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Methods for the petrographic analysis of bituminous coal and anthracite -- Part 1: Vocabulary

Méthodes d'analyse pétrographique des charbons bitumineux et de l'anthracite -- Partie 1: Vocabulaire

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Methods for the petrographic analysis of bituminous coal and anthracite —

Part 1: Vocabulary

Méthodes d'analyse pétrographique des charbons bitumineux et de l'anthracite —

Partie 1: Vocabulaire

Reference number
ISO 7404-1:1994(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 7404-1 was prepared by Technical Committee ISO/TC 27, *Solid mineral fuels*.

This second edition cancels and replaces the first edition (ISO 7404-1:1984), which has been technically revised.

ISO 7404 consists of the following parts, under the general title *Methods for the petrographic analysis of bituminous coal and anthracite*:

- *Part 1: Vocabulary*
- *Part 2: Method of preparing coal samples*
- *Part 3: Method of determining maceral group composition*
- *Part 4: Method of determining microlithotype, carbominerite and minerite composition*
- *Part 5: Method of determining microscopically the reflectance of vitrinite*

Annex A of this part of ISO 7404 is for information only.

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Introduction

Petrographic analyses have been recognized internationally as important in the context of the genesis, vertical and lateral variation, continuity, metamorphism and usage of coal. The International Committee for Coal and Organic Petrology (ICCP) has made recommendations concerning nomenclature and analytical methods and has published an extensive handbook describing in detail the characteristics of a wide range of coals. The text of this part of ISO 7404 agrees substantially with the text of the handbook and incorporates many useful comments made by members of the ICCP and by member bodies of ISO/TC 27, *Solid mineral fuels*.

Petrographic analyses of a single coal provide information about the rank, the maceral and microlithotype compositions and the distribution of minerals in the coal. The reflectance of vitrinite is a useful measure of coal rank and the distribution of the reflectance of vitrinite in a coal blend, together with a maceral group analysis, can provide information about some important chemical and technological properties of the blend.

ISO 7404 is concerned with the methods of petrographic analysis currently employed in characterizing bituminous coal and anthracite in the context of their technological use. It establishes a system for petrographic analysis and comprises five parts, as follows:

Part 1: Vocabulary.

Part 2: Method of preparing coal samples.

Part 3: Method of determining maceral group composition.

Part 4: Method of determining microlithotype, carbominerite and minerite composition.

Part 5: Method of determining microscopically the reflectance of vitrinite.

For information on the nomenclature and analysis of brown coals and lignites, reference should be made to the *International Handbook of Coal Petrography*[1] published by the ICCP.

The complexity of coals mined throughout the world, coupled with the many applications of coal petrology in all branches of coal utilization, makes the compilation of a fully comprehensive glossary of terms a very difficult task.

This difficulty is compounded because some of the terms requiring definition have different meanings in different national nomenclatures. As a consequence, several general terms, such as bituminous coal, anthracite, brown coal and lignite, and sub-bituminous coal have had to be defined very loosely in this part of ISO 7404 pending international agreement on a new rationalized system of coal nomenclature. The definitions given are intended for use solely in connection with the generally accepted inter-

national methods of petrographic analysis of bituminous coal and anthracite described in the other parts of ISO 7404.

The petrographic terms listed are those most widely used internationally. They do not include terms such as pseudovitrinite, semi-vitrinite and semi-inertinite which refer to types of maceral with particular properties but which are difficult to define. Such terms may be considered important for specific applications in certain countries but their wider use is not recommended.

Methods for the petrographic analysis of bituminous coal and anthracite —

Part 1:
Vocabulary

1 Scope

This part of ISO 7404 defines terms that are used in connection both with maceral and microlithotype analyses carried out in white light and with the determination of the reflectance of vitrinite. It applies to the terms used in the examination of bituminous coal and anthracite only and is not concerned with the analysis of brown coal, sub-bituminous coal or lignite.

This part of ISO 7404 is not intended to be a comprehensive glossary of coal petrographic terminology, nor does it attempt to provide sufficient information to allow recognition of all the coal components described. Further information may be obtained from the *International Handbook of Coal Petrography* (see the fourth paragraph of the introduction).

2 Definitions

For the purposes of this part of ISO 7404, the following definitions apply.

2.1 General terms

2.1.1 coal: Combustible sedimentary rock formed from altered plant remains consolidated under superimposed strata.

NOTE 1 The characteristics of different coals are due to differences in source plant material, in the conditions and the degree of change that the material has undergone in its geological history, and in the range of impurities present. Coals can be characterized microscopically by their maceral and microlithotype compositions.

2.1.2 coalification: Process by which sedimented compacted plant remains are transformed into coal.

NOTE 2 This process is characterized by an increase in the carbon content in the plant remains and a decrease in the yield of volatile matter from the plant remains. As coalification proceeds, the reflectances of the macerals increase. Vitrinite is used as a reference material for the determination of the rank of coal because its reflectance increases uniformly with the extent of coalification.

2.1.3 rank: Position of a coal in the coalification series from brown coal (low rank) to anthracite (high rank), indicating maturity in terms of chemical and physical properties.

2.1.4 brown coal and lignite: Coals of low rank which, in their natural state, are characterized by high inherent moisture content, high volatile matter content and low calorific value, and are non-agglommerating.

NOTE 3 In some countries, the terms are used to describe all low rank coals up to bituminous coals. In other countries, the coals at the higher end of this range are referred to as sub-bituminous coals.

2.1.5 sub-bituminous coal: Coal of rank immediately below that of bituminous coal.

2.1.6 bituminous coal: A general descriptive term for coal between anthracite and brown coal/lignite.

NOTE 4 The vitrinites in all coals in the bituminous range melt and form a coke when the coal is heated above 400 °C.

2.1.7 anthracite: Coal of high rank, with a low volatile matter content and a semi-metallic lustre, and which does not soften or swell when heated.

2.2 Optical microscopy terms

2.2.1 reflectance: Percentage of the near-normal incident light reflected from a polished surface.

NOTE 5 For the purpose of this part of ISO 7404, reflectance refers to measurements made on coal under oil immersion.

2.2.2 maximum reflectance: Highest value of reflectance obtained when any polished section of a particle or lump of coal is rotated in its own plane in linearly polarized light.

2.2.3 random reflectance: Reflectance of any polished section of a particle or a lump of coal when determined in unpolarized light without rotation of the specimen.

NOTE 6 The term "random reflectance" has replaced the terms "mean reflectance" and "average reflectance" to avoid any possible confusion arising from the meaning of the words "mean" and "average" in the mathematical sense.

2.2.4 parasitic reflection: Percentage of the incident light reaching the photomultiplier from lens boundary faces and other reflecting surfaces in the microscope.

2.2.5 reflectance standard: Polished surface of a material of known reflectance which is used for calibrating reflectance-measuring equipment.

2.2.6 zero standard: Non-reflecting standard used for calibrating reflectance-measuring equipment.

2.2.7 particulate block: Solid block consisting of particles of crushed coal representative of the sample, bound in resin, cast in a mould and with one face ground and polished.

2.2.8 lump section: Piece of coal of size suitable for polishing and examination under the microscope.

NOTE 7 One face of the lump section, usually that perpendicular to the bedding plane, is ground and polished.

2.2.9 point: The area overlain by the intersection of the cross-wires in the eyepiece graticule during microscopical analysis.

2.3 Petrographic terms

2.3.1 maceral: Microscopically recognizable organic constituents of coal analogous to the minerals of inorganic rocks, but differing from them in that macerals have no characteristic crystal form and are not constant in chemical composition.

NOTE 8 The macerals are distinguished from one another microscopically on the basis of their differences in such properties as reflectance, colour, fluorescence, morphology, size and hardness. They originate from the remains of different tissues of plants and their physical and chemical properties change as coalification proceeds.

2.3.2 submaceral: Subdivision of a maceral based on slight morphological and physical differences.

NOTE 9 Information on the description and properties of the macerals and submacerals may be obtained by reference to the *International Handbook of Coal Petrography*[1].

2.3.3 maceral group: Collective term for macerals having broadly similar properties in a single coal of specific rank. (See also 3.1.)

2.3.4 microlithotype: Naturally occurring maceral or association of macerals with a minimum bandwidth of 50 µm. (See also 3.2.)

2.3.5 minerals: Natural inorganic constituents of coal observed during microscopical examination.

NOTE 10 Minerals are determined on a volume basis as part of a maceral analysis.

2.3.6 mineral matter: The inorganic material, except moisture, in a coal.

NOTE 11 Mineral matter is calculated on a mass basis either from a direct determination at low temperature or from the ash yield at high temperature.

2.3.7 carbominerite: Collective term for intergrowths of minerals and macerals. (See also 3.3.)

2.3.8 minerite: Collective term for intergrowths of minerals with different macerals in which the proportion of minerals is more than 60 % by volume, or in which more than 20 % by volume of sulfide minerals is present.

3 Classification of macerals, microlithotypes and carbominerites

3.1 Macerals

Three maceral groups are recognized: vitrinite, liptinite[1] and inertinite. Maceral groups and their subdivisions are shown in table 1.

Table 1 — Maceral groups and their subdivisions

Maceral group	Maceral	Submaceral
Vitrinite	Telinite	Telinite 1 Telinite 2
	Collinite	Telocollinite Gelocollinite Desmocollinite Corpocollinite
	Vitrodetrinite	
Liptinite	Sporinite Cutinite Resinite Suberinite[1] Alginite Liptodetrinite Bituminite	
Inertinite	Micrinite Macrinite Semifusinite Fusinite	Pyrofusinite Degradofusinite
	Sclerotinite Inertodetrinite	

1) Occurs in post-carboniferous bituminous coals.

3.2 Microlithotypes

Microlithotypes are classified in one of three categories, namely monomaceral, bimaceral and trimaceral microlithotypes, according to whether they contain significant proportions of macerals of one, two or three maceral groups. A monomaceral microlithotype contains at least 95 % by volume, on a mineral-free basis, of the principal maceral group. A bimaceral microlithotype contains at least 95 % by volume, on a mineral-free basis, of the two principal maceral groups and at least 5 % by volume of each. A trimaceral microlithotype contains at least 95 % by volume, on a mineral-free basis, of the three principal maceral groups and at least 5 % by volume of each. Microlithotypes may contain not more than 5 % by volume of sulfide minerals or 20 % by volume of clay minerals as impurities.

The classification of the main microlithotypes and their maceral group compositions is given in table 2.

Table 2 — Classification of the main microlithotypes

Microlithotype	Maceral-group composition (Total ⩾ 95 % by volume, mineral-free basis)
Monomaceral	
Vitrite	Vitrinite
Liptite	Liptinite
Inertite	Inertinite
Bimaceral	
Clarite	Vitrinite + Liptinite
Durite	Inertinite + Liptinite
Vitrinertite	Vitrinite + Inertinite
Trimaceral	
Trimacerite	Vitrinite + Liptinite + Inertinite

3.3 Carbominerites

The various types of carbominerite are given in table 3.

Table 3 — Types and compositions of carbominerite

Type	Volume percentage of minerals
Carbargilite	20 to 60, clay minerals
Carbopyrite	5 to 20, sulfides
Carbankerite	20 to 60, carbonates
Carbosilicite	20 to 60, quartz
Carbopolyminerite[1]	20 to 60, various minerals

1) The term is also used for carbopolyminerite containing a maximum of 5 % minerals, provided sulfides form a substantial part of the mineral matter.

1) This maceral group has also been referred to as "exinite" but the use of this term is now deprecated.