Emerald treatments and its disclosure

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Colombian Emerald

The lush green of an emerald has always attracted attention. Ever since the Zambian mines have opened up their treasures, emerald has become an increasingly popular coloured gemstone. Sales of the green gem have crossed those of ruby and sapphire, and its popularity is booming in the U.S., Europe and even more so in Asia. But there is one problem emerald tends to be more heavily included than any other kind of gemstone. Most emeralds have not only numerous internal inclusions and fractures, but also tiny surface breaking fissures or cracks. For this reason, the vast majority of emeralds are treated to improve their clarity. This practice is widely accepted in the trade, but there is some controversy surrounding recent developments in emerald treatments. Strict testing and reporting by gem labs has helped to build confidence in the market and to make the emerald a safe buy. Consumers can rely on lab reports that disclose the one type of commonly applied treatment, the filling of fissures with a foreign substance to enhance the clarity and transparency of the stone.

Formation of Natural Emerald

In nature there are two entirely different geo-chemical processes that form emeralds. These processes determine the myriad inclusions that make up the lovely "gardens" commonly called "*jardin*" so prevalent in emerald interiors. The nature of these inclusions often provides diagnostic clues to the source of individual emerald gemstones. 1. Natural emeralds formed in pegmatites and in

the surrounding metamorphic rocks contain solid, often eroded, mineral particles of the host rock called protogenetic inclusions. Rising acidic beryllium-bearing magmatic materials invaded the chrome-bearing iron-calcium and magnesium-rich rock outcrops, composed of mica schists and hornblendes of tremolite, actinolite, and related minerals. New mineral emerald formed through pneumatolytic chemical reactions is influenced by extreme heat and pressures. The temperatures and pressures involved precluded the participation of substantive amounts of any liquid water that may have been present. Therefore, the inclusions in these crystals seldom exhibit liquid inclusion characteristics common to those developed by hydrothermal processes.

2. Hydrothermally-created natural emerald occurred in connection with tectonic faults only in the Andes in South America, chiefly in Colombia. Hydrothermal solutions bearing albite rose into the hollow spaces in the carbonaceous clay slates of the Chivor region. Crevices in similar formations in the Muzo area filled with solutions containing calcite. These liquid solutions, saturated with mineral nutrients, sodium, chlorine, and fluid carbonic acid under high pressure, produced emerald crystals that housed inclusions of a nature quite different from crystals formed from contact-metamorphic origin. Any solid mineral inclusions usually developed syngenetically with the emerald crystals from the solutions as the emerald crystal grew. Tiny halite (salt) and calcite crystals floating in myriad characteristic liquid cavities are the most common.

Cracks on the surface have to be filled

Need for treatments

In both these processes of emerald formation, the trapped inclusions are under great pressure which is released from the gem through fissures and cracks. As such most of the emeralds would develop some imperfection which would mar their clarity and transparency. These cracks create a whitish appearance as the air in the cracks stands out in relief. Fissures are mostly the result of the formation of emeralds in nature, typically related to geological events such as movements in the earth’s crust.

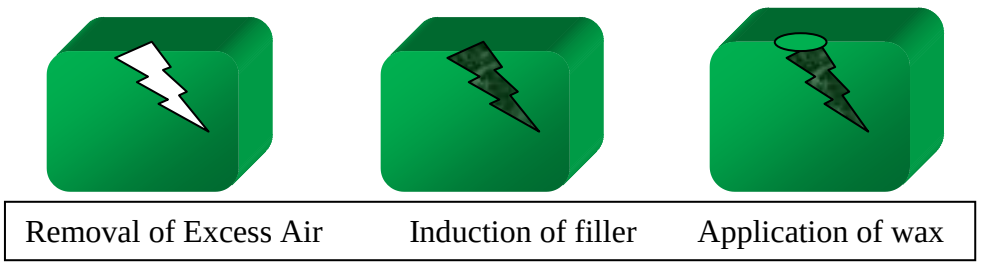
Fracture Filling of Gems

During and after growth, the emerald may experience significant mechanical strain, resulting in fissures and fractures throughout the stone. These fissures affect the transparency of the stone to a certain extent, depending on their number and extent. By filling these fissures with a foreign substance, such as oil, resin or wax, the transparency of the emerald can be enhanced.This is the main reason for doing treatment on emeralds. If in some way these ugly cracks are made less obvious then the green colour of the emerald stands out.
This is achieved by oiling emeralds. Such oiled emeralds look more presentable as their colour is evenly spread out and therefore are more saleable. So if an emerald has a surface reaching crack that will accept the oil then as they say with nothing to lose and everything to gain, the emerald would be subject to this treatment. This oiling of emerald is a standard practice in the world's main emerald mining centers like Colombia, Zambia and Brazil and processing centers like Israel, India, Hong Kong etc.

Oiled Emerald

Cedar Oil

The traditional treatment for emerald is oiling with cedar oil. Cedar oil is a natural product from cedar trees and is colourless and viscous. It can be produced in a very pure form and has a number of industrial uses. Cedar oil has been used for fracture-filling emerald because it has a refractive index that is similar to emerald. According to Ted Themelis who is an authority on gem treatments, oiling is done in three steps:
1. Removal of air and gases from the cavities of the emerald using vacuum
2. Application and induction of the filler using high pressure
3. Removal of excess sealer and application of wax for lustre



Since cedar oil is so sticky, it is not easy for it to penetrate the microscopic cracks in emerald. So it requires some heat and pressure to do the job. First the emeralds are cleaned, usually in an acid bath. Then the gems are placed in a heated hydraulic cylinder with pure cedar oil and locked tight. The heat liquefies the cedar oil and the pressure helps it penetrate any tiny cracks in the emerald.

There are various electromechanical apparatus designed and fabricated for oiling of emeralds, essentially the mechanism includes a high vacuum pump to remove air from the cracks and crevices of the emerald which is being treated at the same time there is a hydraulic piston to push the filler into the emerald's surface at about 3,000 psi in designed time at a controlled rate. In the apparatus designed by Ted Themelis there is a a control switch to "change over from pressure to vacuum" without induction of air in the piping.

After several hours the cylinder is left to cool. The stones are then removed and cleaned. The cedar oil that has penetrated the emerald returns to its thick, viscous state, making it very difficult for it to leak out without the aid of ultrasonic cleaners, excessive heat or harsh solvents. In the local Indian market Johnson & Johnson Baby oil is used and it gives similar results
Traditional oiling is stable but not permanent. Eventually an oiled emerald will require re-oiling to keep it looking at its best. Therefore, a number of attempts have been made to introduce more permanent fillers.

The most commonly used fillers are:

Organic and Synthetic oils

In the past castor oil, coconut oil, palm oil, and many other oils have been tried but as their refractive indices are low 1.50 and also the viscosity being too low, these oils were not effective enough in stability as well as longevity. When the viscosity is low then the filler either dries out early and then comes out. Cedar oil in that respect is better as it is slightly yellow in colour, viscous and insoluble in water with a refractive index of 1.510 and specific gravity of 0.94.

Oleoresins like Canada balsam,

Oleoresins are solutions of resins in oil like Canada balsam which is actually a resin in oil extracted from North American balsam tree. Canada balsam is slightly yellowish green viscous, fluorescent, water insoluble, but completely soluble in ether or turpentine oil. Good thing about it is the refractive index which is around 1.54 and specific gravity 0.98.

Synthetic Epoxy Resins

Epoxy or resin filters are also very popular as fillers. The most well known among them is a synthetic polyester epoxy resin called "Opticon" and is used as a fracture sealer and is more stable than oil. Opticon is transparent with refractive index 1.545. It has light a brown colour and a weak fluorescence viscosity like Canada balsam.
Although this filler Opticon is much used still it is not permanent. It is sometimes used with another hardener, but should Opticon have a chemical breakdown then its removal is very difficult.

Other fillers

There are other fillers like "Joban" which are herbal concoction in oil which are very frequently used by emerald dealers. There are also certain green organic dyes used to convert pale low grade beryl into emerald colour. Although it is imperative to disclose this treatment, it is rarely done.

Multiple Fillers

Cedar wood oil and Canada balsam are sometimes mixed in approximately 3:1 ratio to use as fillers. There are untold combinations of oils and epoxies made and each combination gives different type of result. The use of these fillers has created some controversy, particularly in cases when the exact filler has not been disclosed.

The Problem

The emerald fillers like oils, oleoresins, epoxy, plastic etc eventually decompose with time. As the constituent elements of the filler start to separate and the substance as a whole begins to lose its bonding strength with the host emerald giving rise to what is generally termed as dissociation. When dissociation sets in, the camouflaged crack or fissure in the emerald reverts back and the emerald starts looking uglier than original. This loss of filler is a very gradual process under normal conditions and therefore takes a long time before it is actually noticed by the consumer. Therefore it is important to disclose the fact that the emerald is "oiled". Especially in the present day when uninformed consumers wash their jewellery in ultrasonic cleaners and the dissociation is speeded up. And the emerald becomes unsightly in appearance.

Emerald Before Fracture Filling **Emerald After Fracture Filling**

Clarity Enhancement

Today, most reputable laboratories apply a grading system to quantify the degree of clarity enhancement, ranging from "insignificant," "minor" and "moderate" to "significant." The end consumer is then able to make an educated decision on what he or she is buying, as the report indicates the amount of enhancement that has been applied to the stone
Only a very small percentage of emeralds show no indication of clarity enhancement. These are either "natural beauties," i.e., they are naturally free from fissures or fissures are present, but they do not contain any filling material. This absence of any foreign substance in the fissures again has two possible explanations: either the fissures are pristine (they have not been filled to date) or the fissures have been cleaned to remove filling material that was introduced at an earlier time. The latter is far more common, as most emeralds are routinely treated with some kind of clarity-enhancing material shortly after mining.

The clarity enhancement of emeralds is a reversible and repeatable process and stones may be filled and cleaned multiple times during their "life" as a gemstone. This is especially true when oil is used as a filling agent because oil dries out over time and it can leak out when heated or when surrounding air pressure is changed. Oil also is more easily and safely removed. But generally, all types of filling material, including epoxy and resins, can be removed. Consequently, consumers must be aware that an emerald could potentially be treated again after being tested in the lab and receiving a gemmological report.

If clarity-enhancement treatments are applied to an emerald with a high density of fissures, the appearance of the stone changes dramatically. Most labs —add a clause in the small-print statement addressing this limitation of the report's validity and noting that it may not reflect treatments done after the stone was tested by the lab.

The end consumer, however, might want more protection beyond the laboratory report. Buying from a trustworthy source is recommended, and ensures that a stone can be returned if necessary. In addition, certain have taken a further step toward protecting the final customer, by judging the susceptibility of a stone to clarity enhancement. In this step, an emerald with fissures is declared "susceptible" to a clarity-enhancement process, whereas an emerald without fissures is not, as there are no fissures to receive a clarity-enhancing agent. Obviously, a fissure-free emerald does not require any clarity enhancement.
A brief comment by the laboratory about the presence or absence of fissures is especially helpful for a stone that has no indications of clarity enhancement at the time it is tested. This gives clients either peace of mind, or alerts them. If the emerald is free of fissures the customer gets complete assurance that the stone is not susceptible to any clarity enhancement, and that it is one of the very rare specimens of emerald that is free of fissures. On the other hand, a statement that mentions the presence of fissures and the predisposition for treatment draws the customer's attention to the possibility that the emerald might be clarity enhanced, in spite of a gem lab report stating the opposite.

Dried coloured oil can be seen in the cracks

More recently, for every emerald that does not show any indications of clarity enhancement, labs have included an additional comment on the report plus a note on a separate page indicating either that the stone is without fissures or the stone has fissures. These notes distinguish the two different types of emeralds: One note addresses the rare emeralds without fissures; the other note emphasizes the possibility of subsequent clarity enhancement. The intention of this new service is to supply the end consumer with additional information that is considered relevant and critical in making an informed buying decision, and also to protect the credibility and sustainability of the emerald market.

Sample of note concerning fissures and clarity enhancements attached to a lab report on an emerald without any fissures:

The formation of emeralds in nature is related to tectonic events affecting the rock in which the emerald is forming. The developing emerald experiences

significant mechanical strain, resulting in fissures and fractures throughout the stone. In most cases, this process lowers the transparency of the stone, depending on the number and extent of the fractures.
Only a very small number of emeralds are not affected by this natural process. Thus, emeralds with only very minute fissures or no fissures at all are true rarities and deserve special notice. The absence of fissures makes them immune to any enhancement of the clarity by filling the fissures with a foreign substance such as oil, resin or wax.

Sample of note concerning fissures and clarity enhancements attached to a lab report on an emerald with fissures:

The formation of emeralds in nature is related to tectonic events affecting the rock in which the emerald is forming. The developing emerald experiences significant mechanical strain, resulting in fissures and fractures throughout the stone. In most cases, this process lowers the transparency of the stone, depending on the number and extent of the fractures.
By filling these fissures and fractures with a foreign substance such as oil, resin or wax, the transparency of the emerald can be enhanced. Such a clarity-enhancement process is usually reversible and repeatable at any time.

Identification

The key to finding and determining emerald fillers involves magnification, careful observation and knowledge of the characteristics of different fillers.
Organic fillers tend to fluoresce under ultraviolet light, a characteristic that also helps to determine the quantity of filler present in an emerald.
To detect organic substances, SSEF uses an FTIR Phillips infrared spectrophotometer. This instrument features a broad infrared beam that collects spectral information throughout an emerald. The resulting spectrum shows all materials encountered in the path of the beam. Fillers and other materials are detected through a recognizable pattern of peaks and valleys.
The lab also uses a Raman microscope system, which includes a laser light source, a spectrophotometer box and a microscope to target microscopic areas in the emerald. This system helps to identify mixed substances, including synthetic resins. "When we lower the focus into the stone, we can follow the plane of an emerald fissure and find a promising spot for analysis," says Hänni. "Observations are usually made at 50X, and the area for analysis is centered in the viewing mode with a cross-hair ocular. The instrument is switched from viewing mode to analyzing mode, and the laser beam is directed onto the sample at the center of the cross-hairs." In other words, you find an area of interest in the viewing mode then switch to analyzing mode to obtain a Raman spectrophotometer reading. That, combined with gemological expertise, is used to identify fillers. Hänni claims an 80%-90% success rate in identifying fillers

with these methods. The fillings that can't be identified are too far decomposed, he says.

Conclusion

No doubt emeralds having cracks and crevices have to be filled to make them appear better. At the same time it is indeed the need of the hour that labs and jewellers clearly disclose the treatment done so as to maintain the consumer confidence in coloured stones.

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