geol. Inst. Acad. Sci. U.S.S.R. Moscow)

Brown coal
Hard coal
T. L.

I — ORIGIN OF TERM

The term was introduced in 1956 by Krylova, Walz, Ginsburg and Luber [1].

II — DESCRIPTION

Resinite coal consists of more than 50% of small resin bodies embedded in gelito-collinite, fusinito-collinite, or in collinite of fusinitic nature. The resin bodies differ in shape and may be angular, spheroidal or lenticular. Varying in size, they may be visible to the unaided eye in a hand specimen of coal or only distinguishable under the microscope. Resinite coal may also contain small quantities of microspores, fine fragments of fusinised tissue and not infrequently, broad streaks of vitrinite.

Hand specimens of resinite coal are matt or semi-matt and in coals of low rank are brown or brownish-black. On fractures perpendicular to the bedding the resin bodies appear rounded, black and lustrous: in the bedding planes themselves they frequently appear as matt rodlets.

Resinite coals frequently are high in ash.

III — OCCURRENCE

Resinite coal occurs in seams of different geological age as bands or beds up to 0.5 metre thick.

IV — PRACTICAL SIGNIFICANCE

Resinite coals are used as raw material in the chemical industry.

Fig. 1.

Resinite coal (resinite and fusinito-collinite) from a Russian seam. (Tkibulsk)
Transmitted light, 200×.

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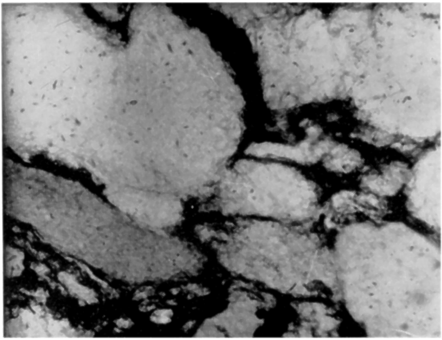
[1] Krylova (M. M.), Walz (I. E.), Ginsburg (A. I.) and Luber (A. A.). The terminology and fundamental classification of the petrographic constituents of humic coals. Akad. Nauk SSSR, Trudy Labor. coal Geol., *6*, (1956), p. 42-53.

CHARBON DE RÉSINITE
RESINIT - KOHLE
RESINITE COAL



1

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

RESINITE

(Stopes-Heerlen System)

Hard coal
R. L.

I — ORIGIN OF TERM

M. C. Stopes [1], 1935.

Analogous terms: resinous substance, (in part) resin rodlets.

II — DESCRIPTION

Constituent occurring as discrete small bodies of various shapes which, in cross section, are round, oval or rod-like; as diffuse impregnations or filling cell cavities in telinite.

Colour: by R. L. black to grey in coals with more than 20 % V.M.; in general, darker than that of the corresponding vitrinite.

In T. L. yellow to reddish orange in coals with more than 20 % V.M.; generally lighter than that of the corresponding vitrinite [2].

R: generally weaker than that of the corresponding vitrinite [2].

Anisotropy: weak to strong in T.L.; may vary from one particle to another.

Density: no information.

Micro-hardness: no information.

Relief: weak to nil when the resinite occurs as an impregnation; often more marked when it occurs in the form of discrete small bodies.

III — OCCURRENCE

Common in clarite: sometimes present in small quantities in durite.

Sometimes fairly abundant between cuticles.

Sometimes in distinct bands.

Associated with vitrinite.

IV — PRACTICAL IMPORTANCE

The properties of resinite are not yet known in detail. It is feasible to consider that they are similar to those of other members of the exinite group.

---

[1] Stopes (M. C.). On the petrology of banded bituminous coal. Fuel, *14*, (1935), 4.

[2] The rounded bodies which have a higher reflectance than the vitrinite in reflected light and a deeper shade in transmitted light are counted as Inertinite in the maceral analysis even if they are resinous in origin.

Fig. 1.

Resinous body with concentric structures
in an American coal (35 % V.M.)
Polished thin section in reflected light,
oil immersion. 200 ×

Fig. 2.

The same in transmitted light.

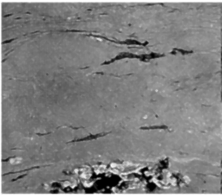
Fig. 3.

Resinite in cellular cavities.
Belgian coal (36 % V.M.)
Polished section in reflected light,
oil immersion. 350 ×

Fig. 4.

Grey resinite between cuticles in a French coal
(Lorraine, 36 % V.M.)
Polished section in reflected light,
oil immersion, 250 ×

RESINITE - RESINIT



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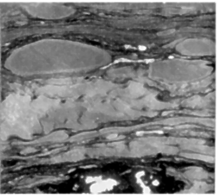

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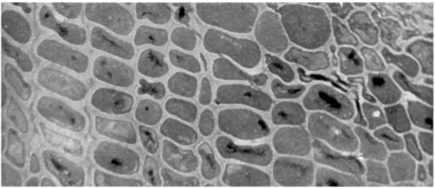

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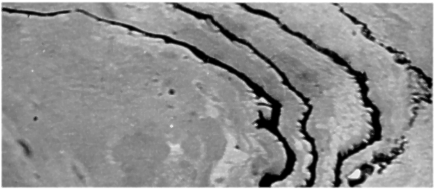


4

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **SAPROPELIC COAL**	General Term

I — ORIGIN OF TERM

The term was introduced by H. Potonie [1] in 1906 to designate coal of which the original plant material was more or less transformed by putrefaction.

Synonym: Faulschlamm-Kohle.

Analogous terms: Sapanthrakon (sapropelic bituminous coal) Sapanthracit (sapropelic anthracite).

II — DESCRIPTION

Macroscopic: in comparison with most humic coals sapropelic coal is more or less unstratified, and shows little or no development of cleat fractures. The surface is matt with dull or faintly greasy lustre. It breaks conchoidally.

Microscopic: under the microscope sapropelic coals can be divided into cannel and boghead coals although the distinction becomes difficult in high rank coals. See these terms.

III — OCCURRENCE

Complete seams of sapropelic coals are rare, but layers or bands of varying thickness within seams are more frequent. Not abundant.

IV — PRACTICAL IMPORTANCE

1. *Preparation.*

Sapropelic coals prove troublesome in cleaning processes with jig and dense medium washers because of their lower density relative to humic coals of the same rank and the same ash content.

---

[1] Potonie (R.). Klassifikation und Terminologie der rezenten brennbaren Biolithe und ihrer Lagerstätten. Abh. preuss. geol. Landesanstalt, *19*, (1906), p. 1-94.

2. *Carbonization.*

The coking properties of sapropelic coals are poorer than those of humic coals of the same rank. By virtue of their high hydrogen content they give good yields of gas and tar and were formerly valued for the manufacture of illuminating gas.

3. *Hydrogenation.*

No information.

4. *Oxidizability.*

No information.

5. *Formation of dust.*

No tendency to produce dust.

1963

EDITION

International Committee for Coal Petrology

Nomenclature Sub-Committee

SCLEROTINITE

(Stopes-Heerlen System)

Hard coal

R. L.

I — ORIGIN OF TERM

E. Stach [1], 1951.

II — DESCRIPTION

Occurs in two principal forms :

a) Round or oval bodies of varying size (20-300 microns), appertaining in the majority of cases to sclerotia, less frequently to fungal spores and to resinous bodies.

b) Interlaced fungal hyphae (plectenchyma) appertaining in the main to mycelia: form and size irregular, with both small and large cavities.

Colour: in R.L. varies from light grey to white, sometimes to yellowish white; in T.L. dark reddish brown to opaque.

R: generally between that of vitrinite and fusinite of the same coal; it is always higher than that of the vitrinite, and may be higher than that of the fusinite.

Sometimes shows very slight anisotropy in R.L., and in T.L. when the section is sufficiently thin.

The density is not precisely known.

Sclerotinite is generally hard, but sometimes deformable.

The micro-hardness varies from 50 to 150 kg/mm^2: it is always greater than that of vitrinite and sometimes even greater than that of fusinite of the same coal.

Relief: generally strong: sometimes weak or nil.

III — OCCURRENCE

May be found in all microlithotypes in nearly all coals.

Fairly widely distributed, but usually in small quantities.

---

[1] Stach (E.). Heutiger Stand der genetischen Deutung der Kohlengefügebestandteile. Comptes rendus du 3^e Congrès de Statigraphie et de Géologie du Carbonifère, II, (1952), p. 586.

IV — PRACTICAL IMPORTANCE

Occurring only in small proportions, sclerotinite is unimportant in industrial processes: in general it behaves as an inert element. In particular circumstances it can be an aid in the identification of seams.

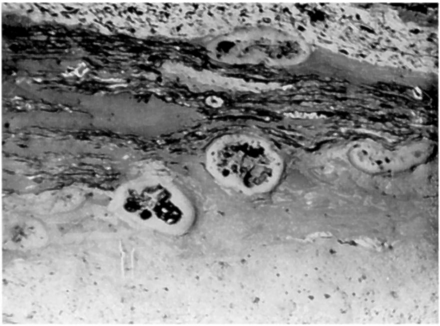
Fig. 1.

Sclerotia in a French coal (Lorraine, 36 % V.M.)
Polished section in reflected light, oil immersion,
110×.

Fig. 2.

Sclerotinite. Plectenchyma in a Belgian coal. (31 % V.M.)
Polished section in reflected light, oil immersion,
350×.

SCLEROTINITE - SKLEROTINIT



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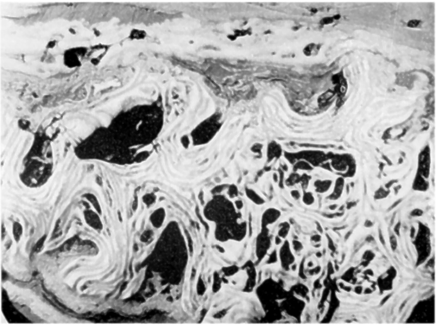


2

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **SEMIFUSINITE** (Stopes-Heerlen System)	Hard coal R. L.

I — ORIGIN OF TERM

W. J. Jongmans [1], 1935.

Synonyms: xylain (Duparque), Vitrofusit (Stach), Fusovitrit (Jongmans), Ubergangsstufen (Kuhlwein), intermediates (Seyler).

Analogous terms : corresponds in part to semifusain and brown matter (R. Thiessen).

II — DESCRIPTION

Constituent intermediate between vitrinite and fusinite showing well defined structure of wood and sclerenchyma. The cell cavities, round, oval or elongated in cross section, vary in size but are generally smaller and sometimes less well defined than those of fusinite.

Bogen-structure is less common than in fusinite.

Colour: between that of vitrinite and fusinite of the same coal; by R. L., light grey to white; by T.L., orange red to opaque.

R : variable : ca. 0.6 to 7 % in oil immersion; ca. 6.5 to 15 % in air.

Sometimes shows very slight anisotropy in R. L. and also by T. L. when the section is sufficiently thin.

The density varies between that of the corresponding vitrinite and fusinite (generally between 1.4 and 1.5).

Micro-hardness and relief vary between those of vitrinite and fusinite of the same coal.

III — OCCURRENCE

As lenses and bands of variable thickness, and as small fragments: associated with fusinite, or included in vitrite, clarite, duroclarite, clarodurite and durite.

Often lies as a transition material between vitrinite and fusinite.

Widely distributed, common.

---

[1] Jongmans (W. J.), Koopman (R. G.) Roos and (G.). Nomenclature of Coal Petrology. Comptes rendus du 2e Congrès de Statigraphie et de Géologie du Carbonifere, III, (1938), p. 1734.

IV — PRACTICAL IMPORTANCE

Properties lie between those of fusinite and vitrinite. Behaves as a semi-inert diluent in carbonization.

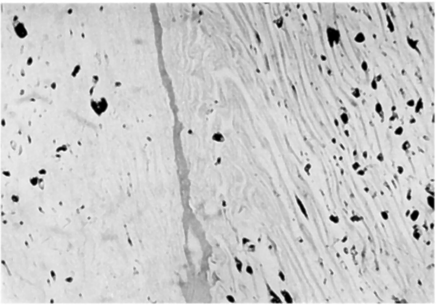
Fig. 1.

Semifusinite in a French coal (Nord-Pas-de-Calais 14 % V. M.)
Polished section in reflected light, oil
immersion. 250 ×.

Fig. 2.

Semifusinite becoming telinite in a French coal
(Lorraine, 40 % V. M.). Polished section in
reflected light, oil immersion. 250 ×.

SEMIFUSINITE - SEMIFUSINIT



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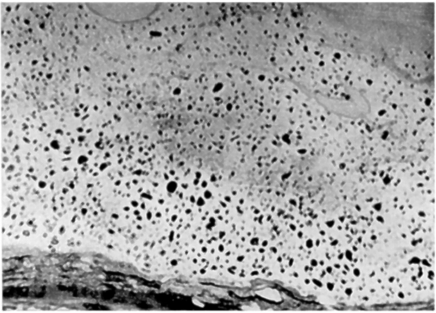


2

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **SEMISPLINT COAL** (THIESSEN-Bureau of Mines System)	Hard coal T. L.

I — ORIGIN OF TERM

Term originally applied by R. THIESSEN [1] in 1931 to coal "composed of anthraxylon and opaque attritus in which the proportion of anthraxylon exceeds that of the attritus." However it is clear from his descriptions that the semisplint coal of THIESSEN also includes elements of translucent attritus. In 1948 a quantitative definition of the term semisplint was given by B. C. PARKS and H. J. O'DONNELL [2] in terms of anthraxylon and opaque matter.

II — DESCRIPTION

According to U. S. Bureau of Mines practice semisplint coal has between 20 per cent and 30 per cent of opaque matter and more than 5 per cent anthraxylon as determined from thin sections. The content of anthraxylon and opaque matter is determined perpendicular to the bedding entirely across the thin section (2-3 cm. width).

III — CORRELATION WITH TERMS OF THE STOPES-HEERLEN NOMENCLATURE

Corresponds either to duroclarite or clarodurite, according to the ratio of vitrinite and inertinite. May also correspond to vitrinertite.

IV — OCCURRENCE

Mainly as bands and benches in otherwise bright banded coal. Widespread in bituminous coal seams.

V — PRACTICAL IMPORTANCE

1. *Preparation*

Because of its toughness, tends to concentrate in the coarser nut sizes of commercial coal.

2. 3. 4. 5. Properties intermediate between bright banded coal and splint coal.

---

[1] THIESSEN (R.) in FIELDNER (C. A.), DAVIS (J. D.), THIESSEN (R.), KESTNER (E. B.) and SELVIG (W. A.). Methods and apparatus used in determining the gas coke and by-product making properties of American coals. U. S. Bur. Mines Bull., 344, (1931), p. 56.

[2] PARKS (B. C.) and O'DONNEL (H. J.). Determination of petrographic components of coal by examination of thin sections. Trans. A. I. M. E., 177, (1948), p. 537.

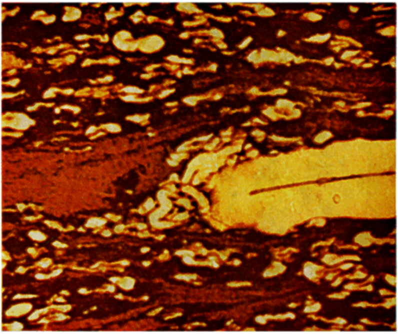
Fig. 1.

Semisplint coal from an English coal (37 % V. M.).
Polished thin section in transmitted light, 250 ×.

Fig. 2.

The same in reflected light, oil immersion, 250 ×.

SEMISPLINT COAL



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2

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **SPLINT COAL** (THIESSEN-Bureau of Mines System)	Hard coal T. L.

I — ORIGIN OF TERM

A miner's term long used in eastern U.S.A. and Scotland for certain hard dull coals with a distinctive type of fracture. Adopted by R. THIESSEN [1] in 1930. In 1948 B. C. PARKS and H. J. O'DONNELL [2] gave a definition of splint coal based on its quantitative composition in terms of anthraxylon and opaque attritus.

II — DESCRIPTION

Splint coals are irregular and blocky, with an uneven rough fracture, greyish black in colour and of granular texture. Splint coals are banded coals.

Coals containing more than 5 per cent of anthraxylon and more than 30 per cent of opaque attritus determined by microscopic examination are classed as splint coal. The content of anthraxylon and opaque matter is determined perpendicular to the bedding across the entire thin section (2-3 cm. width). The opaque attrital portion of the splint coal may be intercalated with fine, hair-like streaks of anthraxylon.

III — CORRELATION WITH TERMS OF THE STOPES-HEERLEN NOMENCLATURE

Corresponds either to duroclarite or, more frequently, to clarodurite according to the ratio of vitrinite and inertinite. May also correspond to vitrinertite.

IV — OCCURRENCE

Mainly as bands and benches in otherwise bright banded coal. Widespread in bituminous coal seams.

V — PRACTICAL IMPORTANCE

1. *Preparation.*

Because of its toughness, tends to concentrate in the larger sizes of commercial coal.

---

[1] THIESSEN (R.). Splint coal. Trans, A. I. M. E., Coal Division, 88, (1930), p. 79-106.

[2] PARKS (B. C.) and O'DONNELL (H. J.). *Determination of petrographic components of coal by examination of thin sections.* Trans. A. I. M. E., 117, (1948), p. 537.

2. *Carbonization.*

In general as the amount of opaque matter in splint coal increases it produces coke that is progressively less swollen and with progressively weaker cellular structure. Some splint coals with a relatively high spore content have excellent carbonization properties.

3. *Hydrogenation.*

From the results of small-scale hydrogenation tests made by the U. S. Bureau of Mines splint coals are less suitable for conversion to liquid products than bright coal and certain other types.

4. *Oxidizability.*

Not tested, but probably more resistant to oxidation than bright coal.

5. *Tendency to form dust.*

Not tested, but relative hardness would indicate that splint coal has a rather low tendency to form dust.

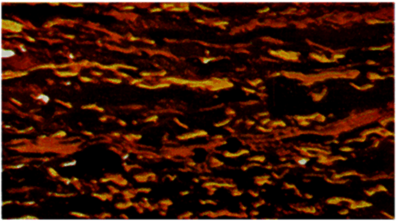
Fig. 1.

Splint coal from an English coal (37 % V. M.) Polished thin section in transmitted light. 250 ×.

Fig. 2.

The same in reflected light, oil immersion, 250 ×.

SPLINT COAL



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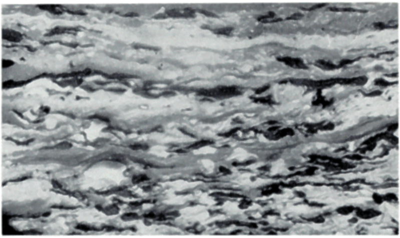


2

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

SPORINITE COAL

(System of Geol. Inst. Acad. Sci. U.S.S.R. Moscow)

Brown coal
Hard coal
T. L.

I — ORIGIN OF TERM

The term was introduced in 1956 by Krylova, Walz, Ginsburg and Luber[1].

II — DESCRIPTION

Sporinite coal consists of more than 50% of spores (microspores and megaspores). The spores occur embedded in gelito-collinite, fusinito-collinite or collinite of fusinitic nature. Other structured components uniformly distributed through the coal are cuticles, resin bodies, gelified and fusinised tissues.

Hand specimens of low rank sporinite coal are brownish, with matt or granular surfaces. The coal may have high or low ash.

III — OCCURRENCE

Sporinite coal occurs in seams of different geological age, but is particularly common as bands of limited thickness in seams of the Lower Carboniferous.

IV — PRACTICAL SIGNIFICANCE

Sporinite coal naturally admixed with medium rank gelito-collinite coals is used for coking.

Fig. 1.

Sporinite coal (sporinite and gelito-collinite) from a Russian seam. (Donetz). Transmitted light, 200 ×.

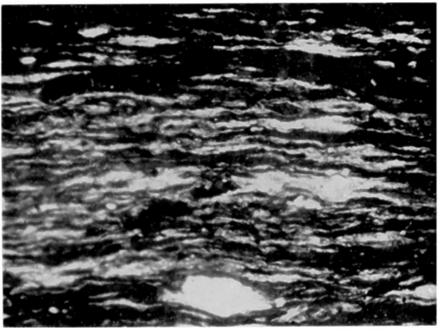
Fig. 2.

Sporinite coal (sporinite and fusito-collinite) from a Russian seam. (Irkoutsk). Transmitted light, 200 ×.

---

[1] Krylova (N. M.), Walz (I. E.), Ginsburg (A. I.) and Luber (A. A.). The terminology and fundamental classification of the petrographic constituents of humic coals. Akad. Nauk SSSR, Trudy Labor. coal Geol., *6*, (1956), p. 42-55.

CHARBON DE SPORINITE
SPORINIT - KOHLE
SPORINITE COAL



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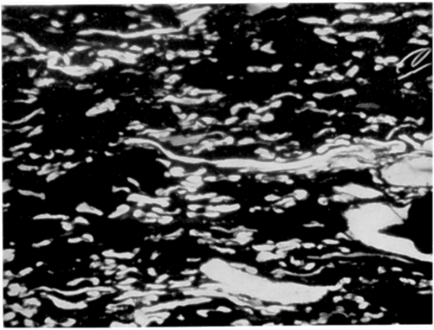

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1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **SPORINITE** (Stopes-Heerlen System)	Hard coal R. L.

I — ORIGIN OF TERM

Term introduced by C.A. Seyler[1].

Analogous term: spore coat material.

II — DESCRIPTION

Constituent formed from spore exines, flattened parallel to stratification; the interior of the spore is generally recognizable only as a very thin band.

Morphography: see illustration.

Colour: by R.L., sporinite is brownish in coals with more than about 37 % V.M. and dark grey to black in coals with between 37 and 29 % V.M., in coals of increasing rank it becomes a lighter grey, and in those with less than 18 % V.M. it is hardly distinguishable from vitrinite; in coals with less than 12 % V.M., however, distinction is once again possible using polarised light.

In T.L. the colour of sporinite also varies with the rank of the coal, being golden yellow in those with more than 35 % V.M., reddish yellow to rust in those with 20-35 % V.M. and the same colour as the vitrinite in coals with less than 20 % V.M.

R: in oil immersion this varies from ca. 0.1 to 1.5 as the V.M. content of the coal decreases from 40 to 20 %.

Anisotropy: in R.L. practically nil; in T.L. marked but uneven extinction is observed.

Density: about 1.1 in coals with more than 30 % V.M.

Relief: quite marked in low rank coals, diminishing and eventually disappearing in coals of higher rank.

III — OCCURRENCE

Important constituent of clarite, durite and their transitions: widely distributed in most coals; particularly abundant in Palaeozoic coals.

---

[1] Jongmans (W. J.), Koopman (R. G.) and Roos (G.). Nomenclature of Coal Petrography. Comptes rendus du 2e Congrès de Statigraphie et de Géologie du Carbonifere, III, (1938), p. 1734.

IV — PRACTICAL IMPORTANCE

1-5. see exinite.

6. Spores, which give rise to sporinite, are used in palynology for stratigraphical and seam correlation purposes.

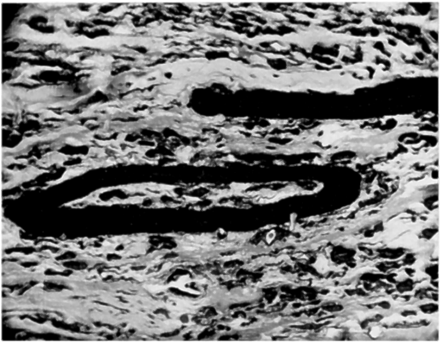
Fig. 1.

Megaspore and thick-walled microspores (crassispores) in a durite of high-volatile American coal. Polished thin section in reflected light, oil immersion, 200 ×.

Fig. 2.

The same in transmitted light.

SPORINITE - SPORINIT



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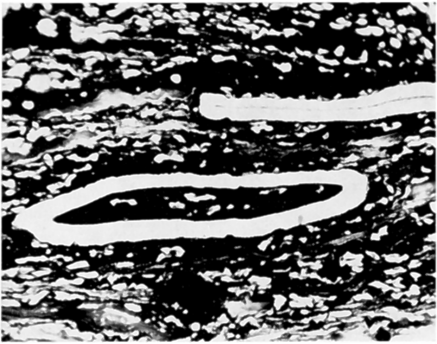

2

1963

EDITION

International Committee for Coal Petrology

Nomenclature Sub-Committee

Hard coal

R. L.

TELINITE[1]

(STOPES-Heerlen System)

I — ORIGIN OF TERM

The term telinite was proposed by W.J. JONGMANS[2] (1935) to designate a vitrinite showing cellular structure. The Nomenclature Sub-Committee decided in 1957 to use the term telinite only for the cell walls seen in vitrinite. Only in this manner can telinite be rightly included among the macerals.

Analogous terms: provitrite (R. POTONIE 1924), xylovitrain (A. DUPARQUE); anthraxylon = telinite in bands more than 14 microns in thickness.

II — DESCRIPTION

Shows more or less clearly defined cell structure (wood, periderm, etc.) sometimes deformed. The cells are generally filled with collinite, but the structure is better shown when the cells are either empty or filled by material such as resinite, fine micrinite, clay minerals etc. The botanical structure is more visible in T.L. than R.L.

Colour: reflectance, anisotropy and density are generally very similar to those of collinite, and vary with rank.

The micro-hardness is unknown.

Relief is always very similar to that of collinite.

III — OCCURRENCE

With collinite, widely distributed in vitrite and clarite in discrete bands of varying thickness.

IV — PRACTICAL IMPORTANCE

See vitrite.

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[1] See vitrinite.

[2] JONGMANS (W. J.), KOOPMAN (R. G.) and ROOS (G.). Nomenclature of coal petrography. Comptes rendus du 2^{e} Congrès de Statigraphie et de Géologie du Carbonifère, III, (1938), p. 1734.

Fig. 1.

Telinite with cellular cavities filled with resinite (French coal) Polished thin section, in reflected light, oil immersion. 110 ×.

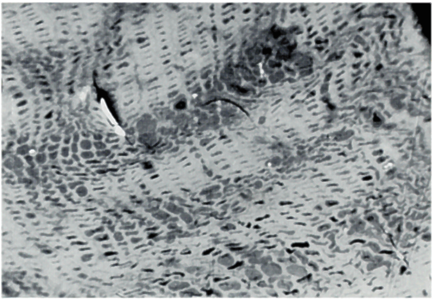
Fig. 2.

Telinite (French coal) Polished thin section in reflected light, oil immersion, 250 ×.

Fig. 3.

The same in transmitted light.

TELINITE - TELINIT



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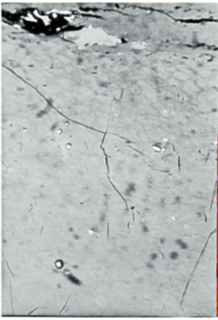

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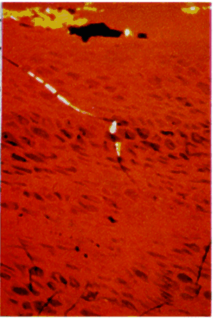


3

1963
EDITION

International Committee for Coal Petrology
Nomenclature Sub-Committee

TRANSLUCENT HUMIC DEGRADATION MATTER (THDM)

(THIESSEN-Bureau of Mines System)

Brown coal
Hard coal
T. L.

I — ORIGIN OF TERM

Term introduced by R. THIESSEN[4] in 1930 for transparent humic matter consisting "of irregular particles varying greatly in shape and size. Although rounded or ovoid particles are not rare, humic matter is mostly flattened in form and usually of frayed or tattered appearance. The particles are of the same deep red colour as the anthraxylon strips, becoming lighter in thinner sections".

Synonyms: Translucent humic matter, finely divided anthraxylous matter, cell wall degradation matter.

II — DESCRIPTION

According to the practice at the U.S. Bureau of Mines THDM includes all humic matter less than 14 μ in width perpendicular to the bedding. May be fibrous or in fine bands. See also I: Origin of term.

Colour: orange to red to brownish red, depth of colour increasing with rank and thickness of thin section. Differences in colour are sometimes observable in the same coal.

III — CORRELATION WITH TERMS OF THE STOPES-HEERLEN NOMENCLATURE

THDM is that part of the vitrinite which is less than 14 μ in thickness perpendicular to the bedding; cf. Anthraxylon. Such vitrinite is found in clarite, clarodurite, duroclarite and durite.

IV — OCCURRENCE

Occurs as the groundmass of translucent attritus in which are embedded the microscopic plant entities (phyterals) such as spores, cuticles, resins and waxes. May also be associated with opaque attritus. In bright coal containing little anthraxylon it may be the predominant constituent. In semisplint and splint coals, particularly the latter, it is generally a minor constituent.

---

1. THIESSEN (R.). Splint coal. Trans. A.I.M.E., Coal Division, (1930), p. 644-672.

V — PRACTICAL IMPORTANCE

1. *Preparation.*

Translucent humic degradation matter is not separable from banded coal as a pure constituent, see translucent attritus.

2. *Carbonization.*

There is some evidence that THDM becomes plastic but does not swell when heated under certain conditions.

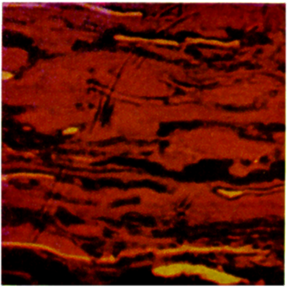
Fig. 1.

Translucent humic degradation matter from an English coal (37% V.M.)
Polished thin section in transmitted light, 500 ×.

Fig. 2.

The same in reflected light, oil immersion, 500 ×.

TRANSLUCENT HUMIC DEGRADATION MATTER



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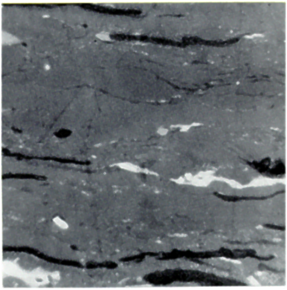

2

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee	Brown coal Hard coal T. L.
	TRANSLUCENT ATTRITUS (Thiessen-Bureau of Mines System)	

I — ORIGIN OF TERM

Term first used by R. Thiessen[1] in 1930 referring to the "attritus of ordinary humic coal, which is ordinarily composed largely of transparent humic matter, with spores, cuticles, resins, and opaque matter in minor proportions".

II — DESCRIPTION

Translucent attritus consists of the complex residual organic matter, exclusive of anthraxylon, in bituminous lower rank coal that transmits light in thin section.

The following kinds of organic matter (phyterals) are included in various proportions in translucent attritus :

1. Translucent humic or cell wall degradation matter in particles which are less than 14 microns thick.

2. Translucent spore and pollen coats, cuticular material, and amorphous waxy matter.

3. Translucent resinous bodies of varying nature detached from their original enclosing tissue (note : resinous matter occupying tissue classed as anthraxylon is identified as part of the anthraxylon).

4. Translucent fungal sclerotia and hyphae that are isolated in the attrital ground mass.

5. Other organic materials, if they are translucent and not included in entities otherwise defined. Translucent attritus may vary greatly in its properties. Specific properties can be assigned only when the various separate constituents (phyterals) are quantitatively identified.

III — CORRELATION WITH TERMS OF THE STOPES-HEERLEN SYSTEM

The following macerals of the Stopes-Heerlen nomenclature are included in translucent attritus: vitrinite less than 14 microns thick; sporinite, cutinite, alginite, resinite; and those parts of semifusinite, micrinite, and sclerotinite that are weakly reflecting, i.e. semitranslucent.

Translucent attritus is a collective term and not comparable with any of the microlithotypes of the European system of nomenclature.

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[1] Thessen (R.). Splint coal, Trans. A.I.M.E. Coal Division (1930), p. 664-672.

IV — OCCURRENCE

Present in all hard coals and brown coals. Some of the nonbanded coals consist almost entirely of translucent attritus. Opaque matter is usually present in various proportions.

V — PRACTICAL IMPORTANCE

1. *Preparation.*

Translucent attritus does not separate as a pure constituent from banded coal but tends to be concentrated in the coarser sizes of commercial coal.

2. *High—and low—temperature carbonization.*

The coking properties of translucent attritus are largely governed by the amount of humic degradation matter present in it. The larger the amount of humic degradation matter present, the more nearly the properties are to those of anthraxylon.

3. *Hydrogenation.*

All the constituents comprising translucent attritus, except occasional particles of opaque matter, are reactive and amenable to hydrogenation.

4. *Oxidizability.*

Translucent attritus is less oxidizable than anthraxylon, but is more oxidizable than fusain and opaque attritus.

5. *Tendency to form dust.*

The tendency to form dust is less than fusain and anthraxylon but greater than opaque attritus.

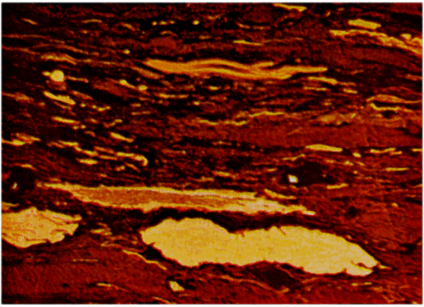
Fig. 1.

Translucent attritus from an English coal (37% V.M.)
Polished thin section in transmitted light, 250 ×.

Fig. 2.

The same in reflected light, oil immersion, 250 ×.

TRANSLUCENT ATTRITUS



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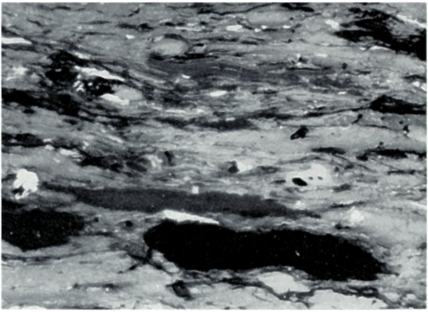

2

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International Committee for Coal Petrology
Nomenclature Sub-Committee

TYPE OF COAL

(Thiessen-Bureau of Mines System)

Brown coal
Hard coal
T. L.

I — ORIGIN OF TERM

See type of coal (U.S.A.).

Thiessen [1] (1931) adopted the term but with a somewhat different and restricted significance than was recognized by White [2] (1909).

II — DEFINITION

The concept type with the restricted meaning recognized by the Bureau of Mines (Parks & O'Donnell [3] 1956) provides a means for classifying standard varieties of coal microscopically on the basis of simple proportions of anthraxylon or anthraxylon and opaque attritus, including their subdivision into banded and non-banded coals. This classification is shown in the following table :

	Type	Main components	Opaque matter per cent	Anthraxylon per cent
Banded coal	Bright coal	Anthraxylon Translucent attritus	< 20	< 5
	Semisplint	Translucent and Opaque attritus	20 — 30	
	Splint	Opaque attritus	> 30	
Non-banded coal	Cannel	Attritus with spores		< 5
	Boghead	Attritus with algae		

---

[1] Thiessen (R.) in Fieldner (A. C.), Davis (J. D.), Thiessen (R.), Kestner (E. B.) and Selvig (W. A.). Methods and apparatus used in determining the gas coke and by-product making properties of American coals. U. S. Bur. Mines. Bull. *344*, (1931), p. 64.

[2] White (D.). The effect of oxygen in coal. U. S. Geol. Surv. Bull. *382*, (1909), p. 71. Reprinted as U. S. Bureau Mines, Bull. *29*, (1911).

[3] Parks (B. C.) and O'Donnell (H. J.). Petrography of American coals. Bureau of Mines Bull. *550* (1956).

III — CORRELATION WITH TERMS OF THE STOPES-HEERLEN NOMENCLATURE

There is no term in the Stopes-Heerlen nomenclature precisely synonymous with the word type as used by the Bureau of Mines, and no similar type classification. For an approximate correlation of type sub-divisions see the correlation table.

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International Committee for Coal Petrology
Nomenclature Sub-Committee

TYPE OF COAL (U.S.A.)

General
Term

I — ORIGIN OF TERM

Although the word type has the common meaning of variety it was applied to coal with restricted significance by D. White [1] (1909) and later somewhat differently by R. Thiessen [2] (1931). See : type of coal (Thiessen-Bureau of Mines).

II — DEFINITION

According to White [1] (1909) a type of coal is a variety "initially determined by the nature of the ingredient matter, the conditions of deposition, and the extent of operation of the first or biochemical process of coal making". Although every individual coal belongs to one or another type of coal, no systematic and comprehensive classification of coal by type exists. Coals designated as humus coal, resinous coal, spore coal, leaf coal, bark coal, etc., represent coal types. For restricted application of the term see : Type of coal (TBM). Some coal chemists [3], at least since 1927 have used the term type with a meaning similar to that of the term rank but such a meaning of type is not generally recognized as valid by coal geologists and petrologists.

III — CORRELATION WITH TERMS OF THE STOPES-HEERLEN NOMENCLATURE

No other special term for designating characteristic varieties of coal according to the meaning introduced by White is employed in the Stopes-Heerlen nomenclature.

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[1] White (D.). The effect of oxygen in coal, U.S. Geol. Surv. Bull, *382*. (1909), p. 71; reprinted as U.S. Bur. Mines. Bull. *29*, (1911).

[2] Thiessen (R.) in Fieldner (A. C.), Davis (J. D.), Thiessen (R.), Kestner (E. B.) & Selvig (W. A.). Methods and apparatus used in determining the gas-coke and by-product making properties of American coals. U.S. Bureau Mines, Bull. *344*, (1931), p. 64.

[3] Parr (S. W.), Ode (W. H.) & Frederic (W. H.). Solid fuels. Intern. critical Tables, vol. II, (1927), p. 130-136. *The international systems of hard coal classification and their application to American coals* U.S. Bur. Mines Rept. Inv. *5435*, (1958), p. 3-6.

1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee **VITRAIN** (Stopes-Heerlen System)	Hard coal

I — ORIGIN OF TERM

The term vitrain was introduced by M.C. Stopes [1] in 1919 to designate the *macroscopically* recognizable very bright bands of coals.

Synonyms: Glanzkohle — charbon brillant.

II — DESCRIPTION

Very bright bands or lenses, usually a few mm (3-5) in width: thick bands are rare. Clean to the touch. In many coals the vitrain is permeated with numerous fine cracks at right angles to stratification, and consequently breaks cubically, — with conchoidal surfaces. In other coals the vitrain is crossed by only occasional perpendicular cracks.

In the macroscopic description of seams only the bands of vitrain having a thickness of several mm [2] are usually noted.

Examination with the microscope shows vitrain to consist of microlithotypes very rich in vitrinite.

III — OCCURRENCE

After clarain, vitrain is the most widely distributed and common macroscopic constituent of humic coals.

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[1] Stopes (M. C.). On the four visible ingredients in banded bituminous coals. Proc. Roy. Soc., Series B, 90, (1919), p. 470.

[2] The minimum thickness varies from 3 to 10 mm. in different countries.

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International Committee for Coal Petrology
Nomenclature Sub-Committee

VITRINERTITE

(STOPES-Heerlen System)

Hard coal
R. L.

I — ORIGIN OF TERM

The term vitrinertain was introduced by B. ALPERN [1], in 1954, and in the modified form vitrinertite was adopted by the Nomenclature Sub-Committee to designate a microlithotype consisting principally of the macerals vitrinite and inertinite.

II — DESCRIPTION

Contains at least 95% of vitrinite and inertinite. The proportions of these two macerals may vary widely but each must be greater than the proportion of exinite and neither must exceed 95%. The inertinite may be present as fragments of fusinite or semifusinite, as sclerotinite, or as fine-grained or massive micrinite. Vitrinertite V. and vitrinertite I. connote vitrinertites rich in vitrinite and inertinite respectively.

In petrographic analysis it is conventional to record only bands of vitrinertite more than 50 microns wide.

The density of vitrinertite with average maceral composition varies between 1.35 and 1.7 according to rank. In any given coal with more than 20% V.M. it varies directly with the proportion of inertinite present.

The strength is greater than that of vitrite.

Mineral impurities?

III — OCCURRENCE

Generally rare in low rank coals, but seems to increase in importance in coals with less than 25% V.M. in which exinite is not visible.

IV — PRACTICAL IMPORTANCE

Its properties are intermediate between those of vitrinite and inertinite: is generally little fissured, tends to concentrate in grain sizes greater than 1 mm.

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[1] ALPERN (B.) and NOMARSKI (G.). Contribution à l'amélioration des méthodes d'examen microscopique et de classification des charbons. Bull. Soc. Fr. Miner. Crist., 77, (1954), p. 905.

Fig. 1.

Vitrinite and fine micrinite in vitrinertite.
High-volatile American coal (35% V.M.).
Polished thin section in reflected light, oil immersion. 500 ×.

Fig. 2.

The same in transmitted light.

Fig. 3.

Vitrinertite in a Belgian coal.
Polished surface in reflected light,
oil immersion. 350 ×.

VITRINERTITE - VITRINERTIT

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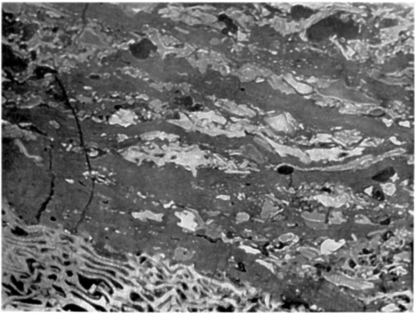

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1963 EDITION	**International Committee for Coal Petrology** Nomenclature Sub-Committee	Hard coal R. L.
	VITRINITE (STOPES-Heerlen System)	

I — ORIGIN OF TERM

M.C. STOPES[1], (1935).

Analogous term: anthraxylon = vitrinite in bands more than 14 microns in thickness.

II — DEFINITION

Group name comprising collinite and telinite (see those terms).

Differentiation between collinite and telinite depends in part on the method of observation. The distinction is more easily made in thin section or after etching a polished surface. Often there is uncertainty of distinction by reflected light, and in such cases it is proper to use the general term vitrinite.

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[1] **STOPES (M. C.). On the petrology of banded bituminous coal, Fuel, *14*, (1935), p. 11.**

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International Committee for Coal Petrology
Nomenclature Sub-Committee

VITRITE

(STOPES-Heerlen System)

Hard coal
R. L.

I — ORIGIN OF TERM

R. POTONIE [1], 1924.

In 1955 the Nomenclature Sub-Committee resolved to apply this term to the microlithotype *consisting principally* of collinite and telinite.

Analogous terms: microvitrain (CADY); anthraxylon in part (THIESSEN).

II — DESCRIPTION

See telinite and collinite.

Must contain at least 95 % vitrinite.

Sometimes contains resinite filling the cell cavities of the telinite or intimately dispersed in the collinite.

Bands of vitrinite having a width of more than 50 microns are recorded as vitrite.

Density: varies from 1.3 to 1.7 depending on the rank of the coal, with a minimum at about 89 % C.

The strength varies from 25 to 80 kg/mm^2.

May contain various inorganic impurities, the most common being clay minerals, pyrites and carbonates.

III — OCCURRENCE

Vitrite is the most abundant constituent of humic coals. It is particularly abundant in vitrains, rather less abundant in clarains, and limited to small amounts in durains.

IV — PRACTICAL IMPORTANCE

1. *Preparation.*

Independent of the rank of the coal, or its strength, vitrite tends to show fine fissures or cracks. It therefore concentrates principally in particle sizes smaller than 1 mm.

---

[1] POTONIE (R.). Einführung in die allgemeine Kohlenpetrographie. Berlin, Verlag Borntraeger, (1924), p. 34.

The presence of syngenetic mineral impurities in vitrite makes it difficult to prepare ultra clean coals; the best method of preparation is one using dense media. Epigenetic minerals on the other hand can be more easily removed by ordinary methods of cleaning.

2. *Carbonization.*

In caking coals with more than 18 % V.M., vitrite contributes outstandingly to coking ability by reason of its high swelling properties and good plasticity.

The relation between coking ability and rank varies in different coalfields.

3. *Hydrogenation.*

In coals with more than 25 % V.M. the vitrite is readily hydrogenated. Hydrogenation of the vitrite of higher rank coals requires the use of special processes.

4. *Oxidizability.*

Vitrite in coal of all ranks is the most readily oxidized constituent. It sometimes shows a tendency towards spontaneous combustion.

5. *Formation of dust.*

Because of its strong tendency to fissure, vitrite is a principal constituent of mine dusts.

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International Committee for Coal Petrology
Nomenclature Sub-Committee

PART II :
METHODS OF ANALYSIS - INTRODUCTION

Part II of the second edition presents the findings of the Analysis Sub-Committee of the International Committee for Coal Petrology.

The Analysis-Sub-Committee was appointed in 1955 with the object of improving the methods of analysis suitable for the quantitative determination of macerals, microlithotypes, and coal rank as defined in the handbook, as also of the composition of mixtures of coals, the mineral matter, and other properties of coals that can be established with the microscope.

The results of about a hundred comparative analyses of samples exchanged between laboratories of participating members of the Committee have been considered at ten meetings. This work has led to improvement in maceral and microlithotype analysis of particulate samples and to the formulation of general recommandations for the preparation of such samples and for their microscopic examination in reflected light.

M. Th. Mackowsky has been chairman of the Committee since it was formed and V. Hevia its secretary. The number of members of the Committee rose from 7 in 1955 to 21 in 1962. G. W. Fenton, National Coal Board, London and F. J. Huntjens of the Central Laboratory of the State Mines, Geleen resigned during this period.

Members of the Analysis Sub-Committee in 1963

B. Alpern	(France)	Centre d'Études et Recherches des Charbonnages de France, Verneuil-en-Halatte (Oise).
W. Berry	(U.S.A.)	Bituminous Coal Research, Pittsburgh Pa.
L. I. Bogoliubova	(U.S.S.R.)	Academy of Sciences of U.S.S.R., Moscow.
H. Brocades-Zaalberg	(Netherlands)	Central Laboratorium, Geleen.
D. Chandra	(United Kingdom)	National Coal Board, Sheffield.
P. Dath	(Belgium)	S.A. Carbonisation Centrale, Tertre.
E. H. Grand'ry	(Belgium)	S.A. Carbonisation Centrale, Tertre.
J.H. Harrison	(U.S.A.)	Illinois State Geological Survey Urbana, Ill.
V. Hevia-Rodriguez	(Spain)	Instituto Nacional del Carbon, Oviedo.
K. von Karmasin	(Germany)	Gelsenkirchener Bergwerks AG, Essen.

G. LENSCH	(Germany)	Geologisches Landesamt Nordrhein Westfalen, Krefeld.
M.Th. MACKOWSKY	(Germany)	Bergbau-Forschung GMBH, Essen.
B.C. MUKERJEE	(India)	Jadapur University, Calcutta.
D.C. MURCHISON	(United Kingdom)	King's College, Newcastle-upon-Tyne.
J. NAHUYS	(Brazil)	Instituto Tecnologico, Estado do Rio Grande do Sul, Porto Alegre.
R. NOEL	(Belgium)	Institut National de l'Industrie Charbonnière, Liege.
A.H.V. SMITH	(United Kingdom)	National Coal Board, Sheffield.
W. SPACKMAN	(U.S.A.)	Pennsylvania State University, University Park, Pa.
G.H. TAYLOR	(Australia)	Commonwealth Scientific and Industrial Research Organisation Chatswood, N.S.W.
R.R. THOMPSON	(U.S.A.)	Bethlehem Steel Company, Bethlehem, Pa.
P.P. TIMOFEEV	(U.S.S.R.)	Academy of Sciences of U.S.S.R., Moscow.

A description of the method of analysis applicable to the THIESSEN-Bureau of Mines System and described in the literature has also been included.

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International Committee for Coal Petrology

Nomenclature Sub-Committee

GENERAL NOTES ON METHODS OF QUANTITATIVE ANALYSIS OF POLISHED SURFACES

As is well known, coals are not homogeneous, but consist of various proportions of different macerals.

Macerals differ widely in their chemical, physical and technological properties, especially in the lower rank coals. The maceral composition may vary within a particular band as well as in the different bands of a seam and most markedly between one seam and another. Hence, the quantitative determination of macerals, and groups of macerals, is an important task of coal petrography; all other methods of analysis provide no more than average values for the whole of the coal represented in the sample. These considerations, therefore make detailed maceral analyses of great importance in the examination of seam profiles, and in studies of seam formation.

The most detailed maceral analysis does not provide, however, a wholly adequate guide to the physical and technological properties of a coal in all cases. The reason for this is that macerals occur in a coal in extremely fine admixture, and are only freed by very fine crushing, roughly to 25 microns. In coarser particle sizes, assemblages of macerals invariably occur. Theses assemblages, or microlithotypes, are defined by certain conventions. Both bi-maceral and tri-maceral microlithotypes have higher mechanical strength than mono-maceral microlithotypes. This is of importance when considering the crushing characteristics of a coal. Further, the technological behaviour of the individual macerals may be distinctly affected by their association with other macerals. This for instance is true for exinite, which occurs not only in clarite, but also in clarodurite, duroclarite and durite, microlithotypes all having dissimilar coking characteristics. It is desirable, therefore, to supplement maceral analysis by microlithotype analysis.

Another important point in this context is that the properties of the macerals — and therefore of the microlithotypes also — change as coalification progresses, thus making close determination of coal rank necessary for the complete assessment of a coal.

Rank, or degree of coalification, can be determined in a number of ways.

Determination of rank on the basis of the reflectance of the vitrinite in a highly polished surface, is an exceedingly important procedure in coal microscopy. Such determinations may be made on particulate specimens, although the use of lumps of coal, e.g. taken from a column section of a seam, polished perpendicular to their bedding planes, is preferable when such samples are available.

The proportions of coals of different rank in blends can be determined with satisfactory accuracy by reflectance measurement. Where the differences in the rank of the coals are great (more than 5-8 % V. M.), subjective rank analysis is possible without resort to actual measurement of reflectance.

The Analysis Sub-Committee set itself the task of examining methods of petrographic analysis to find out how satisfactory their reproducibility and accuracy were.

To test the various methods of analysis developed and used in different laboratories, numerous "exchange" analyses were conducted. In the light of the results of the earlier series of analyses, suggestions were put forward on possible improvements which, in turn, were put to test to establish their value.

In all cases the statistical accuracy and limits of error of the analyses were calculated.

To date the Analysis Sub-Committee has concerned itself with the following different types of analysis:

A — ANALYSES OF PARTICULATE SAMPLES

1. *Maceral analysis.*
2. *Microlithotype analysis:*
   a) using the 20-point ocular;
   b) using the "selon la ligne" method.
3. *Determination of the degree of coalification of vitrinite.*
4. *Rank determination of blends:*
   a) objective method by statistical assessment of reflectance measurements;
   b) subjective method (van Krevelen method) or using methylene iodide.

B — ANALYSES OF SAMPLES IN LUMP FORM

1. *Maceral analysis.*
2. *Microlithotype analysis:*
   a) using 20-point ocular;
   b) by "selon la ligne" method.
3. *Rank determination by reflectance measurements on vitrinite.*

C — DETERMINATION OF OTHER PHYSICAL CHARACTERISTICS OF COAL

1. *Micro-hardness of vitrinite and other macerals.*

When the investigations on methods of analysis on polished surfaces are completed, it is intended to undertake similar studies on methods of analysis of coal in thin section.

It would appear worthwhile, in the course of these investigations, to examine methods for determining the absorption and the refractive indices of coal.

Results of analyses, in particular those relating to microlithotypes are only comparable when carried out on material of similar grain size and hence the Analysis Sub-Committee has made recommendations for the preparation of the different types of analysis samples. It cannot be emphasised too strongly that whatever the purpose of a petrographic investigation, whether it is seam identification or the study of particular seams or the technological behaviour of coals, the utmost care both in sampling and in the preparation of the polished surface for analysis is essential, otherwise even the most precise analysis will be valueless.

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Nomenclature Sub-Committee

MACERAL ANALYSIS ON PARTICULATE COAL

I — GENERAL

Maceral analyses can be made on blocks of coal cut vertically to the bedding place representing column sections of seams and on representative samples of particulate coal.

Maceral composition of coal is unrelated to the size of individual particles and it is unnecessary, therefore, to stipulate any special size "consist" in the samples of particulate coals. In practice the size consist will usually be such that it is possible to undertake maceral and microlithotype analyses on one and the same sample. Crushing to sizes less than 50 microns should therefore be avoided.

The procedures recommended for preparing polished surfaces are described in previous sheets.

II — ANALYSIS PROCEDURE

In general, maceral analyses are carried out, using the point count method.

a) *Maceral analysis using an automatic point counter.*

Using an automatic point counter the polished surface is viewed through an adjustable 8× or 10× ocular fitted with cross wires and the maceral lying under the intersection of the wires is determined.

A 25×, 40× or 50× oil immersion objective is used giving total magnifications of the order of 250×, 400× or 500×.

At least 500 points are counted on the coal, usually working to interpoint and interline distances of 0.5 mm.

If the number of points to be counted is raised to 1,000, it is necessary to reduce the inter-point and inter-line distances to 0.3 mm.

b) *Maceral analysis using an integrating ocular.*

This method of analysis uses an integrating ocular, combining an adjustable 8× or 10× eye piece and a micrometer-controlled graticule with 10-12 divisions (e.g. the Type 2 integrating ocular by Zeiss). The macerals coincident with the intersections of the graticule are counted in each field.

The polished block is moved by hand on a mechanical stage (e.g. as made by Leitz, Wetzlar). The number of points of each maceral is recorded by mechanical counters (e.g. Statitest made by Ferrari, Berlin or the instrument made by Messrs. Clay Adams, New York).

Analysis with the integrating ocular requires an oil immersion objective with a magnification no greater than 25× giving an overall magnification of about 250× and a maximum coverage of 10-12 points per field of view. The use of more powerful objectives impairs the uniform counting of points over the whole polished surface of the specimen.

To obtain a 500 point count, a polished surface of about 4 sq. cm. is required, and inter-point and inter-line distances of 1.5 to 2 mm. For 1,000 points the distance between points and between lines must be reduced on the same size of polished surface to 1 mm.

Maceral analysis involves the recognition of the following macerals and groups of macerals :

MACERALS	MACERAL GROUPS
Collinite Telinite	Vitrinite
Sporinite Cutinite Resinite Alginite	Exinite
Micrinite { massive fine Semifusinite (pore-free) Sclerotinite Fusinite (pore-free)	Inertinite (pore-free)
Clay minerals Calcite Pyrites Quartz etc.	Mineral inclusions

Whether to analyse by individual macerals or by groups of macerals depends on the particular purpose of the investigation being undertaken.

The number of points counted are converted to proportions by volume of the macerals and are expressed to the nearest 1 per cent.

The results may also be expressed as percentages by weight, but to calculate these the rank of the coal must be known in order to allot the appropriate densities to the different macerals. These densities are shown in Table 1 and Fig. 1 for different levels of rank as indicated by the carbon content of the vitrinite.

The individual macerals or even the maceral groups, are not equally readily distinguished in all ranks of coal: e.g. exinite is generally only distinguishable in coal with less than 90% carbon (in the vitrinite). This limit of rank for exinite is not identical for all coals but is a commonly accepted limit.

III — ANALYSIS ACCURACY

The accuracy of analyses based on 500 or 1000 points is about ± 2-3 % for each maceral (or maceral group).

To increase this accuracy to ± 1% it is necessary to count at least 3,000 points. Statistically it is better practice to count 500 points on several preparations made from different portions of the sample than to count 3,000 points on one and the same polished surface.

TABLE I. — MACERAL DENSITIES

RANK (% carbon in vitrinite)	78	79	80	81	82	83	84	85	86	87
Exinite	1.15	1.15	1.15	1.15	1.2	1.2	1.2	1.2	1.2	1.25
Vitrinite	1.4	1.35	1.35	1.35	1.3	1.3	1.3	1.3	1.3	1.3
Semifusinite and micrinite	1.45	1.45	1.45	1.45	1.4	1.4	1.4	1.4	1.4	1.4
Fusinite	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

RANK (% carbon in vitrinite)	88	89	90	91	92	93	94	95	96	
Exinite	1.25						1.5	1.6	1.7	
Vitrinite	1.3	1.3	1.3	1.35	1.35	1.4				
Semifusinite and micrinite	1.4	1.4	1.4	1.4	1.45	1.45				
Fusinite	1.5	1.5	1.5	1.5	1.5	1.5	1.55			

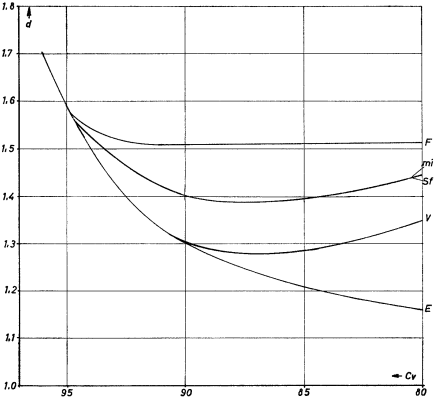
Fig. 1.

Density of macerals as a function of rank (carbon content of vitrinite). The dotted curve is the curve of mean values of micrinite and semifusinite.

ANALYSE MACÉRALE

MAZERALANALYSE

MACERAL ANALYSIS



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MICROLITHOTYPE ANALYSIS

(Polished surfaces of particulate samples)

I — GENERAL

Microlithotype analyses are made primarily to determine the maceral assemblages present in a coal. These assemblages differ one from another in their mechanical and technological properties. If possible microlithotype analyses should always be supplemented by maceral analyses.

As the microlithotype composition of a coal depends to some extent on the size-consist of the sample examined, the analyses should be made on material of the same particle size; otherwise strict comparison of analyses is impossible (see the recommendations for the preparation of polished surfaces).

The microlithotypes represent natural and typical maceral assemblages, but in defining them it has been necessary to adopt certain conventions. Because of this, quantitative microlithotype analysis is more arbitrary in character than maceral analysis.

The following principal conventions have been adopted :

a) Minimum band width: the microlithotype must have a thickness of more than 50 microns, measured perpendicular to the bedding plane.

b) The 5 per cent. rule: macerals present to the extent of less than 5 per cent. in an assemblage are disregarded.

To observe these conventions (minimum band width of 50 microns, and the 5 per cent. rule) it is necessary to use some form of measuring scale in the microscope ocular, and one or other of two types is usually employed. Although the results obtained with the two different types of micrometer are equally reproducible they are never wholely comparable. It is necessary therefore to specify which form of equipment has been used for the analysis.

The two methods are :

a) The 20 point-ocular method.

b) The method using a micrometer ocular, also called the "selon-la-ligne" method.

Apart from differences in the form and the magnification of the micrometer in the ocular (varying from 8 to 10×) the two methods are essentially the same and are described below.

1. A binocular reflected light microscope equipped with oil immersion objective with magnification 25×. Immersion liquid: cedar oil or glycerine. Total magnification: not less than 250×.

2. Suitable point-counting equipment for the separate discontinuous recording of series of points.

The most commonly used instrument for point counting has fourteen counting keys. Number of points to be counted: 500. A polished surface of at least 4 sq. cm. is required. Distance between points and between the lines of points should be 0.5 mm. To cover as many as 1,000 points the spacing of points and lines of points must be reduced to 0.3 mm.

3. Irrespective of the method and appliance used for the analysis the recognition of the various microlithotypes follows the same rules.

Microlithotypes consisting of one, two or three macerals are distinguished: also dirt ("rock") and various different associations of the microlithotypes with mineral impurities. Thus :

a) Monomaceral: vitrite, liptite, microite[1], fusite;

b) Bimaceral: clarite, durite, vitrinertite;

c) Trimaceral: duroclarite, clarodurite.

Dirt ("rock") and different associations of the microlithotypes with mineral impurities are defined as follows :

a) Carbargilite: consisting of coal microlithotypes intimately intergrown with more than 20 and less than 60% by volume of clay minerals and, or quartz.

b) Carbankerite: coal microlithotypes intimately intergrown with more than 20 and less than 60% by volume of carbonate (spar) minerals.

c) Carbopyrite: microlithotypes of coal intimately intergrown with more than 5 and less than 20% by volume of pyrite (these proportions being related to the high density of pyrites).

The limiting percentages of the different types of mineral matter in carbargilite, carbankerite and carbopyrite correspond to limiting densities of 1.5 and 2.0 of the complexes.

d) Dirt ("rock") includes coal so extensively intergrown with mineral matter that the specific gravity is > 2.0. This corresponds to not less than 60% by volume of clay minerals, quartz or carbonate (spar) minerals, but to as little as 20% of pyrite.

In some cases a fine subdivision is made in the microlithotype analysis according to the predominating macerals. Clarite V and clarite E, durite I and durite E, and even vitrinertite V and vitrinertite I may be separately distinguished.

At some stage of increasing rank it is no longer possible to differentiate between exinite and vitrinite. As a result the number of identifiable microlithotypes decreases. It is still useful, however, to list the entire range of the microlithotypes and to bracket together those which cannot be distinguished individually, e.g. vitrite and clarite on the one hand, and vitrinertite, duroclarite and clarodurite on the other.

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[1] The term microite (q.v.) is still under discussion, and in consequence it is not yet included in the list of microlithotypes recognised in the STOPES-Heerlen system.

In coal of the highest rank it is impossible to distinguish clearly between exinite and inertinite, and in consequence durite too becomes unidentifiable.

Microlithotype analysis of the higher rank coals holds less interest, and is more limited in value, than that of coals of lower rank.

Nevertheless, if microlithotype analysis be undertaken in these higher ranges, all the microlithotypes should still be listed and those which are no longer determinable indicated.

Results of analyses are always expressed as percentages by volume.

II — METHOD USING THE 20-POINT OCULAR

In this method of microlithotype analysis an ocular of magnification 8× with adjustable eye-piece is fitted with a micrometer in the form of a cross-gridded graticule having 20 equally spaced intersections.

Used with a 25× immersion objective, the effective area observed through the graticule is of the order of 50 microns in each direction.

With this ocular the convention of the 50 micron band width as well as the so-called 5% rule can be fairly readily observed.

If either the ocular or the objective is changed for one of different magnification then the micrometer must be adjusted to the new magnification so that the field observed in the graticule panel is 50 microns in each direction.

In making an analysis each 50 micron panel is considered as a "point" and only those particles are counted which cover at least ten intersections of the graticule. Where a coal particle covers less than ten intersections, the centre intersection will generally fall outside the coal particle and the particular field is not counted, (the same also holds in maceral analysis). The number of small particles covering less than ten intersections, for which the central intersection lies within the particle should not exceed 5 per cent. This condition is readily satisfied if the analysis specimen is carefully crushed (see recommendations). In cases of doubt it is advisable to undertake a separate count of such small grains using an additional key on the point counter. Analyses of specimens containing more than 5 per cent of such veryfine particles must be discredited.

The allocation of a "point" (a 50 micron square) to a particular microlithotype key, is solely governed by the maceral composition of the gridded field viewed. The same holds even when the natural boundary zone of two different microlithotypes falls within the 20-point field.

This does not imply that the stipulated minimum size of 50 microns should be abandoned since any apparent over-estimation of a microlithotype is compensated statistically. At the same time it should not be forgotten that microlithotype analyses, using the 20-point ocular are not strictly comparable with those made using the micrometer ocular. This is because microlithotype analyses with the 20-point ocular do slightly overestimate the heterogeneous microlithotypes.

The table given below is a guide to the classification of the microlithotypes according to the maceral composition of the 50 micron gridded panel.

Microlithotype composition using the 20-point ocular.

MICROLITHOTYPE	POSITION OF THE GRATICULE INTERSECTIONS
Vitrite.	All intersections on vitrinite.
Clarite.	All intersections on vitrinite and exinite with at least one intersection per maceral.
Vitrinertite.	All intersections on vitrinite and inertinite, with at least one intersection per maceral.
Duroclarite.	At least one intersection on the three macerals, but with a greater number on vitrinite than on inertinite (in the case of equal counts, the identity of the central intersection is decisive).
Clarodurite.	As in duroclarite, but with a greater number of intersections on inertinite than on vitrinite.
Liptite.	All intersections on exinite.
Durite.	All intersections on inertinite and exinite, with at least one intersection per maceral.
Fusite.	All points on inertinite.

III — METHOD USING THE MICROMETER OCULAR

The ocular used for this method is of the ordinary type of adjustable eye-piece in which is placed a graticule with a micrometer scale (100 divisions). The micrometer graticule makes it possible to :

— judge the minimum size of 50 microns;

— establish the proportions of the macerals contained in the microlithotypes by counting the division lines covering each maceral.

The actual magnification of the objective and the eye-piece are not necessarily so specific in this method as in the 20-point ocular method, as the micrometer can be calibrated for any combination of objective and eyepice used. Overall magnification, however, should not be less than 250.

In making the analysis certain conventional procedures should be followed (in addition to observing a minimum size of 50 microns, and the 5 per cent rule) which help to limit the amount of scatter in the analysis recults.

1. The micrometer graticule should be orientated perpendicular to the bedding planes. Where stratification is uncertain the micrometer should be maintained in a vertical position.

2. The particle considered should be that covered by the central intersection of the graticule.

3. The classification of lenses and bands measuring more than 50 microns should be made according to the definitions of Part I of the Handbook.

4. Lenses and bands measuring less than 50 microns should be regarded as being part of the adjoining broader lenses or bands.

5. If the lenses and bands are larger than the field covered by the graticule, only those portions falling within the limits of the graticule should be identified. Particles of between 10 and 50 microns are classified according to their maceral composition along the length of the micrometer scale.

6. Fusinite more than 30 microns thick is counted as a microlithotype when it lies at the edge of a particle. Within a particle, however, the minimum of 50 microns must be observed.

IV — ACCURACY OF MICROLITHOTYPE ANALYSIS

The accuracy of microlithotype analysis is independant of the method used; in general it is less accurate, however, than maceral analysis. This is due to the conventional nature of the distinctions made between the different microlithotypes as well as to the wide range in their composition.

The accuracy actually obtained in comparative exchange analyses is between ± 3 and ± 4 per cent. in the worst instances. In simpler cases accuracies of ± 2 to ± 3 per cent. are obtained, which correspond to those obtained in maceral analysis.

Analyses by the 20-point ocular are not strictly comparable with those using the micrometer type of ocular, and it is therefore necessary to specify the method used in any microlithotype analysis.

V — RECOMMENDATIONS FOR THE DETERMINATION OF DIRT ("ROCK") AND OF ASSOCIATIONS OF MICROLITHOTYPES WITH MINERAL IMPURITIES BY MEANS OF THE 20-POINT OCULAR

In principle this form of ocular aids a strict observance of the 5 per cent. rule thereby facilitating greater accuracy in microlithotype analysis. The suitability of the ocular for the determination of dirt ("rock"), carbonaceous shale, and the various associations of microlithotypes with mineral impurities has also been examined.

The results are satisfactory providing the same polished surface is used as for the microlithotypes, and if the fractions of the dirt ("rock"), and the microlithotype-mineral complexes which at particle size less than 750 microns have densities below 2.0 and 1.5 respectively, are ignored.

The proportions of dirt ("rock") and microlithotype-mineral complexes determined by this method of analysis will invariably be higher than are found in practical operations.

Determination of the various coal-mineral complexes and dirt ("rock") with the aid of the 20-point ocular takes account of the specific gravity of the various minerals contained in the coal.

The terms carbopyrite (q.v.) and carbankerite (q.v.) were introduced by HEVIA, while the term carbargilite was adopted by resolution of the Nomenclature Sub-Committee.

1. *Carbargilite and Carbankerite.*

The identity of these two types of microlithotype-mineral complexes is established by recognition of clay minerals, quartz and carbonate (spar) minerals according to the following scheme using the 20-point ocular :

No. OF INTERSECTIONS IN THE FIELD	No. OF INTERSECTIONS FALLING ON MINERAL	
	At least	*Not more than*
19-20	4	11
17-18	4	10
16	4	9
14-15	3	8
12-13	3	7
11	3	6
10	2	5

2. *Carbopyrite.*

Because of the high specific gravity of pyrite only 5 per cent. admixture with coal is necessary to give a specific gravity of 1.5 and 20 per cent. to give a specific gravity of 2.0. Hence, using the 20-point ocular the identity of carbopyrite is established by recognition of pyrites according to the following scheme :

No. OF INTERSECTIONS IN THE FIELD	No. OF INTERSECTIONS FALLING ON PYRITE
16-20	at least 1, at most 3
11-15	— 1 — 2
10	at most 1

3. *Dirt ("rock") in the form of clay minerals, quartz and carbonate (spar).*

To identify dirt ("rock"), specific gravity > 2.0, from microlithotype-mineral complexes the following limits using the 20-point ocular have been introduced :

No. of intersections in the field	No. of intersections falling on clay minerals, quartz and carbonates
19-20	at least 12
17-18	— 11
16	— 10
14-15	— 9
12-13	— 8
11	— 7
10	— 6

4. *Dirt, ("rock"), pyrites.*

To distinguish pyritous dirt the following limits are applied :

No. of intersections in the field	No. of intersections falling on pyrite
16-20	at least 4
11-15	— 3
10	— 2

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Nomenclature Sub-Committee

Quantitative determination of petrographic components of coal by examination of thin sections[1]

PARKS (B.C.) and O'DONNEL (H.J.)[2]

The basic instrument used in measuring coal components in a thin section is a biological-type microscope equipped with binocular eyepieces. A pair of 15-power oculars is used with 16- and 32-mm objective lenses to obtain working magnifications of 60 and 150 diam.

Into one of the eyepieces is inserted a Whipple micrometer disc. This is a glass disc on which is centered a 7-mm square field divided into one hundred 0.7-mm squares with the central one subdivided into twenty-five 0.14-mm squares. These values represent the real dimensions of the square fields scribed on the Whipple disc (Fig. 1). Under microscopic magnification the dimensions change, therefore, it is necessary to calibrate the disc with a stage micrometer for different powers of magnification as is shown in Table 1. In standard practice opaque attritus, fusain, and mineral matter are measu-

TABLE 1. — CALIBRATED VALUES OF THE WHIPPLE DISC WITH BINOCULAR MICROSCOPE *

MAGNIFICATION	CENTRAL VERTICAL FIELD (10 SQUARES)	ONE SQUARE (1/10 C. V. f.)	ONE SUBSQUARE (1/5 Square)
M	mm	mm	mm
0	7	0,7	0,14
40	2,78	0,286	0,056
60	1,86	0,186	0,037
100	1,09	0,109	0,022
150	0,73	0,073	0,015
200	0,56	0,056	0,011
300	0,36	0,036	0,007
475	0,23	0,023	0,005
712	0,15	0,015	0,003

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* Calibrated values of the Wipple disc made with binocular microscope by different observers vary slightly when horizontal adjustment (interpupillary spread) of the eyepieces is necessary.

[1] This method, which is compatible with the THIESSEN-Bureau of Mines system, has not been examined by the Analysis Sub-Committee.

[2] PARKS (B. C.) and O'DONNEL (H. J.). Am. Inst. min. met. Eng., Technical Publ., No, 2492, Class F (1948) p. 5-8.

red at a magnification of 60 diam. and anthraxylon at 150 diam. Translucent attritus is not measured directly but is determined by difference.

The technique of measuring coal in the thin section is accomplished by manipulating the mechanical stage of the microscope to move the central vertical field of the Whipple micrometer disc along two lines extending from bottom to top of the section and located near the middle of the right and left half of the section. Only the central vertical tier of squares containing the subdivided midsquare of the disc is used in measuring the coal components that are crossed in transecting the section. For visual convenience the remainder of the disc is masked off. In manipulating the mechanical stage during measurement the vertical movement along the transect is not continuous but is done in steps. Each step moves the thin section a distance which is the length of the central field of the Whipple disc. When the total areas of a coal component or components lying under the unmasked central field are determined, the section is moved along the transecting line exactly the distance of the central field. These field moves are thus continued until the section is crossed. From 20 to 25 field moves are necessary to complete a single transect across the section varying of course with width of section and magnification. A shift of the stage horizontally brings the section into position for measuring the next transect (Fig. 1). Values determined from the two transect determinations are recorded separately and the averages of the two are the accepted figures for the section.

After all the thin sections representing the entire column sample have been measured as described, the resulting data are assembled and set up graphically in columnar form as shown in fig. 2. Percentagewise distribution of anthraxylon, translucent attritus, opaque attritus, and fusain throughout the column is shown by bar diagrams in which each bar represents a thin section. On the basis of relative percentages of components the coal is classified into types. The coal types usually are formed into distinct layers which are easily discernible when the coal column is examined megascopically. Distribution of components in the various type layers and the average composition of the entire column, (Fig. 2), is shown in Table 2.

TABLE 2. — COMPONENTS IN TYPE LAYERS, PER CENT

LAYER	TYPE	SECTIONS	ANTHRAXYLON	TRANSLUCENT ATTRITUS	OPAQUE ATTRITUS	FUSAIN
1	Bright	1-27	62	23	11	4
2	Semisplint	28-32	34	38	22	6
3	Semisplint	34-36	28	29	40	3
4	Bright	37-54	48	37	12	3
5	Splint	55-56	5	40	54	1

AVERAGE COMPOSITION OF ENTIRE COLUMN, PER CENT

ANTHRAXYLON	TRANSLUCENT ATTRITUS	OPAQUE ATTRITUS	FUSAIN
51	30	15	4

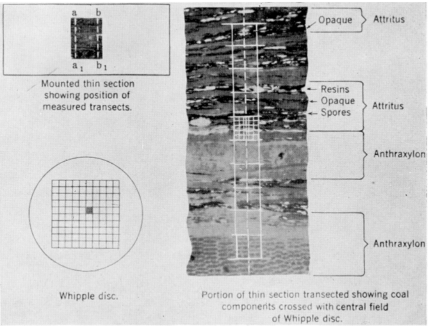
Fig. 1.

Measurement of components of coal under the microscope, in a thin section (graphic representation).

Fig. 2.

Components of coal and types of coal from the Powellton seam, Elk Creek, No. 1 coalfield, Logan Co., W. Va.

Determination of petrographic components of coal by examination of thin sections



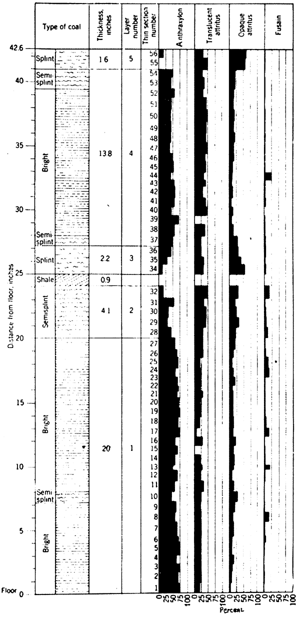
Mounted thin section showing position of measured transects.

Whipple disc.

Portion of thin section transected showing coal components crossed with central field of Whipple disc.

1

Determination of petrographic components of coal by examination in thin sections



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RECOMMENDATIONS FOR THE PREPARATION OF POLISHED SURFACES OF PARTICULATE AND LUMP SAMPLES OF COAL

Polished surfaces for the purpose of qualitative and quantitative petrographic analysis are commonly prepared from two types of material:

1. Particulate samples.
2. Lump samples.

In principle the same analyses are made on both kinds of samples but the evaluation of the results is different in the two cases.

PREPARATION OF PARTICULATE SAMPLES

Before making a microscopic coal analysis on particulate material it is necessary to ensure that the sample from which the polished surface is prepared is representative of the bulk of the material from which it has been drawn.

The weight of the sample which should be taken must be considered carefully and will vary according to the particular investigation being made, and also according to the size "consist" of the material sampled. The draft recommendations on sampling issued by I.S.O. should be followed.

The initial sample is crushed and reduced by appropriate stages to a fine size from which the amount required to make the section necessary for microscopic analysis can be abstracted.

The sample must be crushed below about 750 microns, so as to provide a statistically requisite number of particles in the polished surface, but care should be taken to avoid producing an excessive proportion of material below 100 micron size.

The recommendation to crush to below 750 microns is based on the experience of a number of exchange analysis exercises.

A polished surface can be prepared from material thus crushed without any further treatment, but in many cases it is advisable to separate the dirt ("rock"), s. g. > 2.0, from the coal and prepare polished specimens of each.

The particular advantage of separating the dirt ("rock") from the coal is that it minimises segregation (due to the differences in specific gravity) in the prepared specimen.

From the sample of material crushed to < 750 microns, a portion of 5 g. is abstracted and this is mixed with an embedding material. Various embedding materials are used including Carnauba wax, Schneiderhohn mixture and a number of synthetic resins.

Synthetic resins have proved in recent years to be particularly suitable because their polishing characteristics differ only slightly from those of coal, and because they are inert to various immersion liquids.

The polished surface of the size specified will include a sufficient number of particles if the coal is mixed with the embedding material in the proportions of approximately two parts of coal to three of wax or resin. A block of the particulate coal is cast by a method appropriate to the characteristics of the embedding material and the surface of the block ground and polished by normal methods. No hard and fast rules can be laid down for grinding and polishing since the materials used vary from one country to another. Different processes, carefully applied, give polished surfaces which are quite comparable.

In some cases if one of the less viscous embedding materials is used segregation may occur in the sample during the casting of the block particulary if the dirt ("rock") and coal portions differ widely in density. In such cases the analysis should be made on a surface prepared at right angles to the base of the block.

PREPARATION OF LUMP SPECIMENS

Analysis of lump specimens are chiefly undertaken in the study of seam sections and of particular parts of a seam profile, e.g. a band of durain which can only be identified with certainty under the microscope.

To make a complete analysis of a seam section, it is necessary to have an unbroken series of polished pieces representing the profile from roof to floor, and this demands particular care in sampling, especially if the coal is friable.

The sampling procedure is largely governed by the thickness of the seam, its banded structure, its rank and the way it has been affected by tectonic forces. No rules which would be widely applicable can be laid down for this procedure.

The various constituent blocks, each at most 6-8 cm. in length, are correctly ordered as a column to represent the seam profile and a polished surface is prepared on each block perpendicular to the bedding.

It is also important that the analyses of these surfaces should also be made perpendicular to the bedding.

In certain special studies surfaces parallel to the bedding planes are also examined.

The blocks are impregnated with a synthetic resin, Schneiderhohn mixture or Carnauba wax, the latter being widely favoured because of its good penetration.

GRINDING AND POLISHING

Grinding and polishing is conducted in much the same way for specimen blocks of lump coal and blocks of particulate coal, and is generally done by hand. Carborundum or emery of different grades of fineness are used in the grinding process and suspensions of alumina of various degrees of fineness for the polishing.

Where coals are difficult to polish, e.g., certain high volatile coals, as well as anthracite, chromium oxide is recommended for the preliminary stages of polishing.

The various grades of the different grinding and polishing agent should be as homogeneous as possible in respect to particle size, irrespective of whether they have been prepared by sieving or by elutriation. Failing this, scratches will inevitably occur on the finished polished surface. Another point to be observed is that when passing from one grinding or polishing material to the next finer grade, the surface of the specimen should be carefully rinsed with water, and finally with distilled water, to remove any traces of the coarser agent.

On completing the whole operation the polished surface should be free from scratches and should not show excessive relief.

Where it is essential, a virtually relief-free polish can be achieved by special care; a polishing lap of lime wood, as recommended by TROJER [1] and STACH [2], is useful in these cases.

A relief-free polish is specially recommended where appreciable photographic enlargement is required. It is, however, unnecessary for normal reflectance measurements which are generally made on portions of surface less than 10 microns across. Should the 10 microns limit be exceeded, then relief-free polishing is again desirable.

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[1] TROJER (F.). The preparation of relief-free polished surfaces. Der Karinthin, Folge, *19*, (1952), p. 150-153.

[2] STACH (E.). Private communication.

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