The Gemmological Laboratory Book
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Foreword

CIBJO is the French acronym for the Confédération Internationale de la Bijouterie, Joaillerie, Orfèvrerie, des Diamants, Perles et Pierres, which translates as the International Confederation of Jewellery, Silverware, Diamonds, Pearls and Stones (normally shortened to the International Jewellery Confederation). Founded in 1926 as BIBOAH, a 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 Sector

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

Coloured Stone

Coral
Diamond
Ethics
Gemmological
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.

CIBJO Secretariat:

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E-mail: cibjo@cibjo.org
Web site: www.cibjo.org
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 a CIBJO standard and normative references (Blue Books, PAS).

- "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 2016
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.


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
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. Gemmology

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 reporting activities of the
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. See also CIBJO Application Document for Laboratories (www.cibjo.org). 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

<table>
<thead>
<tr>
<th>Required Test method</th>
<th>Remark</th>
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<tbody>
<tr>
<td>Microscope</td>
<td>Cat’s-eye</td>
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<tr>
<td>Phenomena</td>
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<tr>
<td>Refractometer (refractive index)</td>
<td></td>
</tr>
<tr>
<td>Hydrostatic weighing (specific gravity)</td>
<td></td>
</tr>
<tr>
<td>Raman spectroscopy</td>
<td>If other tests are inconclusive</td>
</tr>
<tr>
<td>XRD</td>
<td>If other tests are inconclusive</td>
</tr>
</tbody>
</table>

References
Burns and Greaves (1971); Crowningshield (1969); Fryer (1993a); Hietanen (1971); Ishida et al. (2002); Lucas (1974); Mustard (1992); Pough (1987); Smelik et al. (1991); Skogby and Annersten (1985); Washington and Merwin (1923)

Special attention: dye

6.1.2. Alexandrite
### Required Test method | Remark
--- | ---
Microscope | 
Phenomena | Cat's-eye, colour-change
Refractometer (refractive index) | 
Spectroscope | 
FTIR(-NIR) spectroscopy | 
Colour call | Clear colour-change
Clarity enhancement check/extent | 

### References

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

### 6.1.3. Amblygonite

| Required Test method | Remark |
--- | --- |
Microscope | 
Refractometer (refractive index) | 
Hydrostatic weighing (specific gravity) | 
Raman spectroscopy | 
XRD | If other tests are inconclusive

### References

### 6.1.4. Ammonite

| Required Test method | Remark |
--- | --- |
Microscope | 
Refractometer (refractive index) | 
Hydrostatic weighing (specific gravity) | 
Raman spectroscopy | 
XRD | If other tests are inconclusive

### References
### 6.1.5. Anatase

<table>
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<td>Hydrostatic weighing (specific gravity)</td>
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<td>EDXRF chemistry</td>
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<td>Raman spectroscopy</td>
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**References**


### 6.1.6. Andalusite

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<td>Refractometer (refractive index)</td>
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<td>Hydrostatic weighing (specific gravity)</td>
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**References**


### 6.1.7. Apatite

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<td>Phenomena</td>
<td>Cat’s-eye, colour-change</td>
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<tr>
<td>Refractometer (refractive index)</td>
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<td>Hydrostatic weighing</td>
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6.1.8. Aquamarine

<table>
<thead>
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<td>Colour call</td>
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<td>Clarity enhancement check/extent</td>
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</tbody>
</table>

**References**


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

6.1.9. Aragonite

<table>
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<tr>
<td>Refractometer (refractive index)</td>
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<tr>
<td>Hydrostatic weighing (specific gravity)</td>
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<tr>
<td>Raman spectroscopy</td>
<td></td>
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</tbody>
</table>
If other tests are inconclusive

References
Brink and van der Berg (2005), Chatgeiner et al. (2000), Chave and Schmalz (1966), Checa et al.
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-
(1988), Ronneberg et al. (1979b), Sen et al. (1994), Soldati et al. (2008), Steinens (1982), Utros et
et al. (2009)

Special attention: dye

6.1.10.  Axinite

Required Test method | Remark
---|---
Microscope |  
Refractometer (refractive index) |  
Hydrostatic weighing (specific gravity) |  
Dichroscope (pleochroism) |  
Spectroscope |  
Raman spectroscopy | If other tests are inconclusive
XRD | If other tests are inconclusive

References
Andreozzi et al. (2000a,b), Cassedanne and Cassedanne (1977), Cassedanne et al. (1983),
(1972), Frost et al. (2006), Hanni (1982), Jobbins et al. (1975), Kalachev (1993), Koivula and
Kammerling (1992), Lumpkin and Ribbe (1979), Peacock (1937, 1938), Pinet et al. (1992), Pohl et

6.1.11.  Benitoite

Required Test method | Remark
---|---
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

References
Benson (1960), Brown (1997), Crowningshield (1960a,b), Frazier and Frazier (1990a), Galt et al.
Launer (1952), Mais 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)
### 6.1.13. Beryllonite

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**References**


Special attention: clarity enhancement, synthetics

### 6.1.14. Brazilianite

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**References**


### 6.1.15. Calcite

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<td>Hydrostatic weighing</td>
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</table>
(specific gravity)

**FTIR(-NIR)**
If other tests are inconclusive

Raman spectroscopy
If other tests are inconclusive

### References


Special attention: fragile, dye, coatings

### 6.1.16. Chalcedony

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<td>Spectroscope</td>
<td>Green variety</td>
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<tr>
<td>EDXRF chemistry</td>
<td>Green variety</td>
</tr>
<tr>
<td>Raman spectroscopy</td>
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### References


Special attention: dye

### 6.1.17. Charoite

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### References


### 6.1.18. Chrysoberyl

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### References

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### 6.1.19. Chrysocolla

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<td>Spectroscope</td>
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<td>EDXRF chemistry</td>
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**References**


**Special attention: irradiation, synthetics**

### 6.1.20. Clinohumite

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**References**


**Special attention: dyed (with Cu)**
Hydrostatic weighing (specific gravity) | If other tests are inconclusive
---|---
Raman spectroscopy | If other tests are inconclusive
XRD | If other tests are inconclusive

### References

### 6.1.21. Danburite

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### References

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

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<td>PL spectroscopy</td>
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### References
Special attention: irradiation, HP-HT, coatings, clarity enhancement, synthetics For diamond grading, see the PAS document

6.1.23. Diamond (coloured)

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References

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

6.1.24. Diaspore

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6.1.25. Diopside

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**References**


6.1.26. Dioptase

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**References**


6.1.27. Dolomite

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**References**

Microscope  
Refractometer (refractive index)  
Hydrostatic weighing (specific gravity)  
FTIR(-NIR) spectroscopy  
EDXRF chemistry  
Raman spectroscopy  
XRD  

References  

Special attention: dye

### 6.1.28. Dumortierite

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<td>Raman spectroscopy</td>
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<td>XRD</td>
<td>If other tests are inconclusive</td>
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References  
Alexander et al. (1986), Applin and Hicks (1987), Bank (1979), Beukes et al. (1987), Cassedanne and Franco (1966), Corwningshield (1964), Goreva et al. (2001), Koivula et al. (1992), Ostwald (1964)

### 6.1.29. Ekanite

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<td>Safe storage</td>
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References  

Special attention: radioactive
### 6.1.30. Emerald

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**References**


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

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### References


### 6.1.32. Epidote

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### References


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

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6.1.34. **Feldspar – labradorite, andesine**

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**References**


**Special attention: fragile, easy cleavage**

6.1.35. **Fluorite**

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<td>Short-wave UV fluorescence</td>
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<td>Raman spectroscopy</td>
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**References**


**Special attention: fragile, easy cleavage**
### 6.1.36. Forsterite

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**References**

**Special attention:** synthetic

### 6.1.37. Gahnospinel

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**References**

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

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**References**


**Special attention: heat treatment (demantoid)**

### 6.1.39. Gypsum

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**References**


**Special attention: soft material, easy cleavage**

### 6.1.40. Hauyn

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**References**


### 6.1.41. Hematite

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Raman spectroscopy
XRD If other tests are inconclusive

References

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

6.1.42. **Idocrase (Vesuvianite)**

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References

6.1.43. **Iolite (Cordierite)**

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References

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

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**References**


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

### 6.1.45. Jasper

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**References**


### 6.1.46. Jeremejevite

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**References**


### 6.1.47. Kornerupine

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**References**

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### Microscope

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**References**


### 6.1.48. Kyanite

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**References**


### 6.1.49. Lapis Lazuli

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**References**


*Special attention: dye, coatings, impregnation, wax, ‘synthetics’, imitations*
### 6.1.50. Magnesite

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**References**


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

### 6.1.51. Malachite

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**References**


Special attention: reconstructed, impregnated, wax, synthetic

### 6.1.52. Maw-sit-sit

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**References**

### 6.1.53. Moldavite

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**References**


*Special attention: artificial glass*

### 6.1.54. Nephrite

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**References**


*Special attention: dye*

### 6.1.55. Obsidian

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**References**

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; Crowingshield, 1975; Faulques et al., 2001; Glascock, 2002; Henn, 1995; Holzhey, 1996; Hughes, 1982; Hyrsl 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; OKeefe, 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**

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**References**


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

6.1.57. **Pectolite**

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6.1.58. Peridot

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References

Special attention: may be damaged by acids

6.1.59. Petalite

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References

6.1.60. Phenakite

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**References**


### Plastic

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**References**

6.1.63. **Prehnite**

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**References**

Akizuki 1987; Bank 1975a; Beattie and Brown 1985; Bracewell 1989; Brown and Snow 1981; Crowingshield 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**

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**References**


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

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

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References

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

6.1.66. Rhodochrosite

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References

Special attention: easy cleavage single crystal material

6.1.67. Rhodonite
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### References


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### 6.1.68. Ruby

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### References

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

### 6.1.69. Sapphire

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**References**

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

6.1.70.  Sapphirine

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6.1.71. **Saussurite**

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**References**
Jobbins and Rutland 1974; Scarratt 1987c, e

6.1.72. **Scapolite**

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**References**

6.1.73. **Serpentine – bowenite, williamsite**

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**References**
6.1.74. **Sinnhalite**

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**References**

6.1.75. **Sillimanite**

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**References**

**Special attention: single crystal has easy cleavage**

6.1.76. **Sodalite**

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Special attention: dye

6.1.77. Sphene (Titanite)

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6.1.78. Spinel

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Special attention: synthetics, heat-treatment

6.1.79. Spinel (cobalt)

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References


Special attention: synthetics

6.1.80. Spodumene

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

### 6.1.81. Sugilite

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**References**


### 6.1.82. Taaffeite

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**References**


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

### 6.1.83. Tektite

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### 6.1.84. Thomsonite

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**References**
- Almquist 1987; Anderson 1978; Wise 1978

*Special attention: characteristic appearance*

### 6.1.85. Topaz

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**References**

*Special attention: coatings, irradiation and heat treatment*
### 6.1.86. Tourmaline

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**References**


### 6.1.87. Tugtupite

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**References**


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

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**References**

Crowningshield 1957; Garlick and Kamb 1991; Ghose 1978; Sinkankas 1955

*Special attention: very soft*

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**References**
6.1.91. Zircon

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References


Special attention: heat treatment

6.1.92. Zoisite

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Special attention: heat treatment, clarity enhancement, coating

6.2. Test methods pearls and organic gem materials

6.2.1. Amber

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References


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

6.2.2. Bone

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References

Arnould and Poirat (1975), Brown and Lund (1979), Cognet 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

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</tr>
<tr>
<td>FTIR(-NIR) spectroscopy</td>
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</tbody>
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**References**

Clery (2002), Winkler et al. (2001)

### 6.2.4. Coral

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<td>Refractometer (refractive index)</td>
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</tr>
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</tr>
<tr>
<td>Raman spectroscopy</td>
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</tbody>
</table>

**References**


### 6.2.5. Horn

<table>
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<tbody>
<tr>
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<tr>
<td>Refractometer (refractive index)</td>
<td></td>
</tr>
<tr>
<td>Hydrostatic weighing (specific gravity)</td>
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</tr>
<tr>
<td>Raman spectroscopy</td>
<td>If other tests are inconclusive</td>
</tr>
</tbody>
</table>

**References**

Brown (1976), Liddicoat (1970), Webster (1973)
Special attention: dye, imitations

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

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<thead>
<tr>
<th>Required Test method</th>
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<td>Refractometer (refractive index)</td>
<td></td>
</tr>
<tr>
<td>Hydrostatic weighing</td>
<td>(specific gravity)</td>
</tr>
<tr>
<td>Long-wave UV fluorescence</td>
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</tr>
<tr>
<td>Raman spectroscopy</td>
<td></td>
</tr>
<tr>
<td>X-Ray CT scan</td>
<td>In some cases to view growth structures</td>
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</table>

References

Special attention: dye, imitations, CITES issues.

6.2.7. Ivory - vegetable

<table>
<thead>
<tr>
<th>Required Test method</th>
<th>Remark</th>
<th>6.2.8. Pearl (Abalone Species)</th>
</tr>
</thead>
<tbody>
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<td>Microscope</td>
<td>Growth structures</td>
<td>Microscope</td>
</tr>
<tr>
<td>Refractometer (refractive index)</td>
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<td>Microradiography</td>
</tr>
<tr>
<td>Hydrostatic weighing</td>
<td>(specific gravity)</td>
<td>UV-Visible(-NIR) spectroscopy</td>
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<td>Raman spectroscopy</td>
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<td>Raman spectroscopy</td>
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</tbody>
</table>

References
Brown (1996), Scarratt (1992), Webster (1949)

6.2.8. Pearl (Abalone Species)

<table>
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<th>Required Test method</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
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<tr>
<td>Raman spectroscopy</td>
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</tbody>
</table>

References

Special attention: blister versus cyst, damage by acids

6.2.9. Pearl (Cassis species)
### 6.2.10. Pearl (Lobatus gigas/Strombus gigas – Conch)

<table>
<thead>
<tr>
<th>Required Test method</th>
<th>Remark</th>
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<tbody>
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<tr>
<td>Microradiography</td>
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<tr>
<td>UV-Visible(-NIR) spectroscopy</td>
<td></td>
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<tr>
<td>Raman spectroscopy</td>
<td></td>
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</table>

**References**


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)

<table>
<thead>
<tr>
<th>Required Test method</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
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<td>Microradiography</td>
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</tr>
<tr>
<td>UV-Visible(-NIR) spectroscopy</td>
<td></td>
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<tr>
<td>Raman spectroscopy</td>
<td></td>
</tr>
<tr>
<td>EDXRF chemistry</td>
<td>Off-white (stronger than light tones) samples only</td>
</tr>
<tr>
<td>Raman spectroscopy</td>
<td></td>
</tr>
<tr>
<td>LA-ICP-MS chemistry</td>
<td>If EDXRF is inconclusive</td>
</tr>
<tr>
<td>X-Ray CT scan</td>
<td>Difficult cases</td>
</tr>
</tbody>
</table>

**References**


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

### 6.2.12. Pearl (Imitation)
<table>
<thead>
<tr>
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<tbody>
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<tr>
<td>Microradiography</td>
<td></td>
</tr>
<tr>
<td>Raman spectroscopy</td>
<td>If other tests are inconclusive</td>
</tr>
</tbody>
</table>

**References**


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)

<table>
<thead>
<tr>
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<th>Remark</th>
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</thead>
<tbody>
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<td>Microradiography</td>
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<tr>
<td>UV-Visible(-NIR) spectroscopy</td>
<td>Raman spectroscopy</td>
</tr>
</tbody>
</table>

**References**

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)

<table>
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<tr>
<td>UV-Visible(-NIR) spectroscopy</td>
<td>Raman spectroscopy</td>
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</tbody>
</table>

**References**

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 porcelaneous pearls, damage by acids, check for shaped examples, shell imitations.

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

<table>
<thead>
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<th>Required Test method</th>
<th>Remark</th>
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<tbody>
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<td>Microradiography</td>
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<td>UV-Visible(-NIR) spectroscopy</td>
<td>Raman spectroscopy</td>
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"
Special attention: possible similarity to other purplish or even white non-nacreous pearls, damage by acids.

6.2.16. **Pearl (Mytilus species)**

<table>
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<th>Required Test method</th>
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<tbody>
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<td>Microscope</td>
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<tr>
<td>UV-Visible(-NIR) spectroscopy</td>
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<tr>
<td>Raman spectroscopy</td>
<td></td>
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</tbody>
</table>

References


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

6.2.17. **Pearl (Pinctada fucata)**

<table>
<thead>
<tr>
<th>Required Test method</th>
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<tbody>
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<td>Microscope</td>
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<td>Microradiography</td>
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<tr>
<td>UV-Visible(-NIR) spectroscopy</td>
<td>Off-white pearls only</td>
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<tr>
<td>EDXRF chemistry</td>
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<tr>
<td>Raman spectroscopy</td>
<td></td>
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</tbody>
</table>

References


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)**

<table>
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<td>EDXRF chemistry</td>
<td></td>
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<td>Raman spectroscopy</td>
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</tbody>
</table>

References

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)**

<table>
<thead>
<tr>
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<td>UV-Visible(-NIR) spectroscopy</td>
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<tr>
<td>EDXRF chemistry</td>
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</tr>
<tr>
<td>Raman spectroscopy</td>
<td></td>
</tr>
<tr>
<td>LA-ICP-MS chemistry</td>
<td>If EDXRF is inconclusive</td>
</tr>
<tr>
<td>X-Ray CT scan</td>
<td>Difficult cases</td>
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**References**

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)**

<table>
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<td>UV-Visible(-NIR) spectroscopy</td>
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<td>Raman spectroscopy</td>
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**References**

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)**

<table>
<thead>
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<td>UV-Visible(-NIR) spectroscopy</td>
<td>Off-white (stronger than light tones) samples only</td>
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<td>EDXRF chemistry</td>
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<td>Raman spectroscopy</td>
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<tr>
<td>X-Ray CT scan</td>
<td>Difficult cases</td>
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6.2.22. **Pearl (Pinna species [including Atrina species])**

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<tr>
<td>UV-Visible(-NIR) spectroscopy</td>
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<td>EDXRF chemistry</td>
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<tr>
<td>Raman spectroscopy</td>
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</table>

**References**


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

6.2.23. **Pearl (Pleuroopa species)**

<table>
<thead>
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<tbody>
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<td>Microscope</td>
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<tr>
<td>UV-Visible(-NIR) spectroscopy</td>
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<tr>
<td>Raman spectroscopy</td>
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</table>

**References**

Landman et al. (2001), Strack (2006)

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

6.2.24. **Pearl (Pteria species)**

<table>
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<tbody>
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<td>EDXRF chemistry</td>
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<tr>
<td>PL spectroscopy</td>
<td>Helps with mollusc identification in some cases</td>
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**References**

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.

6.2.25. **Pearl (Scallops [pectinidae] species)**

<table>
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</table>

References

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

6.2.26. **Pearl (Tridacna [clam] species)**

<table>
<thead>
<tr>
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<td>Raman spectroscopy</td>
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</tbody>
</table>

References
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.

6.2.27. **Shell**

<table>
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</tr>
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<tr>
<td>Hydrostatic weighing (specific gravity)</td>
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</table>

References

Special attention: dye, lustre enhancement
6.2.28. Tortoise shell

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<td>Refractometer (refractive index)</td>
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</tr>
<tr>
<td>Hydrostatic weighing (specific gravity)</td>
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</tr>
<tr>
<td>Short-wave UV phosphorescence</td>
<td></td>
</tr>
</tbody>
</table>

References
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:

\[ \text{SG} = \frac{A}{A-W} \]

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, adularescence; 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 polarscope 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 produces 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.

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