



CIBJO The World Jewellery  
Confederation   
est. 1926

BLUE BOOK

# THE Gemmological Laboratories THE Book

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## Foreword

CIBJO is the French acronym for the **C**onfédération **I**nternationale de la **B**ijouterie, **J**oaillerie, **O**rfèvrerie, des **D**iamants, **P**erles et **P**ierres, which translates as the International Confederation of Jewellery, Silverware, Diamonds, Pearls and Stones (normally shortened to the International Jewellery Confederation). Founded in 1926 as BIBOAHa European organisation whose mission was to represent and advance the interests of the jewellery trade in Europe, it was reorganised in 1961 and renamed CIBJO, in 2009 it was once again reorganised and officially named “CIBJO, The World Jewellery Confederation”. Today CIBJO, which is domiciled in Switzerland, is a non-profit confederation of national and international trade associations including commercial organisations involved in the jewellery supply chain. It now has members from countries representing all five continents of the world. CIBJO printed its first deliberations on terminology and trade practices in 1968.

It is the task of CIBJO to record the accepted trade practices and nomenclature for the industry throughout the world. The records of the trade practices complement existing fair trade legislation of a nation or in the absence of relevant national laws they can be considered as trading standards. In countries where laws or norms exist, which conflict with the laws, norms or trade practices in other countries, CIBJO will support the national trade organisations to prevent trade barriers developing. The purpose of CIBJO is to encourage harmonisation, promote international co-operation within the jewellery industry, consider issues which are of concern to the trade worldwide and to communicate proactively with members. Foremost amongst these the aim is to protect consumer confidence in the industry. CIBJO pursues all of these objectives through informed deliberation and by reaching decisions in accordance with its Statutes. CIBJO relies upon the initiative of its members to support and implement its standards, and to protect the trust of the public in the industry.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

The work of CIBJO is accomplished through Committees, Commissions and Sectors. Committees and Commissions consider standards for use in the jewellery supply chain. Sectors represent levels of trade in the jewellery industry. Sectors and commissions advise the Executive Committee on current trade practices and issues that affect the jewellery industry.

Three independent sectors exist within the confederation:

Sector A— The Products Sector

Sector B — The Supply Chain

Sector Sector C— The Service

The Executive Committee may appoint Commissions that consider detailed issues. At present these are:

Coloured Stone

Coral

Diamond

Ethics

Gemmolog

ical Pearl

Marketing & Education

Precious Metals

World Jewellers Vigilance

The Commissions for Diamonds, Gemstones, Pearls and Precious Metals have collated the guidelines, which present the accepted trade practices for applying descriptions to these materials. It is in the best interest of all those concerned to be aware of them.

The Sectors and Commissions will propose changes in the standards, also known as the Blue Books, to the Executive Committee. After review the Executive Committee will submit the accepted proposals for adoption to the Board of Directors and if approved they will notify the assembly of delegates of the changes at the annual congress. Furthermore, it is our mutual responsibility to support these recommendations, which concern all professional people connected with diamonds, gemstones, pearls and precious metals. CIBJO Standards are subject to government regulations in the respective jurisdictions of CIBJO members.

The national umbrella organisation for each country represents, in principle, all the national trade organisations involved in the sectors mentioned above. This democratic structure, which has contributed to CIBJO's world-wide recognition also includes international trade and commercial organisations, it provides an international forum for the trade to collectively draw attention to issues and implement resulting decisions.

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## Introduction

The CIBJO Gemmological Laboratory Book is intended as a source of information and recommendations for gemmological laboratories on which they may choose to base their activities in order to ensure proper quality control and accountability within their Gemmological Laboratory.

The work of a Gemmological Laboratory and the test results it produces are reliant upon good practices throughout the Gemmological Laboratory's operation, from the first to the last interaction with the Customer.

The following definitions apply in understanding how to implement CIBJO Blue Books and some of its normative references, e.g. when applicable ISO standards.

- “shall” indicates a requirement;
- “should” indicates a recommendation;
- “may” is used to indicate that something is permitted;
- “can” is used to indicate that something is possible.

The Gemmological Commission strongly recommends that all Gemmological Laboratories aspire to achieve the highest possible level of accountability throughout their operations and that the best practices recommended in the CIBJO Gemmological Laboratory Book are followed as a minimum. However, ideally all Gemmological Laboratories should also consider the application of ISO/IEC 17025.

The Gemmological Commission

October 2024

## Acknowledgements

Developed by the Gemmological Commission with help of the appointed Committee on Varietal names, this 2024 edition of the CIBJO Gemmological Laboratories Blue Book could not have been produced without the active contributions made by the following individuals. Hanco Zwaan (President of the CIBJO Gemmological Commission), Ken Scarratt (President of CIBJO sector A), Claudio Milisenda, Thanong Leelawatanasuk, Thomas Lind, Michael Krzemnicki, Jean Pierre Chalain, Shane McClure, and Sudarat Saeseaw.

# CIBJO Guidelines for Gemmological Laboratories

This book takes its concept from ISO/IEC 17025, an International Standard for which it is recommended that all Gemmological Laboratories seriously consider compliance.

**Disclaimer** — CIBJO recommends the best practices but is not responsible for gemmological reports issued by a Laboratory.

## 1. Scope

This CIBJO Gemmological Laboratory Book suggests best practices and general requirements for the competence to carry out tests, grading and/or internal calibrations, on instruments, coloured gemstones, diamonds and pearls within gemmological laboratories. The clauses herein are a guide only and shall not be regarded or considered as rules of application, laws, or statutes that govern the operation of gemmological laboratories.

The CIBJO Gemmological Laboratory Book suggests best practices for testing, grading and internal calibration performed using those methods both typically used and within gemmological laboratories as well as those uniquely developed. The suggestions are pertinent to the operations of all gemmological laboratories that issue test results regardless of whether or not these are part of a service that is paid for by a customer. They are also pertinent regardless of a gemmological laboratory's size and scope.

When a gemmological laboratory does not undertake one or more of the activities covered by this CIBJO Gemmological Laboratory Book, the suggestions stated in those clauses may not apply.

This CIBJO Gemmological Laboratory Book is for use by gemmological laboratories in developing their management system for quality, administrative and technical operations. It is not intended nor should it be considered as a guarantee for the quality of results issued by the laboratories.

Gemmological laboratories should refer to the appropriate International standards when organising compliance with safety requirements for the operation of gemmological laboratories: these are not covered in the CIBJO Gemmological Laboratory Book.

## 2. Normative references

The following referenced documents are recommended readings. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

**ISO/IEC 17025** General requirements for the competence of testing and calibration laboratories. See: <https://www.iso.org/standard/66912.html>

**ISO 24016** – Jewellery and precious metals – Grading polished diamonds – Terminology, classification and test methods.

See: <https://www.iso.org/standard/79795.html>

ISO 68932024 – Jewellery and precious metals – Inspection of batches of small diamonds – Terminology, classification and test methods.

See: <https://www.iso.org/standard/82429.html>

**The Coral Book**, *CIBJO*, International Confederation of Jewellery, Silverware, Diamonds, Pearls and Stones, the World Jewellery Confederation, Viale Berengario, 19, 20149 Milano, Italy. [cibjo@cibjo.org](mailto:cibjo@cibjo.org)

**The Diamond Book**, *CIBJO*, International Confederation of Jewellery, Silverware, Diamonds, Pearls and Stones, the World Jewellery Confederation, Viale Berengario, 19, 20149 Milano, Italy [cibjo@cibjo.org](mailto:cibjo@cibjo.org).

**The Gemstone Book**, *CIBJO* (International Confederation of Jewellery, Silverware, Diamonds, Pearls and Stones), the World Jewellery Confederation, Viale Berengario, 19, 20149 Milano, Italy [cibjo@cibjo.org](mailto:cibjo@cibjo.org).

**The Pearl Book**, *CIBJO* (International Confederation of Jewellery, Silverware, Diamonds, Pearls and Stones), the World Jewellery Confederation, Viale Berengario, 19, 20149 Milano, Italy [cibjo@cibjo.org](mailto:cibjo@cibjo.org).

**The Precious Metals Book**, *CIBJO* (International Confederation of Jewellery, Silverware, Diamonds, Pearls and Stones), the World Jewellery Confederation, Viale Berengario, 19, 20149 Milano, Italy [cibjo@cibjo.org](mailto:cibjo@cibjo.org).

### **3. Terms and definitions**

#### **3.1. Audit**

examination of the quality, state, efficiency of an organisation, system, process, project or product to ascertain its validity and reliability.

#### **3.2. Calibration**

a set of graded measurements that show position or values to mark or correct the units of measurements of an instrument.

#### **3.3. Certificate**

a document of a legal standing.

#### **3.4. Certified reference materials – CRMs**

reference materials, accompanied by documentation issued by an authoritative body and providing one or more specified property values with associated uncertainties and traceability, using valid procedures.

#### **3.5. Competent subcontractor**

a contractor of the primary contractor, in this case the laboratory, who by virtue of their knowledge, experience and equipment is competent to do the work.



### **3.6. Gem materials**

those materials listed in the CIBJO, Diamond, Pearl, and Gemstones Books (see 2, Normative References).

### **3.7. Gemmological laboratory**

an establishment that provides controlled conditions in which the identification, authentication and grading of gem materials may be performed; scientific research, experiments and measurements may be carried on as well with the aim of a better knowledge of gem materials.

### **3.8. Gemmology**

the science, art and profession of identifying, authenticating, researching and grading gem materials.

### **3.9. Gemological laboratory**

an alternative (American English) spelling for gemmological laboratory.

### **3.10. Gemology**

an alternative (American English) spelling for gemmology

### **3.11. Grading**

the classification of technical/commercial characteristics of gem materials

### **3.12. Internal audit**

control of the Laboratory's quality system, to ensure that the activities carried out in the Laboratory are in conformity with the established policies and procedures of the management system, with the aim of correcting any non-conformities and introducing improvements. The final outcome is to minimize the percentage of errors and give valid, consistent and reliable results and services.

### **3.13. Internal calibrations**

calibrations done in a Centre on its own instruments, to check their validity and consistency with the Standards.

### **3.14. Laboratory / Lab**

trade short form for a gemmological laboratory, see 3.7 and 3.9.

### **3.15. Quality and technical record**

written notes on facts related to quality and/or to technical items so that they can be remembered or referred to in the future.

### **3.16. Reference standards and reference materials**

references calibrated by a body that can provide traceability, used to establish, by comparison, the value of physical or chemical properties.

### **3.17. Report**

a description of technical/commercial characteristics of gem materials in accordance with the rules relative to CIBJO international agreements.

### **3.18. Sampling**

a defined procedure whereby a part of a substance, a material, a product or a lot is taken to provide for testing of a representative sample of a whole. Sampling procedures describe the selection, sampling plan, withdrawal and preparation of a sample or samples from a substance, material, product or a lot, to yield the required information.

### **3.19. SI units – International System of Units**

an internationally agreed system of measurement that uses seven base units (length, mass, time, electric current, thermodynamic temperature, luminous intensity and amount of substance) with two supplementary units (plane angle and solid angle).

### **3.20. Subcontract**

a contract that assigns some of the obligations of a prior contract to another party.

### **3.21. Test**

a procedure in which technical characteristics of gem materials are observed, measured, analysed and established.

### **3.22. Traceability**

completeness of the information about every step in a process chain.

### **3.23. Reproducibility of results**

ability of a gemmological laboratory to get the same results when repeating tests, using the same reference samples and standards.

## **4. Management requirements**

### **4.1. Organisation**

**4.1.1.** The gemmological laboratory, the organisation, or commercial company of which it is part shall be legally responsible for the activities of the gemmological laboratory. The management system shall cover work carried out by the gemmological laboratory whether inside or outside the political/administrative borders of its registration.

**4.1.2.** In order to make clear any implied or potential conflicts of interest, if a gemmological laboratory is entirely or partly owned by, or has investors within a gem material (loose or mounted) trade organisation or a commercial

company that trades in gem materials (loose or mounted), in particular where traders or potential customers are on a board(s) and may play a role in, or have an influence upon the testing and/or activities or reporting of the gemmological laboratory; the responsibilities of key personnel in the organisation that have such involvement or influence shall be clearly defined, and openly declared to the Laboratory's clients.

- 4.1.3. A gemmological laboratory should be able to demonstrate that it is impartial and that it and its personnel are free from any undue commercial, financial and other pressures which might influence their technical judgement. The gemmological laboratory should not engage in any activities that may endanger the trust in its independence of judgement and integrity in relation to its testing or internal calibration activities.
- 4.1.4. The gemmological laboratory management system shall ensure that gemmological laboratory personnel are free from any internal and external pressures and influences that may interfere with the quality of their work; the performance of tests, grading and/or instrument calibrations. The management system shall have personnel in-place that monitor such influences and when necessary have the power to take corrective action.
- 4.1.5. The management system shall be clearly defined to staff and customers through an effective means of communication.
- 4.1.6. Testing and internal calibrations shall be properly supervised by technically qualified managers that have overall responsibility and authority over technical staff and the work they carry out, and reports that are issued.
- 4.1.7. A member of the technical staff shall be appointed to manage the quality of the work carried out in the gemmological laboratory. This manager shall ensure that all test protocols are adhered to, that quality systems are followed at all times that the staff is aware of their quality related responsibilities at all times.

## **4.2. Management systems**

- 4.2.1. A system of protocols that ensure the quality of the work carried out by the gemmological laboratory shall be available to the staff and that the contents are effectively communicated. These protocols shall cover all aspects of the gemmological laboratory functions, including but not limited to, receipting of goods, weights and measures, inventory control, work distribution, instrument maintenance and operation, results analysis and report nomenclature.
- 4.2.2. All management systems shall be reviewed at least annually and a written quality statement issued by top management. This statement shall commit management to the observation of best practices in the identification and reporting on gem materials and the quality of services given to customers. The statements should also indicate management's commitment to compliance with the Gemmological Laboratory Book and / or ISO/IEC 17025.

## **4.3. Document Control**

- 4.3.1. A full list of approved documents and their current status shall be established and shall be readily available to preclude the use of out of date versions. All approved documents shall be available in and to all locations.
- 4.3.2. All altered or new document text shall be identified in the document or the appropriate attachments.
- 4.3.3. There shall be clear procedures to describe how changes in documents are made and controlled.
- 4.3.4. Documents must include the list of related attachments.

#### **4.4. Review of customer requests**

- 4.4.1. Requirements and or requests shall be clearly established upon receiving gem materials from a customer.
- 4.4.2. All test methods shall be adequately defined and be clearly understood by the gemmological laboratory.
- 4.4.3. The gemmological laboratory shall have the capability and resources to meet the customer's requirements and/or requests.
- 4.4.4. Any differences in understanding between the customer and the gemmological laboratory shall be resolved prior to any work being carried out.
- 4.4.5. Records shall be kept of any discussions with customers.

#### **4.5. Subcontracting of tests**

- 4.5.1. When a gemmological laboratory subcontracts work, this work shall be placed with a competent subcontractor.
- 4.5.2. If customer's work is subcontracted the gemmological laboratory shall advise customers of the circumstances, including the acknowledgement of their continued responsibility for the gem materials submitted.

#### **4.6. Service to the customer**

- 4.6.1. Within the limitations set by security requirements, the gemmological laboratory shall agree to any customer request for the monitoring of performance related to the work performed, provided also that the gemmological laboratory ensures confidentiality to other customers.
- 4.6.2. The gemmological laboratory shall seek feedback from its customers. This feedback shall be used to improve the management system, testing and internal calibration activities and customer services.

#### **4.7. Complaints**

- 4.7.1. The gemmological laboratory shall have a policy and procedure for the

resolution of complaints received from customers or other parties. Records shall be maintained of all complaints and of the investigations and corrective actions taken by the gemmological laboratory.

- 4.7.2.** A secondary customer should make any complaints through the primary customer. Responses to complaints shall be given to the primary customer only.

#### **4.8. Corrective action**

- 4.8.1.** The gemmological laboratory shall establish a policy and a procedure and shall designate appropriate authorities for implementing corrective action when departures from the policies and procedures in the management system or technical operations have been identified.

#### **4.9. Additional audits**

- 4.9.1.** Where the identification of departures casts doubts on the gemmological laboratory's compliance with its own policies and procedures, or on its compliance with this CIBJO Gemmological Laboratory Book, the gemmological laboratory shall ensure that the appropriate areas of activity are audited as soon as possible.

#### **4.10. Control of records**

- 4.10.1.** The gemmological laboratory shall establish and maintain procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. Quality records shall include reports from internal audits and management reviews as well as records of corrective and preventive actions.

#### **4.11. Internal audits**

- 4.11.1.** The gemmological laboratory shall periodically conduct internal audits of its activities to verify that its operations continue to comply with the requirements of the management system and this CIBJO Gemmological Laboratory Book. Such audits shall be carried out by trained and qualified personnel who are, wherever resources permit, independent of the activity to be audited.

#### **4.12. Management reviews**

- 4.12.1.** The gemmological laboratory's top management shall periodically conduct a review of the gemmological laboratory's management system and testing and/or internal calibration activities to ensure their continuing suitability and effectiveness, and to introduce necessary changes or improvements. The review shall take account of
- the suitability of policies and procedures;
  - reports from managerial and supervisory personnel;
  - the outcome of recent internal audits;
  - corrective and preventive actions;

- assessments by external bodies;
- the results of inter laboratory comparisons or proficiency tests;
- changes in the volume and type of the work;
- customer feedback;
- complaints;
- recommendations for improvement;
- other relevant factors, such as quality control activities, resources and staff training.

A typical period for conducting a management review is once every 12 months. Results should be fed into the laboratory planning system and should include the goals, objectives and action plans for the coming year.

A management review includes consideration of related subjects at regular management meetings.

## **5. Technical requirements**

Many factors determine the correctness and reliability of the tests, grading and/or internal calibrations performed by a gemmological laboratory. These factors include contributions from:

- human factors;
- accommodation and environmental conditions;
- test and calibration methods and method validation;
- equipment;
- measurement traceability;
- samples;  
the handling of test and calibration items.

### **5.1. Personnel**

**5.1.1.** The gemmological laboratory management shall ensure the competence of all who operate specific equipment, perform tests and/or internal calibrations, evaluate results, and sign test reports. When using staff that are undergoing training, appropriate supervision shall be provided. Personnel performing specific tasks shall be qualified on the basis of appropriate education, training, experience and/or demonstrated skills, as required. The gemmological laboratory shall maintain current anonymous job descriptions for managerial, technical and key support personnel involved in tests and/or internal calibrations.

**5.1.2.** The gemmological laboratory should count on the presence of a minimum of three persons as defined in 5.1.1.

### **5.2. Accommodation and environmental conditions**

**5.2.1.** Gemmological laboratory facilities for testing and/or grading and internal calibration shall be such as to facilitate correct performance of the tests and/or grading and in line with international agreements. The gemmological laboratory shall ensure that the environmental conditions do not invalidate the results or adversely affect the required quality of any measurement. The

technical requirements for accommodation and environmental conditions that can affect the results of tests and grading shall be documented.

### **5.3. Equipment**

**5.3.1.** The gemmological laboratory shall be furnished with all items of equipment required for the correct performance of the tests and/or grading and internal calibration. In those cases where the gemmological laboratory needs to use equipment outside its permanent control, it shall ensure that the requirements of this CIBJO Gemmological Laboratory Book are met.

**5.3.2.** Equipment shall be operated by authorised personnel. Up-to-date instructions on the use and maintenance of equipment shall be readily available for use by the appropriate gemmological laboratory personnel.

**5.3.3.** Records shall be maintained of each item of equipment and its software significant to the tests, grading and/or internal calibrations performed. The records shall include at least the following:

- date of purchase
- the identity of the item of equipment and its software;
- the manufacturer's and distributors name, type identification, and serial number or other unique identification;
- checks that equipment complies with the specification;
- the current location, where appropriate;
- the manufacturer's instructions, if available, or reference to their location;
- dates, results and copies of reports of all calibrations, adjustments, acceptance criteria and the due date of next calibration;
- the maintenance plan, where appropriate, and maintenance carried out to date;
- any damage, malfunction, modification or repair to the equipment.

### **5.4. Testing and grading**

**5.4.1.** Where traceability of measurements to SI units is not possible and/or not relevant, the same requirements for traceability to, for example, certified reference materials, agreed methods (see under 6.) and/or consensus standards, are required.

### **5.5. Reference standards and reference materials**

**5.5.1.** The gemmological laboratory shall have a programme and procedure for the calibration of its reference standards. Reference standards shall be calibrated by a body that can provide traceability. Such reference standards held by the gemmological laboratory shall be used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated.

### **5.6. Sampling**

**5.6.1.** The gemmological laboratory shall have a sampling plan and procedures for sampling when batch testing. The sampling plan as well as the sampling

procedure shall be available at the location where sampling is undertaken. Sampling plans shall, whenever reasonable, be based on appropriate statistical methods.

- 5.6.2.** Where the customer requires deviations, additions or exclusions from the documented sampling procedure, these shall be recorded in detail with the appropriate sampling data and shall be included in all documents containing test and/or calibration results, and shall be communicated to the appropriate personnel.

## **5.7. Assuring the quality of test and grading results**

- 5.7.1.** The gemmological laboratory shall have quality control procedures for monitoring the validity and results reproducibility of tests, grading and internal calibrations undertaken. The resulting data shall be recorded in such a way that trends are detectable and, where practicable, statistical techniques shall be applied to the reviewing of the results.

## **5.8. Reporting the results**

- 5.8.1.** Each test report shall include at least the following information, unless the gemmological laboratory has valid reasons for not doing so:

- a title (e.g. “Test Report”);
- the name and address of the gemmological laboratory, and the location where the tests were carried out, if different from the address of the gemmological laboratory;
- unique identification of the test report (such as the serial number), and on each page an identification in order to ensure that the page is recognised as a part of the test report, and a clear identification of the end of the test report;
- the name and address of the customer (client optional);
- a description of, the condition of, and unambiguous identification of the item(s) tested;
- the date of receipt of the test item(s) where this is critical to the validity and application of the results, and the date(s) of performance of the test;
- the test or grading results with, where appropriate, the units of measurement;
- opinions and interpretations where appropriate and needed; in many cases it may be appropriate to communicate the opinions and interpretations by direct dialogue with the customer : such dialogue should be written down.
- additional information which may be required by specific methods, customers or groups of customers;
- the name(s), function(s) and signature(s) or equivalent identification of person(s) authorising the test report or the name of the legal entity.

- 5.8.2.** In the case of transmission of test results by telephone, telex, facsimile or other electronic or electromagnetic means, the guidelines of this CIBJO Gemmological Laboratory Book shall be met.

- 5.8.3.** The format of the report shall be designed to accommodate each result obtained and to minimise the possibility of misunderstanding or misuse. The headings should be standardized as far as possible.



**5.8.4.** The report should have suitable security measures, such as a hologram or embossed seal, to minimise potential for fraud.

**5.8.5.** Copies of reports, working notes, etc. shall be retained in a secure manner for at least 10 years, or longer if local regulations require.

## 5.9. Amendments to test reports

**5.9.1.** Material amendments to a test report after issue shall be made only in the form of a further document, or data transfer, which includes the statement: “Supplement to Test Report, serial number ... or an equivalent form of wording. When it is necessary to issue a complete new report, this shall be uniquely identified and shall contain a reference to the original that it replaces.

## 6. Test method protocol

Required test methods are listed, which shall be applied to correctly identify the gem material stated. The listed test method is mandatory, unless a remark indicates otherwise. Definitions of the test methods are listed under 6.3. and the indicated key references on which the protocol is based, are given under 6.4.

### 6.1. Test methods gemstones

#### 6.1.1. Actinolite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Cat’s-eye
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	If other tests are inconclusive
XRD	If other tests are inconclusive
<i>References</i>	
Burns and Greaves (1971); Crowningshield (1969); Fryer (1993a); Hietanen (1971); Ishida et al. (2002); Lucas (1974); Mustard (1992); Pough (1987); Skogby and Annersten (1985); Smelik et al. (1991); Washington and Merwin (1923)	

*Special attention: dye*

#### 6.1.2. Alexandrite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Cat’s-eye, colour-change
Refractometer (refractive index)	
Spectroscope	
FTIR(-NIR) spectroscopy	
Colour call	Clear colour-change
Clarity enhancement check/extent	

<i>References</i>
Anderson (1950); Andres et al. (1962); Bank F.H. et al. (1988); Bank (1964, 1967, 1971, 1974, 1987); Bank H. et al. (1988a,b), Bank and Okrusch (1967); Beaume et al. (1997); Benson (1959a, b), Bevan and Downes (1997), Brown and Kelly (1985), Bukin et al. (1981), Cassedane and Roditi (1993), Crowningshield (1963a, 1964, 1970b, 1979); Currie (1994), de Oliveira and Leite (1987), Du Toit (1996), Eppler (1974), Fryer, (1983a, b, 1986, 1987, 1988a, b, 1992, 1993b); Galia (1990); Godovikov and Bulgak (1989); Gravender (1935); Grum-Grzhimailo (1949); Gübelin and Schmetzer (1980); Gübelin (1976a,b,c,d); Guo et al. (1987); Hassan and El-Rakhawy (1974); Henn (1985); Henn and Bank (1992); Horiuchi (1979); Hyrsi and Quintens (1999), Johnson and Kammerling (1995), Kammerling and Fryer (1995a,b,c); Kane (1987); Koivula (1984, 1987); Koivula and Fritsch (1993b,c); Koivula et al. (1988a); Koivula and Kammerling (1988b, 1991c, 1992a); Koivula et al. (1992b); Koivula et al., 1995; Leckebusch (1976); Leithner (1980); Liddicoat (1972b, 1974b, 1976a); Liu and Fry (2006); Machida and Yoshihara (1980); Malley (1988); Panjikar and Ramchandran (1997); Payne (1956); Powers (1993); Proctor (1988); Scarratt (1988, 1992a,b); Schmetzer et al. (1996, 1997a); Stockton and Kane (1988); Trossarelli (1986); Webster (1938)

*Special attention: clarity enhancement, synthetics, clear colour-change*

### 6.1.3. Amblygonite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	
XRD	If other tests are inconclusive
<i>References</i>	
Angino (1964); Berman and Gonyer (1930); Cerna et al., (1973), Chikayama (1981), Crowningshield (1959, 1960, 1962), Franolet and Tarte (1977), Greiner and Bloss (1987), Groat et al.(1990), Gübelin (1955), Heinrich and Corey (1955), Koivula (1986), Liddicoat (1963), Loh and Wise (1976), London (1984), London et al. (2001), Moss et al. (1969), Murdoch (1955), Nel (1946), Palache et al. (1943), Weibel (1956), Winchell (1926)	

### 6.1.4. Ammonite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	If other tests are inconclusive
XRD	If other tests are inconclusive
<i>References</i>	
Chikayama (1981), Koivula and Kammerling (1991), Wight (1981), Zakrevskaya (1995)	

*Special attention: coating, impregnation*

### 6.1.5. Anatase

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	

Hydrostatic weighing (specific gravity)	
EDXRF chemistry	
Raman spectroscopy	
XRD	If other tests are inconclusive
<i>References</i>	
Banfield, et al. (1991), Chesnokov (1960), Garmo (1989), Liu and Mernagh (1992), Millette, et al. (1993), Parker (1923), Pough (1987), Schuiling and Vink (1967), Wehr, et al. (2008).	

### 6.1.6. Andalusite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Cat's-eye
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Dichroscope (pleochroism)	
Spectroscope	
XRD	If other tests are inconclusive
<i>References</i>	
Abs-Wurmbach, et al. (1977), Ahn, et al. (1988), Anderson (1967), Aryal, et al. (2008), Austen (1941, Bank (1972), (1981a, b, c.) Baron (1981), Bastos (1984), Berger (1997), Bohlen, et al. (1991), Bridges (1982), Brightman (1982, Carlson and Rossman (1988), Cassedanne, J. (1985), Cassedanne, J.P. and Cassedanne (1980), Crowningshield (1959a, b, c.) (1960a, b, c.) (1961a, b.) (1970a, b.) Deen (1984), Dharmaratne (1998), Dowty (1976), Dunn (1976), Faye and Harris (1969, Finger and Prince (1972), Fryer (1986), (1990), Garsche, et al. (1991), Grapes (1987), Gunter and Bloss (1982), Harlov and Newton (1993), Heinrich and Corey (1959), Hemingway, et al. (1991.) Heung, et al. (1994), Hietanen (1956), Holdaway and Mukhopadhyay (1993), Iishi, et al. (1979), Johnson and Koivula (1998), Kai, et al. (1980), Koivula (1980), (1984), Koivula and Kammerling (1991b), Langer (1979), Macdonald and Merriam (1938), Mitchell (1986), Murdoch (1936), Pearson and Shaw (1960), Peck (1924), Pinet, et al. (1992), Pough (1964), (1988), Ramsey (1988), Richmond (1940), Roger (1987), Rose (1957), Roy (1954), Ruplinger (1983), Schnellrath (1990), Smith (1977), Smith, et al. (1982), Theye and Fransolet (1994), Webb (1943), Weill (1963), Wilkins and Sabine (1973), Winkler and Buehrer (1990), Winkler, et al. (1991), Zoysa (1991), Zwaan (1955)	

### 6.1.7. Apatite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Cat's-eye, colour-change
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Spectroscope	
Raman spectroscopy	If other tests are inconclusive
XRD	If other tests are inconclusive
<i>References</i>	

Anderson (1972), Audeon (1991), Bank (1975, 1976a, 1988), Bank et al. (1988, 1989, 1990), Barbarand and Pagel (2001); Barot et al., 1995; Baumer and Argiolas (1981); Boyd and Wight (1981); Bridges (1982); Brown et al. (1989); Burrigato et al. (1982); Cario (1989); Cooray (1970); Crowningshield (1959, 1960a,b, 1961, 1963a,b,c, 1965a,b, 1966a,b, 1972, 1973); Deen (1984); Dharmaratne (2002), Dunn (1977); Field (1948), Fryer (1982), Gübelin and Schmetzer (1982), Gübelin (1967a), Hyrsi and Petrov (1998), Johnson and Koivula (1999), Koivula (1980), Koivula and Fritsch (1993, 1994a, 1995a, 1995b), Koivula and Kammerling (1990a,b, 1991, 1992a,b), Landes (1938), Leventouri et al. (2001), Liddicoat (1962a,b, 1963a,b, 1965a,b, 1971), O'Donoghue (1976), Payne (1995), Poirot (1983), Randriamanga (1994), Remaut and Vochten (1985, 1986), Rosasco and Roedder (1979), Rutland (1954), Szenics (1967), Teng et al. (2006), Trzcienski et al. (1974), Whitlock (1925), Zharinov et al. (2008), Zwaan (1965, 1981, 2015a)

### 6.1.8. Aquamarine

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Cat's-eye
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	If RI not possible (rough)
Dichroscope	
Spectroscope	
EDXRF chemistry	If synthetic or irradiation is suspected
Colour call	
Clarity enhancement check/extent	
<i>References</i>	
Algier (2007), Bank et al. (2001), Bank and Henn (1990), Bank et al. (1989), Barot et al. (1995), Bastos (1964), Brown (1985), Crowningshield (1972, 1980), de Goutiere (1993), Duroc-Danner (1989), Eppler (1962), Farn (1973), Fryer (1981, 1984, 1985), Groat et al. (2008), Hänni (1992), Henn (1999a,b), Henn and Bank (1992), Jacobson (1993), Johnson and Koivula (1998), Kammerling et al. (1991), Koivula (1985a), Koivula and Kammerling (1989a,b,d, 1990), Koivula et al. (1992b), Letson (1980), Li (2001), Liccini (1998), Lind et al. (1986), Lindner and Rolff (1967), Middlemiss and Parshad (1918), Millisenda and Bank (2005), Monistier (2006), Moses et al. (1997), Nassau (1977, 1987), Natkaniec-Nowak (2008), Panjekar (1994), Petsch (1990), Phukan (1966), Scarratt (1989a,b), Schmetzer (1989), Segura and Fritsch (2003), Zeitner (1988), Zwaan and Zoysa (2008)	

*Special attention: heat treatment, irradiation (Maxixe), clarity enhancement, coatings, synthetics*

### 6.1.9. Aragonite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	
XRD	If other tests are inconclusive
<i>References</i>	

Alder and Kerr (1962), Anderson (1978), Barik et al. (2004), Belcher et al. (1996), Bischoff (1969), Brink and van der Berg (2005), Chateigner et al. (2000), Chave and Schmalz (1966), Checa et al. (2006), Clark and Lutz (1980), Compere and Bates (1973), Cuif (1992), Cuif et al. (1993), Dal Negro and Ungaretti (1971), de Villiers (1971), Falini et al. (1996), Faust (1950), Gauthier et al. (1994, 1997), Giles et al. (1995), Gregor et al. (1996), Hattan et al. (2001), Hyrsi (1996), Koivula and Fritsch (1993), Koivula et al. (1992), Komatsu et al. (1993), Konishi and Saki (1972), Korago et al. (1978), Low and Ziera (1972), Ma et al. (2007), MacDonald (1956), Makovicky and Karup-Moller (2006), McTigue and Wenk (1985), Narasimhulu and Rao (2000), Pinet et al. (1992), Pough (1988), Ronneberg et al. (1979b), Sen et al. (1994), Soldati et al. (2008), Steinen (1982), Urmos et al. (1991), Watabe (1955), Webster (1973), Zhang C. et al. (2006), Zhang W.A. et al. (2007), Zhou et al. (2009)

*Special attention: dye*

#### 6.1.10. Axinite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Dichroscope (pleochroism)	
Spectroscope	
Raman spectroscopy	If other tests are inconclusive
XRD	If other tests are inconclusive
<i>References</i>	
Andreozzi et al. (2000a,b), Cassedanne and Cassedanne (1977), Cassedanne et al. (1983), Crowley (1983), Crowningshield (1960, 1963), Cummings (1983), Deen (1984), French and Fahey (1972), Frost et al. (2006), Hänni (1982), Jobbins et al. (1975), Kalachev (1993), Koivula and Kammerling (1992), Lumpkin and Ribbe (1979), Peacock (1937, 1938), Pinet et al. (1992), Pohl et al. (1982), Pough (1988), Sanero and Gottardi (1968), Schmetzer (1978), Sinkankas (1965, 1998)	

#### 6.1.11. Benitoite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	Higher index may exceed limit refractometer
Hydrostatic weighing (specific gravity)	
Dichroscope (pleochroism)	
Long-wave UV fluorescence	
Short-wave UV fluorescence	
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
Benson (1960), Brown (1997), Crowningshield (1960a,b), Frazier and Frazier (1990a), Gaft et al. (2004, 2005), Gray (1992, 1994), Hawthorne (1987), Hlawatsch (1909), Laird and Albee (1972), Launer (1952), Laurs et al. (1997), Liddicoat (1963, 1967a, 1968), Louderback (1907), Mitchell (1980), Pinet et al. (1992), Rase and Roy (1955), Zachariasen (1930).	

#### 6.1.12. Beryl (yellow, colourless, pink, red)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	

Hydrostatic weighing (specific gravity)	
Dichroscope (pleochroism)	
Clarity enhancement check/extent	
<i>References</i>	
Anonymous (1999, 2000c), Austin 92002), Baker et al. (2002), Barres et al. (2003), Bekker and Barz (2007), Christenson and Austin (1999), Demianets et al. (2006), Dharmaratne (1999, 2002), Federman (2000a), Fumagalli et al. (2003), Hänni and Krzemnicki (2003a,b, 2004), Henn and Milisenda (1999a,b), Jones (2005), Kleismantas (2003), Kopchikov and Shelementiev (2004), Li (2001), Mathew et al. (1998), Monistier (2006), Moroz et al. (1999b), Moses et al. (1998a,d), Natkaniec-Nowak (2008), Pezzotta (2005a), Qi (2002), Schmetzer et al. (2008), Thompson et al. (2002), White (2005)	

*Special attention: clarity enhancement, synthetics*

### 6.1.13. Beryllonite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	If other tests are inconclusive
XRD	If other tests are inconclusive
<i>References</i>	
Bank et al. (1994), Cerna et al. (2002), Crowningshield (1960), Dunn (1975), Henn and Bank (1994), Koivula and Kammerling (1991), Liddicoat (1962), Pinet et al. (1992)	

### 6.1.14. Brazilianite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
<i>References</i>	
Bookstone (1964), Cassedanne (1981, 1983), Chikayama (1981), Crowningshield (1960, 1962a,b), Dillon (1982), Frondel and Lindberg (1948), Hurlbut and Weichel (1946), Hyrsl (1997), Liddicoat (1971), Pinet et al. (1992), Pough and Henderson (1945), Reeve (1972), Swoboda (1947)	

### 6.1.15. Calcite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
FTIR(-NIR)	If other tests are inconclusive
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	

Alder and Kerr (1962), Alfonso et al. (1999), Bischoff et al. (1983), Borodin and Nefedova (2005), Chave and Schmalz (1966), Compere and Bates (1973), Crowningshield (1959, 1975), Cuif (1992), Cuif et al. (1993), Falini et al. (1996), Faust (1950), Fryer (1981, 1986, 1987, 1989a, 1990b), Gauthier et al. (1994, 1997), Gillet and Madon (1982), Guse (1982), Hassan (1978), Huang and Kerr (1960), Hurlbut and Francis (1984), Jacob et al. (2008), Kammerling et al. (1991, 1995), Koivula and Johnson (1996), Koivula and Kammerling (1990a,b), Liddicoat (1963, 1967), Low et al. (1972), Mason (1997, 1998), Mayerson (2001), Moses et al. (1998), Pinet et al. (1992), Rosenholtz and Smith (1950), Sabatier (1953), Sikes et al. (2000), Vo-Thanh and Hung (1985), Walker (1985).

*Special attention: fragile, dye, coatings*

#### 6.1.16. Chalcedony

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Chelsea Colour Filter	
Spectroscope	Green variety
EDXRF chemistry	Green variety
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
Carr and Fyfe (1958), Cassedanne (1982b), Crowningshield, (1964, 1967, 1969, 1970, 1973, 1975), Du Toit (1997), Fryer (1986, 1987, 1988, 1989a,b, 1991, 1997), Guman, 1976, Halford-Watkins (1941), Hänni et al. (2001), Heflik et al. (1993), Hyrsi (1999), Ibragimov (1996), James (1994), Jayaraman (1953), Jobbins (1981), Johnson and Koivula (1996, 1998a,b, 1999), Jones (1952), Kammerling and Koivula (1991), Koivula (1986), Koivula and Fritsch (1993a,b), Koivula and Johnson (1996a,b), Koivula and Kammerling (1989, 1990a,b,c, 1992a,b), Koivula et al. (1992c), Liddicoat (1965a,b, 1966, 1967a,b), McLean (1967), Nuckles (1984), Pabian (1980), Pelto (1956), Sax (1996), Shaub (1979), Shigley and Koivula (1985), Spendlove (1987), Sukow (1987, 1990), Webster (1971), Willing and Stöcklmayer (2003)	

*Special attention: dye*

#### 6.1.17. Charoite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
<i>References</i>	
Akimov (1991), Bennett (1992), Biryukov and Bernikov (1993), Chikayama (1981), Demenge (1994), Dobrovolksya et al. (1980), Evdokimov (1995), Greenspan (1978), Jobbins et al. (1978), Johnson et al. (1999), Koivula and Fritsch (1993), Koivula et al. (1992), Konev et al. (1993), Kraeff et al. (1980), Lazebnik and Nikishova (1992).	

#### 6.1.18. Chrysoberyl

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Cat's-eye (colour change (alexandrite cat's-eye))
Refractometer (refractive index)	

Hydrostatic weighing (specific gravity)	
Spectroscope	
FTIR(-NIR)	
Raman spectroscopy	If other tests are inconclusive
Colour call	In case of potential colour change
Clarity enhancement check/extent	
<i>References</i>	
Anonymous (1997, 1998), Bank et al. (1997a, 1988c), Bergman (1997), Brown (1985), Cassedanne (1984a,b), Cassedanne and Roditi (1993), Crowningshield (1980b,c), DeMaggio (1997), Dillon (1983), Downes and Bevan (2002), Farn (1978), Fryer (1983b, 1989, 1990), Hayashi (1994), Henn (1985, 1987, 1992, 1994, 1995), Horn (1987), Isogami et al (1986), Jarrell (1997), Johnson and Koivula (1996, 1997a,b,c,d,e, 1999), Jones (1996), Koivula (1984a,b,c), Koivula and Fritsch (1993c), Koivula and Kammerling (1988c, 1989b, 1991a,b, 1992a), Liyanage (1997), Looock (1987), McLean (1997), Moses et al. (1998), Nassau (1980, 1987, 1990), Nassau and Nassau (1980), Ohguchi (1981), Okrusch (1971), Ouyang (1997), Panjikar and Ramchandran (1997b), Pinet et al. (1992), Proctor (1988), Scarratt (1994), Schmetzer (1985a), Schmetzer (1985a,b), Solntsev et al. (2004), Soman and Nair (1985), Tang and Sun (1998), Zoysa (1987)	

*Special attention: irradiation, synthetics*

#### 6.1.19. Chrysocolla

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Within other minerals
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
UV-Visible(-NIR) spectroscopy	
EDXRF chemistry	
Raman spectroscopy	If other tests are inconclusive
XRD	If other tests are inconclusive
<i>References</i>	
Bracewell and Brown (1984), Einfalt and Sujatmiko (2006), Jones (1979), Koivula and Fritsch (1994), Koivula and Johnson (1996), Koivula and Kammerling (1992), Liddicoat (1969), McCondra (1998), Robertson (1981), Shen et al. (2006), Sun (1963), Zwaan (2015d)	

*Special attention: dyed (with Cu)*

#### 6.1.20. Clinohumite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	If other tests are inconclusive
XRD	If other tests are inconclusive
<i>References</i>	



Anderson (1983), Bank (1983), Bank et al. (1990), Choudhary and Golecha (2007), Dungler (1991), Friedrich et al. (2001), Fryer (1986, 1988), Fujino and Takéuchi (1978), Gaspar (1992), Heinrich (193), Henn et al. (2001), Jones (1969), Jones et al. (1969), Kocman and Rucklidge (1973), Koivula and Kammerling (1991), Koivula et al. (1988), Kolesnikova (1980), Langer et al. (2002), Larsen (1928), Mitchell (1978), Ribbe (1979), Robinson et al. (1973), Scarratt (1984), White and Hyde (1982)

### 6.1.21. Danburite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Long-wave UV fluorescence	
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
Anderson and Payne (1939), Bank (1982), Cook (2003), Crowningshield (1960a,b,c,d, 1963), Dharmaratne (1999, 2002), Fryer (1986), Holzhey (1998), Hyrsl (1997), Johnson and Koivula (1998), Koivula (1984), Koivula and Kammerling (1992)	

### 6.1.22. Diamond (colourless) – identification only

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Spectroscope	
Polariscope	
Long-wave UV fluorescence	
Long-wave UV phosphorescence	
Short-wave UV fluorescence	
Short-wave UV phosphorescence	
DiamondView	Possibly synthetic
FTIR(-NIR) spectroscopy	
EDXRF chemistry	As needed
PL spectroscopy	
<i>References</i>	
Anthony et al. (2002), Chalain (1995), Chalain et al. (1999, 2000a,b), Collins (2001a,b, 2003), Collins and Dahwich (2003, 2004), Collins et al. (2000), Collins and Ly (2002), Davies et al. (2007), De Weerd (2001a,b), De Weerd and Collins (2003), De Weerd et al. (2004), De Weerd and Van Royen (2000a,b), Diamond (1995), Dunaigre (1996), Erel (2007), Fizgeer et al. (2001), Fritsch et al. (2001), Frunze et al. (2000), Fryer (1997), Gippius et al (2003), Grampp (1999), Hemley et al. (2006), Horikawa (2001), Hunt et al. (2000), Iakoubovski (2006), Johnson and Kammerling (1995), Johnson and Koivula (1999), Jungnickel et al. (1996), Kammerling and Fryer (1995b,c), Kammerling and Koivula (1995e), Kammerling et al. (1995f,g,h, 1996), Kiefert et al. (2000), Kiflawi et al. (1997), King et al. 2008; King et al. 2006; Koivula and Fritsch (1995), Kupriyanov et al. (2008), Linares and Doering (2007a), Maeta et al. (2006), Maitrallet (1996), Maki et al. (2007), Manfredotti et al. (2006, 2007), Mankelevich et al. (2008), Marcczewska et al. (2007), May et al. (2008b), McClure (2000), McClure et al. 2000; McClure and Kammerling (1995), Meguro et al (2006), Moses et al. (1997a,b,c 1998a,b,c, 1999, 2004), Nelson (1995), Nesladek et al. (2008), Neves et al. (1999), Newton et al. (2002), Novikov et al. (2003), Prins (2001, 2003), Qi et al (2001), Qian et al (2001), Scarratt and Shor (2006), Schmetzer (1999, 2000, 2001, 2002), Shuster (1998), Van Bockstael (1996), Yan (1998).	

*Special attention: irradiation, HP-HT, coatings, clarity enhancement, synthetics for diamond grading, see ISO 24016*

### 6.1.23. Diamond (coloured)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Polariscope	
Long-wave UV fluorescence	
Long-wave UV phosphorescence	
DiamondView	
UV-Visible(-NIR) spectroscopy	Low temperature
FTIR(-NIR) spectroscopy	
EDXRF chemistry	As needed
PL spectroscopy	
Geiger counter	Green and black diamonds
Clarity enhancement check	
<b>References</b>	
Anonymous 1992; Achard et al. (2007a), Allers et al. (1998), Amosov et al. (2000), Barberini et al. (2000), Barnard (2000), Bosshart (1999), Bosshart and Smith (2001), Brauner (2007), Chalain (1995, 2003), Chalain et al. (1999, 2000a), Chao et al. (2007), Charles et al. (2003), Choi et al. 2009; Collins (2001a,b, 2003), Collins and Dahwich (2003, 2004), Collins et al. (2000), Collins and Ly (2002), Davies et al. (2007), De Weerd (2001a), De Weerd and Van Royen (2000a,b), Diamond (1995), Dutov et al. (2003), Edmonds et al. (2008), Ekomov et al. (2006), Fritsch et al. (2001), Fritsch et al. 2007a; Fritsch et al. 2007b; Fritsch et al. 2007c; Fryer (1992c, 1997), Gaillou et al. 2010; Grampp (1999), Hainschwang et al. 2005a,b; Hainschwang and Notari 2011; Hainschwang et al. 2006; Hainschwang et al. 2008; Hainschwang et al. 2009; Henn and Bank 1992b; Hodgkinson (2000), Horikawa (2001), Johnson and Kammerling (1995), Johnson and Koivula (1997, 1999), Kammerling and Fryer (1995b,c,d), Kammerling and Koivula (1995e), Kammerling et al. (1990, 1995a,f,h,i, 1996), Karkin et al., (2008), Katrussha et al. (2004a,b), Kiefert et al. (2000), Kiflawi et al (1997), King 1991; King et al. (1994, 1995, 1998, 2002, 2003, 2005), Koivula and Fritsch (1995), Lason et al. (1996), Liddicoat 1972c, 1975a; Linares (2006), Mairallet (1996), Marinelli et al. (2006), Massi et al. 2005; May et al (2008b), McClure (2000), McClure and Kammerling (1995), Mita (1996), Moses et al. (1997a,b, 1998a,b,c, 1999, 2002), Notari 2002; Sautter et al. 2010; Scandella 1989; Scarratt (2001), Schmetzer (1999, 2000), Shida (1998a,b), Van Bockstael and Joppen (1996), Van Bockstael (1998a, 1996), VanderBogert et al. 2009; Vins (2002a,b), Vins and Konokov (2003), Titkov et al. 2003; Willems et al. 2004; Williams et al. 2002; Yamamoto et al. (1995), Yuan (1998), Zaiser et al. (2000), Zaitsev (2008), Zakharov et al. (1997)	

*Special attention: HP-HT, coatings, clarity enhancement, synthetics*

#### 6.1.24. **Diaspore**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Colour-change
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Spectroscope	
FTIR	If other tests are inconclusive
Raman spectroscopy	If other tests are inconclusive
XRD	If other tests are inconclusive
Colour call	Colour change
<b>References</b>	
Bank (1981), Bariac (1979), Baric (1963), Duroc-Danner (1987), Fryer (1983, 1987), Gosse (1962), Gout and Verdes (1992), Koivula (1985), Koivula and Fritsch (1994, 1995), Ruan et al (2001), Scarratt (1980), Schmetzer (1987), Schmetzer and Bartelke (1979), Wight (1997)	

#### 6.1.25. **Diopside**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Cat's-eye, star
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Spectroscope	
Raman spectroscopy	If other tests are inconclusive
XRD	If other tests are inconclusive
<b>References</b>	
Anderson (1978), Andrut et al. (2007), Bank (1972, 1976, 1977, 1987), Bank et al. (1996), Bromiley et al. (2004), Calrk (1957), Crowningshield (1960, 1962, 1963a,b, 1964a,b, 1965), Eppler (1967), Field (1948), Fryer (1984), Gadiyatov (1996), Gasparik (1990), Gübelin (1981), Hänni et al (1996), Hietanen (1971), Ito (1987), Jackson (1985), Kammerling and Fryer (1994), Kent and Webster (1973), Koivula and Johnson (1996), Koivula and Kammerling (1989, 1990, 1992a), Koivula et al. (1992b), Liddicoat (1965a,b, 1972, 1973), Naito (1990), Nimis (1998), Ponahlo (1968), Robinson (1973), Schmetzer (1978), Schmetzer (1982), Schmetzer and Krupp (1979a), Schmetzer and Medenbach (1974), Schmetzer and Ottemann (1979b), Schrader (1984, 1985), Schramm (1987), Schreiber (1977), Skogby et al. (1990), White and Keester (1966), White et al. (1971), Wight (1990)	

**6.1.26. Diopase**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Spectroscope	
EDXRF chemistry	If other tests are inconclusive
Raman spectroscopy	If other tests are inconclusive
XRD	If other tests are inconclusive
<b>References</b>	
Bank et al. (1990), Breuer and Eysel (1988), Breuer et al. (1989), Cook (2002), Crowningshield (1960), Eysel and Breuer (1981), Galbraith and Kuhn (1940), Gebhard (1982), Heide et al. (1955), Lhoest et al. (1991), Palfi (2005), Ribbe et al. (1977), Schubnel (1992)	

**6.1.27. Dolomite**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
FTIR(-NIR) spectroscopy	
EDXRF chemistry	If other tests are inconclusive
Raman spectroscopy	
XRD	If other tests are inconclusive
<b>References</b>	
Barber and Wenk (1979), Chai and Navrotsky (1996), Douglas (1999), Fryer (1992), Gauthier and Delines (1999), Gem trade lab notes (1998), Koivula and Fritsch (1994), Medlin (1959), Moses et al. (1998), Pinet et al. 1992, Searl (1989)	

*Special attention: dye*

**6.1.28. Dumortierite**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	
XRD	If other tests are inconclusive
<i>References</i>	
Alexander et al. (1986), Applin and Hicks (1987), Bank (1979), Beukes et al. (1987), Cassedanne and Franco (1966), Crowningshield (1964), Goreva et al. (2001), Koivula et al. (1992), Ostwald (1964)	

**6.1.29. Ekanite**

<i>Required Test method</i>	<i>Remark</i>
Geiger counter or dosimeter ( $\mu\text{S/h}$ )	
Safe storage	
Microscope	
Phenomena	Star
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	
XRD	If other tests are inconclusive
<i>References</i>	
Anderson (1974), Arps (1987), Bank (1981a,b), Bank et al. (1989), Chikayama (1981), Deen (1984), Dharmaratne (1998), Fryer (1986), Gauthier and Fumey (1988), Gübelin (1961, 1962a,b, 1964), Johnson et al. (1999), Koivula and Kammerling (1988), Liddicoat (1962b, 1977), Mitchell (1961)	

*Special attention: radioactive*

**6.1.30. Emerald**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Star, Cat's-eye, trapiche
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	If loose and other tests inconclusive
Chelsea colour filter	
Spectroscope	
Long-wave UV fluorescence	
UV-Visible(-NIR) spectroscopy	Origin
FTIR(-NIR) spectroscopy	Synthetic/natural and filler ID
EDXRF chemistry	Origin
Raman spectroscopy	Only for filler ID
LA-ICP-MS spectroscopy	If necessary for origin
Colour call	
Clarity enhancement check/extent	
<i>References</i>	

Amstutz and Bank (1977), Anderson (1935, 1950, 1966, 1969, 1976, 1978), Attanasio et al. (1989), Bank (1960, 1964, 1969, 1973, 1974a,b,c, 1976, 1980, 1981b,c, 1982, 1989), Bank and Henn (1989a, 1990a), Bank et al. (1989b), Bastos (1981), Becker (1991), Benson (1959), Bosshart (1990a,b, 1991a,b,c,d), Bowersox et al. (1991), Bowersox and Anwar (1989), Briggs (1935), Brown (1984), Brown et al. (1989), Brown and Snow (1984, 1988), Calligaro et al. (2000), Cambell (1973, 1974, 1978, 1991), Caplan (1968), Carbonnel (1976), Cassedanne (1972, 1985), Cassedanne and Cassedanne (1974), Cassedanne and Sauer (1982, 1984), Chatham (1982), Clements (1941), Cook (2007), Cotton (1970), Crowningshield (1958, 1961a,b, 1964a,b,c,d,e, 1965a,b,c, 1967a,c, 1968, 1970b,c,d,e, 1971a,b, 1972a,b, 1974, 1980), Devouard (1990), Diehl (1977), Dillon (1981), Draper (1963), Duyk (1963, 1965), Eppler (1958, 1960, 1961, 1962, 1963, 1968), Epstein (1989), Farn (1964, 1980), Fryer (1981b,c,d, 1982a,b,c,d,e,f, 1983a,b, 1984b,c,d, 1988, 1989, 1990a,b, 1991), Fryer et al. (1983), Giuliani et al. (1990a,b), Graindorge (1974), Graziani et al. (1983), Graziani and Lucchesi (1979), Griesbach (1892), Groat et al. (2008), Grubessi et al. (1990), Gübelin and Shipley (1941), Gübelin (1940, 1941, 1944, 1947, 1950, 1956a,b, 1958a,b,c, 1959, 1960, 1961, 1962, 1964a,b, 1968, 1974, 1976, 1981a,b, 1982a,b, 1984), Gübelin and Chudoba (1956), Gübelin and Gysler-Sanz (1991), Hänni (1981, 1982, 1983, 1988), Hänni and Kerez (1983a), Hänni and Klein (1982, 1983b), Henderson (1945), Henn (1988), Henn and Bank (1991), Henn et al. (1984), Hodgkinson (1988), Holmes and Crowningshield (1960), Hosaka (1990), Johnson (1959, 1961a,b), Kammerling and Koivula (1990, 1991a), Kammerling et al. (1991b), Kane (1979, 1980a,b), Kane et al. (1989), Kanis et al. (1991), Kazmi and Snee (1989), Keeling (1991), Keller (1981), Koivula (1982, 1984a,b,c), Koivula and Kammerling (1988, 1989b,c,d,e, 1990a,b,c,d,e, 1991a,b,c,d,e,f), Koivula et al. (1990f), Lefever et al. (1962), Liddicoat (1963, 1964a,b,c, 1965b,c,d, 1967a,b, 1968, 1969a,b,d,e,f,g,h, 1970b,c,d,e,f, 1971b, 1972a,b, 1976, 1977b), Mac Fadden (1934), Mayers (1958a,b), McKague (1964), Metson and Taylor (1977), Mitchell (1981), Nassau (1977, 1980, 1981, 1982, 1990, 1991), Nassau and Jackson (1970), Nassau and Nassau (1980), O'Donoghue (1979, 1981, 1971, 1975), Oppenheim (1948), Pough (1965a,b, 1970, 1971), Rainier (1931), Ringsrud (1983, 1988), Robert et al. (1990), Rogers and Sperisen (1942), Scarratt (1984b, 1987a,b,c,d, 1988a,b, 1989a,b,c), Schlossmacher (1935), Schmetzer (1982, 1988a,b, 1989a,b, 1990a,b, 1991), Schmetzer and Bank (1980, 1981a, 1982), Schmetzer et al. (1981b,c, 1991, 2007), Schmetzer and Brezina (1975), Schmetzer and Kiefert (1990), Schmetzer and Krupp (1979), Schrader (1981, 1983, 1988a,b), Schubnel and Zarka (1971), Schwarz (1987, 1989a,b, 1990a,b,c, 1991a,b,c,d), Schwarz et al. (1988a,b,c,d, 1990), Schwarz and Eidt (1989), Seifert et al. (2004), Shipley (1942), Stockton (1984, 1987), Sunagawa (1964), Tenhagen (1972, 1973), Webster (1950, 1955, 1964), Wild (1935), Zwaan (2006), Zwaan et al. (2012, 2005, 2004, 2000, 1998, 1997)

*Special attention: clarity enhancement (also cavity and wide fracture filling), synthetics, coating and dye*

### 6.1.31. Enstatite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Star, Cat's-eye
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	If loose and other tests inconclusive
Spectroscope	
Raman spectroscopy	
XRD	If other tests inconclusive
<i>References</i>	
Bank (1974, 1984), Beran and Zemann (1986), Crowningshield (1959, 1960, 1964, 1965a,b, 1967a,b), Dharmaratne (1998), Dunn (1978), Eppler (1967), Fryer (1984), Greer and Weber (1969), Harding et al. (1982), Koivula et al. (1988), Liddicoat (1962a,b, 1963), Mitchell (1952, 1954), Morimoto (1989), Schemter and Krupp (1982), Washington and Merwin (1923), Wehr et al. (2008), Zoysa (1985), Zwaan (1996)	

### 6.1.32. Epidote

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	

Hydrostatic weighing (specific gravity)	If loose and other tests inconclusive
Spectroscope	
Raman spectroscopy	If other tests inconclusive
XRD	If other tests inconclusive
<i>References</i>	
Armbruster (2006), Bank (1976), Bank et al. (1989), Cook (2002), Crowningshield (1960, 1963), Dollase (1971), Fisher (1977), Fleet and Pan (1995), Grapes (1981), Griffith (1987), Gübelin (1979), Henn and Bank (1991), Hörmann and Raith (1971), Ito (1947), Janeczek and Sachanbinski (1992), Jimenez and Velilla (1993), Kumskova and Khvostova (1964), Langer and Raith (1974), Lapham (1957), Liddicoat (1963), Pinet et al. (1992), Pough (1965), Seemann (1986), Seki (1959), Wehr et al. (2008).	

### 6.1.33. Feldspar – orthoclase moonstone, microcline, albite, oligoclase, bytownite.

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Cat's-eye, adularescence, aventurescence
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	If loose and other tests inconclusive
EDXRF chemistry	
LA-ICP-MS or SEM-EDS chemistry	If needed for variety separation
Raman spectroscopy	If other tests inconclusive
XRD	If other tests inconclusive
<i>References</i>	
Bank (1967, 1973a,b, 1974), Bank and Henn (1989a), Barth (1934, 1931, 1965b), Bassett (1953), Boyd and Wight (1981), Bracewell and Brown (1985), Bridges et al. (1984, 1989), Brown (1984), Brown and Bracewell (1985), Chalmers (1972), Clewlow (1977), Copley and Gay (1982), Crowningshield (1960, 1962b, 1963b,c, 1964a,b), Fenn (1977), Foster (1955), Fryer (1985, 1991), Gübelin (1987, 1992a), Hofmeister and Rossmann (1985a,b,c, 1986), Koivula (1986a,b, 1987a), Koivula and Kammerling (1988, 1989a, 1990a,b), Liddicoat (1963a, 1964, 1967), Raman and Jayaraman (1950a), Raman et al. (1950b), Umegaki (1966), Vance (1961), Webster (1949, 1952), Zoya (1985)	

### 6.1.34. Feldspar – labradorite, andesine.

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Labradorescence, aventurescence
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	If loose and other tests inconclusive
EDXRF chemistry	
LA-ICP-MS chemistry	
Raman spectroscopy	If other tests inconclusive
XRD	If other tests inconclusive
<i>References</i>	
<a href="http://www.giathai.net/Red_Feldspar_Special_Report.php">http://www.giathai.net/Red_Feldspar_Special_Report.php</a> , <a href="http://www.gia.edu/research-resources/news-from-research/index.html">http://www.gia.edu/research-resources/news-from-research/index.html</a> , Bank and Henn (1989a), Bank et al. (1988, 1989b), Fontaine et al. (2010), Henn (2005), Liddicoat (1967a,b), Muir (1955), Rossmann (2011)	

*Special attention: heat, Cu-diffusion*

### 6.1.35. Fluorite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Colour-change
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	If loose and other tests inconclusive
Polariscope	
Long-wave UV fluorescence	
Short-wave UV fluorescence	
Raman spectroscopy	If other tests inconclusive
XRD	If other tests inconclusive
<i>References</i>	
Allen (1952), Appiani (2007), Bank et al. (1996, 1989), Bariand (1986), Baumer et al. (1990), Berman (1957), Bill and Calas (1978), Bill et al. (1967), Blasse and Dirksen (1980), Bontinck (1958), Calas (1972b), Crowningshield (1962a,b, 1968), Duyk (1971), Elwell (1988), Fisher (2004), Forster (1995), Fryer (1985), Gübelin and Koivula (1987), Gübelin and Schmetzer (1980), Henn (2002), Hyrsl and Milisenda (2003), Kammerling and Koivula (1991), Koivula and Elen (1998), Koivula and Fritsch (1995), Koivula and Kammerling (1993c, 1990), Liddicoat (1970a,c, 1972), Lieber (1994), Linley-Shaw (1975), MacFall (1982), Moroshinkin (1996), O'Donoghue (1978), Pinet et al. (1992), Redmann et al. (1990), Robbins (1996), Schmetzer and Bank (1980), Zwaan (2014c)	

*Special attention: fragile, easy cleavage*

### 6.1.36. Forsterite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
dichroscope	
spectroscope	
Long-wave UV fluorescence	
Short-wave UV fluorescence	
FTIR(-NIR) spectroscopy	
EDXRF chemistry	
Raman spectroscopy	
<i>References</i>	
Basso et al. (1980), Benstock et al. (1997), Bershov et al. (1983), Chopelas (1991), Duffy et al (1995), Durben et al. (1993), Fan et al. (2007), Ferry (2001), Francis (1985), Francis and Ribbe (1980), Freund et al. (1980), Gaité and Hafner (1984), Gasparik and Litvin (1997), Green and Walker (1985), Henn (1999), Hofmeister (1987), Iishi (1978), Imae et al. (1993), Jaoul et al. (1979), Johnson and Koivula (1999), Jordan and Naughton (1964), Kanazawa et al. (2007), Koivula and Fryer (1990), Libowitzky and Beran (1995), Liu (1987), Luttge et al. (1992), Martin et al. (1992), Mohanan et al. (1993), Morin et al. (1977), Mossman and Pawson (1976), Nassau (1994), Rager (1977), Rager et al. (1988), Rao et al. (1987), Shankland and Hemmenway (1963), Smyth and Tafto (1982), Stebbins (1996), Steele et al. (1985), Wang et al. (1993), Weeks et al. (1974), Wentzcovitch and Stixrude (1997), Zamboni and Garobbi (1932)	

*Special attention: synthetic*

### 6.1.37. Gahnospinel

<i>Required Test method</i>	<i>Remark</i>
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Microscope	
Refractometer (refractive index)	May be outside upper range
Hydrostatic weighing (specific gravity)	
EDXRF chemistry	
Raman spectroscopy	
XRD	If other tests are inconclusive
<i>References</i>	
Anderson (1964, 1974), Anderson and Payne (1938), Bank (1983), Burford (1997), Crowningshield (1963), Flinter (1963), Frenzel et al. (1986), Schmetzer and Bank (1985a,b, 1986), Schmetzer et al. (1989), Zoysa (1995)	

**6.1.38. Garnet – Pyrope, Almandine, Spessartine, Grossular (hessonite tsavorite), Andradite (demantoid), Uvarovite.**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Colour-change, star
Refractometer (refractive index)	May be outside upper range
Hydrostatic weighing (specific gravity)	
EDXRF chemistry	
Raman spectroscopy	
XRD	If other tests are inconclusive
<i>References</i>	
Agee (1965), Anderson (1945, 1946, 1947, 1959), Benson (1960), Crowningshield (1960, 1963a,b, 1964, 1966, 1967, 1969a,b,c,d, 1970a,b,c,d), Eliezri and Almor (1996), Gübelin (1945), Hidden and Pratt (1898), Hummel (1950), Ingerson and Barksdale (1943), Johnson and Koivula (1998a,b, 1999a), Johnson et al. (1999b,c,d), Koivula and Fritsch (1995), Lee (1962), Liddicoat (1966, 1967a,b, 1970), Manning (1967), Manson and Stockton (1982), Martin (1970), Pezzotta et al. (2011), Stephenson and Kouznetsov (2009), Webster (1963), Zwaan (2014a).	

*Special attention: heat treatment (demantoid)*

**6.1.39. Gypsum**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Satin spar, cat's-eye
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	
XRD	If other tests are inconclusive
<i>References</i>	
Bosbach et al. (1994, 1995), Cody and Cody (1989), Crowningshield (1960, 1963), Iishi (1979), Kondo and Ahrens (1983), Mann et al. (1993), Pinet et al. (1992), Robbins (1996), Sasowsky (1998), Zeitner (1980)	

*Special attention: soft material, easy cleavage*

**6.1.40. Häüyne**



<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Long-wave UV fluorescence	
Raman spectroscopy	
XRD	If other tests are inconclusive
<i>References</i>	
Barth (1932), Hassan and Grundy (1989b, 1991), Henderson et al. (2000), Henn and Bank (1990), Jahn (2007), Linde (1998), Mertens (1984), Scarratt (1986)	

#### 6.1.41. Hematite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Magnet (magnetic reaction)	
Hydrostatic weighing (specific gravity)	
EDXRF chemistry	
Raman spectroscopy	
XRD	If other tests are inconclusive
<i>References</i>	
Dietrich and Saadi (1969), Fryer (1984), Koivula and Fritsch (1993, 1995a), Koivula and Kammerling (1991), Lu and Sunagawa (1987), Mappin (1946), Ogawa et al. (1999), Pinet et al. (1992), Scarratt (1985a,b), Schmetzer and Bank (1984a)	

*Special attention: various imitations, non-magnetic and magnetic.  
It may not be possible to separate from manufactured material.*

#### 6.1.42. Idocrase (Vesuvianite).

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Spectroscope	
Raman spectroscopy	If other tests are inconclusive
XRD	If other tests are inconclusive
<i>References</i>	
Allen and Burnham (1992), Arem (1973), Bank et al. (1989), Crowningshield (1960, 1965a,b, 1969b,c), Dillon (1983), Ito and Arem (1970), Koivula and Kammerling (1989, 1991), Liddicoat (1970), Scarratt (1986), Wight and Grice (1983)	

#### 6.1.43. Iolite (Cordierite).

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Cat's-eye, bloodshot
Refractometer (refractive index)	

Hydrostatic weighing (specific gravity)	
Dichroscope	
<i>References</i>	
Brown and Bracewell (1990), Dharmaratne (1999), Faye et al. (1968), Fryer (1982, 1991), Henn (1990), Johnson and Koivula (1998, 1999), Kammerling and Koivula (1991), Koivula and Fritsch (1993, 1995a,b), Koivula and Kammerling (1990, 1992), Liddicoat (1967), Pough (1987), Wight (1999b)	

#### 6.1.44. Jadeite – green, white, black, lavender

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	When possible
Chelsea colour filter	
Spectroscope	
Long-wave UV fluorescence	
FTIR(-NIR) spectroscopy	
EDXRF chemistry	
Raman spectroscopy	
<i>References</i>	
Adams (1953), Albright (1981), Anderson (1871), Barber (1954), Battesti and Schubnel (1993), Bauer (1895, 1896), Bergstein (1964), Bishop (1906), Bleeck (1908), Brown (1993a), Cavey (1987), Chuanyi et al. (1988), Crowningshield (1957, 1959, 1961, 1962a,b, 1963a,b,c,d, 1964, 1972, 1973a, 1974), Deer et al. (1963, 1992), Desautels (1986), DeVries and Fleischer (1984), Ehrmann (1958a,b), Fritsch (1993a,b, 1994), Fritsch et al. (1993, 1992), Fryer (1983, 1984, 1985, 1986, 1987a,b, 1988a,b, 1989, 1992a,b, 1993, 1996a,b), Gübelin (1978), Halford-Watkins (1932), Harlow (1994), Healey and Yu (1983), Hertz (1912), Hobbs (1982), Hodgkinson (1993, 1996), Htein and Naing (1994, 1995), Johnson et al. (1995a,b), Kammerling and Fryer (1994a,b,c,d, 1995a,b,c,d,e), Kammerling and Koivula (1990a,b), Koivula (1982a,b), Koivula and Fritsch (1993, 1994), Koivula and Johnson (1996), Koivula and Kammerling (1989, 1990, 1991a,b), Koivula et al. (1992, 1995), Lasnier et al. (1992), Liddicoat (1963b,c, 1971, 1972, 1974, 1975c), Manaka (1994), Meen (1966), Mével and Kienast (1986), Mok (1993), Nassau and Shigley (1987), Ou Yang (1993a,b, 1994, 1996c), Pough (1985), Prewitt and Burnham (1966), Rossman (1974), Scarratt (1986), Shida (1991), Ten (1989b), Yu et al. (1996).	

*Special attention: other jadeite-like minerals or rocks, omphacite, dye, resin, impregnation, wax, plastic coating*

#### 6.1.45. Jasper

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
Cassedanne (1971), Davidson (2000), Demenge (1994), Druzhinina (2000), Fritsch and Ivey (2015), Fryer (1989), Heflik et al. (1993), Henig and Collins (2001), Johnson and Koivula (1999), Koivula and Johnson (1996), Rossman (1994)	

#### 6.1.46. Jeremejevite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
Bank (1986), Bank and Becker (1977), Blass and Graf (1999), Chikayama (1981), de Ascencao-Guedes (2007), Foord and Cunningham (1978a), Foord et al. (1981), Foord and Mills (1978b), Herting and Strunz (1978), Hochleitner and Weiss (2000), Konovalenko et al. (1983), Künzel (1989), Kyi and Thu (2006), Liddicoat (1973a,b, 1976a,b), Liddicoat and Fryer (1974), Rondorf and Rondorf (1988), Stachowiak and Schreyer (1998), Strunz and Wilk (1974), Wilson et al. (2002), Zolotarev et al. (2000)	

**6.1.47. Kornerupine**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Cat's eye
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Polariscope	Small 2V angle
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
Ackermann et al. (1984), Anderson (1974), Bank and Berdesinski (1974, 1975), Barot et al. (1995), Benson (1960), Crowningshield (1962a,b, 1965b, 1965c, 1974a,b, 1975a,b), Fryer (1982), Henn (1985), Koivula and Kammerling (1992a,b), Korevaar and Zwaan (1977), Liddicoat (1966), Moore and Bennett (1968), Payne (1954), Schmetzer (1978b), Schmetzer et al. (1978, 1979), Trumper (1949), Webster (1974), Zwaan (1992b)	

**6.1.48. Kyanite**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Cat's eye, colour change
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Dichroscope	
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
Barot et al. (1995), Bosshart et al. (1982), Chadwick and Rossmann (2009), Crowningshield (1959, 1966a,b), Delor and Leyreloup (1986), Ghera et al. (1986a, 1988), Gübelin and Schmetzer (1982), Hänni (1983), Hyrsl (1997), Hyrsl and Milisenda (1996), Ito (1986), Johnson and Koivula (1999), Key and Ochieng (1991), Langer and Abu-Eid (1977), Liddicoat (1973), Males (1974), Neiva (1984), Renfro and Shen (2013), Saul et al. (1991), Zwaan (2014b)	

**6.1.49. Lapis Lazuli**

<i>Required Test method</i>	<i>Remark</i>
Microscope	Thermal reaction test, acetone
Refractometer (refractive index)	

Hydrostatic weighing (specific gravity)	
Long-wave UV fluorescence	
Raman spectroscopy	Selective components
XRD	If other tests are inconclusive
<i>References</i>	
Anderson (1954), Banerjee (1990), Bank (1970), Bank and Platen (1988), Bariand (1979), Bennett (1992), Brown (1985, 1993a,b), Crowningshield (1967a,b,c, 1974), Dillon (1981), Emmett (1985), Fryer (1981, 1982, 1983, 1985a,b, 1986a,b,c,d, 1988, 1989a, 1992, 1993), Heflik and Natkaniec-Nowak (2003), Johnson and Koivula (1998), Koivula and Fritsch (1993), Koivula and Kammerling (1988, 1991, 1992a), Koivula et al. (1992b,c), Liddicoat (1963a,b), Mitchell (1982), Mok (1991), Nassau (1980, 1982), Scarratt (1983, 1987), Schmetzer (1983, 1985), Webster (1958, 1971), Weerth (1994), Wyart et al. (1981)	

*Special attention: dye, coatings, impregnation, wax, 'synthetics', imitations*

### 6.1.50. Magnesite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Long-wave UV fluorescence	
FTIR(-NIR) spectroscopy	
EDXRF chemistry	
Raman spectroscopy	
XRD	If other tests are inconclusive
<i>References</i>	
Bank et al. (1988a), Bank and Platen (1988b), Fryer (1985), Gillet (1993), Koivula (1986), Superchi (1997)	

*Special attention: crystalline variety very soft, massive variety often used with dye*

### 6.1.51. Malachite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
EDXRF chemistry	If other tests are inconclusive
Raman spectroscopy	
XRD	If other tests are inconclusive
<i>References</i>	
Balitsky and Bublikova (1990), Balitsky et al. (1987a,b), Bank et al. (1998), Bennett (1992), Chernenko and Melnikov (2003), Collyer et al. (1991), Cook (2001), Fedorov (2002), Fryer (1981), Goga (2000), Henn and Schneider (1994), Hosaka (1990), Kammerling and Fryer (1994), Koivula and Fritsch (1995), Koivula and Kammerling (1989), Nassau (1990), Pinet et al. (1992), Strack (1996), Webster (1958)	

*Special attention: reconstructed, impregnated, wax, synthetic*

**6.1.52. Maw-sit-sit**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	Selective components
<i>References</i>	
Anonymous (1997), Gübelin (1964-65), Gübelin (1965a,b,c, 1978), Lacroix (1930), Ou Yang (1984),	

**6.1.53. Moldavite**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
FTIR(-NIR) spectroscopy	
EDXRF chemistry	
<i>References</i>	
Artemieva et al. (2002), Banerjee and Hager (1993), Blum and Chamberlain (1992), Bouska et al. (1985), Bouska and Rost (1972), de Goutiere (1995), Du Toit (1996), Frazier and Frazier (1991a,b), Horn (1985), Hrabanek and Malley (1988), Hurtig (2005), Koivula and Kammerling (1992), Konta and Saul (1976), Liddicoat (1975), Reban (1984), Rejl (1977), Saul (1987), Skalichy (1975), Trnka and Houzar (2002), Webster (1949), Zook (1974)	

*Special attention: artificial glass*

**6.1.54. Nephrite**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	
<i>References</i>	
Bancroft (1983), Bank (1975), Beck (1984), Crowningshield (1965), Fryer (1984), Kammerling and Fryer (1995), Koivula and Kammerling (1988), Liddicoat (1969), Nieder (1982), Ruff (1950), Sun (2005), Yarmack (1964)	

*Special attention: dye*

**6.1.55. Obsidian**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
FTIR(-NIR) spectroscopy	
EDXRF chemistry	

<i>References</i>
Acquafredda et al., 1999; Baugh and Nelson, 1987; Bavay et al., 2000; Bellot-Gurlet et al., 2008; Bellot-Gurlet et al., 2005; Bigazzi et al., 1992; Bigazzi et al., 1986; Biró, 2004; Bunney, 1985; Calligaro, 2008; Cohen, 1958; Craig et al., 2010; Craig et al., 2007; Crowningshield, 1975; Faulques et al., 2001; Glascock, 2002; Henn, 1995; Holzhey, 1996; Hughes, 1982; Hyrsi and Žáček, 1999; Johnson and Koivula, 1997, 1998; Kelloway et al., 2010; Koivula and Fritsch, 1993a, b; Miller, 2006; Millhauser et al., 2011; Moses et al., 1998; O'Keefe, 1984; Pereira et al., 2001; Poupeau et al., 2010; Rosen et al., 2005; Rozsa et al., 2006; Sheppard et al., 2011; Sinkankas, 1996; Spriggs et al., 2011; Webster, 1949; Weiner, 1983; Williams-Thorpe, 1995; Zook, 1973

*Special attention: artificial glass*

### 6.1.56. Opal

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Play of colour, Cat's-eye (rare), Star (rare)
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Polariscope	
Long-wave UV fluorescence	
Long-wave UV phosphorescence	
Short-wave UV fluorescence	
Short-wave UV phosphorescence	
UV-Visible(-NIR) spectroscopy	If dye is suspected
FTIR(-NIR) spectroscopy	
<i>References</i>	
Adamo et al. (2010), Adams et al (1991), Bardosova et al. (2003), Bartoli et al. (1990), Baryshev et al. (2002, 2003), Birdsall (1986), Brajkovic et al. (2007), Brown et al. (2003), Brown et al. (2004), Brown et al. (2002), Cady et al. (1996), Caucia et al. (2008, 2009), Chen et al. (2004), Clarke (2003), Davies (2005), Deelman (1986), de Jong et al. (1987), Einfalt (2007), Eliseev et al. (2009), Elzea et al. (1994), Elzea and Rice (1996), Erel et al. (2003), Esenli et al. (2001, 2003), Flörke et al. (1991), Fritsch et al. (2002, 2003, 2004, 2006), Gaillou et al. (2008a,b), Gauthier et al. (2004), Graetsch (1994), Graetsch et al. (1985, 1987, 1990,1994), Guthrie et al. (1995), Harder (1995), Hatipoglu (2009), Heylmun (1987), Holgado et al. (1999), Hoover et al. (1996), Horton (2002), Ilieva et al. (2007), Kalinin et al. (1998, 2002, 2003, 2004), Kalinin and Serdobintseva (2003), Karpov et al. (2005), Kavtrevva et al. (2007), Kuznetsova et al. (2003), Li et al. (1994), Livstrand (1987), Mazzero et al. (2010), McOrist and Smallwood (1997), Meseguer et al. (2002), Nagase and Akizuki (1997), Nassau (1989), Ni et al. (2001), Ostrooumov (2007), Ostrooumov et al. (1999), Ostrooumov and Talay (2000), Palacios-Lidon et al. (2005), Paris et al. (2007), Pearson (1985), Pechar (1985), Pecover (2007), Pewkliang et al. (2008), Potapov and Kamashev (2006), Rice et al. (1995), Rondeau et al. (2004), Rondeau et al. (2010), Salgueirino-Maceira et al. (2003), Schellnegger (2002), Senior (1996), Serdobintseva and Kalinin (2000, 2001), Simonton et al. (1986), Smallwood (1997), Smallwood et al. (1997a,b), Thomas et al. (2006, 2007, 2008), Viti and Gemmi (2009), Vysotsky et al. (2010), Webb and Finlayson (1987), Williams and Crerar (1985), Williams et al. (1985), Wollaert et al. (1990), Zwaan (2015b)	

*Special attention: sugar and smoke treatments, dye, impregnation, synthetics*

### 6.1.57. Pectolite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Cat's eye (rare)
Refractometer (refractive index)	

Hydrostatic weighing (specific gravity)	
Long-wave UV fluorescence	
Long-wave UV phosphorescence	
Short-wave UV fluorescence	
Short-wave UV phosphorescence	
EDXRF chemistry	
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
Anderson 1989; Bank et al. 2000; Bente et al. 1991; Dunn 1978; Fuetes Marcuello and Garcia Guinea 1990; Koivula 1986b, a; Koivula and Kammerling 1990, 1992; Koivula et al. 1992; Liddicoat 1976a, b; Liebau 1980; Lizzadro 1987; Peacock 1935; Pough 1997; Schaller 1955; Schmetzer 1984; Steiner 1996; Sullasi et al. 2010; Vaughan et al. 1921; Woodruff 1986, 1987; Woodruff and Fritsch 1989	

### 6.1.58. Peridot

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Spectroscope	
<i>References</i>	
Aboosally 1999; Adamo et al. 2009; Agrell et al. 1998; Austin 1991; Bancroft 1981; Bank 1995; Bank et al. 1994; Beard 1995; Benson 1960; Bocchio et al. 1986; Braunwart 1993; Brown and Bracewell 1982; Burford and Gunasekara 2000; Crowningshield 1962, 1973, 1975b; Cruse 2007; Dick 1993; Dill et al. 2006; Dillon 1981; Drucker 1998; Dupuy et al. 1991; Dyar et al. 1998; Dyar et al. 2009; Eppler 1960; Fan et al. 2007; Farrell and Newnham 1965; Federman 1995; Fischer 1985; Frazier and Frazier 1992, 1997; Fryer 1987; Fuhrbach 1992, 1997, 1998; Gübelin 1980, 1981a, b, 1986; Gübelin and Peretti 1996; Gunawardene 1985; Henn 1999; Henn et al. 1994; Henn and Becker 1992; Henn and Milisenda 1997; Hyrs 2011; Kammerling et al. 1995; Kammerling and Koivula 1991, 1995a, b; Kammerling et al. 1994; Kanazawa et al. 2007; Kane 2004; Koivula 1980, 1981, 1992; Koivula and Fritsch 1993b, d, e, f, 1994a, b, c, d; Koivula and Fryer 1986, 1987; Koivula and Kammerling 1990b, 1991, 1992b; Koivula et al. 1995; Kurat et al. 1982; Leelawathanasuk et al. 2011; Lepold and Schramm 1989; Libowitzky and Beran 1995; Liddicoat 1968, 1969, 1970a, b; Lieber 1976; Mao 1990; Mattice 1995; Milisenda et al. 1995; Moses et al. 1999; Mouri and Enami 2008; Nassau 1994; Peretti and Gübelin 1996; Poeter 1999; Pough 1986, 1997b; Sinkankas et al. 1992; Snee and Ahrens 1975; Sokolov et al. 2002; Stockton and Manson 1983; Taylor 1971; Van Pelt 1938; Walmstedt 1825; Webb 1993; Wilson et al. 1974; Wilson 2007; Wilson 1976; Yang 1993; Zeitner 1990; Zolotaryov et al. 2003; Zook 1972	

*Special attention: may be damaged by acids*

### 6.1.59. Petalite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Polariscope	
Raman spectroscopy	
<i>References</i>	
Bank 1971; Cassedanne and Cassedanne 1978; Cerny and Ferguson 1972; Cerny and London 1983; Charoy et al. 2001; Crowningshield 1963; Fryer 1986; Heinrich 1975; Ito 1986; Karfunkel et al. 2002; Leal-Gomes and Dias 2009; Liddicoat 1976b; Lindner 1967; Nel 1946; Pough 1966, 1998; Selway et al. 2002; Wight 1990; Win and Themelis 2003; Zemmann-Hedlik and Zemmann 1955	

**6.1.60. Phenakite**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Long-wave UV fluorescence	
Short-wave UV fluorescence	
Raman spectroscopy	
<i>References</i>	
Anonymous 1911, 1913; Balginina et al. 1988; Bank 1987, 1988; Bank et al. 1996; Bank et al. 1988; Barton 1986; Bastos 1972; Bayle 2010; Beran 1990; Billings 1927; Bulnaev 2006; Cario 1989; Cassedanne 1985; Chaves et al. 1998; Clark et al. 1986; Cook 2009; Crowningshield 1960, 1970; Dunn 1974; Gübelin 1979; Hazen and Au 1986; Hazen and Finger 1987; Hofmeister et al. 1987; Hyrsl and Quintens 1999; Jacobson 1979; Koivula and Fritsch 1994b, f; Lee and Erd 1963; Liddicoat 1963a, b, 1969b, c; Lottermoser 1986; Marcos-Pascual and Moreiras 1997; Melby and Taylor 1983; Niedermayr 1978; O'Donoghue 1976; Pinet et al. 1992; Pough 1935, 1936, 1966b, 1972, 1997c; Remeshilo and Vovk 1973; Shein et al. 2008; Spencer 1906, 1934; Tomaz-Filho et al. 2005; Tsinober et al. 1986	

**6.1.61. Phosphophyllite**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Short-wave UV fluorescence	
EDXRF chemistry	
Raman spectroscopy	
<i>References</i>	
Bank 1975; Fryer 1989; Hill 1977; Hyrsl and Petrov 1998; Kleber et al. 1961; Liddicoat 1969c, 1971; Pough 1997d; Wilson and Petrov 1999	

**6.1.62. Plastic**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Polariscope	
Long-wave UV fluorescence	
Short-wave UV fluorescence	
FTIR(-NIR) spectroscopy	
<i>References</i>	



Alam and Stanton 1994; Anonymous 1958, 1959, 1980; Benson 1960b; Brown 1991, 1993; Bubshait and Sturman 1996; Chaki and Li 1984; Crowningshield 1964, 1969a, b, 1974; Evans and Crook 1997; Farn 1978; Foreman 1997; Foreman et al. 1996; Fryer 1981, 1983, 1984, 1985a, b, 1987a, 1989a, 1990, 1997; Gunawardene 1983; Gunawardene and Mertens 1983; Henn 2008; Hofmeister 1992; Horiuchi 1982; Hughes 1987; Hurwit 2002; Kammerling and Fryer 1995; Kammerling and Koivula 1989; Kammerling et al. 1995b; Koivula 1987; Koivula and Fritsch 1993c, 1995; Koivula and Kammerling 1988, 1989a, b, 1990c, 1991b, c; Koivula et al. 1992b, 1995a; Koivula et al. 1990; Liddicoat 1963a, 1966; Manson 1978; Mark 1984; Milisenda 1996; Nassau 1980, 1982, 1986; Ou Yang 1993; Scarratt 1981, 1984, 1987, 1992; Scarratt et al. 1993; Schmetzer and Bank 1983; Smith 1994; Tinney et al. 1996; Webster 1939, 1949b; Yost and Weidenhamer 2008

### 6.1.63. Prehnite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Polariscope	
Raman spectroscopy	
<i>References</i>	
Akizuki 1987; Bank 1975a; Beattie and Brown 1985; Bracewell 1989; Brown and Snow 1981; Crowningshield 1963a, b; Currier and Pohl 2011; Howard 1997; Huber 1975; Liou 1971; Nazarova et al. 1990; Pan et al. 2009; Papike and Zoltai 1967; Pough 1966b, 1997e; Roger 1987; Rohn 1998; van Houten 1971	

### 6.1.64. Pyrite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	
XRD	If other tests are inconclusive
<i>References</i>	
Abraitis et al. 2004; Annamoe and Alpatov 2001; Bartlett 1997; Blount 1993; Buckley and Woods 1987; Costagliola et al. 1997; Craig and Vokes 1993; Craig et al. 1998; Descostes et al. 2004; Dódonny et al. 1996; Frondel 1936; Fryer 1988; Gunawardene 1983b; Howie 1992; Hu et al. 2006; <a href="http://rruff.info/Marcasite">http://rruff.info/Marcasite</a> ; <a href="http://rruff.info/Pyrite">http://rruff.info/Pyrite</a> ; Hyde and O'Keeffe 1996; Johnson and Koivula 1997a; Kargupikar and Vedeshwar 1988; Koivula and Kammerling 1991b; Lennie and Vaughan 1992; Liddicoat 1972; Luther 1991; Moses and Herman 1991; Moses et al. 1987; Murowchick 1992; Murowchick and Barnes 1987; Nickel 1968, Pough 1996; Rimstidt and Vaughan 2003; Russell et al. 1990; Sawlowicz 1993; Schmetzer 1983; Wilkin and Barnes 1997; Zakrevskaya 1995; Zhu and Wadsworth 1994; Zilbershteyn 1985	

*Special attention: marcasite (misnomer), steel imitation*

### 6.1.65. Quartz (amethyst, citrine, rock crystal, smoky, rose, aventurine, etc.)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Star
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	If loose

Polariscope	
Immersion	In water
Long-wave UV fluorescence	
Short-wave UV fluorescence	
FTIR(-NIR) spectroscopy	
<i>References</i>	
Abdukadyrova (2004), Adekeye and Cohen (1986), Aines and Rossmann (1986), Antao et al. (2008), Bachheimer (2000), Bahadur (2006), Bailey (2001), Balitsky and Balitskaya (1986), Balitsky and Balitskaya (2009), Balitsky et al. (1998, 1999, 2000, 2001, 2004), Baran et al. (1987), Bettioli et al. (1997), Blatt H. (1987), Bons (2001), Botis et al. (2005), Bulur et al. (2000), Cassedanne and Roditi (1991), Cherniak et al. (2007), Cohen (1985), Cohen and Makar (1985), Commin-Fischer et al. (2009), Cordier and Doukhan (1991), Dedushenko et al. (2004), de Miranda-Pinto et al. (2011), Demars et al. (1996), Demazeau et al. (1994), Di Benedetto et al. (2009), Dolino (1990), Donaldson and Borm (1998), Donovan et al. (2011), Dotto and Isotani (1991), Duarte et al. (2011, 2009), Duttine et al. (2002), Epstein (1988), Ericksen (2001a,b), Farver and Yund (1991), Fast (2008), Ferreira de Souza (2010), Flem et al. (2002), Garland (2004), Gilg et al. (2003), Goreva and Rossman (2001), Götte et al. (2011), Götze (1997, 2009), Götze and Plötze (1997), Götze et al. (2001, 2004, 2005), Gunter (1999), Hartmann et al. (2010), Heaney and Veblen (1991a,b), Hebert and Rossman (2008), Henn and Güttler (2009), Hickel et al. (2000), Hyrsl (2006), Ihinger and Zink (2000), Iwasaki and Iwasaki (2002), Jaek et al. (2003), Karampelas et al. (2005), Kibar et al. (2007), Killingback (2008), Kronenberg (1994), Kurosawa et al. (2003), Landmann (1999), Landtwing and Pettke (2005), Lehmann et al. (2009), Lin et al. (1994), Lu and Sunagawa (1990), Lu et al. (1990), Ma et al. (2002),	
Manning (1994), Marko et al. (2006), Marler (1988), McArthur et al. (1993), McConnell (1995), Monecke et al. (2000), Moore (1986), Moore (2007), Morteani et al. (2010), Muller et al. (2003), Murray and Olley (2002), Muto et al. (2004), Neumann and Schmetzer (1985), Notari et al. (2001), Ontiveros et al. (2004), Ostapenko and Mitsyuk (2006), Owen (1988), Pagonis et al. (2010, 2011), Pan et al. (2008, 2009), Pankrath an Flörke (1994), Partlow and Cohen (1986), Paterson (1986), Perny et al. (1992), Philippot et al. (1996), Proust and Fontaine (2007a,b), Rakov (2003), Rakov and Krylova (2001), Rakov and Shuriga (2009), Ramseyer et al. (1988), Ream (1991), Richards (1990), Rosa et al. (2005), Rossman (1994), Rusk et al. (2011), Sawakuchi and Okuno (2005), Schmetzer (1987, 1988, 1989), Schmetzer and Glas (2003), Schmetzer and Krzemnicki (2006), Schultz-Güttler et al. (2008), Seifert et al. (2011), SivaRamaiah et al. (2011), Spicuzza et al. (1998), Stegger and Lehmann (1989), Stenina (2004), Stevens-Kalceff (2009), Subedi et al. (2011), Sunagawa (1999), Sunagawa and Balitsky (1990), Suzuki and Nakashima (1999), Swanson and Fenn (1986), Tajika and Hashimoto (2006), Thomas et al. (2000), Trossarelli (1985), Umari et al. (2001), Vasconcelos et al. (1994), Wenrich and Christensen (1996), White and Cook (1990), Wilson (1999), Wintle and Murray (1997), Zhang et al. (1994), Zolensky et al. (1988).	

*Special attention: synthetics, coatings, irradiation, heat treatment, dyed and impregnated (quartzite)*

### 6.1.66. Rhodochrosite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	Upper limit outside range
Spectroscope	
Long-wave UV fluorescence	
Short-wave UV fluorescence	
EDXRF chemistry	If other tests are inconclusive
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
Auzat 1992; Bank 1975c; Bank and Becker 1977; Bartos et al. 2007; Birch 1986; Boettcher et al. 1992; Brusentsova et al. 2010; Cassedanne 1997, 1998; Cory 1991; Crowningshield 1962a; da Cunha 1993; de Brodtkorb and de Brodtkorb 1979; Dillon 1981a; Fedorov 2002; Frost et al. 2006; Galloni 1950; Hyrsl 1997, 2001; Jones 1997; Knox and Lees 1997; Koivula and Fritsch 1993h; Koivula and Kammerling 1990b; Kosnar 1979; Kuck and Saaid 1998; Lees et al. 1998; Liddicoat 1963d, 1967; Miller 1971; Petsch 1990; Pinet et al. 1992; Saadi 1988; Saadi and Carlos 1992; Sala et al. 1973; Schmetzer and Berdesinski 1974; Sinkankas 1955, 1977; Sutherland 1997; Sutthirath et al. 2011; Von Bezing et al. 1991; Wilson and Dunn 1978a, b; Zwaan 2015d	

*Special attention: easy cleavage single crystal material*

### 6.1.67. Rhodonite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Spectroscope	
EDXRF chemistry	If other tests are inconclusive
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
Millsteed 2006; Millsteed et al. 2005; Nelson and Griffen 2005; O'Neill 1986; Ohashi and Finger 1975; Ohashi et al. 1975; Paião and Watanabe 2008; Peacor and Niizeki 1963; Peacor et al. 1978; Pinet et al. 1992; Pirsson 1890; Pough 1966c; Sapountzis and Christofides 1982; Simandl et al. 2001; Smith et al. 1981; Suhner 1979; Takei and Hosoya 1985; Thurm 1973; Zhao et al. 1986; Zigovecki-Gobac et al. 2010	

### 6.1.68. Ruby

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Star
Immersion	Be diffusion, synthetic
Refractometer (refractive index)	
Spectroscope	
Long-wave UV fluorescence	
Short-wave UV fluorescence	
DiamondView	Glass filling
UV-Visible(-NIR) spectroscopy	If necessary for origin
FTIR(-NIR) spectroscopy	
EDXRF chemistry	
LA-ICP-MS chemistry	Be test heated stones, if necessary for origin
Residue check and extent	Flux healing
Colour call	
Clarity enhancement check and extent	Glass filling
<i>References</i>	
Abduriyim and Kitawaki 2008; Abduriyim et al. 2012; Achiwawanich et al. 2006; American Gemological Laboratories 1982a, b; Anderson 1980a, b; Anderson 1981; Arem 1987; Arkhangelskii et al. 1969; Arrouas 1993; Balmer et al. 2009; Bancroft 1988; Banerjee et al. 1985; Bank 1963, 1971b, 1974, 1975d, 1978; Bank et al. 1988a; Bank and Henn 1988, 1989; Bank et al. 1988b; Bank and Okrusch 1976; Barthem et al. 1982; Bassett 1997; Basun et al. 2007; Belt 1967; Berrangé and Jobbins 1976; Bessonova et al. 1981; Bessonova and Stanislavskii 1981; Bosshart 1982, 1983; Bosshart and Schmetzer 1986; Bowersox et al. 2000; Brown 1981, 1992a, b; Brown and Beatti 1992; Butcher and White 1964; Calligaro et al. 1998; Calligaro et al. 1999; Cartier 2011; Chaiwong et al. 2005; Chalain 1995; Christie Manson and Woods 1990; Clark 1992, 1993; Cockayne et al. 1969; Coenraads 1992; Coldham 2009; Cozar 1995; Crowningshield 1966, 1969b, 1974a; Currie 1988; Davison and Houghton 2007; Delé-Dubois et al. 1993; Dele et al. 1997; Devouard 1989; Dill 2005; Duroc-Danner 1988, 2002, 2003; Emmett et al. 2003; Emmett 1999; Frederic 1994; Fryer 1987c, 1992, 1996a, b, 1997b; Galia 1987; Galibert and Hughes 1995; Garcia-Lastra et al. 2005; Garnier et al. 2008; Garnier et al. 2002; Geisler 1976; Geranicheva et al. 1975; Giuliani et al. 2005; Giuliani et al. 2012; Grapes and Palmer 1996; Grapes and Hoskin 2004; Grubessi 1990; Grundmann and Morteani 1995; Gübelin 1966, 1979a, 1981a, 1982, 1985–86; Gübelin and Knischka 1980; Gunawardene 1984; Hager 2007; Hager et al. 2010; Hamid et al. 1999; Hänni 1992, 1993, 1994, 2001a, b; Hänni and Krzemnicki 2009; Hänni et al. 2001; Hänni and Schmetzer 1991; Hänni et al. 1994; Hänni and Stern 1982; Harding and Jobbins 1984; Harding and Scarratt 1986; Henn 1991, 1994; Henn and Bank	

1991a, b, 1993a, b; Henn et al. 1990a; Henn et al. 1990b; Henn and Milisenda 1994; Hintze 2010; Hoang et al. 1999; Holzapfel 2003; Hughes and Galibert 1997; Hughes 1992, 1996a, b, 1997; Hughes and Galibert 1998; Inamori Jewelry Division 1980; Jobbins and Berrangé 1981; Johnson and Koivula 1997b, 1998a; Johnson et al. 1999a, b; Joseph et al. 2000; Kammerling et al. 1995a; Kammerling and Koivula 1994; Kammerling et al. 1995c; Kane 1983, 1985, 1997; Kane et al. 1991; Kawano 2009; Keller 1983; Kiefert and Schmetzer 1991; Kissin 1994; Knischka and Gübeline 1980; Koivula and Fritsch 1993b, i, 1994b, f, h, 1995a; Koivula and Johnson 1996; Koivula and Kammerling 1988a, c, 1991b, 1992b, c; Koivula et al. 1992a, b, 1995c; Koivula et al. 1995d; Krzemnicki 2011; Krzemnicki and Hänni 2008; Lee and Hoggard 1990; Leelawathanasuk-Pavaro et al. 2008; Leelawathanasuk et al. 2009; Leonyuk et al. 2005; Li et al. 2011; Liccardo et al. 2005; Liddicoat 1962, 1969d, 1970a; Linares 1965; Lu and Shigley 1998; McClure et al. 1993; McClure et al. 2006; Mercier et al. 1999; Milisenda et al. 2005; Muhlmeister et al. 1998; Mullenmeister and Zang 1995; Nassau 1969, 1981, 1990; Nguy et al. 2006; Oishi et al. 2004; Pardieu 2007; Pardieu et al. 2009; Peretti 1993; Peretti et al. 1995; Peretti and Smith 1993; Pham et al. 2004a; Pham et al. 2004b; Pongkrapan et al. 2010; Qi 1996; Qi et al. 1999; Rakontondrazafy et al. 2008; Ribeiro and Zanatta 2003; Saminpanya and Sutherland 2011; Sanchez et al. 2001; Sanchez et al. 1997; Scarratt 1985, 1994; Schmetzer 1985, 1986, 1999; Schmetzer and Peretti 1999; Schmetzer et al. 2009, 2010; Schmetzer and Schwarz 2007; Schwarz et al. 2008; Schwarz and Schmetzer 2001; Shida 1996; Smith 1992, 1995, 1996, 1998; Smith and Bosshart 1993; Smith et al. 1997; Sun 1992; Sun and Guang 1999; Sunagawa et al. 1999; Superchi and Rolandi 1980; Sutherland et al. 2009; Sutherland et al. 2006; Sutherland and Schwarz 2001; Syassen 2008; Tang et al. 1989; Teshima et al. 2005; Themelis 1992, 2003, 2005; Verneuil 1891, 1892, 1903; Wang et al. 2007; Wanthanachaisaeng et al. 2006; Webb 1997; Webster et al. 1939; Winotai et al. 2004; Winotai et al. 2000; Yui et al. 2008.

*Special attention: heat treatment, residues, diffusion, (lead) glass filling, dye, synthetics*

#### 6.1.69. Sapphire

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Star, colour change
Immersion	Synthetic, Be diffusion
Refractometer (refractive index)	
Spectroscope	
Long-wave UV fluorescence	
Short-wave UV fluorescence	
DiamondView	Glass filling
UV-Visible(-NIR) spectroscopy	Be diffusion, if necessary for origin
FTIR(-NIR) spectroscopy	
EDXRF chemistry	
LA-ICP-MS chemistry	Be test heated stones, if necessary for origin
Residue check and extent	Flux healing
Colour call	e.g., Padparadscha
<i>References</i>	

<p>Anderson et al. 1958; Anderson and Payne 1948; Anderson et al. 1981; Atkinson and Kothavala 1983, 1985; Bank 1970, 1995b; Bank et al. 1972; Bank and Henn 1989b; Bank et al. 1997, 1999; Bank et al. 1991; Bank et al. 1978; Barot et al. 1989; Barot and Harding 1994; Beesley 1982; Berg 2004; Berg and Dahy 2002; Berger and Berg 2006; Berrangé and Jobbins 1976; Birch 2008; Blauwet 2006; Borodin 2008; Bottrill 1996; Bowersox et al. 2000; Brown 1990, 1991a; Brown et al. 1985; Brown 1956, 1958; Brownlow and Komorowski 1988; Bunoiu et al. 2010; Burch 1987; Cartier 2009; Cartier 2011; Chaiwong et al. 2005; Chapoulie et al. 1999; Chatham 1982; Coenraads 1992, 1994, 2012; Coenraads and Laird 2000; Coenraads et al. 1990; Coldham 1986; Coldham 1973, 1992; Crowningshield 1959, 1961, 1962a, 1969d, 1970a, 1971, 1974c, 1979a, b, 1983; Crowningshield and Nassau 1981; David and Fritsch 2001; Dele-Dubois et al. 1980; Dirlam et al. 1992; Dobrovinskaya et al. 1980; Du Toit 1995; Duroc-Danner 1985, 1988, 2002b; Duroc-Danner 2011; Ediriweera 1991; Ediriweera and Perera 1989; Eigenmann and Gunthard 1971, 1972; Eigenmann et al. 1972; Elen and Fritsch 1999; Emmett 2002; Emmett et al. 2003; Emmett 1999; Emmett and Douthit 1993; Engineering and Mining Journal 1890; Epstein et al. 1994; Faye 1971; Federman 1992; Ferguson and Fielding 1971, 1972; Field 1992; Flamini et al. 1987; Fontana et al. 2008; Fontana et al. 2009; Francis et al. 2003; Fritsch and Mercer 1993; Fritsch and Rossman 1990; Fryer 1981a, c, 1982a, b, c, d, 1983b, 1984b, 1985c, 1986b, 1987d, e, 1990b, 1992b, c, 1996a; Furui 1988; Gaines 1951; Galibert and Hughes 1995; Garland 2002; Garnier et al. 2005; Giuliani et al. 2009; Giuliani et al. 2007; Giuliani et al. 2005; Giuliani et al. 2012; Grossman et al. 2001; Gübelin 1983, 1998; Gübelin et al. 1989; Gübelin and Peretti 1997; Gunaratne 1981; Gunawardene 1983c, 1984a, 1985a; Gunawardene and Chawla 1985; Guo et al. 1996; Guo et al. 1992; Gutierrez et al. 2010; Häger et al. 2003; Hainschwang 2008; Halford-Watkins 1935, 1936; Hamid et al. 1999; Hänni 1990, 2002; Hänni and Pettke 2002; Harutunyan et al. 1999; Hauzenberger et al. 2003; Heilmann and Henn 1986; Henn 1986; Henn and Bank 1990, 1992; Henn et al. 1989; Henn and Milisenda 2005; Henn et al. 1999; Henn and Petsch 2000; Hughes 1988, 1997; Hughes and Vock 2000; Hughes and Win 1995; Jackson 1984; Jobbins 1971; Jobbins and Berrangé 1981; Johnson and Koivula 1997c, d; Johnson et al. 1999a; Johnson et al. 1995; Jones et al. 2003; Joseph et al. 2000; Kammerling et al. 1996; Kammerling et al. 1994a; Kammerling and Koivula 1995b; Kammerling et al. 1994b; Kane 1982, 1985, 2010; Kane and Kammerling 1992; Kane et al. 1990; Kane et al. 1991; Keller and Keller 1986; Keller 1982; Keller et al. 1985; Khanchuk et al. 2003; Kiefert 1987; Kiefert and Schmetzer 1987a, b, 1988, 1991b; Kiefert et al. 1996; Koivula 1986a; Koivula and Fritsch 1995a, c; Koivula and Kammerling 1992d, e; Koivula et al. 1995e, f; Krzemnicki et al. 1996; Krzemnicki et al. 2004; Kurlov and Theodore 1999; Kvapil et al. 1973; Kyi et al. 1999; La Touche 1890; Lee et al. 1999; Levinson and Cook 1994;</p>
<p>Liddicoat 1962b, 1972a, 1975a, b; Lin et al. 1998; Linton 1997; Malikova 1999; Malyukin et al. 2000; Massi 2005; McCallum and Morpeth 1999; McClure and Moses 2002; McClure 2002, 2005; Meyer and Mitchell 1988; Milisenda and Henn 1996; Mogilevsky et al. 2009; Moine et al. 1998; Moon and Phillips 1986, 1991; Morita et al. 1993; Morpeth et al. 2001; Moses 2002a, b; Nassau 1981, 1982b, 1991, 1996; Nassau and Valente 1987; Nechaev et al. 2009; Notari 1997; Notari et al. 2003; O'Donoghue 1983; Pakhomova et al. 2011; Palanza et al. 2010; Pechar 1985; Peretti and Günther 2002; Peretti et al. 2003; Peretti et al. 1990; Peretti et al. 1997; Peucat et al. 2007; Pisutha-Arnond et al. 2006; Pisutha-Arnond et al. 2009; Ponalho 1990, 1995; Pough 1972a; Rakontondrazafy et al. 2008; Ramdohr and Milisenda 2006; Roberts et al. 2004; Rupasinghe et al. 1993; Saito et al. 1991; Sakkaravej et al. 2006; Scarratt 1977, 1984a, b, 2002; Scarratt and Charoensrihanakul 1994; Scarratt et al. 1994; Schmetzer 1977, 1987, 1990, 2007; Schmetzer and Bank 1980, 1981; Schmetzer et al. 1983; Schmetzer and Keifert 1990; Schmetzer and Kiefert 1987; Schmetzer and Peretti 1999, 2000; Schmetzer et al. 2010; Schmetzer and Schwarz 2004, 2005, 2007; Schwarz et al. 2000; Schwarz et al. 2008; Schwarz et al. 1996; Schwiager 1990; Seifert and Hysrl 1999; Shida 1990, 1996; Smith 1998; Smith et al. 1997; Smith et al. 1995; Superchi et al. 1997; Sutherland 1994, 1996; Sutherland et al. 2002; Sutherland et al. 2009a; Sutherland et al. 2006; Sutherland et al. 2009b; Tay et al. 2012; Themelis 1992, 2003; Tombs 1974, 1978; Tombs 1982; Troup et al. 1992; Verneuil 1911; Wang et al. 2009; Wang and Yang 1992; Wang 1988; Wang et al. 2006; Wanthanachaisaeng et al. 2006; Wathanakul and Atichat 2001; Wathanakul et al. 2010; Webb 1997; Willard 1981; Yang et al. 2005; Zoysa and Rahuman 2012; Zwaan 2015b; Zwaan 1974</p>

*Special attention: heat treatment, diffusion, (lead, cobalt) glass filling, Synthetics*

### 6.1.70. Sapphirine

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Dichroscope	
Raman spectroscopy	

<i>References</i>
Bank et al. 1989; Christy and Grew 2004; Deer et al. 1978; Francis and Matsueda 2004; Fryer 1985c, 1987c; Grew et al. 2008; Haapala et al. 1971; Harding and Zoysa 1990; Henn 2001; Horrocks 1983; Janardhanan and Leake 1974; Koivula 1996; Koivula and Fryer 1987b; Koivula and Kammerling 1988d; Langer et al. 1994; McColl and Warren 1984; McKie 1963; Moore 1969; Moses et al. 1998b; Ostwald 1964; Saul et al. 1991; Scarratt 1987b, c; Segnit 1957; Steffen et al. 1984; Su et al. 2012; Sutherland and Coenraads 1996; Wight 1990b; Wilson and Hudson 1967; Zeitner 1986; Zoysa 1995

### 6.1.71. Saussurite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	
<i>References</i>	
Jobbins and Rutland 1974; Scarratt 1987c, e	

### 6.1.72. Scapolite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Cat's-eye
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Polariscope	
Long-wave UV fluorescence	
Short-wave UV fluorescence	
FTIR(-NIR) spectroscopy	
Raman spectroscopy	If other results are inconclusive
<i>References</i>	
Antao and Hassan (2002, 2008a,b, 2011a,b), Antao et al. (2008), Baker (1994), Chamberlain et al. (1985), Comodi et al. (1990), Couper (1991), De Grave et al. (1986), Hassan and Buseck (1988), Hawthorne and Sokolova (2008), Hazen and Sharp (1988), Henn (2005), Moecher and Essene (1991), Moecher et al. (1994), Pan and Dong (2003), Seto et al. (2004), Sherriff et al. (1987, 1998, 2000), Sidike et al. (2008), Sokolova and Hawthorne (2008), Sokolova et al. (1996), Stolz (1987), Superchi et al. (2010), Teertstra and Sherriff (1996), Vassilikou-Dova (1991), Vochten et al. (1986), Zhang (1992), Zolotarev (1993), Zolotarev et al. (2003), Zwaan (1986, 1996)	

### 6.1.73. Serpentine – bowenite, williamsite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
FTIR(-NIR) spectroscopy	
Raman spectroscopy	
<i>References</i>	

Auzende et al. 2004; Baese et al. 2010; Bank and Berdesinski 1975; Baronnet and Devouard 1996; Brown and Bracewell 1995; Chen and Menu 2010; Choudhary 2011; Crowningshield 1959a, 1961b, c, 1962c, 1972, 1973b, 1975a; Dódony and Buseck 2004; Ferguson 1977; Fryer 1983b, 1987e; Groppo et al. 2006; Harlow and Sorensen 2005; Hoyer 1997; Johnson and Koivula 1998a; Kammerling and Fryer 1995a; Kammerling et al. 1991; Kammerling et al. 1995d; Kim 1998; Kim and Cho 1998; Koivula and Kammerling 1989a; Krstanovic 1997; Liddicoat 1962c, 1965, 1967b, 1972b; McMahon 1890; Miura et al. 2011; Schreur 1982; Segnit 1985; Wang and Zhang 2011; Webster 1958, 1967; Zalishchak et al. 2007; Zeitner 1980

*Special attention: dye*

#### 6.1.74. Sinhalite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Polariscope	
Spectroscope	
FTIR(-NIR) spectroscopy	
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
Anderson 1952a, b, 1974; Bank 1977; Bauernhansl and Beran 1997; Bowden et al. 1969; Claringbull and Hey 1952; Crowningshield 1958, 1960; Deen 1984; Dharmaratne 1998, 1999; Fang and Newnham 1965; Hayward et al. 1994; Henn 1985; Koivula and Fritsch 1993j; Liddicoat 1970d, 1976c; Moore et al. 1989; Payne 1952, 1958; Pinet et al. 1992; Pitman et al. 1995; Pough 1964; Werding et al. 1981; Wight 2000; Zeitner 1986; Zwaan 1955	

#### 6.1.75. Sillimanite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Cat's-eye
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Polariscope	
FTIR(-NIR) spectroscopy	
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
(Althaus 1967; Bank 1974a; Bank et al. 1978a; Beran et al. 1983; Burnham 1963; Crowningshield 1957; Dharmaratne 1999; Fernandes 1993; Fleet and Arima 1985; Fryer 1981d, 1987b; Fyfe 1967; Gamini Zoysa 1985; Gübelin et al. 1986; Hanson 1956; Hayashi and Manaka 1994; Karanth et al. 1999; Kempe 1967; Koivula and Fritsch 1993d, 1994b; Mernagh and Liu 1991; Milisenda and Henn 2006; Pinet et al. 1992; Randriamanga 1994; Rossman et al. 1982; Saini et al. 1995; Scarratt 1986a, b; Spencer 1920; Yan et al. 1995; Zoysa 1995; Zwaan 1982	

*Special attention: single crystal has easy cleavage*

#### 6.1.76. Sodalite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Dichroscope	
Spectroscope	
Long-wave UV fluorescence	

Raman spectroscopy	
<i>References</i>	
Anonymous 1824; Balassone et al. 2012; Ballentyne and Bye 1970; Ballirano et al. 1991; Bank 1974b; Brandstatter et al. 1997; Brousse et al. 1969; Brown 1998; Cano et al. 2010; Cassedanne and Cassedanne 1980; Denisov et al. 1977; Denks et al. 1974; Depmeier 2005; Field 1948; Fijal and Tokarz 1981; Frazier and Frazier 1997b; Friis 2011; Fryer 1990c; Hassan and Grundy 1984; Henn and Bank 1990b; Henn et al. 1994b; Hyrsl and Petrov 1999; Kirk 1955; Koivula and Kammerling 1989b, e; Koivula et al. 1992a; Kondo and Beaton 2009; Liddicoat 1974; Liu 1982, 1991; Naqvi et al. 1991; Paulin 1979; Peterson 1983; Petrov 2009; Pinet et al. 1992; Pizani et al. 1985; Webster 1958; Weerth and Hammer 2000; Wight 1993, 1996; Zilio and Bagnato 1984	

*Special attention: dye*

### 6.1.77. Sphene (Titanite)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Polariscope	
FTIR(-NIR) spectroscopy	
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
Aleksandrov and Troneva (2007), Angel et al. (1999), Beirau et al. (2010), Bernau and Franz (1987), Bismayer et al. (1992, 1999), Blasse et al. (1988), Carswell et al. (1996), Cherniak (1993, 1995, 2006, 2010), Cherniak and Watson (2011), Chrosch et al. (1997, 1998), Crowe et al. (1986), Enami et al. (1993), Enkelmann et al. (2005), Farges (1997), Fliegel et al. (2010), Frost et al. (2001), Gaft et al. (2003), Ghose et al. (1991), Green and Pearson (1986), Hawthorne et al. (1991), Hayden et al. (2008), Hayward et al. (2000), Heyns et al. (2000), Holenyi and Annersten (1987), House et al. (2000), Hughes et al. (1997), Kek et al. (1997), Kennedy et al. (2010), Knoche et al. (1998), Kunz et al. (1996, 2000), Liferovich and Mitchell (2005a,b, 2006a,b), Lucassen et al. (2010), Lumpkin et al. (1991), Lussier et al. (2009), Malcherek et al. (1999, 2001), Marks et al. (2008), Mazdab (2009), Meyer et al. (1996, 1998), Morishita et al. (1996), Mukhopadhyay et al. (1992), Oberti et al. (1991), Pan et al. (1993), Paterson and Stephens (1992), Paulmann et al. (2000), Perseil and Smith (1995), Pezzotta (2005), Piuzana et al. (2008), Prowatke and Klemme (2005, 2006), Reiners and Farley (1999), Robinson and Wight (1997), Russell et al. (1994), Salje et al. (1993, 2000, 2011), Seifert (2005), Simonetti et al. (2006), Steiner (2010), Storey et al. (2006), Tanaka et al. (1988), Tiepolo et al. (2002), Tilley and Eggleton (2005), Troitzsch et al. (1999), Tropper and Manning (2008), Vance and Metson (1985), Van Heurck et al. (1991), Vassilikou-Dova and Lehmann (1988), Willigers et al. (2002), Xirouchakis et al. (1997), Xirouchakis and Lindsley (1998), Zhang et al. (1995, 2000, 2002, 2003, 2006)	

### 6.1.78. Spinel

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Star, colour change
Refractometer (refractive index)	
Polariscope	
Spectroscope	
Long-wave UV fluorescence	
Short-wave UV fluorescence	
UV-Visible(-NIR) spectroscopy	
Raman/PL spectroscopy	
<i>References</i>	



Andreozzi (1999), Andreozzi et al. (2000, 2001), Andreozzi and Princivalle (2002), Arai (1992), Barnes and Roeder (2001), Belykh et al. (2005), Blauwet (2006), Bodinier et al. (1996), Bouchard and Gambardella (2010), Brigida et al. (2007), Bromiley et al. (2010), Carbonin et al. (1996), Chopelas and Hofmeister (1991), Cynn et al. (1992), Czaja (2001), Czaja and Mazurak (1993), Daneu et al. (2007), Dekkers and Woensdregt (2002), Della Giusta et al. (1986), Deren et al. (1996), Dezsi et al. (2000), Finger et al. (1986), Foley et al. (2001), Fregola et al. (2005), Fregola and Scandale (2007), Fregola et al. (2000), Garcia-Lastra et al. (2008), Gobbi et al. (1985), Gritsyna et al. (2004), Hålenius et al. (2010), Harder (1986), Harding and Wall (1987), Harrison et al. (1999), Hlaing (1989), Jouini et al. (2006), Kamenetsky et al. (2001), Kamperman et al. (1996), Kashii et al. (1999), Kumaratilake (1998), King (2004), Krokhn et al. (1998), Kurazhkovskaya et al. (2000), Larsson (1995), Lavina et al. (2002, 2003), Lavrentiev et al. (2003), Lee (1999), Lenaz et al. (2008), Libowitzky (1994), Liermann and Ganguly (2002), Lucchesi and Della Giusta (1994), Lucchesi et al. (1997, 1998), Maekawa et al. (1997), Malsy and Klemm (2010), Martignago et al. (2003), Millard et al. (1992), Muhlmeister et al. (1993), Nakatsuka et al. (2004), Notari and Grobon (2003), Paktunc and Cbri (1995), Palin and Harrison (2007), Princivalle et al. (2006), Righter et al. (2006), Rinaudo and Trossarelli (1997), Rubie and Ross (1994), Sack and Ghiorso (1991), Salviulo et al. (1999), Schmetzer et al. (1989), Shannon and Rossman (1991), Sickafus et al. (1999), Slotznick and Shim (2008), Spry (1987), Strek et al. (1988), Sutherland and Coenraads (1996), Talanov (1986), Taran et al. (2005, 2009), Thy (1995), Uchida et al. (2005), Vilissov et al. (2002), Wang et al. (2006), Warren et al. (2000), Watson and Price (2002), Wdowik et al. (2006), Wyon and Aubert (1986).

*Special attention: synthetics, heat-treatment*

### 6.1.79. Spinel (cobalt)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Chelsea Colour Filter	
Polariscope	
Spectroscope	
Long-wave UV fluorescence	
Short-wave UV fluorescence	
UV-Visible(-NIR) spectroscopy	
LA-ICP-MS Chemistry	
<i>References</i>	
Dharmaratne (1993), Fryer (1982, 1986, 1990, 1991), Guo et al. (1994), Ivchinova and Zhelyazkova-Panaitova (1969), Koivula and Fritsch (1994), Koivula and Kammerling (1990), Mitchell (1976), Shannon (1923), Shigley and Stockton (1984)	

*Special attention: synthetics*

### 6.1.80. Spodumene

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Polariscope	
Long-wave UV fluorescence	
Short-wave UV fluorescence	
<i>References</i>	

Anderson and McCarron (2011), Bartkowska et al. (1998), Bobos et al. (2007), Camara et al. (2003), Chandrasekhar and White (1992), Charoy et al. (1992, 2001), Cook (1997), De Lima et al. (2008, 2009), Diego-Gatta et al. (2005), Filip et al. (2006), Gaite et al. (1985), Göd (1989), Gordiyenko et al. (1988), Isotani et al. (2007), Ito and Isotani (1991), Karfunkel et al. (2002), Khomenko and Platonov (1985), Kuznetsova (2009), Kuznetsova and Prokofev (2009), Lagache and Sebastian (1991), Lipatov et al. (2007), London and Burt (1982), Makagon (2009), Mauthner (2011a,b), Natkaniec-Nowak (2007), Nunes and Gomes (1994), Pimeta-Romeiro and Pedrosa-Soares (2005), Pommier et al. (2003), Prencipe et al. (2003), Salis (1995), Singhe and Gilkes (1993), Skogby et al. (1990), Souza et al. (2007, 2009), Tacker (2010), Tribaudino et al. (2003), Walker et al. (1997), Weselucha-Birczynska et al. (2011), Wise (2009), Wise and Anderson (2006), Wood and Williams-Jones (1993)

*Special attention: easy cleavage, irradiation: blue-green will fade*

### 6.1.81. Sugilite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Polariscope	
Spectroscope	
Raman spectroscopy	
<i>References</i>	
Armbruster and Oberhänsli 1988; Boardman 1964; Chikayama 1981; Clark et al. 1980; de Villiers 1983; Dillon 1981b; Dixon 1985; Dunn et al. 1980; Fritsch and Shigley 1994; Fryer 1981e, 1982e; Henn 1986b; Kammerling and Koivula 1990; Kawachi et al. 1994; Kleyenstuber 1996; Koivula and Fritsch 1995b; Koivula and Kammerling 1990a, 1992a; Moore et al. 2011; Moses et al. 1998b; Murakami et al. 1976; Olivier et al. 1983; Ponalho 1991; Shigley et al. 1987; Taggart et al. 1994; Wilson and Dunn 1978a; Zeitner 1982	

### 6.1.82. Taaffeite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Polariscope	
Raman spectroscopy	
<i>References</i>	
Abduriyim et al. 2008; Anderson 1952b, 1967, 1968; Anderson et al. 1951; Anderson et al. 1952; Bank and Henn 1989a; Crowningshield 1974a; Demartin et al. 2004; Demartin et al. 1993; Dillon 1983; Fernando et al. 2005; Fernando and Hofmeister 2000; Fryer 1982f, 1987b, 1988b; Gübelin 1981c; Gunawardene 1984c; Hudson et al. 1967; Jayakody 1983; Johnson and Koivula 1996; Kampf 1991; Kiefert and Schmetzer 1998; Koivula 1986d; Koivula and Kammerling 1991b; Koivula et al. 1992d; Liddicoat 1967a; Moses et al. 1999a; Ponalho 1993; Scarratt 1986c; Schmetzer et al. 1999; Schmetzer et al. 2000; Schmetzer et al. 2006; Schmetzer et al. 2005; Schmetzer et al. 2007; Zoysa 1995	

*Special attention: Taaffeite is a synonym of Magnesiotaafeite-2N'2S, Musgravite is a synonym of Magnesiotaafeite- 6N'3S.*

### 6.1.83. Tektite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	

Hydrostatic weighing (specific gravity)	
FTIR(-NIR) spectroscopy	
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
Albin 1997; Aramu et al. 1994; Artemieva et al. 2002; Baker 1940, 1960, 1961, 1962; Banerjee and Hager 1993; Bentor 1986; Blum and Chamberlain 1992; Bouska 1997; Cohen 1958; de Goutiere 1995; Delano et al. 1986; Delano et al. 1992; Dunlap 1997; Dunlap et al. 1998; Dunlap and Sibley 2004; Faulques et al. 2001; Fenner 1939; Fudali et al. 1987; Futrell 1999a; Futrell 1999b; Ganapathy and Larimer 1984; Giuli et al. 2010; Heide et al. 2001; Jacobs 1997; Kim and Kim 2006; Kinnunen 1990; Koeberl 1990, 1992, 1994; Koivula et al. 1995d; Lee et al. 2004; Neuville et al. 2010; Pinter 1999; Rauch et al. 1992; Reban 1984; Taylor 1962, 1973; Volovetsky et al. 2008; Vrana 1988; Wasson 1991; Zook 1974	

**6.1.84. Thomsonite**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
<i>References</i>	
Almquist 1987; Anderson 1978; Wise 1978	

*Special attention: characteristic appearance*

**6.1.85. Topaz**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Polariscope	
Dichroscope	
<i>References</i>	
Abbott (1990), Albuquerque et al. (1988), Beny and Periou (1987), Cairncross (2005), Cassedanne (1989), Christiansen et al. (1986), da Costa et al. (2000), Dantas et al. (2006), da Silva et al. (2005), Dewonck et al. (1998), Diego-Gatta et al. (2006), Frazier and Frazier (1990), Frindt et al. (2004), Gabasch et al. (2008), Gaft et al. (2003), Gübelin et al. (1986), Haapala et al. (2007), Hervig et al. (1987), Holzhey (1997), Jackson et al. (2002), Jackson and Valerio (2004), Jones (2006), Komatsu et al. (2003), Krambrock et al. (2007), Leal et al. (2007), Leithner (2008), Leroy et al. (2002), Lyckberg et al. (2009), Marques et al. (2000, 2002), Mizuno et al. (2006), Morteani et al. (2002), Morteani and Voropaev (2007), Nassau (1985), Northrup and Reeder (1994, 1995), Pinheiro et al. (2002), Raines (2001), Rohn (2005), Rojas et al. (2009), Sabioni et al. (2003), Sauer et al. (1996), Schmetzer (1987, 2008), Schott et al. (2003), Shinoda and Aikawa (1994), Song and Yuan (2009), Souza et al. (1995, 2002, 2004, 2006), Spengler (1985), Struth et al. (1999), Taran et al. (2003), Tarashchan et al. (2006), Taylor and Fallick (1997), Watenphul et al. (2010), Watenphul and Wunder (2010), Wise (1995), Wunder et al. (1999), Yukihiro et al. (1996, 2002), Yukihiro and Okuno (1998)	

*Special attention: coatings, irradiation and heat treatment*

**6.1.86. Tourmaline**

<i>Required Test method</i>	<i>Remark</i>
Microscope	Fracture filling

Phenomena	Cat's-eye, colour change
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Polariscope	
Dichroscope	
Spectroscope	
UV-Visible(-NIR) spectroscopy	
EDXRF chemistry	For Paraiba
Colour call	
<b>References</b>	
Abduriyim et al. (2006), Akizuki et al. (2001), Andreozzi et al. (2008), Arif et al. (2010), Aurisicchio et al. (1999), Babinska et al. (2008), Balen and Broska (2011), Benard et al. (1985), Benesch and Wöhrmann (1985), Beurlen et al. (2011), Bilal et al. (1998), Bloodaxe et al. (1999), Bosi (2008, 2010, 2011), Bosi et al. (2004, 2005), Bosi and Lucchesi (2004, 2007), Bueno de Camargo and Isotani (1988), Buettner (2005), Burns et al. (1994), Camara et al. (2002), Cassedanne and Roditi (1996), Castaneda et al. (2000, 2006), Choi and Hawthorne (2002), Clark (2007), Clark et al. (2008), de Oliveira et al. (2002), Dias and Wilson (2000), Dietrich (1985), Dirlam et al. (2002), Ertl (2008), Ertl et al. (2006), Ertl et al. (2003, 2007, 2008, 2010), Federico et al. (1998), Fisher (2011), Fisher et al. (1998), Foit (1989), Foord et al. (1989), Foord et al. (1986), Francis (1985), Fritsch et al. (1990), Furuya (2007), Gasharova et al. (1997), Gonzalez-Carreno et al. (1988), Grice and Ercit (1993), Hawkins et al. (1995), Hawthorne (1996), Hawthorne and Henry (1999), Hawthorne et al. (1993), Henn and Bank (1990), Henry and Dutrow (1990, 1992, 2011), Henry and Guidotti (1985), Henry et al. (2008, 2011), Hughes et al. (2001), Jiang (1998), Jiang and Palmer (1998), Jolliff et al. (1986), Johnson et al. (1997), Jones (2005), Karfunkel and Wegner (1996), Kihara et al. (2007), King (2000), King et al. (1988), Kraczka et al. (1986), Krambrock et al. (2002, 2004, 2009), Laurs et al. (2007, 2008, 2009), London (1986, 2011), Ludwig et al. (2011), Lussier et al. (2008, 2009, 2011), Lussier and Hawthorne (2011), Lyckberg (2011), MacDonald and Hawthorne (1995), Maloney et al. (2008), Marschall et al. (2009), Mashkovtsev et al. (2006), Mattson and Rossman (1987), Milisenda (2005), Milisenda and Henn (2001), Milisenda et al. (2000, 2006), Novak and Povondra (1995), Ottolini and Hawthorne (1999), Peretyazhko et al. (2004), Perugini and Poli (2007), Pesquera et al. (2008), Pieczka (1999, 2000), Pough (1987), Povondra and Novak (1986), Proctor (1985a,b), Reinitz and Rossman (1988), Rosenberg and Foit (1985), Rosenberg et al. (1986), Rossman et al. (1991), Rossman and Mattson (1986), Schmetzer and Bank (1985), Schmetzer et al. (2007), Selway et al. (1998), Setkova et al. (2009, 2010), Shabaga et al. (2010), Shigley et al. (2001), Shtukenberg et al. (2007), Simmons et al. (2001, 2005, 2011), Simonet (2000), Soares et al. (2008), Taran et al. (1993, 1998), Trumbull et al. (2008, 2009), van Hinsberg (2011), van Hinsberg and Marschall (2007), van Hinsberg et al. (2011), Van Hinsberg and Schumacher (2007, 2009), von Goerne and Franz (2000), von Goerne et al. (1999, 2001, 2011), Vorbach (1989), Wilson (1989, 2002, 2007), Zagoroski et al. (1989), Zagorsky (2010), Zagorsky and Peretyazhko (1996), Zolotarev et al. (2007), Zwaan (2015c)	

### 6.1.87. Tugtupite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Long-wave UV fluorescence	
Short-wave UV fluorescence	
PL spectroscopy	
<b>References</b>	
Antao et al. 2004; Armstrong and Weller 2006; Chikayama 1981; Danø 1966; Dragsted 1970; Gaft et al. 2009; Jensen and Petersen 1982; Mitchell 1996; Newsome 1976; Petersen 1978; Petersen and Secher 1993; Povarennykh et al. 1971; Sorensen et al. 1971; Tunzi and Pearson 2008; Werner and Plech 1995; Xu and Sherriff 1994	

### 6.1.88. Turquoise

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
FTIR(-NIR) spectroscopy	
EDXRF chemistry	Zachery treatment
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
Crespo-Feo et al. (2010), Dill and Henn (2005), Foord and Taggart (1998), Frazier and Frazier (1999), Fritsch et al. (1999), Frost et al. (2006), Henn and Milisenda (2005), Hull et al. (2008), Jones (2000, 2005), King (2002), Kolitsch and Giester (2000), Mathien (2001), Mirnejad et al. (2010), Pavese et al. (2005), Qi et al. (1998), Reddy et al. (2006), Sharma et al. (1988), Sklavounos et al. (1992), Taki and Hosaka (1988), Taniguchi et al. (2002), Voynick (1999), Yang et al. (2003), Zeitner (1990)	

*Special attention: impregnation, dye, composites, imitation matrix, synthetics*

#### 6.1.89. Ulexite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Phenomena	Cat's-eye
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	
<i>References</i>	
Crowningshield 1957; Garlick and Kamb 1991; Ghose 1978; Sinkankas 1955	

*Special attention: very soft*

#### 6.1.90. Variscite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Spectroscope	
FTIR(-NIR) spectroscopy	
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
Arribas et al. 1970; Barwood 1997; Brown 1990b; Calas et al. 2005; Camprubi et al. 2003; Crowningshield 1960a; Dill et al. 1991; Elton 1996; Garcia-Guinea et al. 2008; Koivula 1986b; Larsen 1942; Liddicoat 1975c; Mertens 1988; Murray 1968; Nickel et al. 2008; Novak 1982; Odriozola et al. 2010; Pepperberg 1911; Pinet et al. 1992; Querre et al. 2008; Schaller 1912; Smith-Gharet 1999; Willing et al. 2008; Wilson 2010; Zeitner 1987	

#### 6.1.91. Zircon

<i>Required Test method</i>	<i>Remark</i>
Microscope	

Phenomena	Cat's-eye
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Polariscope	
Spectroscope	
<i>References</i>	
Akhtar and Waseem (2001), Aines and Rossman (1986), Amelin (2004), Balan et al. (2001), Belousova et al. (1998, 2002), Biagini et al. (1997), Black et al. (2003, 2004), Capitani et al. (2000), Caruba et al. (1985), Chakoumakos et al. (1987, 1991), Chang et al. (2006), Chen et al. (2011), Cherniak et al. (1997), Cherniak and Watson (2003), Claoué-Long et al. (1991), Colombo et al. (1999), Cook (2007), Corfu et al. (2003), Crocombette (1999), Crocombette and Ghaleb (1998, 2001), Ellsworth et al. (1994), Evans et al. (2005), Ewing et al. (1988), Ewing et al. (2003), Farges (1994), Farges and Calas (1991), Farnan and Salje (2001), Faulkner and Shigley (1989), Fedo et al. (2003), Fedotova et al. (2008), Feng et al. (1993), Ferry and Watson (2007), Finch and Hanchar (2003), Finch et al. (2001), Fowler et al. (2002), Friis et al. (2010), Gaft et al. (2000, 2002), Gagnevin et al. (2009), Geisler (2002), Geisler et al. (2001, 2002, 2003, 2007), Gerdes and Zeh (2009), Grimes et al. (2007), Halden and Hawthorne (1993), Hanchar et al. (2001), Hanchar and Miller (1993), Hanchar and Rudnick (1995), Hanchar and Watson (2003), Hänni and Weibel (1988), Harley and Kelly (2007), Harley et al. (2007), Hinton and Upton (1991), Hirata and Nesbitt (1995), Hoskin (2000), Hoskin and Ireland (2000), Hoskin and Schaltegger (2003), Iizuka and Hirata (2005), Ireland and Williams (2003), Ireland and Wlotzka (1992), Jackson et al. (2004), Jain et al. (2001), King (2008), Kinny and Meyer (1994), Kolesov et al. (2001), Koschek (1993), Kosler and Sylvester (2003), Lee and Tromp (1995), Makishima and Nakamura (1994), Marks et al. (2008), Mattinson (2005), McLaren et al. (1994), Meldrum et al. (1998, 1999), Menneken et al. (2007), Mezger and Krogstad (1997), Murukami et al. (1986, 1991), Mursic et al. (1992), Nasdala et al. (1995, 1996, 2001, 2005, 2008), Page et al. (2007), Palenik et al. (2003), Payette and Pearson (2011), Pidgeon (1992), Radlinski et al. (2003), Rahn et al. (2004), Reiners (2005), Rignanesi et al. (2001), Rimsa et al. (2007), Rios et al. (2000), Rubatto (2002), Rubatto and Hermann (2007), Rupasinghe (1985), Rupasinghe and Senaratne (1986, 1996), Salje et al. (1999), Schärer et al. (2011), Scheepers et al. (1999), Scherer et al. (2007), Simonetti et al. (2005, 2006), Sinha et al. (1992), Siyanbola et al. (2005), Slama et al. (2008), Stern and Amelin (2003), Sturm (1999), Tanner et al. (2004), Tennant et al. (2004), Tiepolo (2003), Tiepolo et al. (2003), Trachenko et al. (2002), Trocellier and Delmas (2001), Valley (2003), Valley et al. (1994, 1998, 2005), Vavra (1990), Wang et al. (1991), Wang and Ewing (1992), Watson and Cherniak (1997), Watson et al. (1997, 2006), Watson and Harrison (2005), Wayne and Sinha (1988), Weber (1990), Weber et al. (1994), Wiedenbeck et al. (2007), Woodhead et al. (2004), Woodhead et al. (1991), Wu and Zheng (2004), Yada et al. (1987), Yuan et al. (2004), Zhang and Salje (2001, 2003), Zhang et al. (2000, 2004)	

*Special attention: heat treatment*

### 6.1.92. Zoisite

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Dichroscope	
Polariscope	
EDXRF chemistry	Cobalt coating
<i>References</i>	
Alemany et al. (2000), Armbruster et al. (2006), Barot and Boehm (1992), Blauer (1996), Comodi and Zanazzi (1997), Czaja et al. (1995), Dörsam et al. (2007), Feineman et al. (2007), Franz and Selverstone (1992), Gottschalk (2004), Grevel et al. (2000), Javier-Ccallata et al. (2011), Jenkins et al. (1985), Koziarska et al. (1994), Langer et al. (2002), Liebscher et al. (2002), Liu et al. (1995), Malisa (2003a,b, 2005), Malisa and Kinabo (2005), McClure and Shen (2008), Muhongo et al. (1999), Notari et al. (2001), Pardieu et al. (2009), Pearson (2008), Poli and Schmidt (1998), Reddy et al. (2011), Schroeder (2010), Smith et al. (1987), Srinivasulu et al. (1992), Wilson et al. (2009), Winkler et al. (1989)	

*Special attention: heat treatment, clarity enhancement, coating*

## 6.2. Test methods pearls and organic gem materials

### 6.2.1. Amber

<i>Required Test method</i>	<i>Remark</i>
Microscope	Acetone reaction, thermal reaction test
Polariscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
FTIR(-NIR) spectroscopy	
<i>References</i>	
Alexandrowicz and Kwiecinska (1977), Anderson (2001, 2006), Anderson and Bray (2006), Anderson and Muntean (2000), Angelini and Bellintani (2005), Azar (2007), Beck et al. (1965), Beck (1982b), Beck et al. (1964), Benson (1961a), Brodzinsky (1985), Brouwer and Brouwer (1980), Brown (1982, 1996a), Brown and Lund (1979), Brown and Snow (1988), Bubshait and Sturman (1993a,b,1996), Cario (1989), Costa (2007), Cox (1953), Crowningshield (1964b, 1977a), Delclos et al. (2007), Dierick et al. (2007), Faibisovich and Bordovskaya (1996), Farrington (1923), Feist et al. (2007), Field (1947), Francis (1988), Fraquet (1982, 1989), Fryer (1983, 1985, 1986, 1987a,b, 1988, 1991, 1993a,b), Grimaldi et al. (1994), Gübelin (1978), Gübelin and Koivula (1986), Helm (1892, 1893, 1894), Hernandez (1980), Hillmer (1999), Hlaing (1999), Hollick (1905), Johnson and Koivula (1997a,b), Kennedy (2002), Koivula and Fritsch (1993a,b,c), Koivula and Kammerling (1992a), Koivula et al. (1992b,c, 1993d, 1995a,b), Kosmowska (1990), Langenheim and Beck (1965), Liddicoat (1970), Liebert (1996), Mills et al. (1984), Mukerjee (1997), Pedersen (2008), Peng and Zhu (2006), Poinar et al. (1999), Poirot (1992), Ragazzi et al. (2003), Rice (1979, 1981b), Safar and Sturman (1998), Scarratt (1986a,b, 1989a,b,c,d), Webster (1951)	

*Special attention: clarity enhanced, dyed, heated (with pressure), pressed, reconstructed (encased in plastics), faked insects, recent resins*

### 6.2.2. Bone

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
<i>References</i>	
Arnould and Poirot (1975), Brown and Lund (1979), Cagnet et al. (2003), Lesh (1980), Mann and Brown (2008), Pewkliang et al. (2008), Scarratt (1992), Webster (1948)	

*Special attention: dye, impregnation*

### 6.2.3. Copal

<i>Required Test method</i>	<i>Remark</i>
Microscope	Acetone reaction, thermal reaction test
Polariscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
FTIR(-NIR) spectroscopy	

<i>References</i>
Clery (2002), Winkler et al. (2001)

#### 6.2.4. Coral

<i>Required Test method</i>	<i>Remark</i>
Microscope	Thermal reaction test
Refractometer (refractive index)	If possible
Hydrostatic weighing (specific gravity)	
FTIR(-NIR) spectroscopy	If other tests are inconclusive
Raman spectroscopy	If other tests are inconclusive

<i>References</i>
Akagi et al. 2004; Alamaru et al. 2009; Aliprandi et al. 1983; Allison 1996; Anderson, 2008; Bayer 1996; Beger et al. 2003; Benson 1959; Bocchio et al. 2006; Böhm et al. 2006; Bramanti et al. 2005; Brown 1977, 1978, 1979, 1985; Brown 1996; Brown and Lund 1979; Bubshait and Sturman 1993; Calcinai et al. 2002; Cicogna and Cattaneo-Vietti, 1993; Cohen and McConnaughey 2003; Connell et al. 1997; Crowningshield 1960a, 1975a; de Villiers et al. 1994; Dele-Dubois et al. 1981; Deng et al. 2010; Douglas 2003; Emms 1997; Fritsch and Karampelas 2008a, b; Fryer 1981a, 1984a, 1990a; Gao and Zhang 2002; Gauthier and Karampelas 2009; Greeger et al. 1997; Grigg 1993, 2001, 2004; Grigg and Brown 1991; Grottoli and Eakin 2007; Hakomori and Seto 1951; Henn 2006; Johnson and Koivula 1998a; Karampelas et al. 2009; Kiefert et al. 2000; Koivula and Kammerling 1990a; Leverette et al. 2008; Liddicoat 1974a; Linares et al. (2010); Love et al. 2007; MacFall 1974; Merlin and Dele-Dubois 1986; Nassau 1979a, b; Opresko 1996; Peres and Picard (1964), Pienaar 1981; Roger 1991; Rolandi et al. 2005; Santangelo et al. (1993), Scarratt 1984a, d; Scarratt 1996; Shirai et al. 2008; Sholkovitz and Shen 1995; Sinkankas 1996; Smith et al. 2007; Taki and Hosaka 1988; Torrents et al. 2005; Ugalde et al. 2004; Webster 1954, 1958a, 1973; Wei and Qiu 2004; Weldon 1996

#### 6.2.5. Horn

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Raman spectroscopy	If other tests are inconclusive

<i>References</i>
Brown (1976), Liddicoat (1970), Webster (1973)

*Special attention: dye, imitations*

#### 6.2.6. Ivory – elephant, mammoth/mastodon, hippopotamus, walrus, narwhal

<i>Required Test method</i>	<i>Remark</i>
Microscope	Growth structures
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Long-wave UV fluorescence	
Raman spectroscopy	
X-Ray CT scan	In some cases to view growth structures



<i>References</i>
Boone (1986), Brown (1978, 1990, 1996), Brown and Lund (1979), Brown and Mann (2007), Brown and Moule (1982), Carra (1970), Crowningshield (1970a,b, 1979), Cuadra (1994), Edwards et al. (1996), Fryer (1981, 1988, 1997), Kunz (1916), Lee (1991), Lesh (1980), Liddicoat (1969a,b), Scarratt (1992), Strack (1975), Webster (1948, 1973)

*Special attention: dye, imitations, CITES issues.*

### 6.2.7. Ivory - vegetable

<i>Required Test method</i>	<i>Remark</i>
Microscope	Growth structures
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
<i>References</i>	
Brown (1996), Scarratt (1992), Webster (1949)	

### 6.2.8. Pearl (*Abalone Species*)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Microradiography	
UV-Visible(-NIR) spectroscopy	
Raman spectroscopy	
<i>References</i>	
(Aboosally 1998; Anonymous 2000; Bostwick 1938; Brown 1994, 2006; Cropp 1997; Crowningshield 1961a, 1965; Day et al. 2000; Edwards 1913; Fankboner 1991; Fankboner 1995, 2001, 2002; Fryer 1984a, 1993, 1996c, d; Johnson and Koivula 1996a; Kammerling and Fryer 1994; Kelly and Brown 2003; Landman et al. (2001), Li and Zhang 2001; Liu et al. (2002), Luckow 1989; Miyashita and Takagi 2011; Strack (2006), Verma et al. 2006; Wentzell 1998, 2004; Yao et al. 2006; Zarembo et al. 1996)	

*Special attention: blister versus cyst, damage by acids*

### 6.2.9. Pearl (*Cassis species*)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Microradiography	
UV-Visible(-NIR) spectroscopy	
Raman spectroscopy	
<i>References</i>	
Landman et al. (2001), Strack (2006)	

*Special attention: possible similarity with Melo pearls and other orange porcellaneous pearls, damage by acids, shell imitations*

### 6.2.10. Pearl (*Lobatus gigas/Strombus gigas – Conch*)

<i>Required Test method</i>	<i>Remark</i>
Microscope	

UV-Visible(-NIR) spectroscopy	
Raman spectroscopy	
<i>References</i>	
Anonymous (1977), Acosta-Salmon and Davis 2007; Davis et al. 1986; Farn (1977, 1979a,b, 1986), Fritsch and Misiorowski (1987), Kamat et al. (2000), Komatsu et al. 1993; Kornitzer (1937), Landman et al. (2001), Mikkelsen (2003), Moses (2001), Sciaquato (2004), Stoner and Ray 1996; Strack (2006)	

*Special attention: X-ray discolouration to pink samples, possible similarity to other porcellaneous pearls when not the usual pink colour (i.e., white, orange to purplish), damage by acids, shell imitations*

### 6.2.11. Pearl (*Hyriopsis cummingi* and other freshwater mussels)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Microradiography	
UV-Visible(-NIR) spectroscopy	Off-white (stronger than light tones) samples only
EDXRF chemistry	
Raman spectroscopy	
LA-ICP-MS chemistry	If EDXRF is inconclusive
X-Ray CT scan	Difficult cases
<i>References</i>	
Akamatsu et al. (2001), Anonymous (2005a,b), Bai et al. 2012; Farn (1986), Hänni (2000), Howells (2005), Izumida et al. 2011; Jobbins et al. (1993), Karampelas et al. 2007; Landman et al. (2001), Mikkelsen (2003), Scarratt et al. (2000), Sweeny and Latendresse (1982), Strack (2006); Wen et al. 2007; Zhang et al. 2002	

*Special attention: natural versus non-beaded cultured, blister versus cyst, bleaching, irradiation, dyes, Maeshori treatment, damage by acids.*

### 6.2.12. Pearl (Imitation)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Microradiography	
Raman spectroscopy	If other tests are inconclusive
<i>References</i>	
Bubshait and Sturman 1996; Farn 1976, 1978, 1979, 1986; Fryer 1984c, d, e, 1986b; Hänni 1996; Johnson and Koivula 1997c, 1999; Kammerling and Fryer 1995a; Kennedy et al. 1988; Koivula et al. 1992a; Mayerson 2001; Poirot 1987; Pough 1965; Scarratt 1984e, 1985b, 1986a, 1992c; Strack (2006), Tan et al. 2005; Webster 1958b, 1966, 1973; Wentzell 2004b	

*Special attention: mixed into items with nacreous samples. When applying microradiography, some solid plastic imitations may appear similar to nacreous pearls with a tight structure.*

### 6.2.13. Pearl (*Lambis* species)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Microradiography	

UV-Visible(-NIR) spectroscopy	
Raman spectroscopy	
<i>References</i>	
Landman et al. (2001), Strack (2006)	

*Special attention: possible similarity to other brownish or near-white porcelaneous pearls, damage by acids.*

#### 6.2.14. Pearl (*Melo species*)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
UV-Visible(-NIR) spectroscopy	
Raman spectroscopy	
<i>References</i>	
Landman et al. (2001), Poppe (1992), Scarratt 1992d, 1994b; Sciaguato 2004; Strack (2006); Traub 1997; Traub et al. 1999	

*Special attention: X-ray discolouration to orange samples, possible similarity to other orange porcellaneous pearls, damage by acids, check for shaped examples, shell imitations*

#### 6.2.15. Pearl (*Mercenaria mercenaria*)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Microradiography	
UV-Visible(-NIR) spectroscopy	
Raman spectroscopy	
<i>References</i>	
Hill (2004), Landman et al. (2001), Strack (2006)	

*Special attention: possible similarity to other purplish or even white non-nacreous pearls, damage by acids.*

#### 6.2.16. Pearl (*Mytilus species*)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Microradiography	
UV-Visible(-NIR) spectroscopy	
Raman spectroscopy	
<i>References</i>	
Caceres-Martinez and Vasquez-Yeomans 1999; Landman et al. (2001), Narasimhulu and Rao 2000; Strack (2006); Vander Putten et al. 2000; Wentzell and Elen 2004	

*Special attention: possible similarity to other dark hued or purplish nacreous pearls, damage by acids.*

#### 6.2.17. Pearl (*Pinctada fucata*)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Microradiography	
UV-Visible(-NIR) spectroscopy	Off-white pearls only
EDXRF chemistry	
Raman spectroscopy	
<i>References</i>	
Farn (1986), Hänni (2006), Hurwit (2001), Landman et al. (2001), Mikkelsen (2003), Shirai (1994), Shouguo and Lingyum (2001), Strack (2006), Traub et al. (1999), Walker and Mayerson (2001)	

*Special attention: possible similarity to other nacreous pearls, blister versus cyst, coatings, irradiated bead nuclei in bead cultured pearls, damage by acids.*

#### 6.2.18. Pearl (*Pinctada margaritifera*)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Microradiography	
UV-Visible(-NIR) spectroscopy	
EDXRF chemistry	
Raman spectroscopy	
<i>References</i>	
Ellis and Haws 1999; Farn (1986), Hänni (2006), Hodgkinson 2002; Iwahashi and Akamatsu 1994; Karampelas et al. 2011; Landman et al. (2001), Liu et al. 1999; Mikkelsen (2003), Miyoshi et al. 1987; Pouvreau and Prasil 2001; Rousseau and Rollion-Bard 2012, Sanchez (2004), Shirai (1994), Shouguo and Lingyum (2001), Strack (2006), Wentzel et al. (2000)	

*Special attention: possible similarity to other nacreous pearls, blister versus cyst, dye, bleaching (“Chocolate pearls”), coatings, damage by acids.*

#### 6.2.19. Pearl (*Pinctada maxima*)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Microradiography	
UV-Visible(-NIR) spectroscopy	Off-white (stronger than light tones) samples only
EDXRF chemistry	
Raman spectroscopy	
LA-ICP-MS chemistry	If EDXRF is inconclusive
X-Ray CT scan	Difficult cases
<i>References</i>	
Elen (2001, 2002), Ellen and Wentzell (2003), Farn (1986), Hänni (2006), Landman et al. (2001), Mikkelsen (2003), Scarratt (1992, 2001), Scarratt et al. (2012), Shirai (1994), Shouguo and Lingyum (2001), Strack (2006), Traub et al. (1999), Wentzel et al. (2000)	

*Special attention: natural versus non-beaded cultured, possible similarity to other nacreous pearls, blister versus cyst, dye, bleaching, coatings, Maeshori treatment, damage by acids.*

**6.2.20. Pearl (*Pinctada mazatlantica*)**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Microradiography	
UV-Visible(-NIR) spectroscopy	
EDXRF chemistry	
Raman spectroscopy	
<i>References</i>	
Hurwit (2000), Landman et al. (2001), McLaurin (2002), Mikkelsen (2003), McLaurin and Arizmendi (2002), Strack (2006)	

*Special attention: possible similarity to other nacreous pearls, blister versus cyst, dye, bleaching (“Chocolate pearls”), coatings, damage by acids.*

**6.2.21. Pearl (*Pinctada radiata*)**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Microradiography	
UV-Visible(-NIR) spectroscopy	Off-white (stronger than light tones) samples only
EDXRF chemistry	
Raman spectroscopy	
X-Ray CT scan	Difficult cases
<i>References</i>	
Fam (1986), Landman et al. (2001), Mikkelsen (2003), Shirai (1994), Shouguo and Lingyum (2001), Strack (2006), Traub et al. (1999)	

*Special attention: natural versus non-beaded cultured, possible similarity to other nacreous pearls, blister versus cyst, dye, bleaching, coatings, damage by acids.*

**6.2.22. Pearl (*Pinna* species [including *Atrina* species])**

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Microradiography	
UV-Visible(-NIR) spectroscopy	
EDXRF chemistry	
Raman spectroscopy	
<i>References</i>	
Landman et al. (2001), Gauthier et al. (1997), Karampelas et al. (2009), Sturman (2014), Strack (2006), Wentzel and Elen (2005)	

*Special attention: possible similarity to other dark hued nacreous and non-nacreous pearls, durability of heavily cracked samples, damage by*

**Pearl (*Pleuropoca* species)**

<i>Required Test method</i>	<i>Remark</i>
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Microscope	
Microradiography	
UV-Visible(-NIR) spectroscopy	
Raman spectroscopy	
<i>References</i>	
Landman et al. (2001), Strack (2006)	

*Special attention: possible similarity to other yellowish to brown porcellaneous pearls, damage by acids*

### 6.2.23. Pearl (*Pteria* species)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Microradiography	
UV-Visible(-NIR) spectroscopy	
EDXRF chemistry	
PL spectroscopy	Helps with mollusc identification in some cases
Raman spectroscopy	
<i>References</i>	
Hurwitt (2003), Landman et al. (2001), Mao et al. (2004), Strack (2006)	

*Special attention: natural versus non-beaded cultured, a-typical bead nuclei, possible similarity to other nacreous pearls, blister versus cyst, bleaching, dyes, coatings, damage by acids.*

### 6.2.24. Pearl (*Scallop [pectinidae]* species)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Microradiography	
UV-Visible(-NIR) spectroscopy	
Raman spectroscopy	
<i>References</i>	
Federman (2004), Landman et al. (2001), Moragat et al. (2001), Scarratt and Hänni (2004), Strack (2006), Wight (2004)	

*Special attention: possible similarity to other white to lightly coloured non-nacreous/porcellaneous pearls, damage by acids.*

### 6.2.25. Pearl (*Tridacna [clam]* species)

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Microradiography	
UV-Visible(-NIR) spectroscopy	
Raman spectroscopy	
<i>References</i>	
Hardy (1947), Landman et al. (2001), Strack (2006)	

*Special attention: possible similarity to other white to lightly coloured porcellaneous pearls, shell imitations, CITES, damage by acids*

### 6.2.26. Shell

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
<i>References</i>	
Brown 1986, 1988, 1995; Chateigner et al. 2000; Compere and Bates 1973; Dauphin et al. 2008; Dauphin et al. 2005; Day et al. 2000; Farn 1979; Farre et al. 2007; Fitzpatrick and Boyle 2002; Giridhar and Srivatsa 1999; Hainschwang et al. 2010; Hardy 1959; Hedegaard et al. 2006; Hill and Carmihael 2004; Koivula and Kammerling 1989c, d, 1991b; Koivula et al. 1992a; Lee et al. 2008; Li and Zhang 2001; Li 2007; Lin et al. 2006; Liu et al. 2003a; Liu et al. 2002; Liu et al. 2003b; Liu et al. 1999; Markwitz et al. 2003; Mayerson 2001; Narasimhulu and Rao 2000; Parker 1989; Ren et al. 2009; Saucedo et al. 1998; Suzuki et al. 2011; Tagliamonte 1984; Webster (1966), Wye 1991; Yao et al. 2006	

*Special attention: dye, lustre enhancement*

### 6.2.27. Tortoise shell

<i>Required Test method</i>	<i>Remark</i>
Microscope	
Refractometer (refractive index)	
Hydrostatic weighing (specific gravity)	
Short-wave UV phosphorescence	
<i>References</i>	
Brown 1978, 1995b; Brown and Lund 1979; Hainschwang and Leggio 2006; Scarratt 1992a	

*Special attention: structure, protein smell (hot point), plastic (common imitation)*

## 6.3. Test methods definitions

### 6.3.1. Clarity enhancement check/extent

Detection of filling of fissures and/or wide fractures and cavities with oils, resins, or any other filler, and an estimation of the extent of this treatment (e.g., none/ insignificant, minor, moderate, or significant).

### 6.3.2. Colour call

Precise colour description is required, for instance to make sure a colour-change is present, or to establish whether a sapphire may be called Padparadscha.

### **6.3.3. Chelsea colour filter**

A filter that only transmits deep red and yellow-green light.

### **6.3.4. DiamondView**

The DiamondView instrument illuminates a diamond with intense short-wave ultra-violet radiation and detects the surface fluorescence that is caused. Fluorescence and Phosphorescence images, showing clear growth patterns, are projected on a computer screen.

### **6.3.5. Dichroscope**

An instrument that allows to detect whether a gemstone shows pleochroism and, if it does, to observe the pleochroic colours side by side, for easy comparison and description.

### **6.3.6. EDXRF chemistry**

Energy-dispersive X-ray fluorescence is a technique whereby a sample is targeted by a high-energy X-ray beam, causing its chemical elements to fluoresce with a spectrum of lower-energy X-rays, each peak being characteristic of a chemical element. The relative concentrations of elements are indicated by the fluorescent X-ray peak intensities.

### **6.3.7. FTIR(-NIR) spectroscopy**

Accurate measurement of absorption or transmission positions, and their relative intensities in the (near-)infrared range of the electromagnetic spectrum. The resulting spectra are measured and digitally recorded by a Fourier Transform Infrared spectrometer. “Fourier Transform” is a mathematical technique used to convert the spectrometer signal into a spectrum plotted as a function of energy. The measurements can be done in different modes, such as e.g., transmission, diffusion reflectance, or by using KBr pellets.

### **6.3.8. Hydrostatic weighing**

The method used to measure the specific gravity (SG) of a gemstone. It is based on the principle of Archimedes, comparing the weight of an object in air (A) with the weight of that object in water (W). The SG can then be calculated:

$$SG = A/(A-W).$$

### **6.3.9. Immersion**

A gemstone is immersed in a liquid with a similar refractive index to observe features that are otherwise not or less visible, for instance colour distribution or zoning.

### **6.3.10. LA-ICP-MS Chemistry**



Laser Ablation Inductively Coupled Plasma Mass Spectrometry is an analytical technology that enables highly sensitive elemental and isotopic analysis to be performed directly on solid samples. LA-ICP-MS begins with a laser beam focused on the sample surface to generate fine particles – a process known as Laser Ablation. The ablated particles are then transported to the secondary excitation source of the ICP-MS instrument for digestion and ionisation of the sampled mass. The excited ions in the plasma torch are subsequently introduced to a mass spectrometer detector for both elemental and isotopic analysis. It is not entirely non-destructive, but can perform ultra-highly sensitive chemical analysis down to ppb (parts per billion) level.

#### **6.3.11. Microradiography**

The process of taking a photograph of an object by using X-rays, showing minute internal structure.

#### **6.3.12. Microscope**

A gemmological microscope is a stereo binocular microscope with good depth of vision and field of view, with generally magnification varying in between 10x and 80x. Research microscopes with much higher magnification power may be used as well in gemmological laboratories.

#### **6.3.13. Phenomena**

Detection of phenomena, such as colour-change of a gemstone, when viewed in different light conditions, play of colour, labradorescence, reflection of light by inclusions causing chatoyancy (Cat's-eye), asterism (Star), aventurescence, adularscent; inclusion patterns causing the trapiche effect, bloodshot effect.

#### **6.3.14. PL spectroscopy**

Detection of photoluminescence (light emission) of an object illuminated by a laser. Light emission occurs after the excitation by photons (electromagnetic radiation). Different lasers may be used, for example red (633 nm), green (514 and 532 nm), blue (488 nm) and UV (250 nm) lasers. For diamonds, PL is usually performed at low temperature (-196°C)

#### **6.3.15. Pleochroism**

A property of doubly refractive coloured gemstones of absorbing light to an extent that depends on the vibration direction of the polarised light rays. The effect causes two different colours (*dichroism*) or three different colours (*trichroism*), depending on the type of gemstone. These different colours may be seen when viewing a gemstone from different directions under transmitted light.

#### **6.3.16. Polariscope**

A polariscope is an instrument with two polarising filters fitted one above the other in a fixed crossed position, meaning that the transmitted vibration direction of polarisation of the upper filter is at right angles to that of the lower filter. The filters are either fixed on an inbuilt light or placed on a separate light source.

### **6.3.17. Raman spectroscopy**

Detection of an extremely slight shift of energy of the light or radiation scattered on the surface of an object illuminated by a laser. The resulting re-emitted spectrum, or Raman spectrum, is characteristic for different (solid or fluid) substances, and allows rapid identification, also if they are enclosed within another transparent substance. Different lasers may be used, for example near-infrared (780 nm), red (633 nm), green (514 and 532 nm), blue (488 nm) and UV (250 nm) lasers.

### **6.3.18. Refractometer**

The gemmological refractometer is designed to measure the refractive index or indices of a gemstone. It makes use of total internal reflection of monochromatic light, going through an in-built special type of glass, which is in contact with a flat, polished surface of a gemstone.

### **6.3.19. Refractive index**

A simple relationship between the light's angle of incidence and angle of refraction (the amount of bending), when it reaches and enters a gemstone. The slower the light's speed in a material, the greater the bending effect, thus the higher the refractive index. Depending on the structure of the material, light will remain as a single ray or be split into two rays; the effects are called "single refraction" (giving one refractive index), and "double refraction" (giving two refractive indices, with a minimum and maximum value).

### **6.3.20. Residue check/ extent**

Detection of residue in healed fissures and/or filled cavities as a result of heat-treatment, and an estimation of the extent of this treatment (e.g., none/ insignificant, minor, moderate, or significant).

### **6.3.21. Spectroscope**

A spectroscope is essentially a tube with a narrow slit at one end and a lens at the other, with in between an arrangement of optically connected prisms, or a diffraction grating, creating a spectrum - spectral colours of white light that enters the slit and are spread out by the prisms or grating and can be viewed through the lens.

### **6.3.22. Long-wave UV fluorescence**

Emission of visible light by a substance when excited by long-wave ultraviolet radiation (principal wavelength of 365 nm), produced by a UV-lamp.

### **6.3.23. Long-wave UV phosphorescence**

Continued emission of visible light by a substance after excited by long-wave ultraviolet radiation (principal wavelength of 365 nm), produced by a UV-lamp.

### **6.3.24. SEM-EDS**

Scanning Electron Microscopy with Energy Dispersive X-Ray microanalysis is a technique, using an electron beam to scan the surface of an object. Scattered electron reflections are detected at very high magnification which are displayed as black-and-

white images on a screen. Elemental analysis and mapping can be obtained, as the electrons also cause the object's chemical elements to emit a spectrum of X-rays, each peak being characteristic of a chemical element.

#### **6.3.25. Short-wave UV fluorescence**

Emission of visible light by a substance when excited by short-wave ultraviolet radiation (principal wavelength of 254 nm), produced by a UV-lamp.

#### **6.3.26. Short-wave UV phosphorescence**

Continued emission of visible light by a substance after excited by long-wave ultraviolet radiation (principal wavelength of 365 nm), produced by a UV-lamp.

#### **6.3.27. Specific Gravity**

The ratio of the weight of a substance to the weight of an equal volume of water.

#### **6.3.28. UV-Visible(-NIR) spectroscopy**

Accurate measurement of absorption or transmission positions, and their relative intensities in the UV, Visible light (and near-infrared) range of the electromagnetic spectrum. The resulting spectra are measured and digitally recorded by a UV-Visible(-NIR) spectrometer.

#### **6.3.29. X-Ray CT scan**

X-Ray computed tomography makes use of computer-processed combinations of many X-ray images taken from different angles around a single axis of rotation, to produce cross-sectional (tomographic) images (virtual "slices") of specific areas of a scanned object, allowing the user to see inside the object without cutting. Digital geometry processing is used to generate a three-dimensional image of the inside of the object.

#### **6.3.30. XRD**

X-Ray Diffraction is a scattering of X-rays by the atoms of a crystal that produces an interference effect so that the diffraction pattern gives information on the structure of the crystal or the identity of a crystalline substance. One of two primary types of XRD analysis (X-ray powder diffraction and single-crystal XRD) is commonly applied.

## 7. Gem materials list and definitions

### 7.1. Gemstones general terms and definitions

#### 7.1.1. Gemstone

Natural inorganic, organic or biogenic material which has been formed completely by nature without human interference. Gemstones are usually used in jewellery or objets d'art due to a combination of properties that provide them with beauty, rarity and relative durability. (*CIBJO Gemstone blue book, 2018-1; terms and definitions 5.38*)

*Treated gemstone* is a gemstone that has been treated by ways other than normal lapidary practices to change their appearance and or durability. (*CIBJO Gemstone blue book, 2018-1; terms and definitions 5.82*)

Gemstones encompass:

- Minerals (e.g., aquamarine, diamond, emerald, garnet, opal, sapphire)
- Natural glasses (e.g., obsidian)
- Rocks (e.g., lapis lazuli, opal with matrix and turquoise with azurite and malachite)
- Organic gem materials (e.g., amber and jet)
- Biogenic gem materials (e.g., pearl, coral and tortoise shell)

(*CIBJO Gemstone blue book, 2018-1; classification of materials, 3.1.1.*)

A gemstone name may reflect a mineral supergroup (e.g., tourmaline), a mineral group (e.g., garnet), a mineral species as accepted by IMA (e.g., jadeite), a mineral variety (e.g., aquamarine), a natural glass, a rock, an organic or biogenic material, or may be a commercial or trade name.

NOTE - Definitions of artificial products which encompass artificial products with gemstone components, synthetic stones, artificially crystallised products with no known natural counterpart and artificial uncrystallised products can be found in the CIBJO Gemstone blue book.

#### 7.1.2. Mineral

A mineral is an element or chemical compound that is normally crystalline and that has been formed as a result of geological processes (*IMA definition; Nickel, 1995*).

*Mineral supergroup:* A mineral supergroup consists of two or more mineral groups which have essentially the same structure and are composed of chemically similar elements (Mills et al., 2009)

*Mineral group:* A mineral group consists of two or more minerals with the same or essentially the same structure, and composed of chemically similar elements (Mills et al., 2009)

*Mineral species:* a mineral, which is accepted by IMA

*Mineral variety:* a specific variety of a mineral species. The IMA has strict

rules to describe minerals and to get new mineral names approved. However, it has no such system for variety names.

### **7.1.3. Natural glass**

a silica-rich, amorphous solid of either volcanic origin or formed from terrestrial molten debris ejected during meteorite impacts.

### **7.1.4. Rock**

a natural solid aggregate of minerals.

*(CIBJO Gemstone blue book, 2018-1; terms and definitions, 5.71.)*

### **7.1.5. Organic gem material**

gem material (5.37), relating to or derived from living matter, usually used in jewellery or objets d'art due to a combination of properties that provide it with beauty, rarity and relative durability.

*(CIBJO Gemstone Book, 2018-1; terms and definitions, 5.59.)*

### **7.1.6. Biogenic gem material**

gem material (5.37), resulting from the activity of living organisms usually used in jewellery or objets d'art due to a combination of properties that provide it with beauty, rarity and relative durability.

*(CIBJO Gemstone Book, 2018-1; terms and definitions, 5.9.)*

### **7.1.7. Gemstone variety**

a material that fulfills the definition of a gemstone. A gemstone variety is defined by one or more of the following features:

- A particular colour or colour range
- A particular colour pattern or texture (may include intergrowth textures)
- Colour-change
- Optical effect (chatoyancy, asterism)
- Presence of (a) particular chromophore(s)
- Presence of (a) particular colour centre(s)
- A particular crystallinity (coarsely crystalline, micro- or crypto-crystalline, metamict)
- Different degrees of porosity (e.g., agate)
- A particular inclusion content (e.g., rutilated quartz)

To be accepted as a new gemstone variety, a particular name can be identified according to the features mentioned above, it should have gained global acceptance, and it should have been included as a trade name in the CIBJO Gemstone book and being recommended as a new gemstone variety by the CIBJO Committee on Varietal Names (CVN).

### **7.1.8. Commercial name**

a name assigned for marketing purposes. (*CIBJO Gemstone blue book, 2018-1; terms and definitions, 5.18.*)

The terms ‘commercial name’ and ‘trade name’ are synonymous. Commercial names would include, but are not limited to, brand names and trademarks. Trademarks and brand names will not be listed in the CIBJO gemstone and gemmological laboratory blue book because of legal restrictions.

*References:*

CIBJO Blue Books - The Gemstone book, 2018-1.

Mills S.J., Hatert F., Nickel E.H., Ferraris G., 2009. The standardisation of mineral group hierarchies: application to recent nomenclature proposals. *European Journal of Mineralogy*, 21, 1073 –1080.

Nickel E.H., 1995. The definition of a mineral. *Canadian Mineralogist*, 33, 689-690.

## 7.2. Definitions of gemstones

In addition to the required test methods to correctly identify gem materials, brief definitions and descriptions of gem materials are given below, when applicable.

The International Mineralogical Association (IMA) has strict rules to describe minerals and to get new mineral names approved. The commission on gem materials of the IMA produced a list of gem materials, which indicates the IMA status of mineral names. However, there is no such system for variety names. Additionally there are many loosely applied trade names for gem materials, which lack any definition. The list below seeks to give clarity on names used; for each name it is indicated whether it is an approved mineral name, or if not, whether it is considered as a variety or trade name.

*Approved mineral names:* in the cases of approved mineral names, this is just stated, without any further description. A list of approved mineral names and chemical formulae (the IMA list of minerals) can be found at the IMA website. A list and database with mineral properties can be accessed at <https://rruff.info/ima/>.

The IMA status is indicated as follows:

- A = approved (minerals approved after the establishment of the IMA in 1958)
- G = grandfathered (minerals discovered before the birth of IMA and generally considered as valid species)
- Rd = redefined (existing minerals which were redefined during the IMA era)
- Rn = renamed (existing minerals which were renamed during the IMA era)

*Variety and trade names:* in the cases of variety and trade names the relation with the mineral group or species is indicated, followed by a brief description and criteria for distinction from other varieties, if applicable.

A list of gemstones with information on possible treatments, trade codes used, the degree of stability, care advice and availability of synthetic equivalents, can be found in

Annex D of the *CIBJO Gemstone Book*.**7.2.1. Definitions gemstones of inorganic origin (minerals, natural glasses, rocks)****7.2.1.1. Achroite**

Mineral group	tourmaline
Mineral species	
IMA status	
Mineral/Gem variety	<b>achroite</b>
Rock	
Trade name	
Description	Colourless variety of tourmaline
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-4003.html">https://www.mindat.org/min-4003.html</a>	

**7.2.1.2. Actinolite**

Mineral group	amphibole
Mineral species	<b>actinolite</b>
IMA status	Rd
Mineral/Gem variety	
Rock	
Trade name	
Description	Light to dark green, yellowish green, black; transparent to opaque; may show chatoyancy
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-18.html">https://www.mindat.org/min-18.html</a>	

**7.2.1.3. Agate**

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>agate</b>
Rock	

Trade name	
Description	Chalcedony with curved or angular bands or layers, also called banded agate; chalcedony with other coloured patterns or dendritic inclusions may be called landscape agate, picture agate, moss agate and dendritic agate, respectively. Iris agate is translucent, with iridescent colours; Fire agate is largely opaque, with iridescent colours against a brown body colour.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-960.html">https://www.mindat.org/min-960.html</a> ; <a href="https://www.mindat.org/min-51.html">https://www.mindat.org/min-51.html</a> ; <a href="https://www.mindat.org/min-7601.html">https://www.mindat.org/min-7601.html</a> ; <a href="https://www.mindat.org/min-7610.html">https://www.mindat.org/min-7610.html</a> ; <a href="https://www.mindat.org/min-2791.html">https://www.mindat.org/min-2791.html</a>	

#### 7.2.1.4. Alabaster

Mineral group	
Mineral species	gypsum
IMA status	
Mineral/Gem variety	<b>alabaster</b>
Rock	
Trade name	
Description	Massive, aggregate variety of gypsum. White, grey, may be banded and patterned; translucent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-90.html">https://www.mindat.org/min-90.html</a>	

#### 7.2.1.5. Albite

Mineral group	feldspar (plagioclase)
Mineral species	<b>albite</b> (albite-anorthite series)
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	



Description	Albite is the sodium-rich endmember of the plagioclase series. White, cream, light brown, brownish pink, translucent, or nearly colourless and transparent; may show chatoyancy, play-of-colour or adularescence.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-96.html">https://www.mindat.org/min-96.html</a>	

#### 7.2.1.6. Alexandrite

Mineral group	
Mineral species	chrysoberyl
IMA status	
Mineral/Gem variety	<b>alexandrite</b>
Rock	
Trade name	
Variety description	Colour-changing chromium bearing variety of chrysoberyl, showing a colour change: essentially bluish green to green in daylight and purple to red, to purplish brown in incandescent light
Variety distinction criteria	<ul style="list-style-type: none"> <li>• <i>Colour-change</i>: main hue in daylight differs from that seen in incandescent light.</li> <li>• <i>Daylight</i>: for the purposes of this comparison calibrated daylight corresponding to a range between 5500K to 6500K shall be used.</li> <li>• <i>Incandescent light</i>: for the purposes of this comparison standard incandescent light corresponding to a range between 2700K and 3600K shall be used.</li> </ul>
<i>References</i>	
<a href="https://www.mindat.org/min-109.html">https://www.mindat.org/min-109.html</a>	

#### 7.2.1.7. Almandine

Mineral group	garnet
Mineral species	<b>almandine</b>
IMA status	G
Mineral/Gem variety	

Rock	
Trade name	
Description	Reddish purple to slightly purplish red; reddish orange to red, transparent and translucent, typically dark in tone; may show asterism.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-452.html">https://www.mindat.org/min-452.html</a>	

#### 7.2.1.8. Amazonite

Mineral group	feldspar
Mineral species	Microcline
IMA status	
Mineral/Gem variety	<b>amazonite</b>
Rock	
Trade name	
Description	Light green to greenish blue, often with white streaks, opaque to translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-184.html">https://www.mindat.org/min-184.html</a>	

#### 7.2.1.9. Amblygonite

Mineral group	
Mineral species	<b>amblygonite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Colourless to light yellow to greenish yellow, transparent; may be light pink, green, blue or brown
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-189.html">https://www.mindat.org/min-189.html</a>	

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#### 7.2.1.10. Amethyst

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>amethyst</b>
Rock	
Trade name	
Description	Violet to purple to reddish purple variety of quartz
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-198.html">https://www.mindat.org/min-198.html</a>	

#### 7.2.1.11 Ametrine

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>ametrine</b>
Rock	
Trade name	
Description	Bi-coloured variety of quartz with amethyst and citrine colours
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-7606.html">https://www.mindat.org/min-7606.html</a>	

#### 7.2.1.12. Ammolite

Mineral group	
Mineral species	Aragonite (mainly, may also contain pyrite, calcite)
IMA status	
Mineral/Gem variety	
Rock	Ammolite is usually found on a rock matrix (schist, limestone)
Fossil	Ammonite
Trade name	<b>Ammolite</b>

Description	Pseudomorph after the ammonite shell, often shows iridescent colours
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/taxon-7649433.html">https://www.mindat.org/taxon-7649433.html</a> ; <a href="https://www.mindat.org/min-8393.html">https://www.mindat.org/min-8393.html</a>	

### 7.2.1.13 Amphibole

Mineral group	amphibole
Mineral species	
IMA status	
Mineral/Gem variety	
Rock	
Trade name	
Description	see actinolite, nephrite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-207.html">https://www.mindat.org/min-207.html</a>	

### 7.2.1.14. Anatase

Mineral group	
Mineral species	<b>anatase</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	brown or blue, transparent; rarely cut as a gemstone
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-213.html">https://www.mindat.org/min-213.html</a>	

**7.2.1.15. Andalusite**

Mineral group	
Mineral species	<b>andalusite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Brownish or yellowish green to orangish brown, transparent (both green and orange are often visible because of strong pleochroism)
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-217.html">https://www.mindat.org/min-217.html</a>	

**7.2.1.16. Andesine**

Mineral group	Feldspar (plagioclase)
Mineral species	Albite (albite-anorthite series)
IMA status	
Mineral/Gem variety	<b>andesine</b>
Rock	
Trade name	
Description	A plagioclase feldspar with an albite : anorthite molar ratio ranging from 50 : 50 to 70 : 30. Colourless, light yellow to green, red, brownish red to orange, transparent.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-220.html">https://www.mindat.org/min-220.html</a> ; <a href="https://www.gia.edu/doc/separation-abduriyim.pdf">https://www.gia.edu/doc/separation-abduriyim.pdf</a>	

**7.2.1.17 Andradite**

Mineral group	garnet
Mineral species	<b>andradite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	

Description	Yellow, green, brown, black, transparent to opaque; see demantoid, melanite, topazolite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-223.html">https://www.mindat.org/min-223.html</a>	

### 7.2.1.18 Anorthite

Mineral group	Feldspar (plagioclase)
Mineral species	<b>Anorthite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Anorthite is the calcium-rich endmember of the plagioclase series. It is a rare composition of plagioclase, see bytownite, labradorite, spectrolite, sunstone
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-246.html">https://www.mindat.org/min-246.html</a>	

### 7.2.1.19 Antigorite

Mineral group	kaolinite-serpentine
Mineral species	<b>antigorite</b>
IMA status	Rd
Mineral/Gem variety	
Rock	
Trade name	
Description	One of the most common serpentine minerals. Usually dark green, may also be yellowish, grey, brown or black, translucent to opaque.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-260.html">https://www.mindat.org/min-260.html</a>	

**7.2.1.20 Apatite**

Mineral group	<b>apatite</b>
Mineral species	fluorapatite
IMA status	Rn
Mineral/Gem variety	
Rock	
Trade name	
Description	Yellow, green, violet, purple, blue, pink, brown, colourless, transparent to translucent; may show chatoyancy
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-29229.html">https://www.mindat.org/min-29229.html</a>	

**7.2.1.21 Aquamarine**

Mineral group	
Mineral species	beryl
IMA status	
Mineral/Gem variety	<b>aquamarine</b>
Rock	
Trade name	
Variety description	blue to blue-green beryl
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-289.html">https://www.mindat.org/min-289.html</a>	

**7.2.1.22 Aragonite**

Mineral group	
Mineral species	<b>aragonite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Colourless, white, grey, pink, light tones of

	yellow, brown, green, blue, violet; transparent to opaque.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-307.html">https://www.mindat.org/min-307.html</a> ; <a href="https://www.mindat.org/min-42711.html">https://www.mindat.org/min-42711.html</a>	

### 7.2.1.23 Aventurine quartz

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>aventurine quartz</b>
Rock	
Trade name	
Description	Translucent to opaque variety of quartz, commonly green, showing glittery reflections (aventurescence) from small, highly reflective mineral inclusions (such as mica)
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-436.html">https://www.mindat.org/min-436.html</a>	

### 7.2.1.24 Axinite

Mineral group	
Mineral species	<b>axinite</b>
IMA status	Rn (with -Fe, Mg, Mn suffix)
Mineral/Gem variety	
Rock	
Trade name	
Description	Brown, purplish brown, brownish yellow, violet, blue; transparent to translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1459.html">https://www.mindat.org/min-1459.html</a>	



**7.2.1.25 Azurite**

Mineral group	
Mineral species	<b>azurite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Light to dark blue to violetish blue; usually opaque to translucent, rarely transparent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-447.html">https://www.mindat.org/min-447.html</a> ; <a href="https://www.mindat.org/min-448.html">https://www.mindat.org/min-448.html</a>	

**7.2.1.26 Benitoite**

Mineral group	
Mineral species	<b>benitoite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Blue, violetish blue or rarely pink, transparent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-624.html">https://www.mindat.org/min-624.html</a>	

**7.2.1.27 Beryl**

Mineral group	
Mineral species	<b>beryl</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	see gem varieties aquamarine, emerald, green beryl, goshenite, heliodor, maxixe beryl,

	morganite, red beryl
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-819.html">https://www.mindat.org/min-819.html</a>	

### 7.2.1.28 Beryllonite

Mineral group	
Mineral species	<b>beryllonite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Colourless to pale yellow, transparent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-644.html">https://www.mindat.org/min-644.html</a>	

### 7.2.1.29 Black opal

Mineral group	
Mineral species	opal
IMA status	
Mineral/Gem variety	<b>black opal</b>
Rock	
Trade name	
Description	Play-of-colour against a black, dark grey, blue, green, brown or other dark body colour, translucent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3004.html">https://www.mindat.org/min-3004.html</a>	

### 7.2.1.30 Black crystal opal

Mineral group	
Mineral species	opal

IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>black crystal opal</b>
Description	Strong play-of-colour against a dark body colour
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3004.html">https://www.mindat.org/min-3004.html</a>	

### 7.2.1.31 Blue John

Mineral group	
Mineral species	fluorite
IMA status	
Mineral/Gem variety	<b>blue john</b>
Rock	
Trade name	
Description	Massive, bluish violet to purple in curved or angular bands on a colourless background; transparent to translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1576.html">https://www.mindat.org/min-1576.html</a> ; <a href="https://www.mindat.org/min-698.html">https://www.mindat.org/min-698.html</a>	

### 7.2.1.32 Boulder opal

Mineral group	
Mineral species	opal
IMA status	
Mineral/Gem variety	
Rock	ironstone or sandstone
Trade name	<b>boulder opal</b>
Description	Thin seam of opal with play-of-colour occurring in a host rock matrix (ironstone or sandstone)
Variety distinction criteria	
<i>References</i>	

<https://www.mindat.org/min-3004.html>

### 7.2.1.33 Bowenite

Mineral group	Kaolinite-serpentine
Mineral species	antigorite
IMA status	
Mineral/Gem variety	<b>bowenite</b>
Rock	
Trade name	
Description	Light to medium green to yellow-green, translucent variety of antigorite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-744.html">https://www.mindat.org/min-744.html</a>	

### 7.2.1.34 Brazilianite

Mineral group	
Mineral species	<b>brazilianite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	yellowish green to greenish yellow, rarely colourless, transparent to translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-760.html">https://www.mindat.org/min-760.html</a>	

### 7.2.1.35 Bytownite

Mineral group	feldspar (plagioclase)
Mineral species	anorthite (albite-anorthite series)
IMA status	
Mineral/Gem variety	<b>bytownite</b>
Rock	
Trade name	

Description	A plagioclase feldspar with an albite : anorthite molar ratio ranging from 10 : 90 to 30 : 70. Colourless, yellowish, reddish brown, labradorescent; transparent, translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-815.html">https://www.mindat.org/min-815.html</a>	

### 7.2.1.36 Bronzite

Mineral group	
Mineral species	enstatite
IMA status	
Mineral/Gem variety	<b>bronzite</b>
Rock	
Trade name	
Description	Green-brown iron-bearing variety of enstatite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-5293.html">https://www.mindat.org/min-5293.html</a> ; <a href="https://www.mindat.org/min-1995.html">https://www.mindat.org/min-1995.html</a>	

### 7.2.1.37 Calcite

Mineral group	
Mineral species	<b>calcite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Colourless, white, yellow, pink, bluish, orange; transparent, translucent and opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-859.html">https://www.mindat.org/min-859.html</a> ; <a href="https://www.mindat.org/min-34300.html">https://www.mindat.org/min-34300.html</a> ; <a href="https://www.mindat.org/min-9507.html">https://www.mindat.org/min-9507.html</a>	

**7.2.1.38 Californite**

Mineral group	
Mineral species	vesuvianite
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>californite</b>
Description	Green to yellowish or brownish green, often mottled or veined with grey or white; translucent to opaque, massive
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-11025.html">https://www.mindat.org/min-11025.html</a>	

**7.2.1.39 Canary tourmaline**

Mineral group	tourmaline
Mineral species	Fluor-elbaite
IMA status	
Mineral/Gem variety	<b>Canary tourmaline</b>
Rock	
Trade name	
Description	Yellow-green to yellow, orange and brown, transparent Mn-rich fluor-elbaite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1364.html">https://www.mindat.org/min-1364.html</a>	

**7.2.1.40 Carbonado**

Mineral group	
Mineral species	diamond, graphite
IMA status	
Mineral/Gem variety	<b>Carbonado</b>
Rock	
Trade name	

Description	Mixture of diamond, graphite and amorphous carbon. Black, grey or brown, opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-27227.html">https://www.mindat.org/min-27227.html</a>	

#### 7.2.1.41 Carnelian (Cornelian)

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>Carnelian (cornelian)</b>
Rock	
Trade name	
Description	Brownish orange or brownish red, yellow-orange to orangish red, translucent chalcedony
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-9333.html">https://www.mindat.org/min-9333.html</a> ; <a href="https://www.mindat.org/min-9341.html">https://www.mindat.org/min-9341.html</a>	

#### 7.2.1.42 Cassiterite

Mineral group	
Mineral species	<b>cassiterite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Dark brown to black, yellowish brown, colourless banded with brown; transparent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-917.html">https://www.mindat.org/min-917.html</a>	

#### 7.2.1.43 Cat's-eye chrysoberyl

Mineral group	
Mineral species	chrysoberyl
IMA status	
Mineral/Gem variety	<b>cat's-eye chrysoberyl</b>
Rock	
Trade name	
Description	Cat's-eye chrysoberyl is the chatoyant variety of chrysoberyl. Brownish yellow to brown, yellow to yellowish green, black; transparent, translucent, opaque
Variety distinction criteria	chatoyancy
Comments	The terms 'cymophane' or 'Cat's eye' alone were traditionally used for cat's-eye chrysoberyl.
<i>References</i>	
<a href="https://www.mindat.org/min-1039.html">https://www.mindat.org/min-1039.html</a>	

#### 7.2.1.44 Cerussite

Mineral group	
Mineral species	<b>cerussite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	White, brownish, grey, black, blue-green, colourless; transparent, translucent, opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-934.html">https://www.mindat.org/min-934.html</a>	

#### 7.2.1.45 Chalcedony

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>chalcedony</b>
Rock	
Trade name	



Description	Chalcedony is micro- or crypto-crystalline quartz. It shows a variety of colours and textures (see agate, carnelian, chrome chalcedony, chrysoprase, heliotrope, onyx, petrified wood, prase, sard, sardonyx)
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-960.html">https://www.mindat.org/min-960.html</a>	

#### 7.2.1.46 Charoite

Mineral group	
Mineral species	<b>charoite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Violet with white to black swirls, fibrous appearance; translucent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-972.html">https://www.mindat.org/min-972.html</a>	

#### 7.2.1.47 Chessylite

Mineral group	
Mineral species	azurite
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>chessylite</b>
Description	In the trade, chessylite is used as a synonym for azurite.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-447.html">https://www.mindat.org/min-447.html</a> ; <a href="https://www.mindat.org/min-448.html">https://www.mindat.org/min-448.html</a> ; <a href="https://www.mindat.org/min-4704.html">https://www.mindat.org/min-4704.html</a>	

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#### 7.2.1.48 Chialstolite

Mineral group	
Mineral species	andalusite
IMA status	
Mineral/Gem variety	<b>chialstolite</b>
Rock	
Trade name	
Description	White, grey, yellowish, opaque variety of andalusite, usually showing a blackish cross, caused by carbonaceous inclusions
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1001.html">https://www.mindat.org/min-1001.html</a>	

#### 7.2.1.49 Chloromelanite

Mineral group	
Mineral species	jadeite
IMA status	
Mineral/Gem variety	<b>chloromelanite</b>
Rock	
Trade name	
Description	Opaque to partly translucent, very dark green to black variety of jadeite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1023.html">https://www.mindat.org/min-1023.html</a>	

#### 7.2.1.50 Chondrodite

Mineral group	
Mineral species	<b>chondrodite</b>
IMA status	G
Mineral/Gem variety	
Rock	

Trade name	
Description	brownish yellow to brownish red; transparent, translucent, opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1027.html">https://www.mindat.org/min-1027.html</a>	

### 7.2.1.51 Chrome chalcedony (Mtorolite)

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>chrome chalcedony (mtorolite)</b>
Rock	
Trade name	mtorite
Description	Green chalcedony, colour due to chromium
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-39291.html">https://www.mindat.org/min-39291.html</a> ; <a href="https://www.mindat.org/min-27172.html">https://www.mindat.org/min-27172.html</a>	

### 7.2.1.52 Chrome diopside

Mineral group	
Mineral species	diopside
IMA status	A
Mineral/Gem variety	<b>chrome diopside</b>
Rock	
Trade name	
Description	Medium to dark, vivid green, transparent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.gemdat.org/gem-10648.html">https://www.gemdat.org/gem-10648.html</a>	

### 7.2.1.53 Chrome enstatite

Mineral group	
Mineral species	enstatite
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>Chrome enstatite</b>
Description	emerald green variety of enstatite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1384.html">https://www.mindat.org/min-1384.html</a>	

#### 7.2.1.54 Chrome tourmaline

Mineral group	tourmaline
Mineral species	<b>chromium-dravite</b>
IMA status	Rd
Mineral/Gem variety	
Rock	
Trade name	<b>chrome tourmaline</b>
Description	bluish green to slightly yellowish or brownish green chromium-dravite
Comments	Colour due to chromium and/or vanadium
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-9904.html">https://www.mindat.org/min-9904.html</a>	

#### 7.2.1.55 Chrome tremolite

Mineral group	
Mineral species	tremolite
IMA status	
Mineral/Gem variety	<b>chrome tremolite</b>
Rock	
Trade name	
Description	Green, transparent or translucent, chromian variety of tremolite
Variety distinction criteria	

<i>References</i>
<a href="https://www.mindat.org/min-4011.html">https://www.mindat.org/min-4011.html</a>

#### 7.2.1.56 Chrysoberyl

Mineral group	
Mineral species	<b>chrysoberyl</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Brownish yellow to green-yellow; transparent, translucent; see also gem varieties alexandrite, cat's eye chrysoberyl and vanadium chrysoberyl
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1039.html">https://www.mindat.org/min-1039.html</a>	

#### 7.2.1.57 Chrysocolla

Mineral group	
Mineral species	<b>chrysocolla</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Green-blue to blue, opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1040.html">https://www.mindat.org/min-1040.html</a>	

#### 7.2.1.58 Chrysoprase

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>chrysoprase</b>

Rock	
Trade name	
Description	Light to medium (yellowish) green, translucent to nearly transparent chalcedony; colour due to nickel
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-952.html">https://www.mindat.org/min-952.html</a>	

#### 7.2.1.59 Chrysotile

Mineral group	Kaolinite-serpentine
Mineral species	<b>chrysotile</b>
IMA status	Rd
Mineral/Gem variety	
Rock	
Trade name	
Description	soft fibrous, grey to light green, light yellow to light brownish
Variety distinction criteria	
<i>References</i>	
<a href="https://www.gemdat.org/gem-975.html">https://www.gemdat.org/gem-975.html</a>	

#### 7.2.1.60 Citrine

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>citrine</b>
Rock	
Trade name	
Description	Yellow to orange to brownish orange macrocrystalline variety of quartz
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1054.html">https://www.mindat.org/min-1054.html</a>	

**7.2.1.61 Clinohumite**

Mineral group	
Mineral species	<b>clinohumite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Yellow, yellow-brown, brownish-orange, red-brown; transparent, translucent, opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1077.html">https://www.mindat.org/min-1077.html</a>	

**7.2.1.62 Cobalt spinel**

Mineral group	spinel
Mineral species	spinel
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>Cobalt spinel</b>
Description	blue to violetish blue variety of spinel
Variety distinction criteria	cobalt is the main chromophore.
<i>References</i>	
<a href="https://www.mindat.org/min-3729.html">https://www.mindat.org/min-3729.html</a>	

**7.2.1.63 Colour-change garnet**

Mineral group	garnet
Mineral species	
IMA status	
Mineral/Gem variety	Mixed composition pyrope-spessartine
Rock	
Trade name	<b>Colour-change garnet</b>
Description	Colour change from bluish green in daylight to

	pink to purplish red in incandescent light.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-42908.html">https://www.mindat.org/min-42908.html</a>	

#### 7.2.1.64 Colour-change sapphire

Mineral group	
Mineral species	corundum
IMA status	
Mineral/Gem variety	colour-change sapphire
Rock	
Trade name	
Description	Blue (daylight) to violet or purple (incandescent) variety of corundum; many other colour changes are possible
Variety distinction criteria	<ul style="list-style-type: none"> <li>• <i>Colour-change</i>: main hue in daylight differs from that seen in incandescent light.</li> <li>• <i>Daylight</i>: for the purposes of this comparison calibrated daylight corresponding to a range between 5500K to 6500K shall be used.</li> <li>• <i>Incandescent light</i>: for the purposes of this comparison standard incandescent light corresponding to a range between 2700K and 3600K shall be used.</li> </ul>
<i>References</i>	
<a href="https://www.mindat.org/min-3529.html">https://www.mindat.org/min-3529.html</a>	

#### 7.2.1.65 Common opal

Mineral group	
Mineral species	opal
IMA status	
Mineral/Gem variety	<b>common opal</b>
Rock	
Trade name	
Description	translucent to opaque opal without play-of-colour. Bluish white, porcelain-like common opal may be called cacholong opal; prase opal



	is green and moss opal is common opal with inclusions that look like moss.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3004.html">https://www.mindat.org/min-3004.html</a>	

### 7.2.1.66 Cordierite

Mineral group	
Mineral species	<b>cordierite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	light to dark blue and violet, transparent to translucent
Comment	lolite is the gemmological term for cordierite (see lolite)
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1128.html">https://www.mindat.org/min-1128.html</a>	

### 7.2.1.67 Corundum

Mineral group	
Mineral species	<b>corundum</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	see gem varieties colour-change sapphire, green sapphire, orange sapphire, Padparadscha, pink sapphire, purple sapphire, ruby, star ruby, sapphire, star sapphire, white sapphire, yellow sapphire
Variety distinction criteria	
<i>References</i>	

<https://www.mindat.org/min-1136.html>

### 7.2.1.68 Crystal opal

Mineral group	
Mineral species	opal
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>crystal opal</b> (or water opal)
Description	Strong play-of-colour against a colourless body, transparent to translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3004.html">https://www.mindat.org/min-3004.html</a>	

### 7.2.1.69 Danburite

Mineral group	
Mineral species	<b>danburite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	yellow to brown, pink, colourless; transparent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1218.html">https://www.mindat.org/min-1218.html</a>	

### 7.2.1.70 Datolite

Mineral group	
Mineral species	<b>datolite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	colourless, white, yellowish, greenish, orange-

	brown, transparent, translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1340.html">https://www.mindat.org/min-1340.html</a>	

### 7.2.1.71 Demantoid

Mineral group	garnet
Mineral species	andradite
IMA status	
Mineral/Gem variety	<b>demantoid</b>
Rock	
Trade name	
Description	Green to yellow green variety of andradite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-223.html">https://www.mindat.org/min-223.html</a> ; <a href="https://www.mindat.org/min-1258.html">https://www.mindat.org/min-1258.html</a>	

### 7.2.1.72 Diamond

Mineral group	
Mineral species	<b>diamond</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	colourless to yellow or brown, pink (rarely red), green, blue, orange, grey, black; transparent, translucent, opaque
Variety distinction criteria	
<i>References</i>	
<a href="http://www.cibjo.org/wp-content/uploads/2020/04/20-12-26-Official-Diamond-Book.pdf">http://www.cibjo.org/wp-content/uploads/2020/04/20-12-26-Official-Diamond-Book.pdf</a>	

**7.2.1.73 Diaspore**

Mineral group	
Mineral species	<b>diaspore</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	greenish-brown, yellow, colourless, sometimes pink or white; transparent, translucent. May show a colour change from greenish in daylight to pinkish brown under incandescent light
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1285.html">https://www.mindat.org/min-1285.html</a>	

**7.2.1.74 Diopside**

Mineral group	
Mineral species	<b>diopside</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Green, yellow, colourless, brown, black, blue to violet, transparent, translucent and opaque. May show asterism ('black star')
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1294.html">https://www.mindat.org/min-1294.html</a>	

**7.2.1.75 Dioptase**

Mineral group	
Mineral species	<b>diopside</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	

Description	Dark to intense bluish green, transparent to translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1295.html">https://www.mindat.org/min-1295.html</a>	

### 7.2.1.76 Dolomite

Mineral group	
Mineral species	<b>dolomite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Colourless (white), light yellow to brown, transparent, translucent, opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1304.html">https://www.mindat.org/min-1304.html</a>	

### 7.2.1.77 Dravite

Mineral group	tourmaline
Mineral species	<b>dravite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Yellow to brown, transparent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1318.html">https://www.mindat.org/min-1318.html</a>	

### 7.2.1.78 Dumortierite

Mineral group	
Mineral species	<b>dumortierite</b>

IMA status	Rd
Mineral/Gem variety	
Rock	
Trade name	
Description	Dark blue, violet blue, colourless, pink, red, translucent, opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1329.html">https://www.mindat.org/min-1329.html</a>	

### 7.2.1.79 Dumortierite quartz

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>dumortierite quartz</b>
Description	Quartz containing eye-visible dark blue to violet dumortierite inclusions
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3337.html">https://www.mindat.org/min-3337.html</a>	

### 7.2.1.80 Ekanite

Mineral group	
Mineral species	<b>ekanite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Dark green to brown, transparent to translucent. May show chatoyancy and asterism, and may show relatively high levels of natural radioactivity
Variety distinction criteria	

<i>References</i>
<a href="https://www.mindat.org/min-1361.html">https://www.mindat.org/min-1361.html</a>

#### 7.2.1.81 Elbaite

Mineral group	tourmaline
Mineral species	<b>elbaite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Many gem varieties of tourmaline, such as rubellite, indigolite, verdelite, Paraiba tourmaline, are or may be varieties of elbaite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1364.html">https://www.mindat.org/min-1364.html</a>	

#### 7.2.1.82 Emerald

Mineral group	
Mineral species	beryl
IMA status	
Mineral/Gem variety	<b>emerald</b>
Rock	
Trade name	
Description	green variety of beryl
Variety distinction criteria	green colour due to chromium and vanadium
<i>References</i>	
<a href="https://www.mindat.org/min-1375.html">https://www.mindat.org/min-1375.html</a>	

#### 7.2.1.83 Enstatite

Mineral group	pyroxene
Mineral species	<b>enstatite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	

Description	Green, yellowish-green, brownish-green, greenish-grey, yellow-brown, brownish-pink and colourless, transparent to opaque; may show chatoyancy and asterism
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1384.html">https://www.mindat.org/min-1384.html</a> ; <a href="https://www.mindat.org/min-1995.html">https://www.mindat.org/min-1995.html</a>	

#### 7.2.1.84 Epidote

Mineral group	
Mineral species	<b>epidote</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Light to very dark green to brown, reddish brown; transparent to translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1389.html">https://www.mindat.org/min-1389.html</a>	

#### 7.2.1.85 Euclase

Mineral group	
Mineral species	<b>euclase</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	colourless, yellowish to bluish green, (usually light) blue to greenish blue; transparent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1418.html">https://www.mindat.org/min-1418.html</a>	



**7.2.1.86 Fei Cui**

Mineral group	
Mineral species	Jadeite
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>Fei Cui</b> (Chinese specific market terminology)
Description	'Fei Cui' is an Asian trade name, which may be spelled and pronounced differently, depending on the particular Asian country. 'Fei Cui' is understood to be jadeite jade throughout Asia as is mentioned in GBT 16553-2017, a Chinese national standard document. However, industry members and consumers should be aware that in some Asian market places the term 'Fei Cui' is used more loosely and it is therefore vital that if the name 'Fei Cui' is used in sales it shall be clearly stated which mineral(s) are/is being referred to.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-50397.html">https://www.mindat.org/min-50397.html</a> ; <a href="https://www.mindat.org/min-2062.html">https://www.mindat.org/min-2062.html</a>	

**7.2.1.87 Feldspar**

Mineral group	<b>feldspar</b>
Mineral species	
IMA status	
Mineral/Gem variety	
Rock	
Trade name	
Description	see albite, amazonite, andesine, anorthite, bytownite, labradorite, microcline, moonstone, rainbow moonstone, oligoclase, orthoclase, spectrolite, sunstone
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1624.html">https://www.mindat.org/min-1624.html</a>	

**7.2.1.88 Fibrolite**

Mineral group	
Mineral species	sillimanite
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>fibrolite</b>
Description	white to grey, brown, green, rarely violetish to greyish blue; usually translucent to opaque, rarely transparent. May show chatoyancy
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3662.html">https://www.mindat.org/min-3662.html</a>	

**7.2.1.89 Fire opal**

Mineral group	
Mineral species	opal
IMA status	
Mineral/Gem variety	<b>fire opal</b>
Rock	
Trade name	
Description	Yellow, red, or orange to brown body colour, with or without play-of-colour, transparent to translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3004.html">https://www.mindat.org/min-3004.html</a>	

**7.2.1.90 Fluorite**

Mineral group	
Mineral species	<b>fluorite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	

Description	Green, purple, violet, blue, yellow, colourless, orange, pink, brown; may show colour change of violet in daylight and red in incandescent light; transparent to translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1576.html">https://www.mindat.org/min-1576.html</a>	

### 7.2.1.91 Forsterite

Mineral group	
Mineral species	<b>forsterite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Colourless to green; transparent to translucent; see also peridot
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1584.html">https://www.mindat.org/min-1584.html</a>	

### 7.2.1.92 Gahnite

Mineral group	spinel
Mineral species	<b>gahnite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Black, rarely green or blue; transparent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1632.html">https://www.mindat.org/min-1632.html</a>	

**7.2.1.93 Gahnospinel**

Mineral group	spinel
Mineral species	spinel
IMA status	
Mineral/Gem variety	<b>gahnospinel</b>
Rock	
Trade name	
Description	Light to dark blue, transparent to translucent; zinc-rich variety of spinel
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1633.html">https://www.mindat.org/min-1633.html</a>	

**7.2.1.94 Garnet**

Mineral group	<b>garnet</b>
Mineral species	
IMA status	
Mineral/Gem variety	
Rock	
Trade name	
Description	see almandine, pyrope, rhodolite, grossular, hessonite, tsavorite, spessartine, mandarin garnet, andradite, demantoid, melanite, topazolite, Malaya garnet, umbalite, Mali garnet, uvarovite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-10272.html">https://www.mindat.org/min-10272.html</a>	

**7.2.1.95 Gem silica**

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	(Chrysocolla in) chalcedony
Rock	
Trade name	<b>gem silica</b>

Description	Green to blue, translucent chalcedony; colour caused by copper or minute inclusions of chrysocolla
Variety distinction criteria	Presence of copper or chrysocolla inclusions
<i>References</i>	
<a href="https://www.mindat.org/min-1040.html">https://www.mindat.org/min-1040.html</a>	

#### 7.2.1.96 Golden beryl

Mineral group	
Mineral species	beryl
IMA status	
Mineral/Gem variety	<b>golden beryl</b>
Rock	
Trade name	
Description	Golden beryl is used as a synonym of heliodor
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-6727.html">https://www.mindat.org/min-6727.html</a>	

#### 7.2.1.97 Goshenite

Mineral group	
Mineral species	beryl
IMA status	
Mineral/Gem variety	<b>goshenite</b>
Rock	
Trade name	
Description	Colourless variety of beryl
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-7555.html">https://www.mindat.org/min-7555.html</a>	

#### 7.2.1.98 Grandidierite

Mineral group	
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Mineral species	<b>grandidierite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	bluish green, blue, transparent to translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1737.html">https://www.mindat.org/min-1737.html</a>	

### 7.2.1.99 Green Beryl

Mineral group	
Mineral species	beryl
IMA status	
Mineral/Gem variety	<b>green beryl</b>
Rock	
Trade name	
Description	Green variety of beryl
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-819.html">https://www.mindat.org/min-819.html</a>	

### 7.2.1.100 Green sapphire

Mineral group	
Mineral species	corundum
IMA status	
Mineral/Gem variety	green sapphire
Rock	
Trade name	
Description	Bluish green to yellowish green variety of corundum
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3529.html">https://www.mindat.org/min-3529.html</a>	

**7.2.1.101 Grossular**

Mineral group	garnet
Mineral species	<b>grossular</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	light to dark green, light to dark yellow to reddish orange, rarely colourless; transparent (usually) to opaque. See also hessonite and tsavorite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1755.html">https://www.mindat.org/min-1755.html</a>	

**7.2.1.102 Gypsum**

Mineral group	
Mineral species	<b>gypsum</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Colourless, white, yellowish, bluish, pink, transparent to opaque.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1784.html">https://www.mindat.org/min-1784.html</a> ; <a href="https://www.mindat.org/min-8574.html">https://www.mindat.org/min-8574.html</a>	

**7.2.1.103 Häüyne**

Mineral group	Cancrinite-sodalite (Sodalite subgroup)
Mineral species	<b>häüyne</b>
IMA status	G
Mineral/Gem variety	

Rock	
Trade name	
Description	Blue, transparent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1833.html">https://www.mindat.org/min-1833.html</a>	

#### 7.2.1.104 Heliodor

Mineral group	
Mineral species	beryl
IMA status	
Mineral/Gem variety	<b>heliodor</b>
Rock	
Trade name	
Description	Yellow (greenish yellow to orangish yellow or yellowish brown) variety of beryl
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-6727.html">https://www.mindat.org/min-6727.html</a>	

#### 7.2.1.105 Heliotrope (bloodstone)

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>heliotrope (bloodstone)</b>
Rock	
Trade name	
Description	Dark green with red to brownish red spots, (largely) opaque chalcedony
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1851.html">https://www.mindat.org/min-1851.html</a> ; <a href="https://www.mindat.org/min-7616.html">https://www.mindat.org/min-7616.html</a>	



**7.2.1.106 Hematite**

Mineral group	
Mineral species	<b>hematite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	dark grey to black, opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1856.html">https://www.mindat.org/min-1856.html</a>	

**7.2.1.107 Hessonite**

Mineral group	garnet
Mineral species	grossular
IMA status	
Mineral/Gem variety	<b>hessonite</b>
Rock	
Trade name	
Description	(brownish) yellow-orange to reddish orange variety of grossular
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1882.html">https://www.mindat.org/min-1882.html</a>	

**7.2.1.108 Hexagonite**

Mineral group	
Mineral species	tremolite
IMA status	
Mineral/Gem variety	<b>hexagonite</b>
Rock	
Trade name	
Description	Pink to purple, transparent variety of tremolite
Variety distinction criteria	

<i>References</i>	
<a href="https://www.mindat.org/min-4011.html">https://www.mindat.org/min-4011.html</a> ; <a href="https://www.mindat.org/min-11106.html">https://www.mindat.org/min-11106.html</a>	

**7.2.1.109 Hibonite**

Mineral group	
Mineral species	<b>hibonite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Brownish black to black, reddish brown in thin fragments; translucent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1897.html">https://www.mindat.org/min-1897.html</a>	

**7.2.1.110 Hiddenite**

Mineral group	
Mineral species	spodumene
IMA status	
Mineral/Gem variety	<b>hiddenite</b>
Rock	
Trade name	
Description	Green variety of spodumene, coloured by chromium. Colour may fade.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3733.html">https://www.mindat.org/min-3733.html</a> ; <a href="https://www.mindat.org/min-7740.html">https://www.mindat.org/min-7740.html</a>	

**7.2.1.111 Howlite**

Mineral group	
Mineral species	<b>howlite</b>

IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	White, often with dark grey and black spiderweb matrix, commonly dyed blue to imitate turquoise or lapis lazuli
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1936.html">https://www.mindat.org/min-1936.html</a>	

### 7.2.1.112 Hydrophane

Mineral group	
Mineral species	opal
IMA status	
Mineral/Gem variety	<b>hydrophane</b>
Rock	
Trade name	
Description	Hydrophane is a variety of opal that will absorb liquids to the point of affecting the appearance and potentially the weight of the gemstone. Most opals have a porous structure to some extent, but when this porosity is considerable the term hydrophane may apply. Such opals could come from any opal locality. Opals from deposits in Ethiopia produce an unusually high percentage of such gemstones.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3004.html">https://www.mindat.org/min-3004.html</a>	

### 7.2.1.113 Idocrase

Mineral group	
Mineral species	vesuvianite
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>idocrase</b>

Description	In the trade, idocrase is used as synonym for vesuvianite. Yellowish green, green, yellowish brown, violet; transparent, translucent.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-4223.html">https://www.mindat.org/min-4223.html</a>	

#### 7.2.1.114 Indigolite (Indicolite)

Mineral group	tourmaline
Mineral species	
IMA status	
Mineral/Gem variety	<b>indigolite (indicolite)</b>
Rock	
Trade name	
Description	violetish to greenish blue variety of tourmaline
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2027.html">https://www.mindat.org/min-2027.html</a>	

#### 7.2.1.115 Iolite

Mineral group	
Mineral species	cordierite
IMA status	
Mineral/Gem variety	<b>iolite</b>
Rock	
Trade name	
Description	In the trade, iolite is used as a synonym for cordierite; violet to blue, transparent, translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-5119.html">https://www.mindat.org/min-5119.html</a>	

**7.2.1.116 Iris quartz**

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	rock crystal
Rock	
Trade name	<b>Iris quartz</b>
Description	Iris quartz is rock crystal containing iridescent fractures, reflecting rainbow colours
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-42133.html">https://www.mindat.org/min-42133.html</a>	

**7.2.1.117 Jade**

Mineral group	
Mineral species	Jadeite, omphacite, nephrite
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>jade</b>
Description	Jadeite, omphacite (or a combination of both) and nephrite are commonly called jade.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2881.html">https://www.mindat.org/min-2881.html</a>	

**7.2.1.118 Jadeite**

Mineral group	pyroxene
Mineral species	<b>jadeite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Green, white, light purple, yellow to reddish orange, brown, grey, black, often mottled;

	translucent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2062.html">https://www.mindat.org/min-2062.html</a>	

**7.2.1.119 Jasper**

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>jasper</b>
Rock	
Trade name	
Description	Opaque, impure microcrystalline quartz, red, yellow, brown or green in colour
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2082.html">https://www.mindat.org/min-2082.html</a> ; <a href="https://www.mindat.org/min-27171.html">https://www.mindat.org/min-27171.html</a>	

**7.2.1.120 Jeremejevite**

Mineral group	
Mineral species	<b>Jeremejevite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Blue, violet, colourless, yellow; transparent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2090.html">https://www.mindat.org/min-2090.html</a>	

**7.2.1.121 Johachidolite**

Mineral group	
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Mineral species	<b>johachidolite</b>
IMA status	Rd
Mineral/Gem variety	
Rock	
Trade name	
Description	yellow, transparent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2101.html">https://www.mindat.org/min-2101.html</a>	

### 7.2.1.122 Kosmochlor

Mineral group	
Mineral species	<b>kosmochlor</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	bright to dark green, translucent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2258.html">https://www.mindat.org/min-2258.html</a>	

### 7.2.1.123 Kornerupine

Mineral group	
Mineral species	<b>kornerupine</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Yellowish to brownish green, blue-green, yellow, brown, rarely colourless; transparent to translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2254.html">https://www.mindat.org/min-2254.html</a>	

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**7.2.1.124 Kunzite**

Mineral group	
Mineral species	spodumene
IMA status	
Mineral/Gem variety	<b>kunzite</b>
Rock	
Trade name	
Description	Pink to bluish purple variety of spodumene. Colour may fade.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3733.html">https://www.mindat.org/min-3733.html</a> ; <a href="https://www.mindat.org/min-2289.html">https://www.mindat.org/min-2289.html</a>	

**7.2.1.125 Kyanite**

Mineral group	
Mineral species	<b>kyanite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Blue, blue-green, green, yellow to red, colourless; transparent, translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-25543.html">https://www.mindat.org/min-25543.html</a>	

**7.2.1.126 Labradorite**

Mineral group	feldspar (plagioclase)
Mineral species	anorthite (albite-anorthite series)
IMA status	
Mineral/Gem variety	<b>labradorite</b>
Rock	
Trade name	



Description	A plagioclase feldspar with an albite : anorthite molar ratio ranging from 30 : 70 to 50 : 50  Grey to nearly black, labradorescence causing interference colours at the surface, translucent to opaque; also colourless, green, yellow, orange to brown or brownish red, transparent to translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2308.html">https://www.mindat.org/min-2308.html</a> ; <a href="https://www.gia.edu/doc/separation-abduriyim.pdf">https://www.gia.edu/doc/separation-abduriyim.pdf</a> ; <a href="https://www.mindat.org/min-9131.html">https://www.mindat.org/min-9131.html</a>	

#### 7.2.1.127 Lagoon tourmaline

Mineral group	tourmaline
Mineral species	
IMA status	
Mineral/Gem variety	
Rock (natural glass)	
Trade name	<b>lagoon tourmaline</b>
Description	tourmaline with lighter tones of higher saturated blue, greenish blue, blue-green to bluish green
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-4003.html">https://www.mindat.org/min-4003.html</a>	

#### 7.2.1.128 Lapis Lazuli

Mineral group	
Mineral species	
IMA status	
Mineral/Gem variety	
Rock	<b>Lapis lazuli</b>
Trade name	
Description	Rock composed primarily of lazurite, calcite and pyrite
Variety distinction	

criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2330.html">https://www.mindat.org/min-2330.html</a>	

**7.2.1.129 Larimar**

Mineral group	
Mineral species	pectolite
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>larimar</b>
Description	Blue to blue-green, mottled with white, translucent to opaque pectolite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-29025.html">https://www.mindat.org/min-29025.html</a>	

**7.2.1.130 Lazulite**

Mineral group	
Mineral species	<b>lazulite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Dark (violetish) blue, green-blue, transparent, translucent; opaque massive material often mottled with white; transparent crystals show strong pleochroism, dark blue, light blue and colourless.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2356.html">https://www.mindat.org/min-2356.html</a>	

**7.2.1.131 Lazurite**

Mineral group	
Mineral species	<b>lazurite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Blue, opaque; main component of lapis lazuli
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2357.html">https://www.mindat.org/min-2357.html</a>	

### 7.2.1.132 Liddicoatite

Mineral group	tourmaline
Mineral species	<b>Fluor-liddicoatite</b>
IMA status	Rd
Mineral/Gem variety	
Rock	
Trade name	
Description	redefined as fluor-liddicoatite.  Brown, green, pink, red, blue, commonly zoned, transparent, translucent.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-4003.html">https://www.mindat.org/min-4003.html</a> ; <a href="https://www.mindat.org/min-2395.html">https://www.mindat.org/min-2395.html</a>	

### 7.2.1.133 Lizardite

Mineral group	Kaolinite-serpentine
Mineral species	<b>lizardite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Lizardite is the most common serpentine species. Green, light yellow to white;

	translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2425.html">https://www.mindat.org/min-2425.html</a>	

**7.2.1.134 Londonite**

Mineral group	
Mineral species	<b>londonite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	vivid yellow, pale yellow, pale yellow-green, colourless, white; transparent, translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-7082.html">https://www.mindat.org/min-7082.html</a>	

**7.2.1.135 Magnesite**

Mineral group	
Mineral species	<b>magnesite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Colourless, transparent; also massive, white, yellowish to brown or grey, translucent. Dyed blue to imitate turquoise.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2482.html">https://www.mindat.org/min-2482.html</a>	

**7.2.1.136 Magnetite**

Mineral group	spinel
Mineral species	<b>magnetite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	black, opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2538.html">https://www.mindat.org/min-2538.html</a>	

### 7.2.1.137 Malachite

Mineral group	
Mineral species	<b>malachite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Vivid, bluish green to green, usually banded in two or more tones of green, opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2550.html">https://www.mindat.org/min-2550.html</a>	

### 7.2.1.138 Malaya garnet

Mineral group	garnet
Mineral species	
IMA status	
Mineral/Gem variety	Mixed composition pyrope-spessartine-almandine-grossular
Rock	
Trade name	<b>Malaya garnet (or Malaia garnet)</b>
Description	Yellowish to pinkish/reddish brown, to brown-orange variety of garnet with mixed compositions
Comments	See Umbalite
Variety distinction criteria	

criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-42908.html">https://www.mindat.org/min-42908.html</a>	

**7.2.1.139 Mali garnet**

Mineral group	garnet
Mineral species	
IMA status	
Mineral/Gem variety	andradite-grossular
Rock	
Trade name	<b>Mali garnet</b>
Description	Yellowish green to yellow, to yellowish orange and orangish, brownish red variety of garnet with a mixed andradite-grossular composition.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-8597.html">https://www.mindat.org/min-8597.html</a>	

**7.2.1.140 Mandarin garnet**

Mineral group	garnet
Mineral species	spessartine
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>mandarin garnet</b>
Description	orange variety of spessartine
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3725.html">https://www.mindat.org/min-3725.html</a>	

**7.2.1.141 Marble**

Mineral group	
Mineral species	
IMA status	

Mineral/Gem variety	
Rock	<b>marble</b>
Trade name	
Description	Metamorphic rock, essentially composed of carbonates, such as calcite or dolomite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-9507.html">https://www.mindat.org/min-9507.html</a>	

#### 7.2.1.142 Marcasite

Mineral group	
Mineral species	<b>marcasite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Bronze, light brass yellow, tin white, metallic lustre, opaque. Marcasite is unstable and brittle; the name of the accepted mineral 'marcasite' is often used as a misnomer for pyrite when it is faceted and used in jewellery.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2571.html">https://www.mindat.org/min-2571.html</a> ; <a href="https://www.mindat.org/min-3314.html">https://www.mindat.org/min-3314.html</a> ;	

#### 7.2.1.143 Matrix opal

Mineral group	
Mineral species	opal
IMA status	
Mineral/Gem variety	
Rock	sedimentary or volcanic rock
Trade name	<b>matrix opal</b>
Description	Thin seams or spots of opal with play-of-colour scattered throughout matrix (sedimentary or volcanic rock)

Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3004.html">https://www.mindat.org/min-3004.html</a>	

**7.2.1.144 Maxixe beryl**

Mineral group	
Mineral species	beryl
IMA status	
Mineral/Gem variety	<b>Maxixe beryl</b>
Rock	
Trade name	
Description	Medium to dark blue variety of beryl, with fading colour; colour is due to irradiation
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-10019.html">https://www.mindat.org/min-10019.html</a>	

**7.2.1.145 Maw-sit-sit**

Mineral group	
Mineral species	
IMA status	
Mineral/Gem variety	
Rock	<b>Maw-sit-sit</b>
Trade name	
Description	Rock composed primarily of kosmochlor and amphibole group, chlorite group minerals and feldspar
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-42915.html">https://www.mindat.org/min-42915.html</a>	

**7.2.1.146 Melanite**

Mineral group	garnet
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Mineral species	andradite
IMA status	
Mineral/Gem variety	<b>melanite</b>
Rock	
Trade name	
Description	Black, titanium-bearing variety of andradite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-7443.html">https://www.mindat.org/min-7443.html</a>	

#### 7.2.1.147 Microcline

Mineral group	feldspar
Mineral species	<b>microcline</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	see amazonite. Amazonite is the only gem variety of microcline.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2704.html">https://www.mindat.org/min-2704.html</a>	

#### 7.2.1.148 Moldavite

Mineral group	
Mineral species	
IMA status	
Mineral/Gem variety	
Natural glass	<b>Moldavite</b>
Trade name	
Description	Medium to dark, yellowish to greyish green, transparent to translucent natural glass; considered to be a variety of tektite (splash product created by meteor impacts)
Variety distinction criteria	

<i>References</i>
<a href="https://www.mindat.org/min-10860.html">https://www.mindat.org/min-10860.html</a>

**7.2.1.149 Montebbrasite**

Mineral group	
Mineral species	<b>montebbrasite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	colourless, white, yellowish, light green, light blue, pink; transparent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2763.html">https://www.mindat.org/min-2763.html</a>	

**7.2.1.150 Moonstone**

Mineral group	feldspar
Mineral species	
IMA status	
Mineral/Gem variety	<b>moonstone</b>
Rock	
Trade name	
Description	Moonstone is a translucent to transparent feldspar, showing a wide range of colours, such as (near-) colourless, brown, orange, yellow, grey, and which reflects a bluish, milky sheen (adularescence) that has been compared to the light of the moon.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2774.html">https://www.mindat.org/min-2774.html</a>	

**7.2.1.151 Morganite**

Mineral group	
Mineral species	beryl

IMA status	
Mineral/Gem variety	<b>morganite</b>
Rock	
Trade name	
Description	Pinkish orange to slightly purplish pink variety of beryl
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2783.html">https://www.mindat.org/min-2783.html</a>	

### 7.2.1.152 Morion

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	smoky quartz
Rock	
Trade name	<b>morion</b>
Description	Dark brown to black (nearly opaque) smoky quartz
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-6270.html">https://www.mindat.org/min-6270.html</a>	

### 7.2.1.153 Musgravite

Mineral group	
Mineral species	<b>Magnesiotaaffeite- 6N'3S</b>
IMA status	Rn
Mineral/Gem variety	
Rock	
Trade name	
Description	Musgravite is a synonym of Magnesiotaaffeite-6N'3S (see also taaffeite)  Grey green, green, transparent. See also taaffeite.
Variety distinction criteria	

<i>References</i>
<a href="https://www.gemdat.org/gem-27238.html">https://www.gemdat.org/gem-27238.html</a>

**7.2.1.154 Nephrite**

Mineral group	amphibole
Mineral species	Actinolite - tremolite
IMA status	
Mineral/Gem variety	<b>nephrite</b>
Rock	
Trade name	
Description	Fibrous, polycrystalline aggregate of actinolite-tremolite series amphibole
Variety distinction criteria	
<i>References</i>	
	<a href="https://www.mindat.org/min-2881.html">https://www.mindat.org/min-2881.html</a>

**7.2.1.155 Nuummite**

Mineral group	
Mineral species	
IMA status	
Mineral/Gem variety	
Rock	anthophyllite and gedrite (two amphiboles) bearing metamorphic rock
Trade name	Nuummite
Description	Dark grey, brown to black, opaque, with yellow, blue and red iridescence
Variety distinction criteria	
<i>References</i>	
	<a href="https://www.mindat.org/min-30937.html">https://www.mindat.org/min-30937.html</a>

**7.2.1.156 Obsidian**

Mineral group	
Mineral species	
IMA status	

Mineral/Gem variety	
Rock (natural glass)	<b>obsidian</b>
Trade name	
Description	Obsidian is a volcanic natural glass, formed as an extrusive igneous rock. The lava extruded from a volcano cooled rapidly, causing minimal crystal growth.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-8519.html">https://www.mindat.org/min-8519.html</a>	

### 7.2.1.157 Odontolite

Mineral group	
Mineral species	fluorapatite
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>odontolite</b>
Description	Odontolite is fossilized bone or teeth consisting of light blue, microcrystalline fluorapatite.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-32412.html">https://www.mindat.org/min-32412.html</a> ; Pedersen M.C., 2015. Ivory. The Crowood Press Ltd., 240 pp. (book)	

### 7.2.1.158 Oligoclase

Mineral group	feldspar (plagioclase)
Mineral species	albite (albite-anorthite series)
IMA status	
Mineral/Gem variety	<b>oligoclase</b>
Rock	
Trade name	
Description	A plagioclase feldspar with an albite : anorthite molar ratio ranging from 90 : 10 to 70 : 30.  Green oligoclase may look similar to amazonite
Variety distinction criteria	

<i>References</i>
<a href="https://www.mindat.org/min-2976.html">https://www.mindat.org/min-2976.html</a>

**7.2.1.159 Olivine**

Mineral group	<b>olivine</b>
Mineral species	forsterite - fayalite
IMA status	
Mineral/Gem variety	
Rock	
Trade name	
Description	see peridot
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1584.html">https://www.mindat.org/min-1584.html</a>	

**7.2.1.160 Onyx**

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>onyx</b>
Rock	
Trade name	
Description	Chalcedony composed of straight, parallel black and white layers
Variety distinction criteria	
Comments	A large part of sold as 'onyx' are in fact black dyed chalcedony, which is therefore a misnomer
<i>References</i>	
<a href="https://www.mindat.org/min-2999.html">https://www.mindat.org/min-2999.html</a>	

**7.2.1.161 Oolitic opal**

Mineral group	
Mineral species	opal

IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>Oolitic opal</b>
Description	Oolitic opal shows play-of-colour in combination with numerous black or brown spherical inclusions that have the appearance of fish eggs (roe) and are scattered throughout the stone
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3004.html">https://www.mindat.org/min-3004.html</a>	

#### 7.2.1.162 Opal

Mineral group	
Mineral species	<b>opal</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	white, grey, black, virtually any body colour, play-of-colour is often present. May show chatoyancy.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3004.html">https://www.mindat.org/min-3004.html</a>	

#### 7.2.1.163 Opalised fossil

Mineral group	
Mineral species	opal
IMA status	
Mineral/Gem variety	<b>opalised fossil</b> (fossil name)
Rock	
Trade name	
Description	material that has been replaced by opal, such as opalised shell, opalised wood, etc. (see below)

Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3004.html">https://www.mindat.org/min-3004.html</a> ; <a href="https://www.mindat.org/min-9837.html">https://www.mindat.org/min-9837.html</a>	

**7.2.1.164 Opalised shell**

Mineral group	
Mineral species	opal
IMA status	
Mineral/Gem variety	<b>opalised shell</b> - or (animal name) shell opal
Rock	
Trade name	
Description	shell that has been replaced by opal
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3004.html">https://www.mindat.org/min-3004.html</a> ; <a href="https://www.mindat.org/min-9837.html">https://www.mindat.org/min-9837.html</a>	

**7.2.1.165 Opalised wood**

Mineral group	
Mineral species	opal
IMA status	
Mineral/Gem variety	<b>opalised wood</b>
Rock	
Trade name	
Description	Wood that has been replaced by opal, with (partly) preservation of its original wood structure.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3004.html">https://www.mindat.org/min-3004.html</a> ; <a href="https://www.mindat.org/min-9837.html">https://www.mindat.org/min-9837.html</a>	



**7.2.1.166 Opicalcite**

Mineral group	
Mineral species	
IMA status	
Mineral/Gem variety	
Rock	<b>opicalcite</b>
Trade name	
Description	Brown to grey-green recrystallised impure limestone composed of calcite and serpentine; may be highly veined and brecciated.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-42741.html">https://www.mindat.org/min-42741.html</a> ; <a href="https://www.mindat.org/min-42809.html">https://www.mindat.org/min-42809.html</a>	

**7.2.1.167 Orange sapphire**

Mineral group	
Mineral species	corundum
IMA status	
Mineral/Gem variety	<b>orange sapphire</b>
Rock	
Trade name	
Description	Yellowish orange to reddish orange variety of corundum
Comment	The colour of some orange sapphires is not stable when exposed to light.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3529.html">https://www.mindat.org/min-3529.html</a>	

**7.2.1.168 Orthoclase**

Mineral group	Feldspar
Mineral species	<b>orthoclase</b>
IMA status	A
Mineral/Gem variety	
Rock	

Trade name	
Description	Colourless, yellow, transparent. See also moonstone
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3026.html">https://www.mindat.org/min-3026.html</a> ; <a href="https://www.mindat.org/min-2774.html">https://www.mindat.org/min-2774.html</a>	

### 7.2.1.169 Padparadscha

Mineral group	
Mineral species	corundum
IMA status	
Mineral/Gem variety	<b>Padparadscha</b> (or Padparadscha sapphire)
Rock	
Trade name	
Description	Padparadscha is a variety of corundum from any geographical origin whose colour is a subtle mixture of pinkish orange to orangey pink with pastel tones and low to medium saturations when viewed in standard daylight.
Comment	The colour of some Padparadscha sapphires is not stable when exposed to light.
Variety distinction criteria	The name 'padparadscha sapphire' shall not be applied in the following cases: <ul style="list-style-type: none"> <li>• If the stone has any colour modifier other than pink or orange</li> <li>• If the stone has major uneven colour distribution when viewed with the unaided eye and table up +/- 30°</li> <li>• The presence of yellow or orange epigenetic material in fissure(s) affecting the overall colour of the stone</li> <li>• If the stone underwent any diffusion, irradiation or glass-filling treatment</li> <li>• If the colour of the stone is not stable and shifting out of the padparadscha colour range (e.g. shifting to pink) by a colour stability test</li> <li>• If the stone has been dyed, coated, painted, varnished or sputtered.</li> </ul>
<i>References</i>	
<a href="https://www.mindat.org/min-39947.html">https://www.mindat.org/min-39947.html</a> ;	

[https://static1.squarespace.com/static/5bfbb7e6cc8fed3bb9293bf3/t/5bfe9241f950b7627afb4e27/1543410242229/LMHC+Information+Sheet\\_4\\_V9\\_2018.pdf](https://static1.squarespace.com/static/5bfbb7e6cc8fed3bb9293bf3/t/5bfe9241f950b7627afb4e27/1543410242229/LMHC+Information+Sheet_4_V9_2018.pdf)

### 7.2.1.170 Painite

Mineral group	
Mineral species	<b>painite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	deep brownish red, transparent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3063.html">https://www.mindat.org/min-3063.html</a>	

### 7.2.1.171 Paraíba tourmaline

Mineral group	tourmaline
Mineral species	elbaite, liddicoatite
IMA status	
Mineral/Gem variety	<b>Paraíba tourmaline</b>
Rock	
Trade name	
Description	<p>Paraíba is a gem variety of tourmaline containing copper (Cu) and manganese (Mn). It shows a (violet) blue, bluish green to greenish blue, green (or yellowish green) colour, of medium-light tone and high saturation.</p> <p>The variety name is derived from the Brazilian locality Paraíba where this gemstone was first mined, however today it may come from a number of localities.</p>
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-29238.html">https://www.mindat.org/min-29238.html</a> ; <a href="https://static1.squarespace.com/static/5bfbb7e6cc8fed3bb9293bf3/t/5bfe92a90e2e72555d61eec3/1543410345434/LMHC+Information+Sheet_6_V7_2012.pdf">https://static1.squarespace.com/static/5bfbb7e6cc8fed3bb9293bf3/t/5bfe92a90e2e72555d61eec3/1543410345434/LMHC+Information+Sheet_6_V7_2012.pdf</a>	

**7.2.1.172 Pectolite**

Mineral group	
Mineral species	<b>pectolite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	light blue, light green, slightly greyish to yellowish white, rarely very light pink, translucent to opaque; may show chatoyancy
Comment	see Larimar
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-29025.html">https://www.mindat.org/min-29025.html</a>	

**7.2.1.173 Peridot**

Mineral group	olivine
Mineral species	forsterite
IMA status	
Mineral/Gem variety	<b>peridot</b>
Rock	
Trade name	
Description	Greenish yellow to yellowish (or brownish) green variety of forsterite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-1584.html">https://www.mindat.org/min-1584.html</a> ; <a href="https://www.mindat.org/min-7710.html">https://www.mindat.org/min-7710.html</a>	

**7.2.1.174 Petalite**

Mineral group	
Mineral species	<b>petalite</b>
IMA status	G
Mineral/Gem variety	

Rock	
Trade name	
Description	colourless, grey, sometimes yellow, pink or very light green; transparent to translucent, may show chatoyancy
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3171.html">https://www.mindat.org/min-3171.html</a>	

### 7.2.1.175 Petrified wood (silicified wood)

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>petrified wood</b>
Rock	
Trade name	
Description	Wood that has been replaced by chalcedony, with (partly) preservation of its original wood structure.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-8018.html">https://www.mindat.org/min-8018.html</a>	

### 7.2.1.176 Pezzottaite

Mineral group	
Mineral species	<b>pezzottaite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	pink to purplish red, transparent, translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-25652.html">https://www.mindat.org/min-25652.html</a>	

**7.2.1.177 Phenakite**

Mineral group	
Mineral species	<b>phenakite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Usually colourless to light yellow; may also be light brown, pink, and rarely greenish blue; transparent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3188.html">https://www.mindat.org/min-3188.html</a>	

**7.2.1.178 Phosphophyllite**

Mineral group	
Mineral species	<b>phosphophyllite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	colourless, green, blue; transparent to translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3181.html">https://www.mindat.org/min-3181.html</a>	

**7.2.1.179 Pink sapphire**

Mineral group	
Mineral species	corundum
IMA status	
Mineral/Gem variety	<b>pink sapphire</b>
Rock	
Trade name	

Description	Pink to purplish pink variety of corundum
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3529.html">https://www.mindat.org/min-3529.html</a>	

**7.2.1.180 Pollucite**

Mineral group	
Mineral species	<b>pollucite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Colourless, light blue and violet, grey, white; transparent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3255.html">https://www.mindat.org/min-3255.html</a>	

**7.2.1.181 Plastic**

Mineral group	
Mineral species	
IMA status	
Mineral/Gem variety	
Rock	
Trade name	
Description	<p>Plastic is an amorphous artificial material consisting of long chain-like molecules (polymers), usually rich in carbon and hydrogen.</p> <p>All colours, commonly used as an imitation for various gems, particularly materials of organic origin such as amber, coral, jet, ivory; also produced with play-of-colour as imitation of opal.</p>
Variety distinction criteria	
<i>References</i>	

<https://www.mindat.org/min-49974.html>

### 7.2.1.182 Prase

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>prase</b>
Rock	
Trade name	
Description	Green translucent chalcedony
Variety distinction criteria	Darker, less saturated green than in chrysoprase
<i>References</i>	
<a href="https://www.mindat.org/min-6703.html">https://www.mindat.org/min-6703.html</a>	

### 7.2.1.183 Prasiolite

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>prasiolite</b>
Rock	
Trade name	
Description	Green to yellowish green, transparent variety of quartz
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-40112.html">https://www.mindat.org/min-40112.html</a>	

### 7.2.1.184 Prehnite

Mineral group	
Mineral species	<b>prehnite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	



Description	usually greenish yellow to yellowish green, translucent. May show chatoyancy.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3277.html">https://www.mindat.org/min-3277.html</a>	

**7.2.1.185 Purple sapphire**

Mineral group	
Mineral species	corundum
IMA status	
Mineral/Gem variety	purple sapphire
Rock	
Trade name	
Description	Pinkish purple to bluish purple variety of corundum
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3529.html">https://www.mindat.org/min-3529.html</a>	

**7.2.1.186 Purpurite**

Mineral group	
Mineral species	<b>purpurite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Purple to pink, dark brown, translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3311.html">https://www.mindat.org/min-3311.html</a>	

**7.2.1.187 Pyrite**

Mineral group	
Mineral species	<b>pyrite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	metallic yellow (brassy appearance), opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3314.html">https://www.mindat.org/min-3314.html</a>	

### 7.2.1.188 Pyrope

Mineral group	garnet
Mineral species	<b>pyrope</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Medium to dark slightly purplish red to red, to dark reddish orange; transparent to translucent. Colour shift or change may occur.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3321.html">https://www.mindat.org/min-3321.html</a> ; <a href="https://www.mindat.org/min-41651.html">https://www.mindat.org/min-41651.html</a>	

### 7.2.1.189 Pyrophyllite

Mineral group	
Mineral species	<b>pyrophyllite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	White, pale yellow, green or blue, translucent, opaque; compact spherulitic aggregates of acicular radiating crystals or massive.
Variety distinction criteria	

criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3323.html">https://www.mindat.org/min-3323.html</a>	

**7.2.1.190 Quartz**

Mineral group	
Mineral species	<b>quartz</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	see amethyst, ametrine, citrine, dumortierite quartz, iris quartz, morion, prasiolite, rock crystal, rose quartz, rutilated quartz, sagenitic quartz, smoky quartz, tourmalinated quartz, aventurine quartz
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3337.html">https://www.mindat.org/min-3337.html</a>	

**7.2.1.191 Rainbow moonstone**

Mineral group	feldspar
Mineral species	labradorite
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>Rainbow moonstone</b>
Description	Rainbow moonstone is a translucent to transparent feldspar, showing a deep blue adularescence, or a variety of iridescent colours
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2774.html">https://www.mindat.org/min-2774.html</a>	

**7.2.1.192 Rainbow obsidian**

Mineral group	
Mineral species	
IMA status	
Mineral/Gem variety	
Rock (natural glass)	obsidian
Trade name	<b>rainbow obsidian</b>
Description	Obsidian with iridescent colours
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-8519.html">https://www.mindat.org/min-8519.html</a>	

**7.2.1.193 Red beryl**

Mineral group	
Mineral species	beryl
IMA status	
Mineral/Gem variety	<b>red beryl</b>
Rock	
Trade name	
Description	Red to purplish red variety of beryl.
Comment	Bixbite was an alternative, but generally unused name. It should not be used anymore, as there is the IMA approved mineral bixbyite (a Mn-oxide), named after the same person.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-819.html">https://www.mindat.org/min-819.html</a>	

**7.2.1.194 Rhodizite**

Mineral group	
Mineral species	<b>rhodizite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Londonite-rhodizite series.

	Colourless, pink, yellow-green; transparent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3405.html">https://www.mindat.org/min-3405.html</a>	

### 7.2.1.195 Rhodochrosite

Mineral group	
Mineral species	<b>rhodochrosite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Usually pink, in a banded pattern with layers of pink and light pink or white, translucent to opaque. Also occurs in transparent pink to dark red.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3406.html">https://www.mindat.org/min-3406.html</a>	

### 7.2.1.196 Rhodolite

Mineral group	garnet
Mineral species	
IMA status	
Mineral/Gem variety	<b>rhodolite</b>
Rock	
Trade name	
Description	Rhodolite is a purple to red garnet, with a mixed pyrope-almandine composition.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-6719.html">https://www.mindat.org/min-6719.html</a>	

**7.2.1.197 Rhodonite**

Mineral group	
Mineral species	<b>rhodonite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Pink to purplish red, often with black veins and splotches, translucent to opaque; rarely transparent pink to red
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3407.html">https://www.mindat.org/min-3407.html</a>	

**7.2.1.198 Rock crystal**

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>Rock crystal</b>
Rock	
Trade name	
Description	Colourless, transparent variety of quartz
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-6128.html">https://www.mindat.org/min-6128.html</a>	

**7.2.1.199 Rose quartz**

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>rose quartz</b>
Rock	
Trade name	
Description	Pink, translucent to nearly transparent variety of quartz
Variety distinction	

criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3456.html">https://www.mindat.org/min-3456.html</a>	

**7.2.1.200 Rubellite**

Mineral group	tourmaline
Mineral species	elbaite, liddicoatite, rossmanite
IMA status	
Mineral/Gem variety	<b>rubellite</b>
Rock	
Trade name	
Description	Pink to red variety of tourmaline; may be slightly orangish, purplish or brownish
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3472.html">https://www.mindat.org/min-3472.html</a>	

**7.2.1.201 Ruby**

Mineral group	
Mineral species	corundum
IMA status	
Mineral/Gem variety	<b>ruby</b>
Rock	
Trade name	
Description	purplish red, pinkish red, red, to slightly orangish red variety of corundum
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3473.html">https://www.mindat.org/min-3473.html</a>	

**7.2.1.202 Rutilated quartz**

Mineral group	
Mineral species	quartz
IMA status	

Mineral/Gem variety	rock crystal
Rock	
Trade name	<b>rutilated quartz</b>
Description	Rock crystal containing visible rutile needles
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3485.html">https://www.mindat.org/min-3485.html</a> ; <a href="https://www.mindat.org/min-26498.html">https://www.mindat.org/min-26498.html</a>	

### 7.2.1.203 Sagenitic quartz

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>Sagenitic quartz</b>
Description	General term referring to transparent quartz (usually rock crystal) containing visible needle-like inclusions, such as actinolite, rutile and tourmaline, often specified according to the mineral inclusions contained, such as rutilated quartz and tourmalinated quartz
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/glossary/sagenitic_quartz">https://www.mindat.org/glossary/sagenitic_quartz</a>	

### 7.2.1.204 Sapphire

Mineral group	
Mineral species	corundum
IMA status	
Mineral/Gem variety	<b>sapphire</b>
Rock	
Trade name	
Description	Violetish blue, blue to greenish blue variety of corundum
Variety distinction	



criteria	
Comments	The term 'sapphire' alone refers to blue. All other colours typically have a colour prefix.
<i>References</i>	
<a href="https://www.mindat.org/min-3529.html">https://www.mindat.org/min-3529.html</a>	

#### 7.2.1.205 Sapphirine

Mineral group	
Mineral species	<b>sapphirine</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	dark blue, blue-grey, greenish grey to green, rarely yellow-brown or pink; transparent, translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3531.html">https://www.mindat.org/min-3531.html</a>	

#### 7.2.1.206 Sard

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>sard</b>
Rock	
Trade name	
Description	Dark brownish red to brown, to dark orange, translucent chalcedony
Variety distinction criteria	Darker and less saturated colours than those in carnelian
<i>References</i>	
<a href="https://www.mindat.org/min-7607.html">https://www.mindat.org/min-7607.html</a>	

#### 7.2.1.207 Sardonyx

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>sardonyx</b>
Rock	
Trade name	
Description	Onyx showing brownish red to brown bands (sard colours) alternating with white and/or black parallel bands
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-7604.html">https://www.mindat.org/min-7604.html</a>	

#### 7.2.1.208 Saussurite

Mineral group	
Mineral species	
IMA status	
Mineral/Gem variety	
Rock	<b>saussurite</b>
Trade name	
Description	Saussurite is a rock primarily composed of green zoisite and/or epidote with white feldspar and various amounts of other minerals.  Greyish to yellowish green, often mottled, translucent to opaque.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-26894.html">https://www.mindat.org/min-26894.html</a>	

#### 7.2.1.209 Scapolite

Mineral group	<b>scapolite</b>
Mineral species	marialite - meionite
IMA status	
Mineral/Gem variety	
Rock	
Trade name	

Description	Scapolite has a chemical composition that varies between marialite and meionite.  Colourless, pink, orange, yellow, green, blue, violet, purple, transparent to translucent. May show chatoyancy.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-8778.html">https://www.mindat.org/min-8778.html</a>	

#### 7.2.1.210 Scheelite

Mineral group	
Mineral species	<b>scheelite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Yellow, orange, brown, colourless, transparent to translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3560.html">https://www.mindat.org/min-3560.html</a>	

#### 7.2.1.211 Schorl

Mineral group	tourmaline
Mineral species	<b>schorl</b>
IMA status	Rn
Mineral/Gem variety	
Rock	
Trade name	
Description	black, opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3578.html">https://www.mindat.org/min-3578.html</a>	

**7.2.1.212 Serendibite**

Mineral group	
Mineral species	<b>serendibite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Bluish green, green-blue, transparent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3623.html">https://www.mindat.org/min-3623.html</a>	

**7.2.1.213 Serpentine**

Mineral group	<b>serpentine</b>
Mineral species	
IMA status	
Mineral/Gem variety	
Rock	
Trade name	
Description	Most common serpentine species are lizardite, chrysotile and antigorite.  Green to greenish yellow, white, brown, black, often mottled; translucent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-7484.html">https://www.mindat.org/min-7484.html</a>	

**7.2.1.214 Sheen obsidian**

Mineral group	
Mineral species	
IMA status	
Mineral/Gem variety	
Rock (natural glass)	obsidian
Trade name	<b>sheen obsidian</b>

Description	Sheen obsidian shows a whitish ('silvery') or yellowish ('golden') looking sheen
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-8519.html">https://www.mindat.org/min-8519.html</a>	

**7.2.1.215 Sillimanite**

Mineral group	
Mineral species	<b>sillimanite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	white to grey, brown, green, rarely violetish to greyish blue; usually translucent to opaque, rarely transparent. May show chatoyancy.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3662.html">https://www.mindat.org/min-3662.html</a>	

**7.2.1.216 Sinhalite**

Mineral group	
Mineral species	<b>sinhalite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Greenish to brownish yellow, brown, rarely light pink; transparent to translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3672.html">https://www.mindat.org/min-3672.html</a>	

**7.2.1.217 Smithsonite**

Mineral group	
Mineral species	<b>smithsonite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Green, blue, yellow, brown, pink, white to colourless, often light in tone and banded; commonly translucent, rarely transparent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3688.html">https://www.mindat.org/min-3688.html</a>	

#### 7.2.1.218 Smoky quartz

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>smoky quartz</b>
Rock	
Trade name	
Description	light to dark brown and transparent variety of quartz
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3689.html">https://www.mindat.org/min-3689.html</a>	

#### 7.2.1.219 Snowflake obsidian

Mineral group	
Mineral species	
IMA status	
Mineral/Gem variety	
Rock (natural glass)	obsidian
Trade name	<b>snowflake obsidian</b>
Description	Snowflake obsidian shows white patches in a black or dark grey background
Variety distinction	

criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-8519.html">https://www.mindat.org/min-8519.html</a>	

**7.2.1.220 Soapstone**

Mineral group	
Mineral species	talc
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>soapstone</b>
Description	white, grey, brown, light to dark green, often mottled or veined; translucent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3875.html">https://www.mindat.org/min-3875.html</a> ; <a href="https://www.mindat.org/min-3755.html">https://www.mindat.org/min-3755.html</a> ; <a href="https://www.mindat.org/min-9348.html">https://www.mindat.org/min-9348.html</a>	

**7.2.1.221 Sodalite**

Mineral group	
Mineral species	<b>sodalite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Usually dark blue to violetish blue, often with white veining, rarely grey, yellow, green or pink; translucent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3701.html">https://www.mindat.org/min-3701.html</a>	

**7.2.1.222 Spectrolite**

Mineral group	feldspar (plagioclase)
Mineral species	anorthite (albite-anorthite series)
IMA status	
Mineral/Gem variety	labradorite
Rock	
Trade name	<b>spectrolite</b>
Description	grey to nearly black, labradorescence causing interference colours at the surface, translucent to opaque.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2308.html">https://www.mindat.org/min-2308.html</a>	

#### 7.2.1.223 Spessartine

Mineral group	garnet
Mineral species	<b>spessartine</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	
Variety distinction criteria	yellowish orange to reddish orange, medium light to dark tones; transparent
<i>References</i>	
<a href="https://www.mindat.org/min-3725.html">https://www.mindat.org/min-3725.html</a>	

#### 7.2.1.224 Sphalerite

Mineral group	
Mineral species	<b>sphalerite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Yellow, orange, red, brown, green, transparent to translucent
Variety distinction criteria	



<i>References</i>
<a href="https://www.mindat.org/min-3727.html">https://www.mindat.org/min-3727.html</a> ; <a href="https://www.mindat.org/min-6293.html">https://www.mindat.org/min-6293.html</a>

**7.2.1.225 Spheue**

Mineral group	
Mineral species	titanite
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>sphene</b>
Description	In the trade, sphene is used as a synonym for titanite.  Yellow, green, brown, orange, rarely red; transparent to translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-6440.html">https://www.mindat.org/min-6440.html</a> ; <a href="https://www.mindat.org/min-3977.html">https://www.mindat.org/min-3977.html</a>	

**7.2.1.226 Spinel**

Mineral group	spinel
Mineral species	<b>spinel</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Pink to red, orange, blue, blue-green, violet, purple, black; transparent to opaque. Colour change may occur, asterism is rare.  See also cobalt spinel, gahnospinel
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-29156.html">https://www.mindat.org/min-29156.html</a> ; <a href="https://www.mindat.org/min-3729.html">https://www.mindat.org/min-3729.html</a> ; <a href="https://www.mindat.org/min-6684.html">https://www.mindat.org/min-6684.html</a>	

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**7.2.1.227 Spodumene**

Mineral group	
Mineral species	<b>spodumene</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	pink to bluish purple, green, yellow, colourless, transparent; colours typically light in tone and may fade. See also kunzite and hiddenite.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3733.html">https://www.mindat.org/min-3733.html</a>	

**7.2.1.228 Star diopside**

Mineral group	
Mineral species	diopside
IMA status	
Mineral/Gem variety	<b>Star diopside</b>
Rock	
Trade name	
Description	Dark green to black diopside, with asterism
Variety distinction criteria	
<i>References</i>	
<a href="https://www.gemdat.org/gem-1294.html">https://www.gemdat.org/gem-1294.html</a>	

**7.2.1.229 Star ruby**

Mineral group	
Mineral species	corundum
IMA status	
Mineral/Gem variety	<b>Star ruby</b>

Rock	
Trade name	
Description	Ruby showing asterism (usually a six-ray star, sometimes a twelve-ray star)
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3473.html">https://www.mindat.org/min-3473.html</a>	

### 7.2.1.230 Star sapphire

Mineral group	
Mineral species	corundum
IMA status	
Mineral/Gem variety	<b>Star sapphire</b>
Rock	
Trade name	
Description	Sapphire showing asterism (usually a six-ray star, sometimes a twelve-ray star)
Comments	The term 'sapphire' alone refers to blue. All other colours typically have a colour prefix.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3529.html">https://www.mindat.org/min-3529.html</a>	

### 7.2.1.231 Sugilite

Mineral group	
Mineral species	<b>sugilite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Red-purple to bluish purple, rarely pink; translucent to opaque
Variety distinction criteria	
<i>References</i>	

<https://www.mindat.org/min-3822.html>

### 7.2.1.232 Sunstone

Mineral group	feldspar
Mineral species	
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>Sunstone</b>
Description	A variety of feldspar, commonly with an orange/brown background colour, that has 'schiller', due to small, highly reflective mineral inclusions (e.g., hematite, ilmenite, copper) that give it a flash and sparkle. Also called 'Aventurine feldspar'.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-10984.html">https://www.mindat.org/min-10984.html</a>	

### 7.2.1.233 Taaffeite

Mineral group	
Mineral species	<b>Magnesiotaaffeite-2N'2S</b>
IMA status	Rn
Mineral/Gem variety	
Rock	
Trade name	
Description	Taaffeite is a synonym of Magnesiotaaffeite-2N'2S.  Pink to red, blue, violet, purple, brown, colourless, transparent. See also musgravite.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-27242.html">https://www.mindat.org/min-27242.html</a>	

### 7.2.1.234 Talc

Mineral group	
Mineral species	<b>talca</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	white, grey, brown, light to dark green, often mottled or veined; translucent to opaque. See also soapstone.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3875.html">https://www.mindat.org/min-3875.html</a> ; <a href="https://www.mindat.org/min-3755.html">https://www.mindat.org/min-3755.html</a> ; <a href="https://www.mindat.org/min-9348.html">https://www.mindat.org/min-9348.html</a>	

#### 7.2.1.235 Tantalite-(Mn)

Mineral group	
Mineral species	<b>Tantalite-(Mn)</b>
IMA status	Rn
Mineral/Gem variety	
Rock	
Trade name	
Description	Earlier on this mineral was called 'manganotantalite'.  Vivid to dark red, transparent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-2522.html">https://www.mindat.org/min-2522.html</a>	

#### 7.2.1.236 Tanzanite

Mineral group	
Mineral species	zoisite
IMA status	
Mineral/Gem variety	<b>tanzanite</b>
Rock	
Trade name	

Description	blue to violet, or bi-colour (green and blue) variety of zoisite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3885.html">https://www.mindat.org/min-3885.html</a>	

### 7.2.1.237 Tektite

Mineral group	
Mineral species	
IMA status	
Mineral/Gem variety	
Natural glass	<b>tektite</b>
Trade name	
Description	A tektite is natural glass formed from terrestrial debris, created by and ejected during meteorite impacts (splash product of meteorite impact).  green to black, transparent to translucent.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-10859.html">https://www.mindat.org/min-10859.html</a>	

### 7.2.1.238 Thomsonite

Mineral group	
Mineral species	<b>thomsonite-(Ca)</b>
IMA status	Rn
Mineral/Gem variety	
Rock	
Trade name	
Description	Various colours, including brown, yellow, orange, pink, green, white and grey, with a radial fibrous structure; colour patterns and structure produce an agate-like appearance; translucent, opaque.
Variety distinction criteria	
<i>References</i>	

<https://www.mindat.org/min-28896.html>

#### 7.2.1.239 Thulite

Mineral group	
Mineral species	zoisite
IMA status	
Mineral/Gem variety	<b>thulite</b>
Rock	
Trade name	
Description	Pink, translucent to opaque, often mottled with grey or white, massive variety of zoisite
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-4430.html">https://www.mindat.org/min-4430.html</a> ; <a href="https://www.mindat.org/min-3955.html">https://www.mindat.org/min-3955.html</a>	

#### 7.2.1.240 Tiger's-eye

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	<b>tiger's-eye</b>
Rock	
Trade name	
Description	Tiger's-eye is a variety of quartz in which quartz replaced crocidolite (a form of asbestos) without disturbing the fibrous structure of the original crocidolite.  Brownish yellow to brown to reddish brown, translucent to opaque.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3960.html">https://www.mindat.org/min-3960.html</a>	

#### 7.2.1.241 Titanite

Mineral group	
Mineral species	<b>titanite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Yellow, green, brown, orange, rarely red; transparent to translucent.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3977.html">https://www.mindat.org/min-3977.html</a> ; <a href="https://www.mindat.org/min-6440.html">https://www.mindat.org/min-6440.html</a>	

#### 7.2.1.242 Topaz

Mineral group	
Mineral species	<b>topaz</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Colourless, yellow, orange, brown, pink to red to purple-red, light to dark blue, light green; transparent. May show chatoyancy.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3996.html">https://www.mindat.org/min-3996.html</a> ; <a href="https://www.gia.edu/doc/Irradiated-Topaz-and-Radioactivity.pdf">https://www.gia.edu/doc/Irradiated-Topaz-and-Radioactivity.pdf</a>	

#### 7.2.1.243 Topazolite

Mineral group	
Mineral species	andradite
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>topazolite</b>
Description	Yellow, transparent to translucent andradite; may show chatoyancy



Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-7535.html">https://www.mindat.org/min-7535.html</a>	

#### 7.2.1.244 Tourmaline

Mineral group	<b>tourmaline</b>
Mineral species	
IMA status	
Mineral/Gem variety	
Rock	
Trade name	
Description	Tourmaline is often named with a colour prefix; there are also parti-coloured, bi-coloured and tri-coloured tourmaline and cat's-eye tourmaline, showing chatoyancy and typically with green, blue or pink body colour. Common variety names are specifically mentioned in this list.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-4003.html">https://www.mindat.org/min-4003.html</a>	

#### 7.2.1.245 Tourmalinated quartz

Mineral group	
Mineral species	quartz
IMA status	
Mineral/Gem variety	rock crystal
Rock	
Trade name	<b>tourmalinated quartz</b>
Description	Rock crystal containing visible tourmaline needles
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3485.html">https://www.mindat.org/min-3485.html</a> ; <a href="https://www.mindat.org/min-26498.html">https://www.mindat.org/min-26498.html</a>	

**7.2.1.246 Tremolite**

Mineral group	
Mineral species	<b>tremolite</b>
IMA status	Rd
Mineral/Gem variety	
Rock	
Trade name	
Description	Grey-brown, green, colourless, white, pink; transparent, translucent.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-4011.html">https://www.mindat.org/min-4011.html</a>	

**7.2.1.247 Tsavorite**

Mineral group	garnet
Mineral species	grossular
IMA status	
Mineral/Gem variety	<b>tsavorite</b>
Rock	
Trade name	
Description	vivid green to yellowish green and transparent variety of grossular
Variety distinction criteria	colour dominantly due to vanadium ( $V^{3+}$ ) and to a lesser degree to chromium ( $Cr^{3+}$ ).
<i>References</i>	
<a href="https://www.mindat.org/min-1755.html">https://www.mindat.org/min-1755.html</a> ; <a href="https://www.mindat.org/min-7836.html">https://www.mindat.org/min-7836.html</a>	

**7.2.1.248 Tugtupite**

Mineral group	
Mineral species	<b>tugtupite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	

Description	usually pink to red, often mottled with white, grey or black; translucent to opaque.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-4044.html">https://www.mindat.org/min-4044.html</a>	

**7.2.1.249 Turquoise**

Mineral group	
Mineral species	<b>turquoise</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Light to medium blue, greenish blue to green, often mottled, translucent to opaque; may show dark splotches or veins of matrix.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-4060.html">https://www.mindat.org/min-4060.html</a>	

**7.2.1.250 Ulexite**

Mineral group	
Mineral species	<b>ulexite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	white, transparent, translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-4085.html">https://www.mindat.org/min-4085.html</a>	

**7.2.1.251 Umbalite**

Mineral group	garnet
Mineral species	
IMA status	
Mineral/Gem variety	Mixed composition pyrope-spessartine-almandine-grossular
Rock	
Trade name	<b>Umbalite</b>
Description	Yellowish to reddish brown, to brown-orange variety of garnet with mixed compositions. Umbalite is a synonym of Malaya garnet.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-42908.html">https://www.mindat.org/min-42908.html</a>	

**7.2.1.252 Unakite**

Mineral group	
Mineral species	
IMA status	
Mineral/Gem variety	
Rock	<b>unakite</b>
Trade name	
Description	altered granite, principally composed of green epidote, pink orthoclase and clear quartz
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-36075.html">https://www.mindat.org/min-36075.html</a>	

**7.2.1.253 Uvarovite**

Mineral group	garnet
Mineral species	<b>uvarovite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	green, translucent to opaque
Variety distinction criteria	

<i>References</i>
<a href="https://www.mindat.org/min-4125.html">https://www.mindat.org/min-4125.html</a>

#### 7.2.1.254 Vanadium chrysoberyl

Mineral group	
Mineral species	chrysoberyl
IMA status	
Mineral/Gem variety	<b>vanadium chrysoberyl</b>
Rock	
Trade name	
Description	green, bluish green, transparent
Variety distinction criteria	colour caused by V or by V+Cr, with V>Cr
<i>References</i>	
<a href="https://www.ssef.ch/wp-content/uploads/2018/06/2013-Schmetzer-et-al-natural-synthetic-V-chrysoberyl.pdf">https://www.ssef.ch/wp-content/uploads/2018/06/2013-Schmetzer-et-al-natural-synthetic-V-chrysoberyl.pdf</a>	

#### 7.2.1.255 Variscite

Mineral group	
Mineral species	<b>variscite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Light to medium yellowish green to bluish green, often mottled or veined with brown to yellow matrix; translucent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-4156.html">https://www.mindat.org/min-4156.html</a>	

#### 7.2.1.256 Verd-antique

Mineral group	serpentine
Mineral species	
IMA status	

Mineral/Gem variety	
Rock	
Trade name	<b>Verd-antique</b>
Description	Mottled and/or veined dark green serpentine
Variety distinction criteria	
<i>References</i>	
<a href="https://www.gemdat.org/gem-42810.html">https://www.gemdat.org/gem-42810.html</a>	

### 7.2.1.257 Verdelite

Mineral group	tourmaline
Mineral species	elbaite
IMA status	
Mineral/Gem variety	<b>verdelite</b>
Rock	
Trade name	
Description	Yellowish green to bluish green variety of tourmaline; colour due to iron
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-4003.html">https://www.mindat.org/min-4003.html</a> ; <a href="https://www.mindat.org/min-4169.html">https://www.mindat.org/min-4169.html</a>	

### 7.2.1.258 Verdite

Mineral group	
Mineral species	muscovite
IMA status	
Mineral/Gem variety	fuchsite
Rock	
Trade name	<b>verdite</b>
Description	Green, opaque, ornamental stone, consists primarily of fuchsite, with minor albite, chlorite, corundum, diaspore, margarite, quartz, rutile and talc.
Variety distinction criteria	
<i>References</i>	

<https://www.mindat.org/min-5417.html>

#### 7.2.1.259 Vesuvianite

Mineral group	
Mineral species	<b>vesuvianite</b>
IMA status	A
Mineral/Gem variety	
Rock	
Trade name	
Description	Yellowish green, green, yellowish brown, violet; transparent, translucent
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-4223.html">https://www.mindat.org/min-4223.html</a> ; <a href="https://www.mindat.org/min-6538.html">https://www.mindat.org/min-6538.html</a>	

#### 7.2.1.260 Violane

Mineral group	
Mineral species	diopside
IMA status	
Mineral/Gem variety	<b>violane</b>
Rock	
Trade name	
Description	Violet-blue, translucent, opaque, Manganese-rich variety of diopside
Variety distinction criteria	
<i>References</i>	
<a href="https://www.gemdat.org/gem-8118.html">https://www.gemdat.org/gem-8118.html</a>	

#### 7.2.1.261 Watermelon tourmaline

Mineral group	tourmaline
Mineral species	elbaite
IMA status	
Mineral/Gem variety	<b>watermelon tourmaline</b>

Rock	
Trade name	
Description	Variety of tourmaline, which is pink in the centre and green around the periphery
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-4003.html">https://www.mindat.org/min-4003.html</a> ; <a href="https://www.mindat.org/min-10889.html">https://www.mindat.org/min-10889.html</a>	

### 7.2.1.262 White opal

Mineral group	
Mineral species	opal
IMA status	
Mineral/Gem variety	<b>white opal</b>
Rock	
Trade name	
Description	Play-of-colour against a white body colour, translucent to nearly opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3004.html">https://www.mindat.org/min-3004.html</a>	

### 7.2.1.263 White sapphire

Mineral group	
Mineral species	corundum
IMA status	
Mineral/Gem variety	colourless sapphire
Rock	
Trade name	<b>white sapphire</b>
Description	Colourless, transparent variety of corundum
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-3529.html">https://www.mindat.org/min-3529.html</a>	



**7.2.1.264 Williamsite**

Mineral group	serpentine
Mineral species	antigorite
IMA status	
Mineral/Gem variety	
Rock	
Trade name	<b>williamsite</b>
Description	Intense green, nearly transparent to translucent serpentine
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-27232.html">https://www.mindat.org/min-27232.html</a>	

**7.2.1.265 Yellow sapphire**

Mineral group	
Mineral species	corundum
IMA status	
Mineral/Gem variety	yellow sapphire
Rock	
Trade name	
Description	Greenish yellow to orangish yellow variety of corundum
Variety distinction criteria	
Comment	The colour of some yellow sapphires is not stable when exposed to light.
<i>References</i>	
<a href="https://www.mindat.org/min-3529.html">https://www.mindat.org/min-3529.html</a> ; <a href="https://www.gia.edu/doc/The-Seven-Types-of-Yellow-Sapphire-and-Their-Stability-to-Light.pdf">https://www.gia.edu/doc/The-Seven-Types-of-Yellow-Sapphire-and-Their-Stability-to-Light.pdf</a>	

**7.2.1.266 Zircon**

Mineral group	
Mineral species	<b>zircon</b>
IMA status	G
Mineral/Gem variety	

Rock	
Trade name	
Description	Colourless, blue, yellow, green, brown, orange, red, transparent; may rarely show chatoyancy.
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-4421.html">https://www.mindat.org/min-4421.html</a>	

### 7.2.1.267 Zoisite

Mineral group	
Mineral species	<b>zoisite</b>
IMA status	G
Mineral/Gem variety	
Rock	
Trade name	
Description	Blue to violet, green, pink, brown; transparent to opaque
Variety distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-4430.html">https://www.mindat.org/min-4430.html</a> ; <a href="https://www.mindat.org/min-3885.html">https://www.mindat.org/min-3885.html</a>	

## 7.2.2. Definitions gem materials of organic/biogenic origin

### 7.2.2.1. Amber

Mineral species present	
IMA status	
Trade name	
Description	Amber is an amorphous organic material consisting of fossilized tree resin
Distinction criteria	

<i>References</i>	
<a href="https://www.mindat.org/min-188.html">https://www.mindat.org/min-188.html</a>	

**7.2.2.2. Bone**

Mineral species present	apatite
IMA status	
Trade name	
Description	Bone is the hard material that forms the skeleton of most vertebrate animals. It consists of a network of collagen fibres impregnated with calcium phosphate (a form of apatite).
Distinction criteria	
<i>References</i>	
<a href="https://www.sciencelearn.org.nz/resources/1796-bone-and-tooth-minerals">https://www.sciencelearn.org.nz/resources/1796-bone-and-tooth-minerals</a>	

**7.2.2.3. Copal**

Mineral species present	
IMA status	
Trade name	
Description	Copal is an amorphous organic material consisting of (sub) recent to fossilized resin. It is more recent in origin than amber.
Distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-26751.html">https://www.mindat.org/min-26751.html</a>	

**7.2.2.4. Coral**

Mineral species present	calcite, aragonite
IMA status	
Trade name	Trade names of precious corals, see the <i>CIBJO Coral Book</i>
Description	Corals are marine invertebrates. Cnidarians with

	<p>skeletons are referred to collectively as “coral”. Precious corals are those that are used in jewellery and decoration, specifically red, pink and white varieties with porcelain like lustre after polishing. They are limited to species belonging to the family Corallidae, consisting of the three following groups: <i>Corallium</i>, <i>Pleurocorallium</i> and <i>Hemicorallium</i>. Coral mainly consists of calcite or aragonite and may contain organic pigments.</p> <p>Descriptions of precious coral species can be found in the <i>CIBJO Coral Book</i>.</p>
Distinction criteria	
<i>References</i>	
<a href="https://www.gemdat.org/gem-42717.html">https://www.gemdat.org/gem-42717.html</a> ; <a href="http://www.cibjo.org/wp-content/uploads/2020/04/20-12-22-Official-Coral-Blue-Book.pdf">http://www.cibjo.org/wp-content/uploads/2020/04/20-12-22-Official-Coral-Blue-Book.pdf</a>	

#### 7.2.2.5. Horn

Mineral species present	
IMA status	
Trade name	
Description	Horn of a horned animal, such as cows, sheep goats, buffalo, impala, oryx, great kudu. It consists of organic material, hard keratin formed in laminated layers.
Distinction criteria	
<i>References</i>	
Pedersen M.C., 2004. Gem and ornamental materials of organic origin (book)	

#### 7.2.2.6. Ivory

Mineral species present	hydroxylapatite
IMA status	
Trade name	
Description	Ivory consists of calcium phosphate (hydroxylapatite) with collagenous proteins. Most ivory is from elephant tusks although mammoth, walrus, hippopotamus, narwhal

	tusks and tusks of other animals are also used as ivory.
Distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-42718.html">https://www.mindat.org/min-42718.html</a> ; <a href="https://cites.org/sites/default/files/eng/resources/pub/E-Ivory-guide.pdf">https://cites.org/sites/default/files/eng/resources/pub/E-Ivory-guide.pdf</a> ; Pedersen M.C., 2015. Ivory. The Crowood Press Ltd., 240 pp. (book)	

#### 7.2.2.7. Ivory - vegetable

Mineral species present	
IMA status	
Trade name	
Description	Various large nuts, especially tagua nut, have long been used as a simulant for ivory. It consists of cellulose, the most common natural biopolymer on Earth.
Distinction criteria	
<i>References</i>	
Pedersen M.C., 2015. Ivory. The Crowood Press Ltd., 240 pp. (book)	

#### 7.2.2.8 Jet

Mineral species present	
IMA status	
Trade name	Jet
Description	Jet is an opaque, black coalified fossilized drift wood of trees of the family Araucariaceae. Jet is chemically related to brown coal, or lignite, but Jet is more solid and tough.
Distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-9355.html">https://www.mindat.org/min-9355.html</a>	

#### 7.2.2.9 Pearl

Mineral species present	aragonite, calcite
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IMA status	
Trade name	Trade names of natural and cultured pearls, see Annex C in the <i>CIBJO Pearl Book</i>
Description	natural pearl formations secreted in the interior of molluscs and within naturally formed pearl sacs. They are composed of a complex scleroprotein named conchiolin and of calcium carbonate in the form of aragonite and/or calcite arranged in concentric layers.  See the <i>CIBJO Pearl Book</i> for all terms, definitions and classification categories related to pearls.
Distinction criteria	
<i>References</i>	
<a href="http://www.cibjo.org/wp-content/uploads/2020/04/20-12-22-Official-Pearl-Book.pdf">http://www.cibjo.org/wp-content/uploads/2020/04/20-12-22-Official-Pearl-Book.pdf</a>	

#### 7.2.2.10 Shell

Nature of material	
Mineral species present	Aragonite, calcite
IMA status	
Trade name	
Description	Shell is the calcareous outer part of a mollusc's body. It mainly consists of calcium carbonate and an organic matrix (conchiolin)
Distinction criteria	
<i>References</i>	
<a href="https://www.mindat.org/min-42812.html">https://www.mindat.org/min-42812.html</a>	

#### 7.2.2.11 Tortoise shell

Nature of material	
Mineral species present	
IMA status	
Trade name	
Description	Tortoise shell is an organic, protein material

	(hard keratin), which forms the mottled, yellowish or reddish and brown, translucent plates ('scutes') covering the shells of certain species of marine turtle. The best known and the finest tortoise shell comes from the hawksbill sea turtle.
Distinction criteria	
<i>References</i>	
<a href="https://www.gemdat.org/gem-42814.html">https://www.gemdat.org/gem-42814.html</a>	

## Appendix A Test methods references

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