Gemology

By Alain Darbellay GGGems

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Gemology is by definition the study or the science of the precious stones. One knows approximately 4000 minerals produced by the terrestrial body, among which less than 100 produce specimens considered as precious stones. So that a mineral is a gem, it must have three fundamental virtues. Beauty, durability and scarcity.

Beauty; it depends on the following characters:

Transparent minerals: The glare (brightness) dispersion (fire) the transparency (purity) intensity of the color (for the colored stones)

Translucent minerals :
Color or the reflection, opalescence, the changing luster or asterism (in the case of the phenomenal stones)

Opaque minerals:
Purity and intensity of the color, the propensity with reflecting their color well and taking the polish. All these factors of beauty are highlighted by the size and polishing.

Durability depends on resistance to the mechanical or chemical attacks to which the stones are subjected. Dust often containing quartz particles. It is preferable that a gem is as hard as this mineral.
Rarity: A gem often comes from a common and very widespread mineral species, but it consists of a specimen in which exist seldom joined together qualities.

Gemology is the study of the significant properties of the gems it serves of the apparatuses or instruments necessary to the observation and the measurement of these properties.

The gemologist must be able to differentiate the natural stones from the synthetic stones using his instruments.

− Here are the principal instruments used by the gemologist:
The eye which will transmit to the brain the visual data processed instantaneously by the data base in it containing the more or less large experiment of the gem's observer.

The loupe"10x" It is under this enlarging that, by International Convention, the

purity of the stones must be given. Especially diamond. The strong curve of the

lenses used for the loupe "10x" has as a corollary a considerable marginal distortion

and chromatic aberrations, unless the loupe is made up of a whole of lenses

calculated to eliminate these disadvantages. An anastigmatic loupe of good

quality is significant for the gemologist.

The preliminary examination at the eye then with the loupe "10x" is thus of primary importance

because the characteristic signs of a gem will help the gemologist to choose effective instruments

for the identification.

− The characteristic signs of a gem which one can observe at the naked eye or with the loupe are as follows:

Texture: rough gem or opaque

Gloss: diamantine, vitreous or resinous etc.

Substantial dispersion (indication of a high index of refraction) or weak, presence or absence of cleavages.

Characteristic fracture: vitreous, granulous or splintering etc.

Assembled stone: doublet or triplet.

Corners between the facets: sharp or round, often with the concave facets (indication of glass or a cast plastic) or notched (stone of low hardness).

Abundant inclusions: which make the gems translucent, and by consequence, the optical signs could not be obtained under the polariscope.

Moreover, one could not insist enough on the importance of a perfect cleanliness of the stones to examine. The cleaning of the unset stones is easy; it is enough to wipe them with a clean handkerchief. A good cleaning can be obtained with water accompanied by a little liquid detergent.

To avoid dirtying the stones, the specialized tweezers represent a pleasant complement of the fingers.

− Scale determining the purity of a stone. −

FL NFL LI1 LI2 MI1

Flaw less Near flaw less Lightly included 1 Lightly included 2 Medium included 1

−−−

MI2 MI3 VI1 VI2 HI

Medium included 2 Medium included 3 Very included 1 Very included 2 Highly included

Note that our camera can grasp very small inclusions almost invisible at the naked eye; this is why you can usually see these inclusions on the screen.

The Polariscope, here a pocket polariscope.

It is the usual means by which one differentiates on the one hand the unirefractives substances (amorphous or coming from the cubic system) and the birefractives substances, coming from the other systems of crystallization.
This instrument is composed of two filters polarizing between which the stone is placed, and it is while turning the filter of the top that the analysis can be done.

The refractometer is used to determine the indexes of refraction of the stone. This instrument calculates speed with which luminous rays arise from the stone and indicates it on a scale. The gem is placed on a coated pane of a fine particle of liquid made up amongst other things of methylene iodide which shows an index of refraction

of 1.81 (this liquid is toxic)

Dichroscope of which the principal part is made up of a tube comprising a window with the one of the ends and a lens with the other, between the two is assembled a piece of calcite, chosen because of its strong double refraction so that two images of the window appear side by side to the observer which looks in the eye−glass. The light of the adjacent images of the window vibrates in two perpendicular plans one to the other at a rate of one only plan for each image. The rotation of the stone is a significant factor during the control of dichroism, bus in all the double refraction stones, it exists one or two directions of unirefringence, known as optical axe.

The Chelsea color filter. There is a very effective means to reveal the subjacent differences in color, it is the use of colored filters. They are especially effective in the differentiation of natural and synthetic emerald.

The optical fiber lamp is useful to distinguish inclusions in rough stones.
Microscopes: the binocular one, i.e. to double objective is best adapted for gemology. The microscope is of first importance in the detection of counterfeits. Indeed, the study of inclusions which the stone can contain is a practical means to identify the gems while explaining to a certain extent the conditions under which they were formed in nature.

The spectroscope concerns an extremely simple method which allow the identification of all the stones; rough or polished not being able to be seen with the refractometer and which even makes it possible to distinguish certain synthetic or glasses. This method makes it possible to analyze the nature of the dye of the stone. The way in which the spectroscope analyzes the various wavelengths of the light is in theory very simple; that depends on the different degree of refraction to which its subjected various rays of each color (wavelength) when they are propagated through a prism of glass or another transparent substance. After having passed through a prism, a narrow parallel beam of white light is spread out in a ribbon with the colors of the rainbow, the visible spectrum.

Let us note that a powerful instrument used in many fields of science is at disposal of the gemologists, it is the microscope of Raman which spectroscopy supplements the traditional technology of the

laboratory. This instrument can give information on samples lower than 1µm what is not accessible to any technique. The use of the Raman spectroscopy by imagery is single in order to determine in a nondestructive way the molecular composition of inclusions present in the gems.

Analyze by fluorescence: four kinds of radiation are used.

The first consists simply in passing a powerful luminous ray of a lamp of projection of 500W through a balloon filled with a strong copper sulfate solution, this last absorbs all the red light, orange and yellow and the filter rays are invisible if one observes through a good red or orange filter. If a substance only lit by the beam of blue light in which it is shines while being observed through one of these filters, it emits a fluorescence.
The second method of stimulation of fluorescence is the used, it uses a lamp with high pressure out of quartz, and whose light is filtered through the glass of Wood.

The third uses the ultraviolet radiations of short radiation emitted by a quartz−mercury lamp with low pressure, in which the mercury line with 2537 Å is dominating.

X−rays represent the fourth source of radiation, they are dangerous unless the source is not seriously armored.

The unit weight and its measurement. It frequently occurs that only an approximate value of

the density of a stone is necessary to differentiate between gems from similar appearance; in this case a control from the density can be carried out by means of liquors of density. The principle of the method is simple. A stone will be inserted in a less dense liquid, will float in a denser fluid and will remains in suspension in a liquid of equal density.

The three liquids are:

The bromoforme density 2,9.

The methylene iodide density 3,33.

The liquor of Clerici density 4,15.

PRINCIPAL COLORING ELEMENTS IN THE GEMS.

Chromium Ruby, Emerald, Pyrope garnet, grossularite and uvarovite, Tourmaline.
Copper Dioptase, Malachite, Azurite.
Iron Sapphire, Aquamarine, Citrine, Almandin garnet.
Manganese Morganite, Pink tourmaline, Spessartite garnet.
Nickel Chrysoprase.

Titanium Blue Sapphire.
Vanadium Green beryl, Blue zoïsite , Garnet.

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Crystalline Systems

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7 systems of crystallization: There are 32 possibilities of combinations of the elements of symmetry (axis of
rotation, symmetry plane, centers combined inversion and operations).
Since the discovery of the crystals reticular structure, one could show by calculation that to these 32 classes
which relate to the shapes of the crystals, correspond 230 types of network.
One immediately realizes the complexity of the reasoning which should be made to know all the possible
combinations. The 32 classes are grouped in 7 systems. Here are the figures.

CUBIC SYSTEM QUADRATIC SYSTEM HEXAGONAL SYSTEM

Go to Garnet

Go to Zircon

Go to Apatite

Diamond, garnet, spinell. Zircon Beryl, Apatite

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TRIGONAL SYSTEM ORTHOROMBIC SYSTEM MONOCLINIC SYSTEM
(Subdivision of the hexagonal system) Go to Topaz

Go to Orthoclase

Go to Corundum Go to Tourmaline

Calcite, corundum, tourmaline, quartz. Chrysoberyl, topaz Orthoclase

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TRICLINIC SYSTEM
The symmetry of crystals : appear the following symmetrical operations: > >
· Rotation

· Inversion by symmetry plane

· Inversion by a center

· Combination of rotation and inversion

The crystals show in their form and their
structure of the properties of characteristic
symmetry. And like there is a cor −
respondence between reticular plans and
faces of the crystals, there is a
fundamental correspondence between
internal symmetry and external symmetry.
We imagine the drawing of a tapestry, it
will repeat ourselves by a simple parallel
displacement (translation). When a crystal is examined, the first
All the geometrical operations which point which draws the attention is a
cause a repetition of the pattern are certain symmetry. One can see the
called operations of symmetry. In the repetition of faces identical to various
shape of the crystals (external format), places of the crystal. These repetitions
this translation does not appear directly. are controls by laws of symmetry,
On the other hand, in their morphology, Albite the way in which they are repeated
is determined by operators of
symmetry, there are three principal
types of them: Axis of symmetry,
symmetry plane and the center
of symmetry.

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