International Standard 7404/1

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Methods for the petrographic analysis of bituminous coal and anthracite — Part 1: Glossary of terms

Méthodes d'analyse pétrographique des charbons bitumineux et de l'anthracite — Partie 1: Glossaire de termes

First edition — 1984-11-01

UDC 662.642 : 552.001.4 **Ref. No. ISO 7404/1-1984 (E)**

Descriptors : minerals and ores, solid fuels, coal, bituminous coal, anthracite, petrography, vocabulary.

Price based on 3 pages

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

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

Printed in Switzerland

Methods for the petrographic analysis of bituminous coal and anthracite — Part 1: Glossary of terms

0 Introduction

0.1 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 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 International Standard 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 mineral matter 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.

This International Standard 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: Glossary of terms.

Part 2: Method of preparing coal samples. [1]

Part 3: Method of determining maceral group composition.

Part 4: Method of determining microlithotype composition. [2]

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* published by the ICCP. [3]

0.2 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, sub-bituminous coal and lignite 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 international 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 entities such as pseudovitrinite, semi-vitrinite and semi-inertinite that are considered important for particular applications in some countries but not in others. When, in accordance with national practice, reference to these terms is necessary, the appropriate literature should be consulted.

1 Scope and field of application

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.

1) At present at the stage of draft.

2) In preparation.

3) The second edition (1963), together with the supplement issued in 1971 may be obtained from Professor D.G. Murchison, Organic Geochemistry Unit, Department of Geology, University of Newcastle, Newcastle-upon-Tyne, NE1 7RU, United Kingdom. The supplement issued in 1973 may be obtained from Centre national de la recherche scientifique, 15, quai Anatole-France, F-75007 Paris, France.

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 0.1).

2 Definitions

2.1 General terms

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

NOTE — 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 — This process is characterized by an increase in the carbon content and a decrease in the volatile matter in the plant remains on the dry-mineral-matter-free basis. As coalification proceeds, the reflectance of the macerals increases, the reflectance of vitrinite usually being used as a measure of the degree of coalification or rank of the coal.

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 characterized by high inherent moisture, high volatile matter and low specific energy.

NOTE — 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: Coal of medium rank.

NOTE — 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.

NOTE — Anthracites do not melt when heated.

2.2 Optical microscopy terms

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

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

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 — 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.

NOTE — It is essential that the reflectance standard meets stringent requirements with regard to the properties of the material of which it is composed, and the way in which it is mounted and prepared. These requirements are described in detail in ISO 7404/5.

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

NOTE — A suitable zero standard is described in ISO 7404/5.

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

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 — The macerals are distinguished from one another microscopically on the basis of their differences in such properties as reflectance, colour, 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 — Information on the description and properties of the macerals and submacerals may be obtained by reference to the *International Handbook of Coal Petrography* (see 0.1).

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 occuring maceral or association of macerals with a minimum band width of 50 µm. (See also 3.2.)

2.3.5 mineral matter: Inorganic matter that has become associated with the organic matter of a coal during its genesis, its subsequent geological history and its extraction and treatment at the mine.

2.3.6 carbominerite: Collective term for intergrowths of minerals with microlithotypes. (See also 3.3.)

2.3.7 minerite: Collective term for intergrowths of minerals with different microlithotypes where the proportion of the total mineral matter is more than 60 % by volume. The term is also used if more than 20 % of sulfide minerals are present.

3 Classification of macerals, microlithotypes and carbominerites

3.1 Macerals

Three maceral groups are recognized, vitrinite, exinite (liptinite) 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	
Exinite (Liptinite)	Sporinite Cutinite Resinite Suberinite* Alginite Liptodetrinite	
Inertinite	Micrinite Macrinite Semifusinite Fusinite	Pyrofusinite Degradofusinite
	Sclerotinite Inertodetrinite	

* 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 macerals of one, two or three maceral groups. Microlithotypes may contain not more than 5 % by volume of sulfide minerals or 20 % by volume of clay minerals as impurities.

The nomenclature of the main microlithotypes and their maceral group compositions are 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	Exinite (liptinite)
Inertite	Inertinite
Bimaceral*	
Clarite	Vitrinite + Exinite
Durite	Inertinite + Exinite
Vitrinertite	Vitrinite + Inertinite
Trimaceral*	
Trimacerite	Vitrinite + Exinite + Inertinite

* It is necessary for the bimaceral and trimaceral microlithotypes that the porportion of an individual maceral group be ≥ 5 % by volume in each case.

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*	20 to 60, various minerals

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