WORLD GEM FOUNDATION

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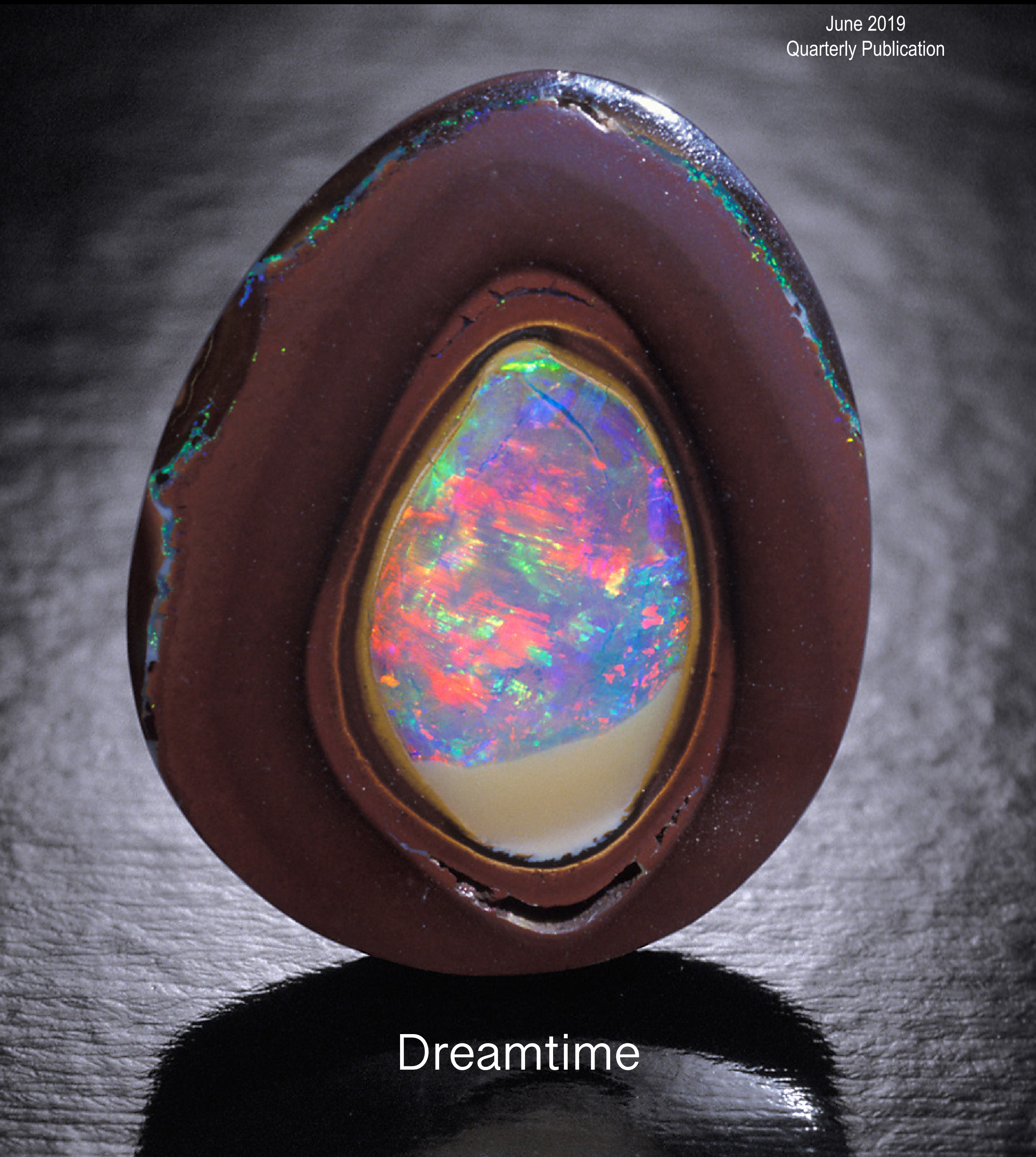
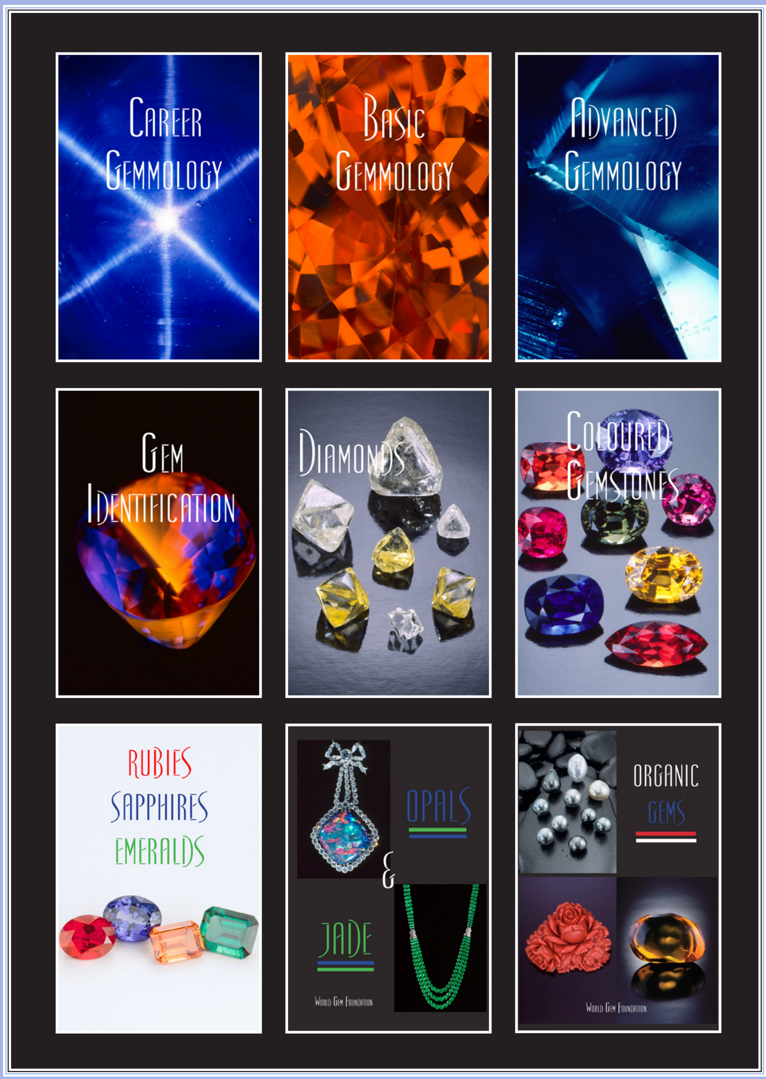


Dreamtime



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In this issue

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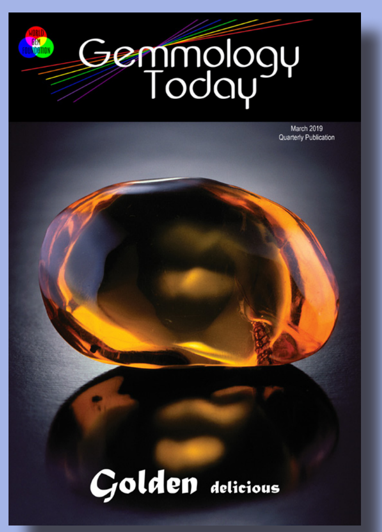
Editor Geoffrey M. Dominy



March 2019 Issue

Editor at Work

Geoffrey M. Dominy is the author and creator of the 'The Handbook of Gemmology', founder of the World Gem Foundation and editor of Gemmology Today.

It's always exciting to start a new issue, to plan it out and then see the fruits of your labour shared throughout social media.

An awful lot of time and effort goes into each issue and it is very gratifying to receive so many wonderful e-mails from readers all over the world who love reading it.

From a personal perspective, the inroads we are making in Africa are truly exciting and I am thrilled to be working with Kyalo, Barickeh and Salomon. Interestingly, all three had to leave their own countries (Kenya, Sierra Leone and DR of Congo) to study gemmology in the U.K.

Imagine growing up in countries that are rich in minerals and gemstones but not having the ability to study gemmology where you were born?

This is now about to change and I believe Africa epitomises the spirt of the World Gem Foundation and why I started it in the first place. Quite simply to give students the opportunity to study gemmology in their own country and to be taught by qualified gemmologists who were also born and raised in that country. Instructors who understand the culture, the mentality and the struggles that so many people face. I do not believe that any student should be denied education because of the circumstances into which they were born. To me, if a person has a passion for gemstones and gemmology then we must do everything we can to help them. Sadly we live in a world that is dominated by corporations who only care about the 'bottom line' and make decisions based on whether or not it will have a positive effect on earnings. That is not the corporate ethos of the World Gem Foundation. Of course we have to be profitable but we must never lose sight of the humanity of helping those who want to learn, create a better life for themselves and their families and make our industry stronger and more professional.

Over the last four years, the World Gem Foundation has grown to thirteen national and regional gem academies. Quite an achievement in such a short period of time. The next twelve months will truly define who we are, as we work to elevate gemmology into a true and legitimate science.

While others are taking the science out of gemmology, we are working very hard to ensure that the key scientific elements of gemmology are retained. We are also committed to ensuring that our courses are continually updated (our corporate mandate is to do this every two years) while making them available in other languages. At the moment we are translating all our courses into Spanish and plan to have them also available in French by early 2020.

Once again, a big thank you to all our contributors and you, our readers, for making Gemmology Today such a success!

These are truly exciting times..........

JEAN-MARIE ARLABOSSE is a chemist and gemologist. He is the president of the independent gemological laboratory (Gem Solid-Phase Gem Lab) located on the French Riviera in France. He was the creator and for fifteen years the animator - webmaster of www.geminterest.com

Crystallography 101 - A Seven-Sided Emerald Crystal?

Introduction

I had recently seen, on websites specializing in synthetic gemstones, an interesting rough synthetic emerald that looked very much like a natural emerald crystal (elongated with a 'hexagonal' habit). Due to the fact that this type of synthetic could reach the rough-emerald market, this article has been written to make gem dealers and rough stone buyers aware of this material and to relay the technical data and my observations so that they can differentiate this material from its natural counterpart.

Sample

A 3.51 carat emerald-green elongated crystal with a 'roughly' hexagonal base (Figure. 1).

Figure 1: The synthetic emerald crystal being analyzed

Equipment

Visible-near infrared (Vis-NIR) spectrometry using an Ocean Optic USB 4000 spectrometer equipped with a homemade setting with an integration sphere. The software rendering was set in absorbance.

Fourier transform Infrared (FTIR) spectrometry using a Bruker Alpha spectrometer with a low noise DLaTGS detector, equipped with a diffuse (or specular) reflectance type (DRIFT) signal capture module running at 4 cm^{-1} resolution.

Energy Dispersive X-Ray Fluorescence (EDXRF) spectrometry collected with a homemade spectrometer involving a silver-anode X-Ray tube running under 10 to 40 kV and 5 to 200 µA and a silicon CCD detector. This setting was chosen to detect elements that were heavier than sulfur with an exposition time that was suitable for a good signal/noise ratio in the Region Of Interest (ROI).

Specific gravity was determined with a homemade set-up involving a Dendritics Gemscale.

Reactions to ultraviolet radiation (shortwave and longwave) were evaluated in a dark box lit with 6W UV tubes.

Results and Related Comments

Superficially, the crystal looked like a natural emerald crystal. Under the polariscope, the stone proved to be uniaxial with light restoration every 90° rotation when observed perpendicular to the length and without light restoration when observed down to the elongation axis (C-axis). The measured specific gravity of 2.68 matched that of emerald. Reaction to ultraviolet radiation was inert under both SWUV (254 nm) and LWUV (365 nm) wavelengths. The refraction indices (taken on a crystal face) matched those expected for natural or hydrothermally grown synthetic emerald. Pleochroism (Figure 2) was typical of certain vanadium or low chromium content emeralds.

Looking more closely at the crystal, it was evident that the crystal had been cut and polished. Indeed, seven major

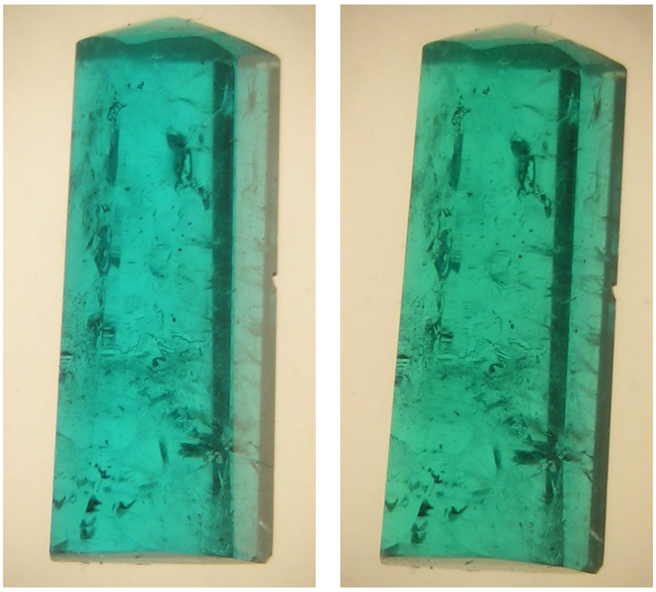


Figure 2: Blue-green / Yellow-green dichroism on the sample best seen perpendicular to the length of the crystal as in natural crystals.

crystal faces plus a smaller one were seen (instead of 6 Figure 3). Moreover, no growing defaults were seen on the faces indicating that they had been polished. At the top and the bottom of the crystal, some extra more or less rounded faces were also seen (Figure 3 far right). Although a cut and polished crystal is not proof of a synthetic or natural stone, one does wonder about the motivations that led to this cutting craftsmanship. Other unnatural looking faces were seen at the top and the bottom of face 5.

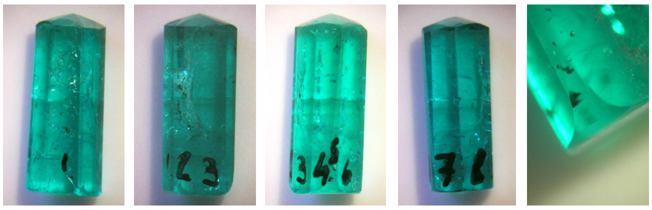


Figure 3: An unnatural number of faces were seen: seven faces (1,2,3,4,6,7,8) plus a small one (5) (3rd image from the left).

Under magnification, some natural looking inclusions (liquid veil and fractures) were seen, with some of the fractures oriented perpendicular to the C-axis (Figure 4).

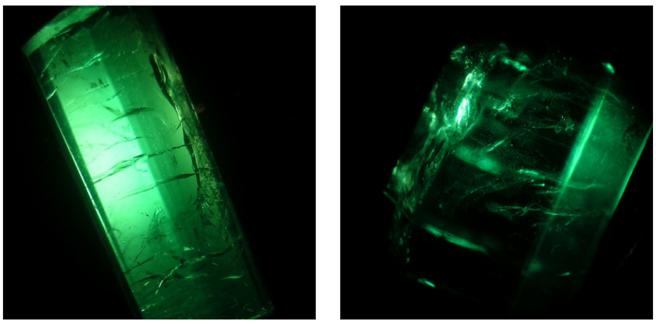


Figure 4: Fracture and liquid veils oriented perpendicular to the elongation axis (C-axis) giving a natural look to the crystal.

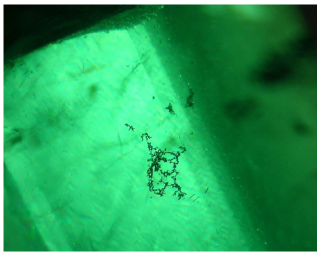


Figure 5: A black dendritic inclusion (platinum or copper?)

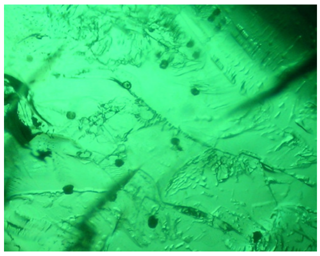


Figure 6a: Black dot inclusions

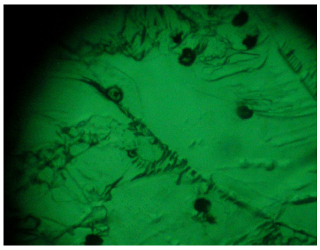


Figure 6b: Black dot inclusions with some encircled

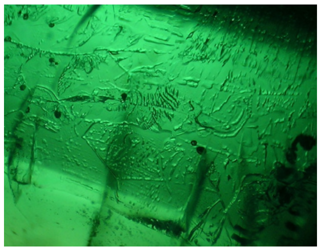


Figure 6c: Low relief pseudo-geometric inclusions

Other interesting inclusions included a black dendritic inclusion close the surface (Figure 5), tiny black discs (Figure 6 a,b,c) and low relief pseudo-geometric shaped inclusions (Figure 6 a,c) .

When observed between crossed polarizing filters, 'rainbow' coloured fringes (interference) perpendicular to the C-axis were seen (Figure 7 left). A 'swirled' texture was also seen along a plane close to the surface of a face (Figure 7 right). Both of these observations are strongly indicative of synthetic hydrothermally grown material [1].

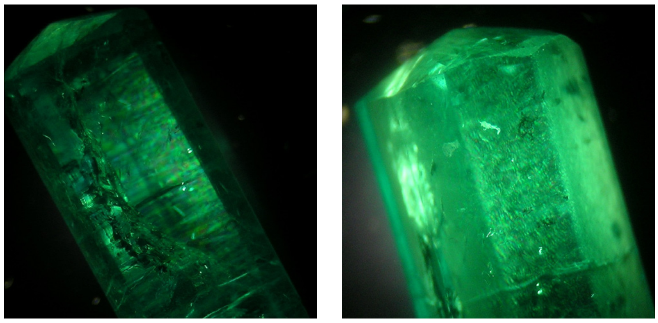


Figure 7: Between crossed polarizers an iridescent fringe can be seen perpendicular to the C axis (Left). A face shows a swirled-like texture along a plane parallel to the crystal face (Right).

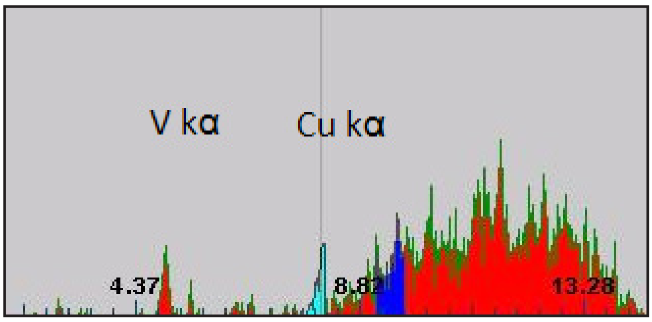


Figure 8: EDXRF spectrum showing vanadium (4.95 KeV) & copper (8.05 KeV) content & signal noise (~8.5 to 14.0 KeV)

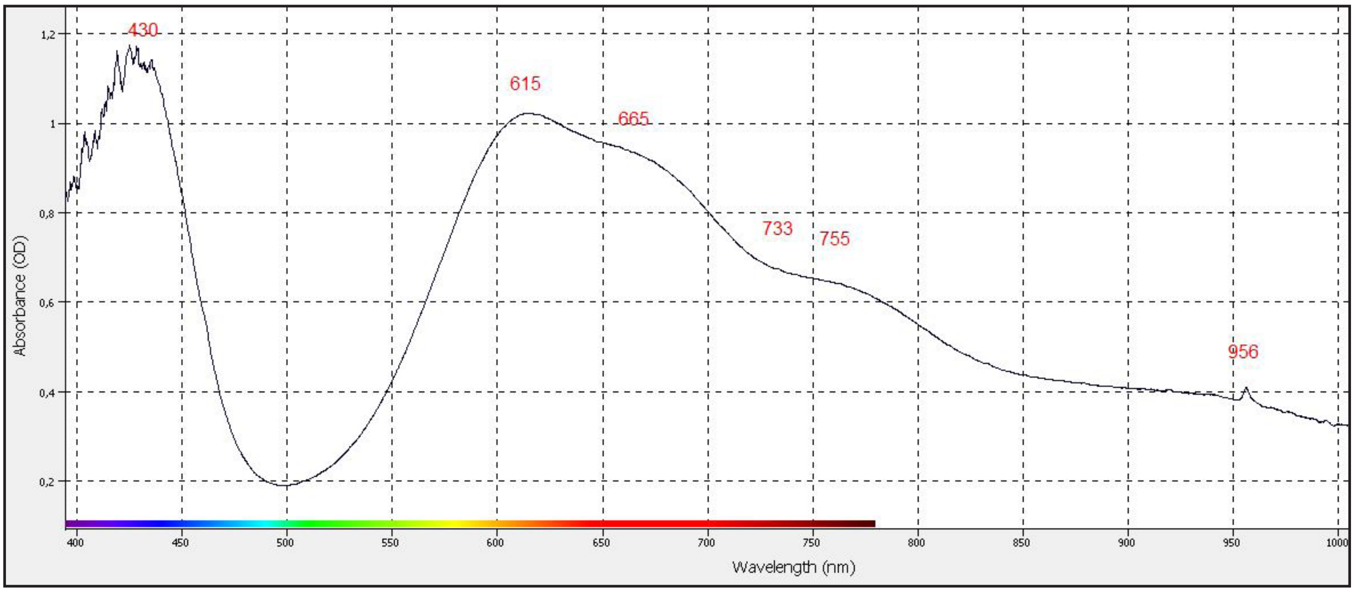


Figure 9: Vis-NIR unpolarized spectrum of the crystal. Absorption patterns indicated that vanadium (615, 665 bands) and copper (755 band) were involved in the final color but not chromium.

Using laboratory spectroscopic tools, copper was detected in the EDXRF spectrum (Figure 8). In this case, this element is the signature of the synthetic origin. Vanadium was also detected but not chromium.

The absorption spectrum in the visible near-infrared domain (Figure 9) showed the typical shape for a vanadium emerald, no expected chromium peak and a band corresponding to copper. When a polarized spectrum for the 'e' and 'o' rays was collected, bands related to vanadium and copper were noted (Figure 10).

When searching in our gem-material database (specular reflectance FTIR identification database) a perfect match was found with beryl. In transmission FTIR, the spectrum indicated synthetic beryl (Figure 11).

Conclusion

The crystal has formally been identified as a Hydrothermal Synthetic Vanadium bearing Emerald.

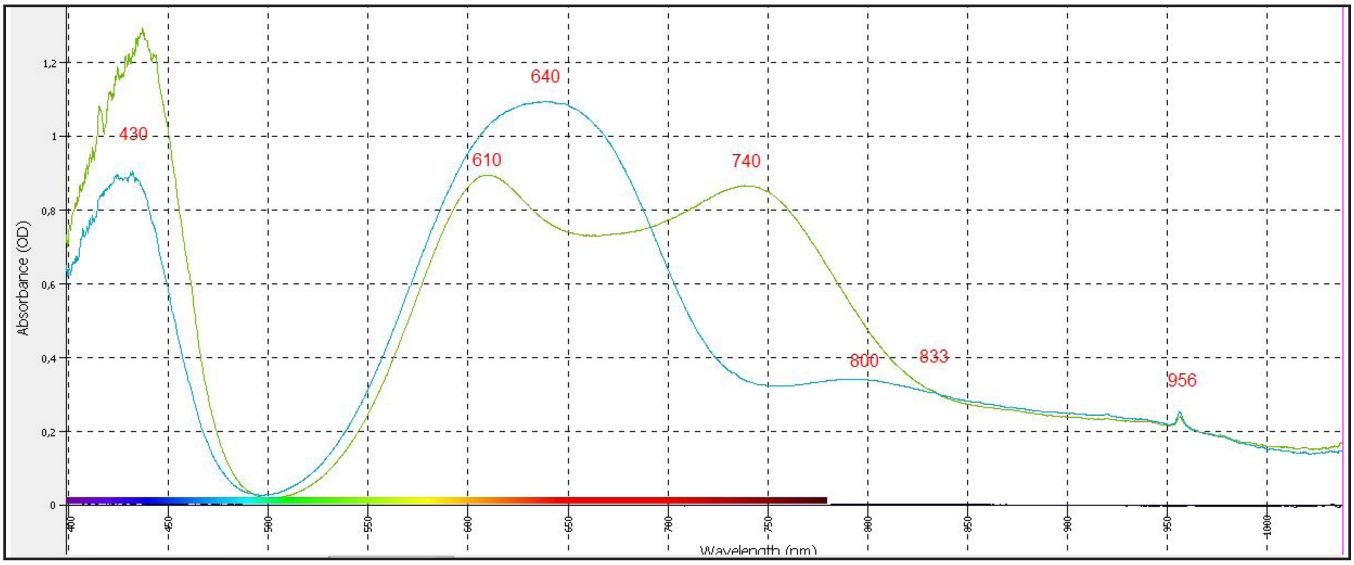


Figure 10: Vis-NIR polarized spectrum of the crystal. When the electric field of the light (E) is perpendicular to the C axis it corresponds to the yellow-green trace on the figure and when E is parallel to the C axis it is represented by the blue-green trace. Absorptions at 430, 610, 640 nm come from V^{3+} in octahedral sites (substitution of Al^{3+}). Absorption at 740 comes from Cu^{2+} in tetrahedral sites (substitution of Be^{2+}). Large band at 800 nm is assumed to come from Cu^{2+} too. The 956 nm peak comes from water. The small peak detected at 833 nm is of an unknown origin.

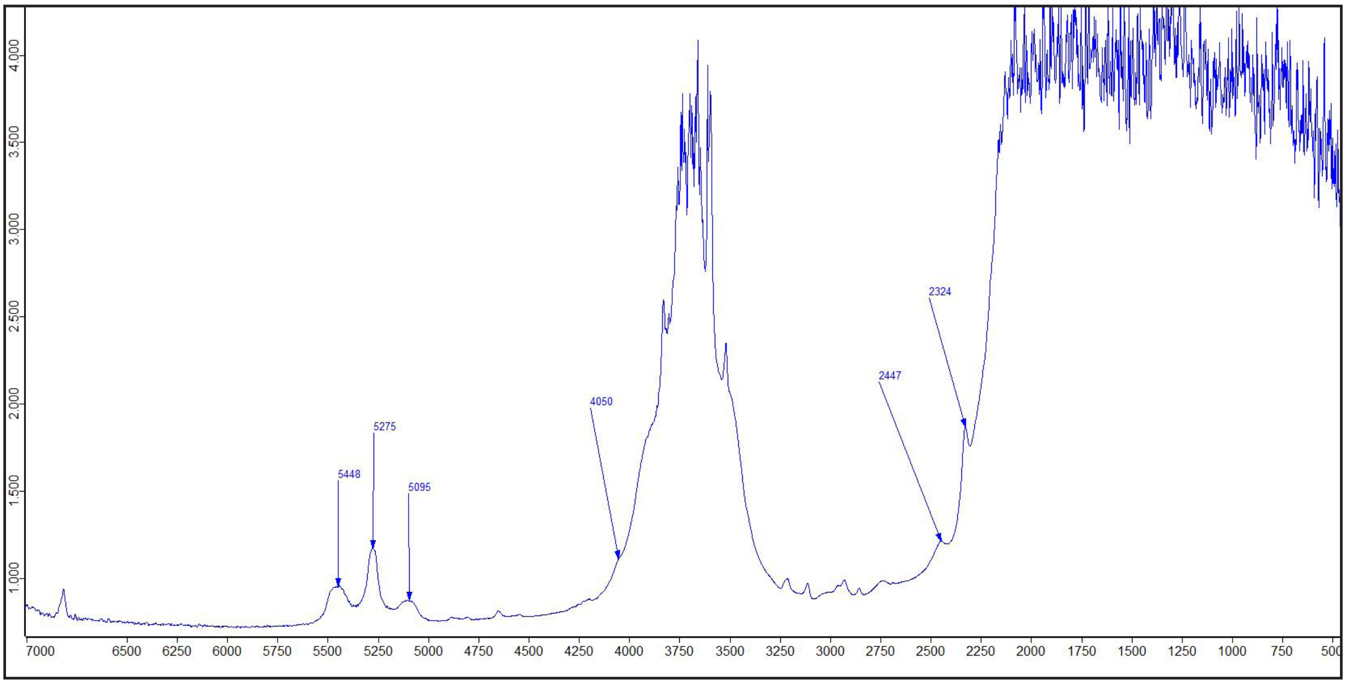


Figure 11: FTIR spectrum of the crystal. Shape of three peaks at 5448, 5275, 5095 cm^{-1} (water type I & II) in conjunction with 4050 cm^{-1} shoulder, 2447 and 2324 cm^{-1} peaks with the lack of obvious CO_2 peak indicate the synthetic nature of this hydrothermally grown material.

Although the identification will be straightforward in a gem lab, this material will be quite difficult to identify with standard gemological tools.

There are however certain characteristics that if present, will help to identify this material as synthetic. These include the lack of regularity in the overall crystal shape (rounded face junction, face number, etc.), a lack of growth structure on the faces (indicating that they have been cut and polished), the pseudo-geometric low relief inclusions, the dendritic black inclusion close to the surface of a crystal face, its reaction under the polariscope (with rainbow colored fringes perpendicular to the C-axis) and the 'swirled' texture along a plane.

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Footnotes

[1] Gubelin & Koivula 1986, 2008, Schmetzer et al. 2006

Editors Note

If you are going to simulate a rough crystal by cutting and polishing it, having a good understanding of crystallography is imperative. Beryl belongs to the hexagonal crystal system and is noted for its six-sided, not seven-sided prisms!

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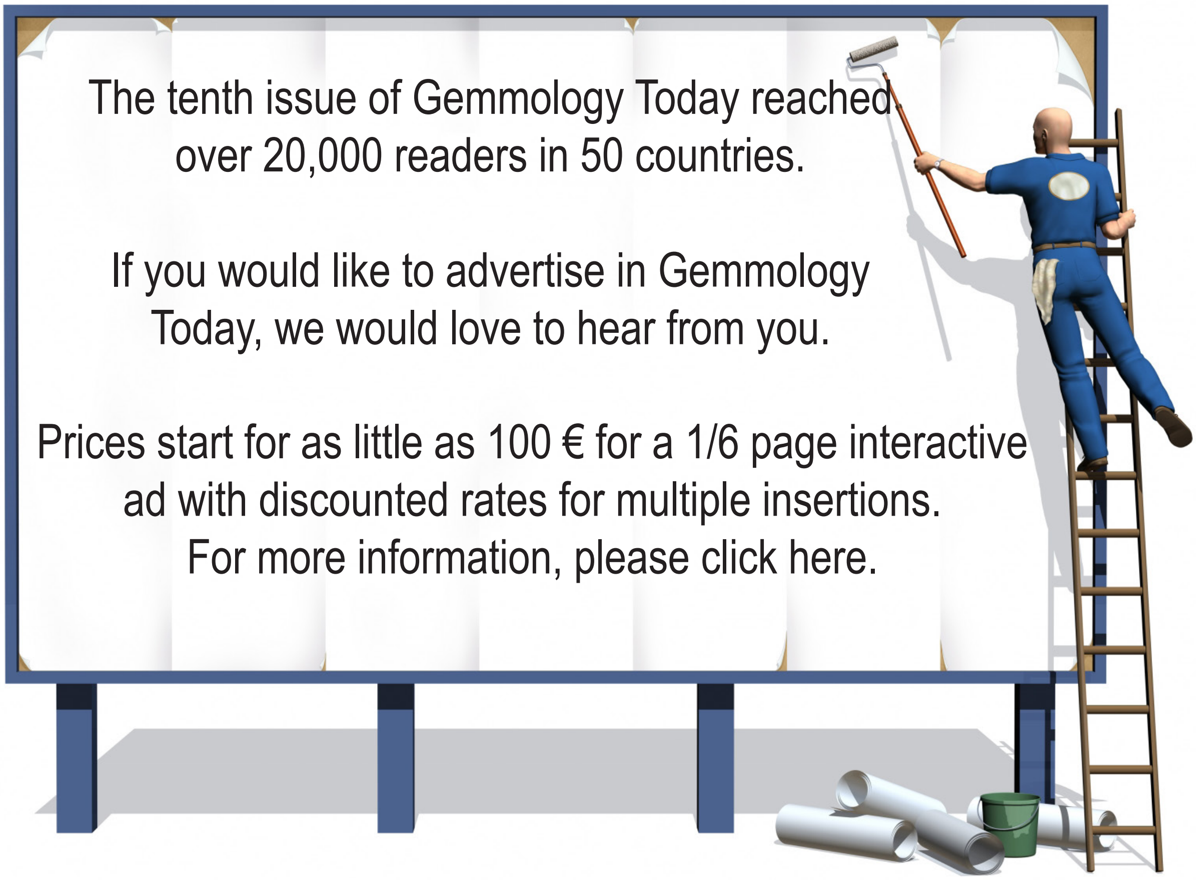
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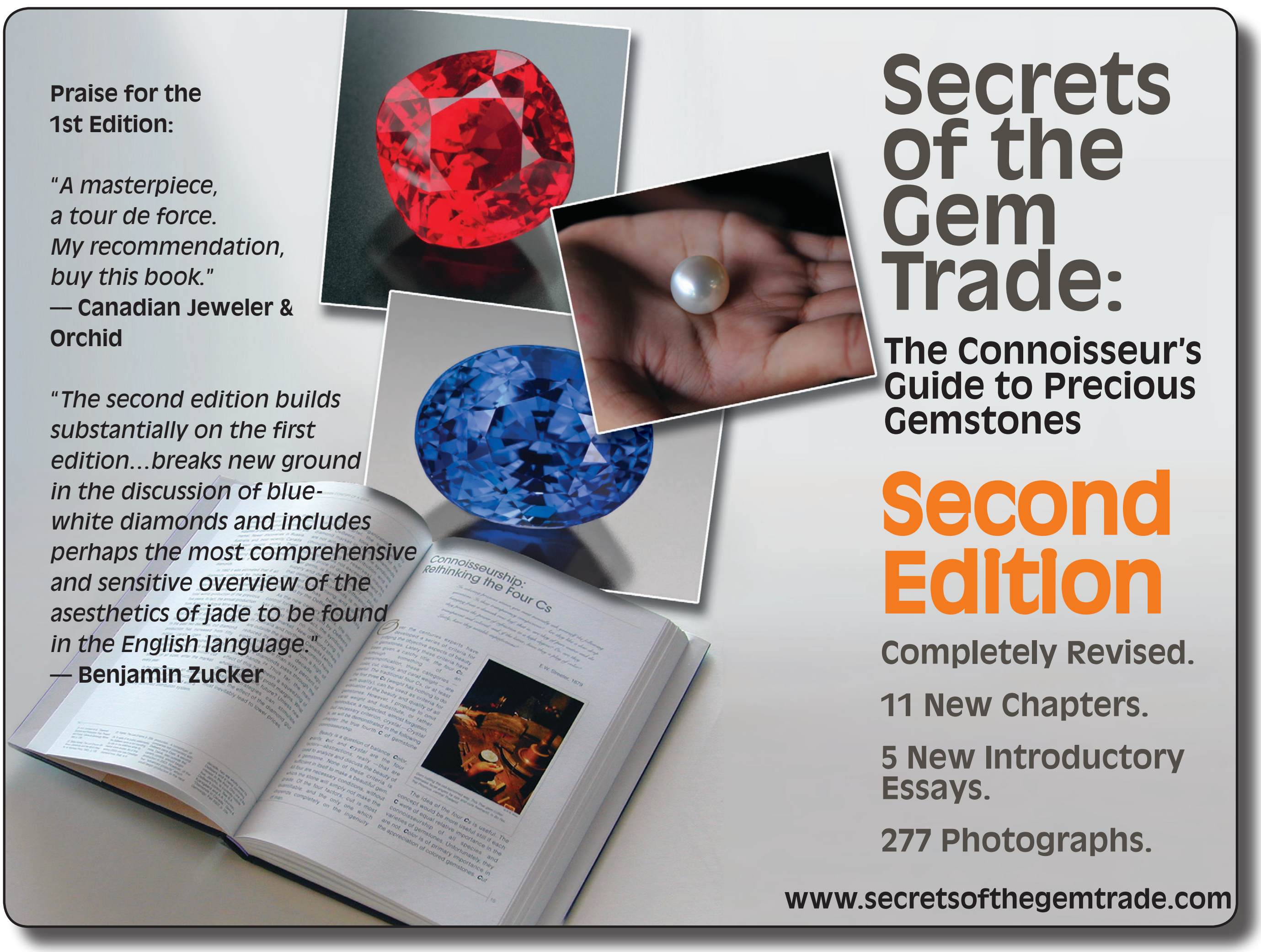
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JAN ASPLUND is the joint CEO of the Scandinavian Gem Academy. He received his FGA (Diploma in Gemmology) and DGA (Gem Diamond Diploma) through Gem-A in 2011, his BA in History from the Mälardalens University in 2000 and studied geology and gemmology at Luleå Technical University (2005 – 2007).

All Roads Lead to......

China is today a major player in the diamond field with the second largest market for polished diamonds after the US, the second largest manufacturer of polished diamonds after India and the world's largest producer of synthetic diamonds. The position China holds today, in all parts of the diamond business, is quite new and goes back only a few decades. Still China has a long relationship with diamonds that dates back several millennia.

The first confirmed finds of diamonds in China were made in the late 1940s and production started around 1967 (Gem-A 2005). Largest of the Chinese mines was 701 Changma Diamond Mine that had a top production of 50,000 carats in one year (Laniado 2015). Since then over 20 kimberlite pipes and more than a 100 diamond placers have been found with approximately 50% located in the Liaoning Province (Danilov 2012). Compared to other diamond producers, the Chinese production has been quite modest with a peak in 2004-2006 when production reached around 70,000 carats annually but has recently fallen to just a few hundred carats in 2017 (Kimberley process 2019).

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DeBeers launched their 'A diamond is forever' campaign in China in 1993 and the campaign has been described as exceptionally successful in establishing a tradition of diamonds for betrothal and wedding rings, a tradition that did not exist before the campaign was launched (Laniado 2015). As a result of the DeBeers campaign, China overtook Japan as the world's second largest consumer of polished diamonds in 2009 (Danilov 2012).

Diamonds in China

Before diamonds were used for jewellery in China, they were used as tools and archaeological finds support the claims that during the Han Dynasty (206 BCE – 220 CE), diamonds were imported to China from the Roman Empire. The tool kun-wu was an engraving and drilling tool consisting of a diamond bit in an iron holder (Lenzen 1970 p 38). Iron started to be used in China just before the Han Dynasty and diamonds set in iron were used for carving no later than the 1st century BCE. There is no indication of diamonds having been used as an abrasive or for polishing at that time (Thomas & Lee 1986).

According to legend, Yu the Great, supposed founder of the Hsia Dynasty at the end of the 3rd millennium BCE, was in possession of a wonder-knife called ´K´un Wu´, which could cut jade as easily as if it were chalk. ´K´un Wu´ appears in several early Chinese legends and perhaps the legend refers to a more efficient tool than the traditional pointed bamboo rod dipped in abrasive powder mixed with various ointments (Luzzatto-Bilitz 1987 p 11). It is doubtful that Yu the Great was in possession of a diamond tool. Berthold Laufer suggested in his 'The Diamond, A study in Chinese and Hellenistic Folklore' that diamonds were used for carving jade from around the 1st millennium BCE but there are no known archaeological artefacts supporting this claim.

The word ´K´un Wu´ is often mentioned together with the word ´chin-kang´, a Chinese character used for several very hard stones, including corundum. When Laufer wrote his book on Chinese jade he translated ´chin-kang´ with the word diamond, a translation that has created some misconceptions concerning when diamonds were first used as a tool in China (Luzzatto-Bilitz 1987 p 13). Inaccurate translations of words used for hard or durable materials into diamond have caused many misconceptions concerning when and where diamonds have been known and used, with examples ranging from the Hindu word 'Vajra' that translates into both lightning bolt and diamond, the Hebrew word 'Jahalom' that has been used for diamond but also other hard materials and the familiar Greek word 'adamas' that was first used for describing qualities in iron but later also became used for any hard material. Eventually becoming synonymous with 'diamond' (Asplund 2017).

As mentioned earlier, there is no evidence indicating diamonds having been used as a polishing agent at the time of the earliest use of diamonds for carving but results from a study conducted in 2005 shows that diamonds have an older history than previously thought. Diamonds seem to have been used as a polishing agent in China as early as the third millennium BCE as archaeological finds of axe heads made out of a corundum rich rock shows signs of having been polished with diamond powder (Lu et al 2005). It is not known if the manufacturer knew he was using diamonds or if the diamonds were part of sand used for polishing. The origin of the diamonds is also unknown; perhaps the diamonds were a result from a meteor impact or of metamorphic origin caused by tectonic forces. Both processes can produce large amounts of microdiamonds and when the rocks have weathered the remaining diamonds may have been suitable as abrasives or for polishing.

China has been producing synthetic diamonds since the 1960s (Lichang 1985). Today China's annual production of synthetic diamonds is around 10 billion carats. A majority of the production is for industrial purposes but several companies are transforming parts of their production toward gem quality diamonds. An example, is the company Sino-Crystal whose production of synthetic diamonds is within the range of 2-3 million carats annually. Earlier the vast majority of the company's production was for industrial purposes but today half of the production is intended for the jewellery business. A majority of the production of synthetic diamonds intended for jewellery is of a lower quality and needs subsequent treatments to be suitable for jewellery purposes (The Diamond Loupe 2019).

The history of synthetic diamond production in China is quite different from other countries. Instead of a few larger companies dominating the production, a kind of 'cottage industry' developed in China where for example, smaller jade carving facilities owned their own diamond presses to produce tools for carving jade and many of the small family owned businesses have started to also produce diamonds for jewellery (Hazen 1993 p 169).

The Chinese interest in diamonds throughout history had primarily been as a tool for carving jade. From around the early first century BCE highly valued carving tools were imported from the Roman Empire and it was for the purpose of making tools for carving jade that the small-scale production of synthetic diamonds started in the 1980's. This has now grown into an industry that today involves a large number of companies producing very large amounts of diamonds, not only for industrial purposes but also in qualities that can be used in jewellery.

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Cartier Panther Necklace (Photo by Tino Hammid)

There are a number of great 'shoots' that did not happen but probably the one I regret the most was the diamond shoot for the National Museum of Natural History (Paris).

Meet Jeff Scovil

Jeff Scovil

GT: Who is Jeff Scovil? Tell us about your background?

JS: I have to blame my father Charles Scovil for my interest in the earth sciences and for photography. He started out as a geologist and all though he did not stick with it, that strange hammer he had plus the collection of rock samples glued into a box really intrigued me. He also gave me my first camera (a Pentax H1a) as a high school graduation present. He taught me the basics of photography including processing film and making prints. I started collecting minerals (along with other natural history objects) when I was 8 years old. Along with a couple of friends, I had a 'natural history museum' in the basement of my parent's home in Connecticut where I grew up. I was fascinated by minerals, fossils, dinosaurs and cave men as a child but eventually decided to concentrate on minerals.

In the 8th grade I joined the Junior Staff at the Mid-Fairfield County Youth Museum, which promoted the natural sciences for children. Of course, I spent most of my time in the mineral collections. I was a member of school earth science clubs and eventually joined the Stamford Museum Mineralogical Society and after starting school at Southern Connecticut State College (now University) I joined the New Haven Mineral Club. Although I started out as a geology major, I switched to sociology with a specialty in anthropology.

All through high school and undergraduate school I did extensive field collecting in Connecticut and neighboring states.

In the summer of 1971, I traveled for the first time to the American southwest where I spent one month in New Mexico searching for fossils with a retired field collector for the American Museum of Natural History. We then spent another month searching in Wyoming. The following summer I attended my first archeological dig at Salmon Ruins in New Mexico as a field excavator. The following six summers I spent on the dig as laboratory photographer where I taught myself the basics of scientific photography.

After three seasons of that work I decided to apply those techniques to the photography of minerals. This became a major part of my hobby of mineral collecting. After moving to Phoenix, Arizona in 1977 to attend Arizona State University and study anthropology, archeology and museology (museum studies) I started publishing my work in Rocks and Minerals and the Mineralogical Record. I did this by illustrating articles written by geologist friends.

Between grad school, buying my first house and having a daughter, I had little time for field collecting. I kept up the photography though and decided to make my mark in the mineral world by being a good amateur mineral photographer. I wrote a series of articles on the subject for Rocks and Minerals. I had also joined the Mineralogical Society of Arizona and eventually served two terms as president.

In 1990 I decided to make mineral photography a full-time business and have never looked back. From humble beginnings begging for photo work door to door at the Tucson Gem & Mineral Show my business has grown beyond my wildest dreams. I now travel the world photographing minerals, gems, jewelry and related items. As I write this, I am nearing the end of a month long shoot in China. I am published in all the magazines in the U.S. and several in Europe and am on their mastheads as Associate Photographer. I have written numerous articles on photography, mineral localities and my travels and in 2007 won the prestigious Carnegie Mineralogical Award.

In 1996 I wrote Photographing Minerals, Fossils and Lapidary Materials (Geoscience Press). A revised book is in the works. I have done over one dozen of the posters each for the Tucson Gem & Mineral Show, the Denver Mineral show and Sainte Marie-aux-Mines show as well as a number of other shows. For over 30 years I have also run the Mineral Photography Seminar and mineral photography competition at the Tucson Gem & Mineral Show. I also lecture extensively on the topics of mineral photography, mineralogy and my travels.

GT: When did you first develop a passion for gemstone and mineral photography? Was there a defining moment when you realised this was what you wanted to do?

JS: I think that the first part of the question was covered in the previous question. Was there a defining moment, not really. I do remember though that since I had decided not to go into either archeology or museum work I had tried several businesses on my own. The last one was custom wood work which although I was good at it, was barely making a living. I realized that I had my foot in the door of the photography business and came up the wacky idea of making a full-time business of it. It took a few years to make it pay all the bills, but I never regretted it or looked back. I had found my calling.

GT: Natural talent or acquired through study?

JS: I am not sure that I can call it natural talent. It took years of work and practice and I look back at my early photography and cringe. I am proud to say though that I have never taken a photography course in my life.

GT: Accomplished anglers always talk about the ‘one that got away’. Is there one gemstone shot that has eluded you over the years?

JS: There are a number of great ‘shoots’ that did not happen but probably the one I regret the most was the diamond shoot for the National Museum of Natural History (Paris). They were putting together a superb display of diamonds and had arranged for me to photograph a collection of superb diamonds that was in the DeBeers collection. The stones were in South Africa and were going to be brought to London. It had been arranged that I would go there following the Munich show. Upon arriving at the show in Munich there was a message waiting for me that the shoot had been canceled because some big shots were coming to South Africa and DeBeers wanted to hold on to the diamonds to show the visitors.

GT: What is the one most memorable gemstone or mineral you have photographed and why?

JS: That is a difficult one because there have been so many great pieces. What comes to mind is the Dragon. Maybe 20 years ago, the Colorado Quartz mine in Mariposa, California produced an amazing crystallized gold specimen through the efforts of the Collector’s Edge. It was an incredible group of flattened octahedral crystals on a quartz matrix that resembled a dragon. I shot it for the Collector’s Edge and it was eventually sold to the famous composer and collector James Horner and finally ended up in the Houston Museum of Science where I was able to photograph it again some years later. The specimen has been hailed by some as the greatest of all mineral specimens.

GT: Is there still a place for analog film in the world of gem and mineral photography?

JS: I believe so, but not so much for the commercial world. It is a bit like people who still collect and listen to LP records and claim that the sound is purer and not so sterile as digital recordings. There is a joy of working with film and handling a physical image particularly a large format transparency. There are those who do prefer the color rendition, the tones and other characteristics of film to digital imagery. It is also true that neither medium is perfect and there are some things, particularly colors that are rendered more accurately with film.

GT: There are pros and cons to everything but in the age of digital photography, do you feel that many photographers rely too heavily on software such as Photoshop? Is there a downside to this technology?

JS: Obviously it gets used too much by some degree or it would not have such negative associations in so many people’s minds. It is so much easier to modify images now than in the days of film and very easy to over do it. The biggest problems are over saturation (and therefore misrepresentation) of color as well as the removal of inclusions and defects in stones. If someone is going to buy a stone over the Internet based on an Internet photo they should get a guarantee that the stone is returnable. This brings up a quandary that stone photographers are faced with. Back in the day, a stone could be sold as ‘eye clean’ which means when held in the hand it looked relatively flawless. However, when the same stone is photographed and put on the Internet, the potential buyer sees it at much greater magnification on his computer monitor. The stone that is 'eye clean' when held in the hand, now looks like it is full of inclusions and other problems. The potential buyer does not understand this difference and sales as well as the dealers reputation can suffer. So how much 'cleaning' of the stone to compensate for the magnification is permissible, if any at all?

GT: Guitarists are always asked about the equipment they use and the ones they most prefer. What is your camera of choice and why?

JS: I do not get too hung up on equipment. What is most important is the lens and the person using the camera. You can give the finest camera in the world to someone who is a poor photographer and it will not improve their work. However, an average camera in the hands of a pro will produce amazing work. That being said, I am using at this time a Nikon D500 which takes great pictures. For a lens I use mostly a 60 mm Micro Nikkor but for small subjects I use a 105 mm Micro Nikkor. For large format work I love my Sinar F but unfortunately there is little if any call for it any more.

GT: Where do you see the future of photography in the gem and mineral world ten years from now?

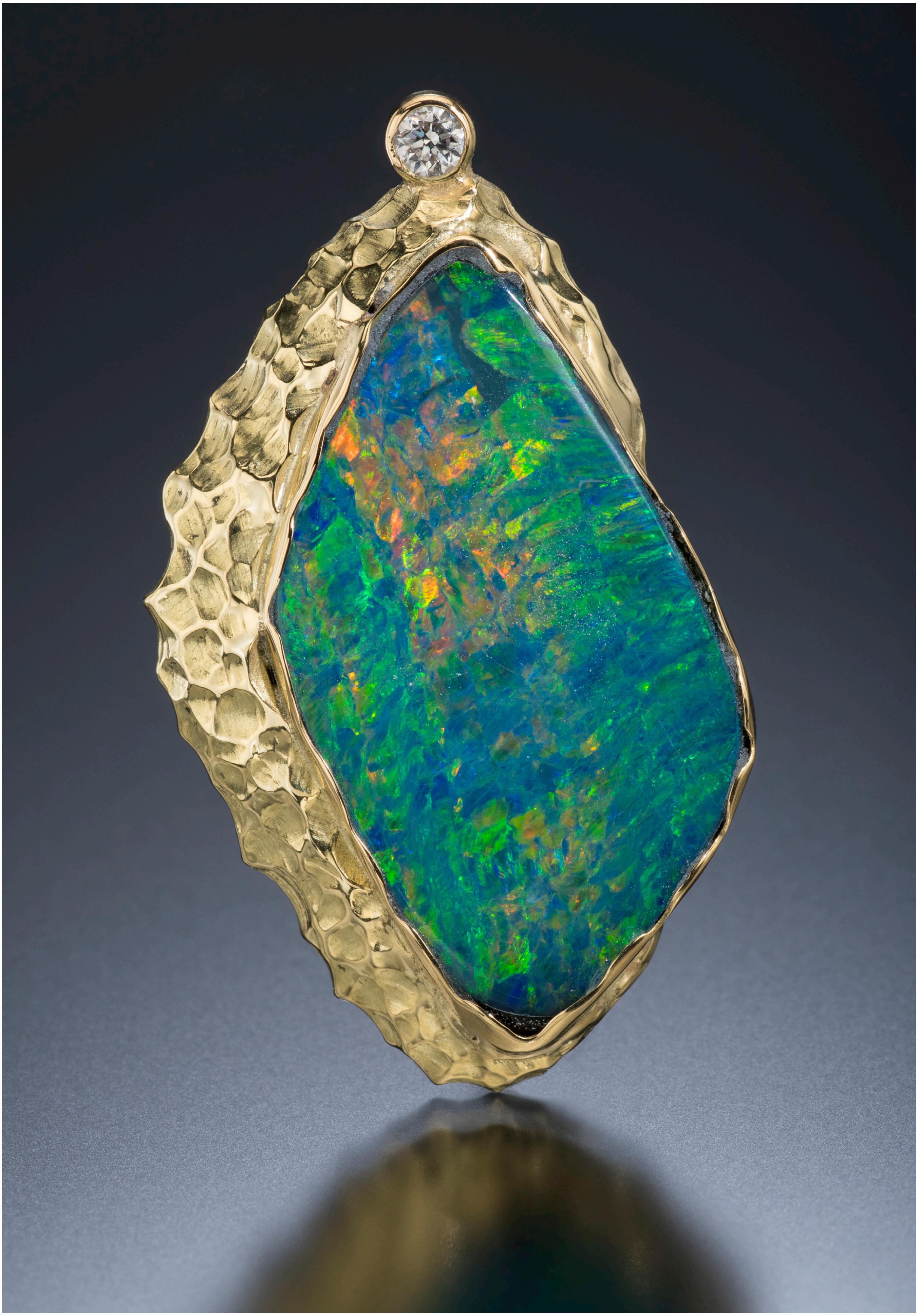
JS: I think that as the resolution of digital cameras increases and other techniques are developed, this problem of accurate representation with grow. It could be that the industry will have to demand that standards have to met concerning the amount of allowable cleaning and accurate color representation. The latter can be a bit of a 'gray' area because some colors are notoriously difficult to capture in either film or digital. We already know that everyone sees colors a little differently and this is made worse by looking at stones under different light sources. The problem is worsened by the fact that a good photographer has both his monitor and camera calibrated but the buyer rarely does. So as a photographer you can get the color as accurate as possible but that all goes out the window when the buyer looks at it on an uncalibrated monitor. Let's not even talk about the problems of accurate color representation on the printed page.

GT: If we were sitting here a year from now celebrating what a great year it's been for Jeff Scovil professionally, what would you say was the reason?

JS: I have been involved in several publication projects that have kept me traveling to some great destinations and shooting some wonderful subjects as well dealing with some wonderful people.

Fluorapatite (Courtesy of David Atkinson) (Photo by Jeff Scovil)

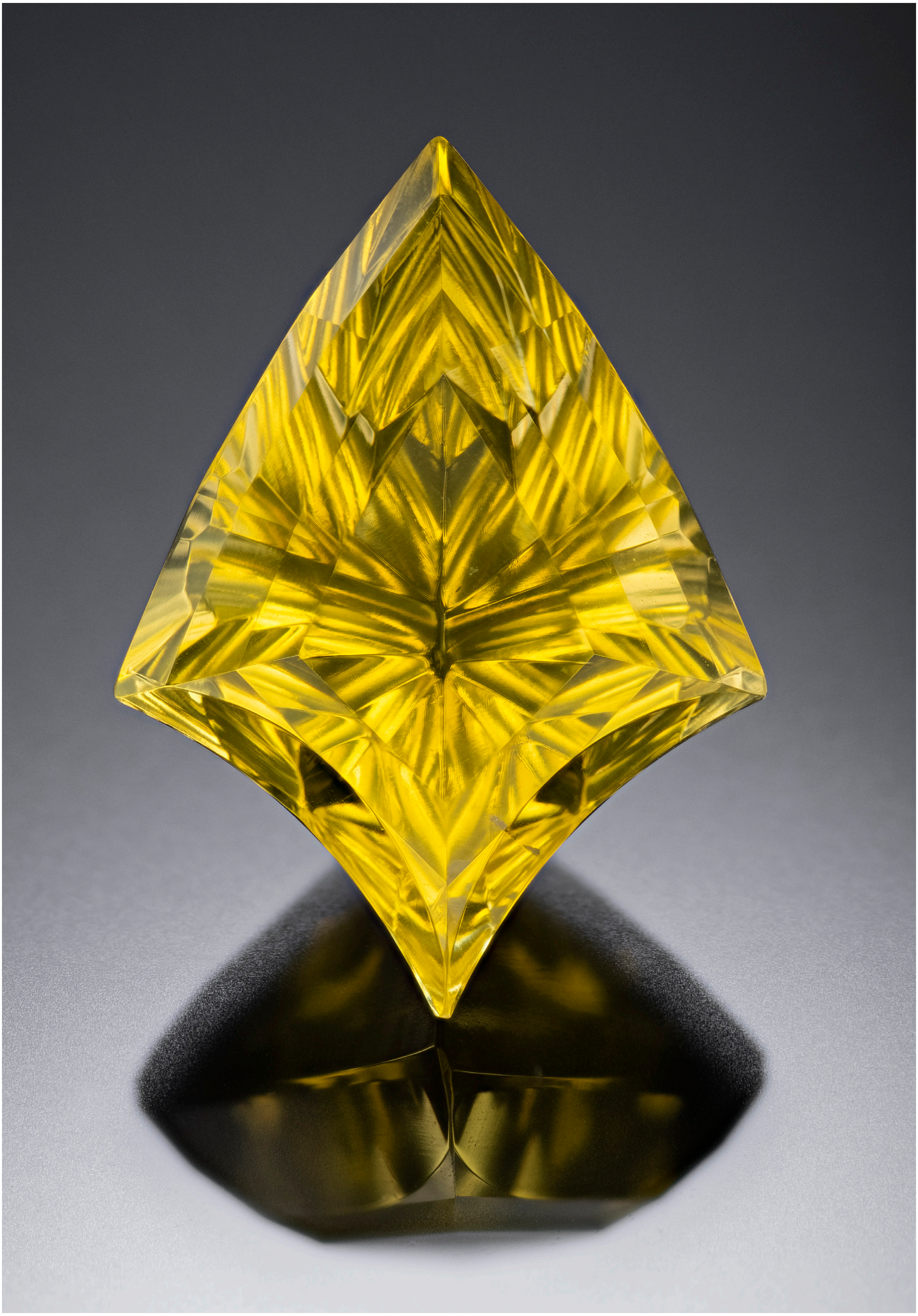
Rubellite Tourmaline (Elbaite) - 5.26 carats (Elayne Luer) (Stewart Mine, San Diego, USA) (Photo by Jeff Scovil)



Opal and Diamond Pendant (Courtesy of R.K. Bryant) (Photo by Jeff Scovil)

Gold & Tourmaline Earrings (Courtesy of Paul Farmer) (Photo by Jeff Scovil)

Silver & Tourmaline Necklace (Courtesy of Maine Mineral & Gem Museum) (Dunton Mine) (Photo by Jeff Scovil)



Citrine Quartz -16.69 carats (Elayne Luer) (Photo by Jeff Scovil)

Amethyst - 7.36 carats (Elayne Luer) (Anahi Mine, Bolivia) (Photo by Jeff Scovil)

Orthoclase Feldspar - 13.09 carats (Madagascar) (Photo by Jeff Scovil)

Fluorapatite (Courtesy of David Atkinson) (Madagascar) (Photo by Jeff Scovil)

Pink Sapphire Ring - 1.05 carats (Courtesy of Paul Farmer) (Photo by Jeff Scovil)

Pezzottaite - Carved by P. Dreher measuring 5.80cm (High) (Madagascar) (Photo by Jeff Scovil)

Assorted Cat's Eyes (Courtesy of Nepali Bazaar Co) (Photo by Jeff Scovil)

Gold & Sphene Pendant - 8.35 carats (Courtesy of Paul Farmer) (Madagascar) (Photo by Jeff Scovil)

Gold & Tourmaline Necklace (Courtesy of Maine Mineral & Gem Museum) (Photo by Jeff Scovil)

Tourmaline & Diamond Ring (Courtesy of Paul Farmer) (Photo by Jeff Scovil)

Ruby & Diamond Ring (Courtesy of Paul Farmer) (Photo by Jeff Scovil)

Aquamarine 252.38 carats (Courtesy of Rare Earth) (Minas Gerais - Brazil) (Photo by Jeff Scovil)

Trapiche Emerald measuring 10.00mm x 8.00mm - 3.40 carats (Courtesy of Paul Farmer) (Boyaca, Colombia) (Photo by Jeff Scovil)

Agate & Sapphires set in Silver (Courtesy of Ana de Los Santos) (Patagonia, Argentina) (Photo by Jeff Scovil)

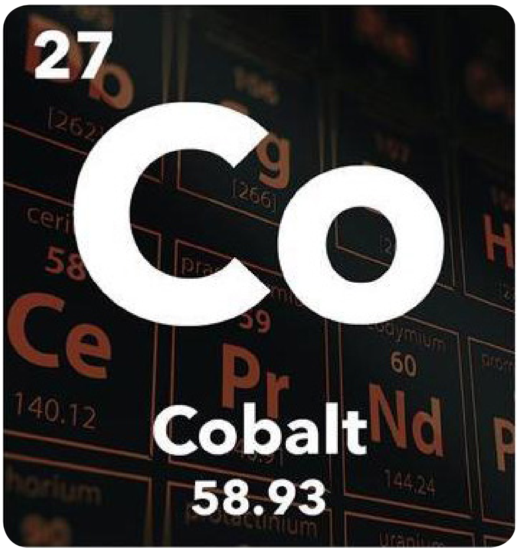
Rossmanite & Diamond (Courtesy of Peter & Nadia Lyckberg) (Transbaikal, Russia) (Photo by Jeff Scovil)

GEOFF DOMINY is an author, independent gemmologist and founder of the World Gem Foundation. He received his F.G.A through the Gemmological Association of Great Britain (Gem-A) in 1987 passing the diploma examinations with distinction.

Money Cent$

Economics for Non-Economists

The Power of Cobalt



Like nickel, cobalt is normally only found in a 'chemically combined form' and while pigments used for cobalt-based paints have been used since antiquity, it was not until 1735, through the work of Swedish chemist Georg Brandt, that the hard, lustrous, silver-grey metal known as cobalt (kobold) was produced through reductive smelting.

Today, cobalt is typically produced as a by-product of copper and nickel mining with the DR of Congo (50% of world production in 2016) and Zambia producing the most cobalt.

Although cobalt is used in the manufacture of magnetic, wear-resistant and high-strength alloys, in leading-edge semiconductor technology (resulting in the most significant advancement in semiconductor manufacturing in the past 20 years), to give a distinctive deep blue colour to glass, ceramics, inks, paints, varnishes and of course as a transition element in certain gemstones, it is the need for lithium-ion and electric car batteries that has caused a surge in the demand for cobalt. This has resulted in the price of cobalt increasing over a two-year period (2015 to 2017) by over 200%. This increase however is not only due to high demand but the need for ethically conscious tech companies to find a more ethical supply chain to combat the use of child and slave labour primarily in the artisanal mines of the DR of Congo.

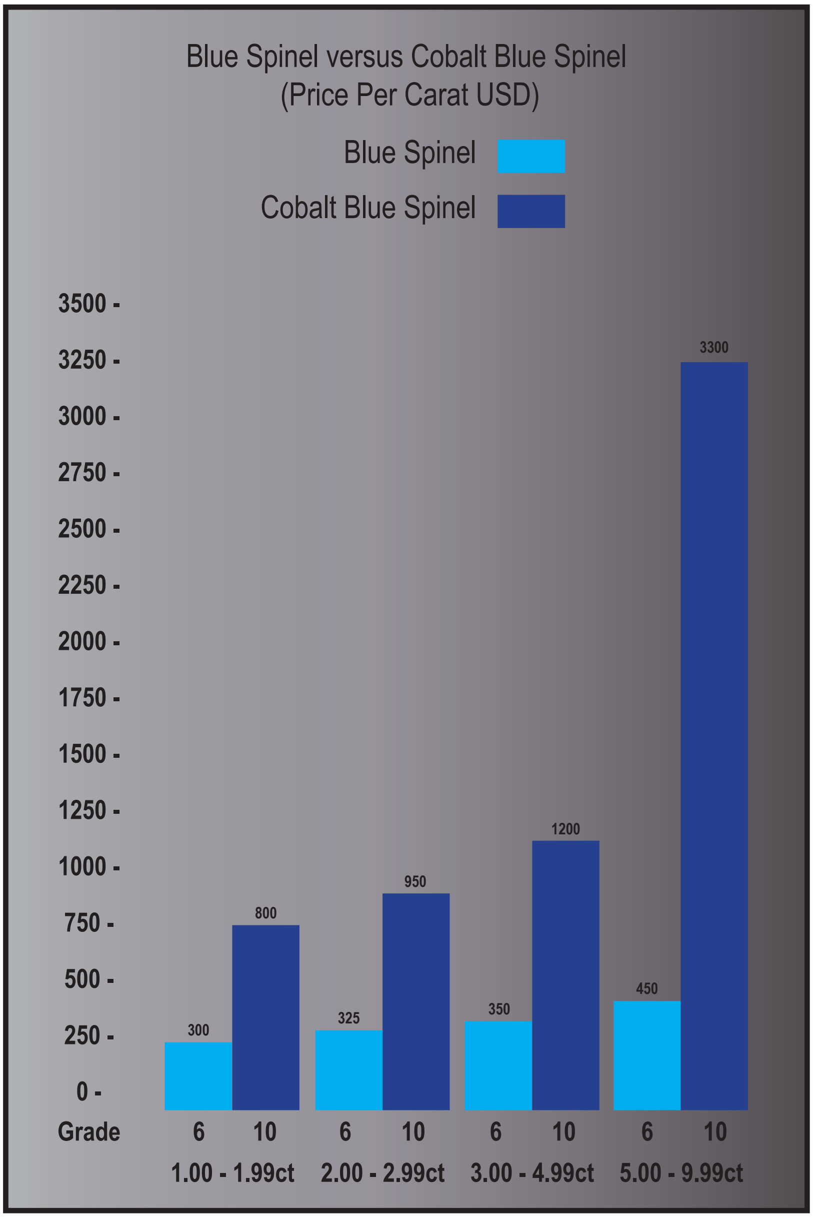
This has lead to a coalition of billionaires spearheaded by Bill Gates investing heavily in a company called Kobold Metals that is hoping to build a 'Google Maps for the earth's crust' to hunt for new sources of cobalt. By using data-crunching algorithms to scour the globe for cobalt, they hope to find significant undiscovered sources of this valuable metal.

With a chemical symbol of Co, an atomic number of 27 and an atomic mass of 58.933195 u, you will find cobalt on the Periodic Table in Group (Column) 9 and Period (Row) 4.

Cobalt is primarily found in gemmology in certain blue spinel. I have to confess that I have a weakness for all spinel. I just love them. They are, without question, one of the most under-rated gems on the market, a gemstone that deserves far more recognition. Sadly, the finest red and blue spinel are forced to compete with rubies and blue sapphires, a battle that is hard to win since most gem dealers, jewellers and indeed consumers are far more familiar with rubies and sapphires than they are of spinel.

Cobalt Mining (Courtesy of Sunday Times March 10th, 2019)

Cobalt Blue Spinel (Photo by Tino Hammid)



Reference: GemGuide January/February 2019

One problem with your 'average' blue spinel, coloured by iron, is that the resulting colour lacks saturation, producing a greyish-blue colouration. However, when cobalt enters the picture, the picture changes completely, producing a gemstone that is truly a sight to behold.

But what role does cobalt play in the price of a spinel?

A cursory search of the Internet revealed a 14mm x 10mm, oval lab-created blue spinel selling for $ 3.63 USD. Since these stones are not sold by the carat, it is hard to tell exactly how much it would really weigh but using a 'weight estimation formula', we can approximate the weight to be roughly 6.75 carats.

Checking the current GemGuide pricelist, a natural stone of this size and quality (a lab-created deep blue spinel will approximate the colour of a 'Fine' to 'Extra Fine' quality natural stone), the price is a staggering $ 22,275 USD. Quite a difference!

Now remember, both have the same chemical constituents but one is formed in a 'controlled environment' while the other is formed through a chance meeting of magnesium, aluminium, oxygen and cobalt.

Lab-created Spinel

Although Auguste Verneuil originally produced blue spinel as an accidental by-product during his early attempts to synthesize blue sapphires through the addition of cobalt with magnesia as the flux, it was not until 1926 that flame-fusion blue spinel were commercially available. This was due to problems in producing boules that did not spontaneously split when using the preferred 1:1 ratio of alumina to magnesia that mirrored the chemical composition of natural spinel.

Eventually this was overcome by adjusting the ratios, using one-part magnesia to anywhere from 1.5 to 3.5 parts alumina depending on the desired colour. Although this solved the problem of the boules splitting, it did make the manufacture of flame fusion red spinel almost impossible since they did require the 1:1 ratio. The increased alumina also caused marked differences in the refractive index and specific gravity of the finished stones leading the industry to question if in fact, they could be considered true 'synthetic' counterparts of natural spinel.

Unlike Verneuil flame fusion corundum boules, flame fusion spinel boules have flattened sides, conforming to the crude crystal faces of the cubic crystal system, and are due to the tendency of the cubic gamma form of alumina to revert to the stable trigonal alpha form (corundum). This creates strain within flame fusion spinel that produces the characteristic anomalous birefringence or tabby extinction seen under crossed polarizers.

Fortunately it is these features that make lab-created spinel one of the easiest stones to separate from its natural counterpart. All you need is a refractometer and a polariscope.

Natural Spinel

Spinel is typically found in host rocks that are similar to those for corundum, including gneiss, serpentine and crystalline limestone rocks with most of them found in secondary alluvial deposits as water-worn pebbles. This has often lead to spinel being mistakenly identified as ruby or sapphire.

Today principal localities include Myanmar, Sri Lanka, and Cambodia with deposits also found in Tanzania (Umba Valley), Afghanistan, Brazil, Madagascar, Nepal, Vietnam, Kenya, Pakistan, Tajikistan, Nigeria, Thailand (black only), the U.S, Sweden, and Australia.

Electric Cars (Courtesy of Mining.com)

Like diamond and garnet, spinel belongs to the cubic crystal system and is therefore isotropic or singly refractive. Invariably, it is found in well-formed octahedrons, octahedral crystals with the edges truncated by the dodecahedron faces and as contact twin crystals known as 'spinel twins'.

Chemically speaking, spinel is a magnesium aluminium oxide with a chemical formula of $MgAl_2O_4$.

While the replacement of aluminium by chromium ions is the cause of colour in red and pink spinel, iron and/or cobalt produce the colour in blue spinel, hence the term 'Cobalt Blue Spinel'.

So in reality, we have the same quantity of cobalt present in both a 6.75 carat lab-created blue spinel and a natural cobalt blue spinel yet there is a difference in price of over $ 22,270 USD.

Renowned gem cutter Victor Tuzlukov once said that you would not determine the value of a fine sculpture by the cost of the marble or a Van Gogh painting by the cost of the paint. The same can be said of gemstones. In reality, the value of the component parts is insignificant but when they combine, in nature, through a chance encounter, under the right geological conditions, with the right amount of heat and pressure, magical things can happen, not just in the beauty of the resulting crystal but in the value as well.

Clearly the cost of the cobalt is insignificant but it is the effects even small trace amounts can have on natural stones that we must consider.

If we look at the chart on the opposite page, we can see that in the four weight categories, the price difference between a blue spinel graded 'Good' (6) by GemGuide and a cobalt blue spinel graded 'Extra Fine' (10) ranges from 167% to 633%. Now of course we can find lower grade cobalt blue spinel but if we are going to achieve a '10', we need significant amounts of cobalt to be present to inject the 'vividness' that is needed to attain the highest colour grade.

If we take a 5.00 carat blue spinel, for example, that difference translates into $ 14,250 USD at wholesale. A difference in value that is attributable to the presence of cobalt and the interaction of the chemical constituents rather than the value of the chemical constituents.

Food for thought........

Reference:

Cobalt Institute - https://www.cobaltinstitute.org

The Fingerprint File GEM IDENTIFICATION

This is the second of a two part series by Kirk Feral where he investigates the roles chromium and vanadium play in the colouration of gems and how their presence can be detected.

Masters of Green: Chromium and Vanadium (Part Two)

Detecting Chromium and Vanadium

So how do we detect chromium or vanadium in gemstones, and how do we distinguish between them? In my own lab, basic tools include a Chelsea color filter, a long wave UV flashlight (365nm), a blue laser (405nm), a dichroscope and a hand-held spectroscope. The absence of any chromium response to these tools in some instances indicates that vanadium rather than chromium is the dominant cause of color. A magnetic wand is also part of my arsenal of equipment. I rely on a UV-Vis-NIR spectrometer as a more definitive tool for detecting chromium and vanadium and for distinguishing between them.

Tools for Detecting Chromium & Vanadium

I find that a handheld spectroscope is of limited use in detecting chromium in natural green gemstones such as jadeite, chrome chalcedony and demantoid garnet. Black absorption lines indicative of chromium may be present in the red/orange region of the spectrum, but these lines are often very difficult to see against the dark red background unless the concentration of chromium in a gem is particularly high, as we find in some synthetic emeralds and some dark green natural emeralds.

Similarly, because the concentration of chromium and vanadium in most natural green gems is very low, an N52 neodymium magnet is seldom able to detect the magnetic susceptibility of these two metallic chromophores. Moderate to strong magnetic responses in natural green stones colored by chromium and vanadium is usually an indication of iron content.

A dichroscope can occasionally be helpful in confirming the presence of chromium in a doubly refractive green gem. When pink color is seen along with green color under a dichroscope, the pink color component is usually indicative of chromium. We encounter pink/green dichroism in green chrysoberyl gems, hiddenite, vanadium diopside and some emeralds. But such dichroism involving chromium is not apparent in other green chromium-bearing gems such as chrome tourmaline, chrome diopside, chrome sphene, singly refractive gems or microcrystalline gems.

Chelsea Filter

To detect chromium, a Chelsea filter is one of the most useful tools. When incandescent light is applied to a green gemstone that is viewed under a Chelsea filter, the presence of chromium is indicated when the gem appears pink or red rather than green. I know of only 3 exceptions to this rule:

- Blue-green synthetic spinel: a red Chelsea filter reaction is due to cobalt.
- Green zircon: a red reaction is due to color centers that are unrelated to chromium.
- Green sphene: a red reaction is likely due to rare earth elements or possibly iron rather than chromium. Yellow and brown sphenes that have no chromium or vanadium show similar red reactions.

Vanadium does not produce a red reaction to a Chelsea filter, and this fact can be helpful for separating gems colored by chromium from those colored by vanadium. However, it's important to know that in some cases gemstones such as 'chrome' tourmaline that are colored primarily by vanadium can still appear pink or red under the filter if any consequential amount of chromium is also present. Vanadium does not suppress red Chelsea filter reactions caused by chromium.

Strong red Chelsea filter reactions by green gemstones typically indicate relatively high levels of chromium. Conversely, extremely low concentrations of chromium may be insufficient to cause a red reaction under a Chelsea filter. Among gems that I've tested, light green hiddenite gems from Brazil colored by chromium along with vanadium show no red Chelsea filter reaction, undoubtedly because so little chromium is present.

As luck would have it, iron (Fe^{2+}) does suppress red Chelsea filter reactions. The level of suppression is dependent on the ratio of iron to chromium, as well as the total amount of iron and chromium in a gem.

If a gem shows just a faint pink reaction or remains green under the Chelsea filter, this doesn't necessarily mean that chromium levels are low or absent. Instead, iron could be suppressing the red reaction. For instance, iron is usually present in natural emeralds, and consequently many natural emeralds colored by chromium remain green under a Chelsea filter instead of appearing pink or red.

As another example, fine translucent jadeite or 'imperial' jade is colored green by a combination of iron and chromium. But due to suppression by iron, jadeite shows no red Chelsea filter reaction from chromium. The same is true of chrome diopside and chrome enstatite gems, which also derive color from chromium and iron.

Jadeite (Iron & Chromium)

A Chelsea filter can still be useful for testing jadeite. If a red Chelsea filter reaction is apparent in jadeite, this is a sure indication that the stone has been treated with a green dye or polymer that contains chromium. Unfortunately, not all treated jadeite can be detected with a Chelsea filter, as jadeite is often treated with vegetable dyes or polymers that aren't chromium-based.

Other translucent or opaque green cabochon gems that may look like jadeite include hydrogrossular garnet, variscite, dyed chalcedony and dyed hydrophane opal. These green gemstones often contain chromium and can often be distinguished from untreated jadeite by a red reaction to a Chelsea filter.

An interesting example of iron that fails to suppress red Chelsea filter reactions is trivalent iron (Fe^{3+}) in tsavorite grossular garnets and demantoid andradite garnets. Chromium is readily detected in these green garnets with a Chelsea filter even when the iron content is extremely high, as we find in demantoid garnets.

Demantoid Garnet (Iron & Chromium)

'Chrome' tourmalines belong to the dravite species. Although they are mostly colored by vanadium, 'chrome' tourmaline gems always contain some amount of chromium and show a pink or red chromium reaction under a Chelsea filter. This reaction can be used to separate 'chrome' tourmalines from the more common 'verdelite' tourmalines of the elbaite species, which are colored green by iron. Verdelite remains green under a Chelsea filter.

The color of 'chrome' tourmalines is typically dark green, but on occasion these gems can have moderate to light green color. The lighter color of these tourmalines is due to lower concentrations of vanadium and chromium. These unusual gems show only a weak pink reaction under a Chelsea filter as a result of the low level of chromium.

Yellow-Green Chrome Tourmaline

UV Flashlight

Chromium is a strong activator of fluorescence in gems, and a high-quality longwave 365nm UV flashlight or longwave UV lamp is an important tool for detecting the presence of chromium. Chromium fluorescence in transparent and translucent gemstones is stronger under longwave UV light than under shortwave UV light.

Whenever a green gemstone fluoresces red or pink under longwave UV light, chromium is indicated, and very strong red fluorescence is often an indication of a high concentration of chromium. The one key exception is synthetic bluish green spinel, which fluoresces red due to cobalt rather than chromium.

Vanadium is not known to be a fluorescence activator, and it never causes red fluorescence. Yellow fluorescence in light green 'chrome' kornerupine gems and light green vanadium diopside gems colored by vanadium is probably due to manganese rather than vanadium.

Unique among gemstones is man-made iron-free glass colored green only by chromium (Cr^{3+}). Even when a significant amount of chromium is present (1.0 %), chromium glass is inert to longwave UV light. Apparently chemical interactions within glass inhibit red chromium fluorescence, and any red reaction under a Chelsea filter is also suppressed.

In natural gems, the presence of chromium is not always revealed through red fluorescence. A green gem that shows no UV fluorescence can still have chromium as the primary cause of green color. For instance, most emeralds, natural or synthetic, don't fluoresce under longwave UV light. There are two important reasons for this.

- iron can reduce or completely quench the red fluorescence of chromium, as it does with red Chelsea filter reactions.

- vanadium is also a powerful quencher of fluorescence, and it can quench the red fluorescence of chromium at least as effectively as iron. This important fact is not generally recognized in gemology.

Some emeralds do fluoresce pink or red from chromium, but only when they contain very little iron and very little vanadium. Such emeralds also show pink & green dichroism under a dichroscope due to chromium.

Most natural emeralds don't fluoresce because they are colored by a mixture of chromium, vanadium and iron. Synthetic emeralds that are free of iron don't fluoresce due to the presence of vanadium, which inhibits chromium fluorescence.

When chromium is revealed in any type of gem by a red reaction to a Chelsea filter, but no concomitant UV fluorescence is apparent, we can safely assume that the chromium fluorescence is being quenched by vanadium. Most 'chrome' tourmalines that I've tested are red under a Chelsea filter, but they show no chromium fluorescence under longwave UV light due to quenching by vanadium.

This quenching effect may indicate that vanadium is present in higher concentrations than chromium, as in most 'chrome' tourmalines. But I've found that in some emeralds, quenching of chromium fluorescence by vanadium can occur even when chromium is the dominant cause of color.

Green garnets colored by vanadium and chromium are quite interesting in their reaction to UV light. Dark green grossular garnets such as tsavorite gems and 'chrome' Mali garnets show little or no chromium fluorescence due to quenching by vanadium, the dominant chromophore. But lighter green grossular garnets such as 'Merelani' garnets typically do show pink fluorescence from chromium. This increased fluorescence suggests that the lower concentration of vanadium in the lighter grossulars is insufficient to quench the fluorescence.


Dark Green 'Chrome' Mali Garnet & Light Green Merelani Garnet

Another interesting point is that these light green garnets show pink and red UV fluorescence in the presence of iron. Fluorescence is possible in grossular garnets due to the relatively low concentration of iron. Also, the type of iron found in grossular and andradite garnets is mostly trivalent (Fe^{3+}), which is much less efficient at quenching fluorescence than divalent iron (Fe^{2+}). The much higher concentration of iron found in green demantoid garnets (andradite species) does quench chromium fluorescence completely.

In any type of green gem, when the concentration of chromium is extremely low, the chromium may be insufficient to induce pink or red fluorescence under UV light. This is the case with some greenish yellow chrysoberyl gems that contain only trace amounts of chromium (less than 0.1% chromium oxide). A greater amount of chromium (still under 1.0%) as we find in green chrysoberyl and alexandrite chrysoberyl results in strong red fluorescence.

At the other extreme, a very high concentration of chromium can quench all UV fluorescence, as is evident in uvarovite garnet, an idiochromatic gem that can contain over 25% chromium oxide. This phenomenon is referred to as concentration quenching. Among green gems that are allochromatic, the level of chromium oxide rarely reaches 2%, a concentration that's probably too low to have any quenching effect on fluorescence.

Magnetic Wand

The only natural green gemstone that shows a strong attraction to a magnetic wand due to chromium is uvarovite garnet. Among man-made green gems, some synthetic emeralds are strongly magnetic due to high concentrations of chromium and vanadium.

Strong attraction to a magnetic wand by a natural green gem usually indicates the presence of iron rather than chromium or vanadium. In some cases, a strong magnetic response can alert us that sufficient iron is present to quench any fluorescence or red Chelsea filter reaction from chromium. As examples, chrome diopside and chrome enstatite gems colored green by chromium don't appear red under a UV light or a Chelsea filter due to the inhibiting effect of magnetic iron.

Like the Chelsea filter, a magnetic wand is a handy tool for separating 'chrome' tourmalines from other green tourmalines. 'Chrome' tourmalines (dravite species) are diamagnetic, or occasionally very weakly magnetic, because they contain almost no iron. In contrast, green tourmalines of the elbaite species contain enough iron to cause significant magnetic attraction to an N52 neodymium magnet. Dark green 'verdelite' tourmalines typically show a drag response.

'Chrome' Tourmaline & Verdelite Tourmaline

Blue Laser

An inexpensive blue laser pointer is an indispensable tool for revealing the presence of chromium. Like a longwave UV light, a blue laser causes pink or red chromium fluorescence. A blue laser employs a concentrated beam of violet light that's barely within the visible range (405nm) and just above the UV range.

This tool is so sensitive that it can reveal trace amounts of chromium even when the concentration is too low to be detected with a high-quality UV flashlight or lamp. In addition, fluorescence under a 405nm laser can reveal the presence of chromium even when iron or vanadium completely quenches fluorescence under UV light.

A blue laser is also more sensitive than a Chelsea filter, revealing chromium in a gem when the concentration is too low to cause a red Chelsea filter reaction. As an example, light green spodumene (hiddenite) gems from Brazil are colored by small amounts of chromium. These hiddenite gems don't show a red Chelsea filter reaction or UV fluorescence from chromium, but chromium can be detected by red fluorescence under a blue laser.

It's important to remember that when we don't see any UV fluorescence in a green gem, nor any fluorescence from a blue laser, nor any red reaction to a Chelsea filter by that gem, chromium can still be present within the gem. Chromium might even be the primary cause of color. The chromium may simply be hidden from detection by a substantial amount of iron.

Strategic use of basic tools such as a blue laser, UV flashlight, Chelsea filter, magnetic wand, dichroscope and spectroscope can help us confirm or eliminate chromium and vanadium as possible causes of green color in a gem, or point toward another possible chromophore such as iron (ex. peridot) or nickel (ex. chrysoprase). But at times we must rely on a UV-Vis-NIR spectrometer to verify the presence of chromium or vanadium, or to distinguish between these two chromophores.

Spectrometer

A spectrometer that spans the ultraviolet, visible and near-infrared range of light is a much more sensitive instrument than a hand-held spectroscope. Absorption spectra as seen with a spectrometer are made up of peaks and valleys, with the peaks corresponding to black lines and bands seen with a spectroscope.

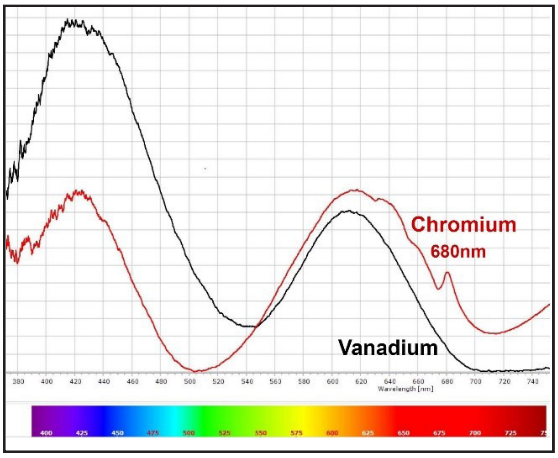
The absorption spectra produced by vanadium are very similar to the spectra of chromium, another confirmation that green colors produced by each chromophore are very similar to each other. A broad absorption peak in the blue region and another in the red region of the visible spectrum indicate that most of the blue and red light is absorbed, leaving a broad valley in the middle of the spectrum where only green light is transmitted, causing green gem color.

In the spectra for both chromium and vanadium, light transmission through the green region near the center of the spectrum can also extend a bit toward the left or right of center. For example, if some light is also transmitted from the blue region to the left, the result is blue-green gem color.

In other gems, some light might be transmitted from the yellow region to the right, and yellow-green body color is the result. These variations in color are seen in the spectra for both chromium and vanadium.

The most characteristic difference between a chromium spectrum and a vanadium spectrum in a green gem is a sharp absorption peak produced by chromium near the 680nm wavelength at the upper limit of the red region of the visible spectrum. The position of this chromium peak can vary from approximately 670nm to 690nm depending on the type of green gem.

The sharp 680nm peak and other less conspicuous peaks near 650nm, 630nm and 600nm are typical of chromium and are never produced by vanadium. The absorption pattern produced by vanadium in the red region of the spectrum is smooth with no sharp peaks.



Spectrometer Absorption Spectra
for Chromium & Vanadium

The 680nm peak produced by chromium is actually a combination of two very closely aligned peaks known as R lines. When the concentration of chromium within a green gem is high, these R lines are also visible with a handheld spectroscope as a chromium doublet of two black lines.

Whenever we see red UV fluorescence from chromium in a green gem, that fluorescence is the result of red light being transmitted precisely at the R lines (and on into the infrared spectrum). Vanadium lacks R lines in its absorption spectrum and fails to cause UV fluorescence.

We can approximate the amount of vanadium in a gem relative to the amount of chromium by looking at the gem's absorption spectrum rendered by a UV-Vis-NIR spectrometer. There are 3 basic variations of the absorption spectrum that give us clues about the proportions of chromium to vanadium.

- When a green gem is colored primarily by chromium, the absorption peak at 680nm is in most cases clearly visible, even when a lesser amount of vanadium is also present.

- When a green gem is colored green primarily by vanadium, it has a smooth spectrum with no chromium peak at 680nm, even though some amount of chromium may also be present.

- When chromium and vanadium are roughly equal in concentration, contributing equally to green color, just a slight curvature or bump at 680nm may be apparent.

Even with the aid of a spectrometer and all our other instruments, determining whether chromium or vanadium is the primary cause of gem color can at times be difficult, and accurate measurements of the relative percentages of chromium and vanadium are generally not possible. More quantitative measurements of these two chromophores require much more sophisticated and costly methods that can analyze the chemical composition of a gem. Such methods include energy dispersive x-ray fluorescence (ED-XRF), laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) and electron probe microanalysis (EPMA).

Emerald and Green Beryl

The world's most valuable green gemstone is emerald, which is a variety of beryl colored by chromium, vanadium and iron. The word 'emerald' is an ancient trade name rather than a scientific one, and so disagreements arise about exactly what constitutes an emerald and what differentiates an emerald from other green gems of the beryl species. Color saturation is one criterion used to classify emerald. The color of emerald beryl actually varies from light green to dark green. Unfortunately, most gemologists ally themselves with tradition rather than science, classifying only moderate green to dark green gems as true emeralds.

Dark Green & Moderate Green Emerald

So, what do we call an emerald with light green color? Well, 'light green emerald' would be a good choice, but these gems are often referred to by gemologists as green beryl. This nomenclature creates confusion, as the name 'green beryl' generally refers to a variety of beryl colored green by iron. The distinctive olive green or yellow-green color of green beryl is the result of a combination of bivalent iron

(Fe^{2+}) and trivalent iron (Fe^{3+}) rather than chromium and vanadium. Green beryl gems also generally have better clarity than emeralds.

Light Green Emerald (Chromium) & Green Beryl (Iron)

Another point of confusion over what constitutes an emerald is whether it is colored by chromium instead of vanadium. An antiquated notion persists among some gemologists that a beryl colored mostly or entirely by vanadium must be classified as a green beryl rather than an emerald.

This is a bit of nonsense, as chromium and vanadium create similar green colors in beryl. Some synthetic hydrothermal emeralds with spectacular green color are doped entirely by vanadium, and based on appearance, no gemologist would classify these gems as green beryl.

In most natural emeralds, chromium and vanadium occur together in varying proportions, and iron is also usually present as a color modifier. Although chromium is usually the primary chromophore in natural emeralds, some natural emeralds are colored mostly by vanadium.

Colombian Emeralds Colored Primarily by Chromium (Left) and Vanadium (Right)

Of the synthetic emeralds that I've examined, those colored primarily by vanadium appear slightly lighter and slightly bluer in color than gems colored primarily by chromium.

Synthetic Emeralds Colored Primarily by Chromium (Left) and Vanadium (Right)

Among natural emeralds, the amount of iron within a gem is a more relevant factor to the quality of color than the amount of vanadium.

Divalent iron (Fe^{2+}) creates the blue color of aquamarine beryl, and small amounts of divalent iron in emerald can add a blue tint to the green color produced by chromium and vanadium.

The blue color component common in many natural emeralds, particularly in emeralds from Zambia, is due mostly to iron rather than to vanadium. In contrast, when enough iron is in the trivalent oxidation state (Fe^{3+}), the iron can add a yellowish hue to an emerald.

Blue-Green Emerald & Yellow-Green Emerald

The most valuable emeralds in the world are generally mined in Colombia, but fine emeralds are not exclusive to that country. They can also be found in Brazil, Zambia, Ethiopia and other regions of the world. Whatever the origin, the beauty and value of an emerald generally corresponds with the saturation or strength of green color.

Colombian emeralds show some of the most desirable green colors precisely because they are so low in iron compared to emeralds from other parts of the world. In many Colombian emeralds, color is entirely the result of chromium and vanadium.

My own study of magnetism in beryl gems indicates that the low level of iron found in many emeralds from Colombia is insufficient to have any effect on body color. In the rare instance that an emerald is diamagnetic and additionally shows no red reaction to a Chelsea filter, we can be confident that vanadium is the sole cause of green color.

Fine Colombian emeralds that have dark green color due to high levels of chromium will fluoresce red in UV light when vanadium and iron levels are too low to quench fluorescence. Red fluorescence in daylight is also possible, much like the daylight fluorescence of some rubies. This daylight fluorescence is not readily apparent to the eye, but it may add vibrance to the appearance of an emerald.

'Vanadium emerald' is a term currently being applied to some light greenish blue beryl gems from Nigeria. This trade name is problematic, in part because these gems are too blue to be classified as emeralds, and also because vanadium is not the cause of the blue color.

The high proportion of blue color in these 'vanadium emeralds' is caused by iron. Other trade names assigned to these beryl gems include vanadium beryl, green beryl and Nigerian emerald.

When the color of a beryl gem is equal parts blue and green, as it is in the 'Nigerian emeralds' that I've examined, the gems look like unheated aquamarine. The light blue color component is due to traces of divalent iron (Fe^{2+}), while the light green color component is derived from trace amounts of both chromium and vanadium. These gems can be accurately regarded as an intermediary between aquamarine and emerald, and a more appropriate name for such a hybrid would be 'chromium-bearing aquamarine'.

Chromium-bearing Aquamarine

Besides chromium-bearing aquamarine, I was surprised to find that some green beryl gems are also colored partly by chromium and vanadium in addition to iron. This iteration of beryl can be called chromium-bearing green beryl. I have not seen these two intermediary color varieties described anywhere else.

A familiar and well-documented color gradation in beryl involves varying proportions of trivalent iron to bivalent iron, with a progression from yellow beryl to green beryl to aquamarine. Results of my own study of beryl gems reveal that a separate but related gradation or continuum of color exists between green beryl, emerald and aquamarine. That continuum involves the presence or absence of chromium and vanadium in relation to iron.

Green Beryl → Chromium-bearing Green Beryl → Emerald → Chromium-bearing Aquamarine → Aquamarine

This new continuum in beryl progresses as follows: green beryl colored only by iron → yellowish green chromium-bearing green beryl → emerald colored by chromium, vanadium and iron → greenish blue chromium-bearing aquamarine → aquamarine colored only by iron. Differences in color between these gradations can be subtle, and color alone may not reveal the presence of chromium/vanadium within intermediary gems.

A curious example of an imitation emerald that had me scratching my head for a bit is a heavily fractured gem colored green by chromium. At first glance, the gem looks much like a light green heavily included emerald. It also shows a chromium absorption spectrum like that of natural emerald.

But a refractive index of 1.76 -1.77 and a thermal inertia reading of 48 identify this gem as corundum. It's a clever imitation, but what's puzzling is that chromium can only create red or pink color in corundum, as we see in ruby and pink sapphire. So how can this corundum gem be green?

The likely explanation is that this gem is a quirky example of a natural glass-filled corundum. Green color was likely imparted when the multiple fractures within a low-quality piece of natural corundum were flushed with acid and then filled with glass colored green by chromium.

Natural Corundum Filled with Chromium Glass

Another example of green chromium-bearing corundum that might pass for emerald are some green synthetic corundum gems. In synthetic corundum, blue-green color can be achieved by combining chromium with another dopant, nickel. Again, chromium doesn't cause green color in corundum. In this case, light green color is created by trace amounts of nickel in 2 different oxidation states: blue color from bivalent nickel (Ni^{2+}) mixes with yellow color from trivalent nickel (Ni^{3+}) to create the green color.

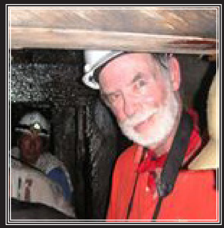
Synthetic Corundum Colored by Chromium & Nickel

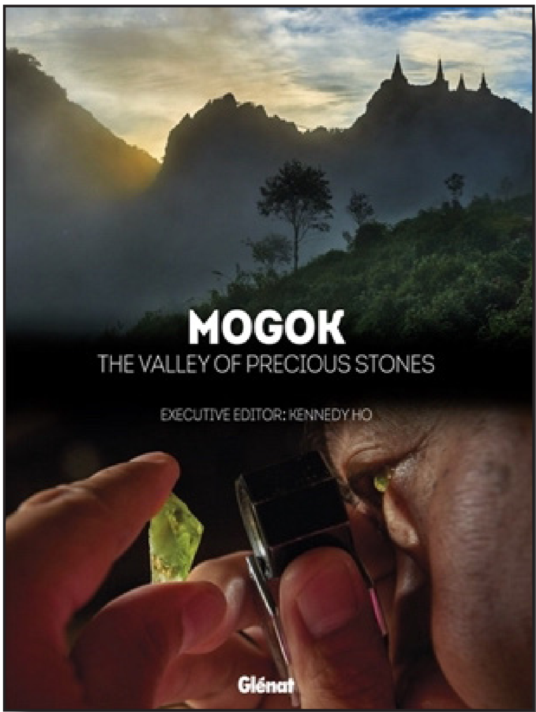
In such gems, a light pink color component derived from chromium modifies the saturation and tone of the green gem without adding pink body color. However, the two distinct color components, pink and green, are revealed with a dichroscope. The chromium in these unusual synthetic corundum gems is also detected as pink color under a Chelsea filter, as pink fluorescence under long wave UV light, and as a chromium absorption spectrum under a spectrometer.

All Photographs by Kirk Feral

Literary Speaking
Expand your Mind

In this issue Richard W. Wise looks at MOGOK The Valley of Precious Stones by Kennedy Ho (Executive Editor), Emmanuel Fritch (Scientific Editor) and Jean-Baptiste Rabouan (Main Photographer)





Several months back I received a copy of Mogok, The Valley of Precious Stones. Kennedy Ho is listed as Executive Editor, Emmanuel Fritch, Scientific Editor and Jean-Baptiste Rabouan the main photographer.

The present volume is a profusely illustrated folio with photographs on nearly every page. The name invites comparison with Ted Themelis' two volume set, Mogok, Valley of Rubies & Sapphires (2000) and Gems & Mines of Mogok (2008). Though the latter at 622 pages is far more comprehensive, the former benefits from a superior layout as well as technical advances in color reproduction which is evident everywhere in the present volume.

Mr. Rabouan exhibits the remarkable ability of capturing charming, unstaged images of the people of Mogok--dealers, miners, buyers--going about their everyday business. A Shan woman sorting ruby rough, a miner rappelling down a shaft in the Baw Mar Mine, a dramatic micro-image of a two-phase inclusion within a Mogok ruby—these are some of the scenes which will seem quite familiar to those who have been lucky enough to visit the valley.

Kennedy Ho, the current Chairman of The Asian Institute of Gemological Sciences (AIGS) recruited an all-star cast and underwrote five separate expeditions to Mogok in the preparation of the book. Contributors include: Emmanuel Fritch, Candice Caplan, Thomas Hainschwang, Frank Notari and photographer Jean-Baptist Rabouan.

Fritch, arguably the senior member of the group, begins his chapter, The Dragon With Ruby Eyes, with an overview of the complex geology of the valley. Fritch is not the first to do this, but his approach is unique. He begins with the macro, telling the story of the valley's formation through the lens of plate tectonics. He then switches to the micro and describes the marbles and the gem-bearing veins which run through the three distinct geological blocks making up the valley. Though overshadowed by ruby, he tells us, the valley produces a full spectrum of gemstones including topaz, peridot, aquamarine, spinel and sapphire, and yes, lapis lazuli.

In the chapter entitled The Mythical Valley of Mogok, Candice Caplan, an archaeogemmologist at the GGTL Laboratories, Geneva, gives the reader a succinct, interesting overview of the valley's history. She hits a few of the historical high points: Tavernier, U Hmat the 'Ruby King' then throws a couple of curves--a version of the Arabian Nights story of the Eagle I had not heard before, plus an intriguing mention of a ruby intaglio portrait of Alexander The Great, reportedly worn by Roman emperors from Augustus to Vespasian (56 BCE – 79 CE) and currently in a private collection. If true, this would imply a trade in Mogok gems in the West stretching back to Republican Rome. Unfortunately, there are no extant examples of ancient Mogok rubies in Western collections.

Caplan cites Larousse's Encyclopedia of Precious Gems as the authority. The reference can be traced back via Suetonius to Pliny who states that the stone was an emerald. (C. W. King, 1882, Vol 1, p.186). Unfortunately, this reference is almost certainly apocryphal. I consulted both ruby expert, Richard W. Hughes, and G. Max Bernheimer of Christies, one of the world's authorities on ancient seal stones. Neither of these experts had ever heard of it.

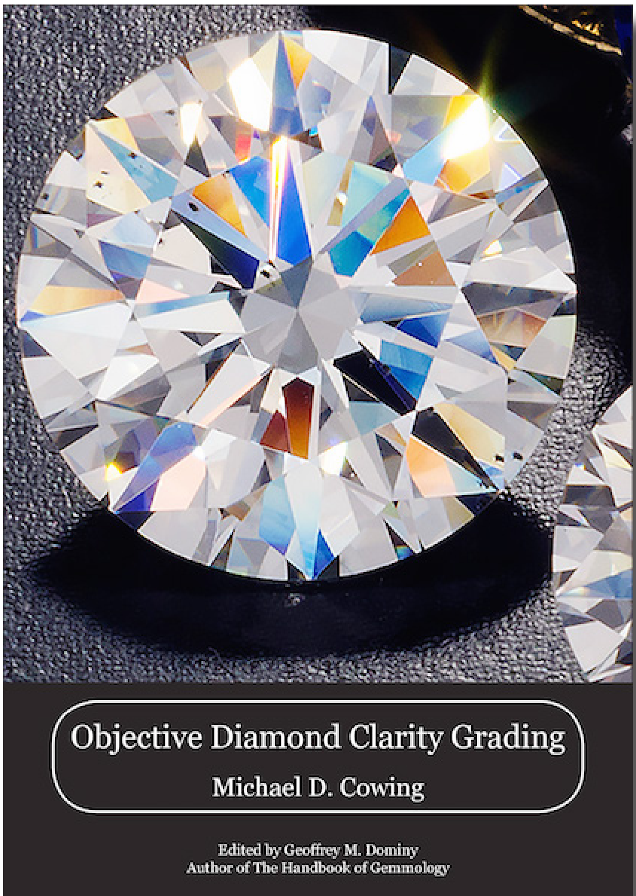
Thomas Hainswang's chapter, The Sapphires of Mogok, includes some excellent photomicrographs of typical interiors of unheated Burmese sapphires taken by the author. Oddly, Dr. Hainswang has little to say about the low iron sapphire mentioned by Fritch. I would have been interested in reading something about their visual appearance as compared to their high iron brethren produced at Baw Mar.

Hainswang goes on to describe fancy color sapphires, including a very rare color-change gem with an alexandrite like color change from red to green.

The book lacks an index and the anemic bibliography is a disappointment. For example, Meen and Tushingham, Bariand and Poirot, Tavernier, and other important works, all footnoted in the text, fail to make an appearance in the bibliography.

Apologies to the other contributors, I could go on, but to summarize, Mogok, The Valley of Precious Stones is both a stimulating read and a visual feast. Highly Recommended.

Mogok, The Valley of Precious Stones
Kennedy Ho, Executive Editor
Publisher: Genat, Grenoble, France
185 pages
ISBN: 978-2-344-02976-3
$190.00



Studying Gemmology with the World Gem Foundation

There's an expression 'different strokes for different folks' and this is certainly true in the case of gemmology. We are fortunate to work in an extremely diverse industry; one that provides unlimited opportunities in a broad range of disciplines.

Some people want to become a professional gemmologist; to forge a career for themselves working with gemstones. At the World Gem Foundation, gemmology is not just a job, it's a profession. This is why we opted for the 'Career Gemmologist' designation. We not only want to raise the level of consciousness with consumers but also within our industry. An awareness that gemmology is a science that demands a high level of theoretical knowledge and practical experience.

At the same token, we also understand that not everyone wants to become a fully fledged gemmologist. Many choose to specialise in a particular area, such as diamonds or coloured gemstones. To recognise this, we introduced two new 'Diploma' programs (Diamond Professional and Coloured Gemstone Professional) in 2018.

But what about gemmologists who may have completed their studies five, ten, fifteen or twenty years ago? Since gemmology is constantly evolving, it is important to continually upgrade your knowledge. You simply cannot afford to become complacent. One minute you may be 'up to speed', the next completely 'out of sync'. Each year brings new treatments and enhancements, new lab-created gemstones and new techniques to identify them. It is not the certificate that hangs on your wall that defines who you are as a gemmologist but the knowledge you possess. Our courses can be taken collectively or independent of each other, allowing our students to customise their own personal development programs based on their own specific needs.

Finally, there are many people who share a passion for gemstones but don't necessarily want to enrol in a gemmological program, they simply want to augment their existing knowledge and upgrade their level of understanding.

Regardless of your motivation to expand your knowledge, the World Gem Foundation has a variety of courses and programs that can help you reach your goal.

Career Gemmologist Program

For students wishing to pursue a career in gemmology, our 'Career Gemmologist' program has been especially designed to give you the knowledge and experience required to work as a professional gemmologist. The World Gem Foundation and our affiliated gem academies offer you two options to earn your Career Gemmologist Diploma with our Gemmology Seven/ Eleven programs.

Gemmology Seven

This option allows you to complete the entire theoretical requirements by enrolling in our Career Gemmology course (78 lessons) and completing the five practical workshops (Gem Identification #1, Gem Identification #2, Diamond Grading and Lab-created Diamonds, Coloured Gemstone Grading #1 and Lab-created and Treated Gems) and our 100 hour online Coloured Gemstone Grading course.

The theoretical component covers the chemical nature of gemstones, their physical and optical properties, basic crystallography, the absorption of light, the spectroscope, refraction and reflection, the refractometer, optical character and sign, dispersion, reflectivity meters, polarized light, the polariscope, pleochroism, the dichroscope, colour filters, specific gravity, luminescence, magnification and thermal conductivity.

From there we move into the most challenging and fluid areas of gemmology; imitation and composite gemstones, lab-created gemstones and the treatment and enhancement of gems.

In the lessons pertaining to lab-created gemstones you will not only learn about the various methods used to manufacture lab-created gemstones (including Verneuil Flame-Fusion, Czochralski Pulling Method, Flux Melt Method, the Hydrothermal Method, Skull Crucible, Zone Melt, Horizontally Oriented Crystallization, the Sublimation Method, and the Modified Stober Method) but also the unique identifying features that allow us to separate them from their natural counterparts.

The use of treatments and enhancements is both demanding and depending on who you talk to, highly controversial. Here we look at not only the techniques used to treat and enhance gemstones (heat treatment, surface and sub-surface diffusion, lead glass fracture filling, flux assisted partial fissure healing, glass fracture filling, cobalt doped glass filled sapphires, clarity enhanced diamonds, HPHT, quench-crackling, surface modifications, coatings and foil backs, laser drilling and irradiation) but also how they can be detected. We also look at the advanced gem testing techniques that are often needed to identify many of these treatments.

The course then takes a slightly different direction, focusing on the identification of gemstones including the tests that are commonly used to identify them and an in-depth look at each of the ten gemstone groupings based on colour and transparency (colourless or white, red, pink, orange, yellow, blue, green, violet or purple, brown, black or grey). These lessons include the important varieties and species of gemstones that commonly occur within each colour grouping, how to distinguish gemstones that are commonly confused with each other (i.e. aquamarine and blue topaz, emerald and chrome green tourmaline, diamond and lab-created moissanite) or gemstones that have physical and optical properties that are similar (i.e amethyst quartz and purple scapolite) to each other. This section also includes gemstones that either exhibit optical phenomena (i.e. asterism or chatoyancy) or are unusual by nature.

The next section looks specifically at diamonds, their physical properties, geology, localities, principle mines, crystal system, chemical composition and classification. You will also find lessons dedicated to fancy coloured diamonds, the causes of colour, absorption spectra, inclusions, fluorescence, mining, gem identification, methods of synthesis (including HPHT, CVD, Detonation and Ultrasonic Cavitation), common treatments and enhancements and a comprehensive examination of the 4 C's (colour, clarity, cut and carat weight) and how they are measured and assessed. The lesson on 'Cut' compares some of the most important and recognized 'Cut' grading systems used today including those pioneered by the Gemological Institute of America (GIA), the American Gem Society (AGS), Hoge Raad voor Diamant (HRD), the International Gemological Institute (IGI), the European Gemological Laboratory (EGL) and the Accredited Gem Appraisers (AGA).

The final twenty-nine lessons (29) are devoted to coloured gemstones and covers their physical properties, geology, localities, crystal system, chemical composition and causes of colour, varieties, absorption spectra, pleochroism, inclusions, fluorescence, gem identification, synthesis, common treatments and enhancements, and care guidelines. Gemstones covered include corundum, beryl, chrysoberyl, spinel, zircon, topaz, tourmaline, peridot, quartz, garnet, tanzanite, lapis lazuli, turquoise, spodumene, feldspars, iolite, andalusite, diopside, apatite, and organic gems (pearls, coral, jet, ivory, and amber). You will also learn about the various colour grading systems currently used (GIA, Gemewizard, GemDialogue and the World of Color) including how to accurately describe colour based on hue, tone and saturation, the clarity classification of gemstones, how cut is assessed, opal, jadeite and pearl grading, and how to estimate the weight of 'mounted' stones.

The study of gemmology simply would not be complete without a comprehensive program of practical instruction. This involves five practical workshops (Gem Identification #1 & #2, Diamond Grading and Lab-created Diamonds, Lab-created and Treated Gems and Coloured Gemstone Grading #1) totalling twenty-eight days of in-class instruction and a 100 hour online Coloured Gemstone Grading course where you will work with the Gemewizard Colour Grading system.

Gemmology Eleven

While the information is the same, the theoretical portion of this program is divided into five free-standing courses (Basic Gemmology, Advanced Gemmology, Gem Identification, Diamonds and Coloured Gemstones). This option allows you to take each course separately giving you greater flexibility in terms of time and how you can pay for the courses.

Like the 'Gemmology Seven' program, there are five practical workshops and one 100 hour online course.

Diamond Professional Program

Designed specifically for those engaged in the diamond trade, this program covers the same theoretical information covered in our 'Diamonds' course plus our eight-day Diamond Grading and Lab-created Workshop.

Coloured Gemstone Professional Program

If your area of expertise is coloured gemstones, this program is ideally suited for you. The CGP program involves the completion of four theoretical courses (Basic Gemmology, Advanced Gemmology, Gem Identification and Coloured Gemstones) plus our two five-day practical Gem Identification workshops, our five-day Coloured Gemstone Grading #1 workshop, our five-day Lab-created and Treated Gems workshop plus our 100 hour online Coloured Gemstone Grading #2 course.

Courses in Other Languages

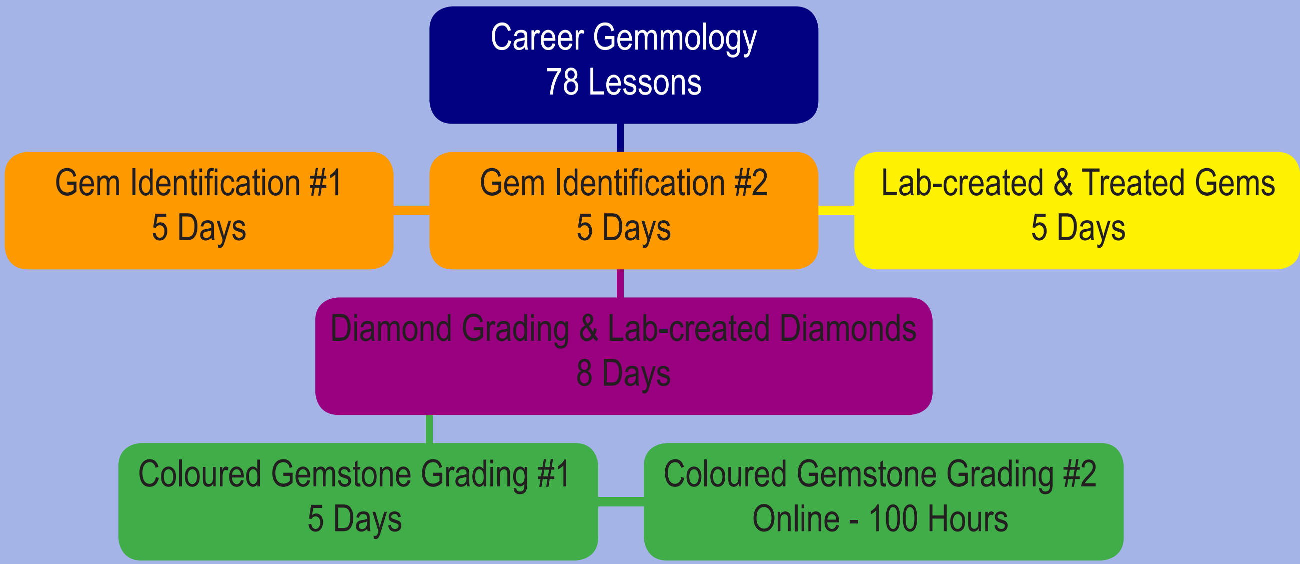
We are currently translating all of our 'Diploma' program courses into Spanish and Chinese to meet the needs of our Spanish and Chinese speaking students.

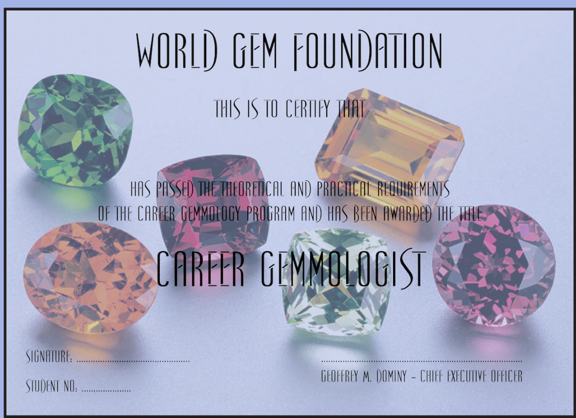
Currently our Gemología Básica (Basic Gemmology) and Gemología Avanzada are available in Spanish in digital, print and also online.

General Interest Courses

For those interested in gemstones but not wishing to take our 'Diploma' programs, all of our theory courses can be taken independently without prerequisites. In addition to the six theoretical courses (Career Gemmology, Basic Gemmology, Advanced Gemmology, Gem Identification, Diamonds and Coloured Gemstones) that make up our Career Gemmologist, Diamond Professional and Coloured Gemstone Professional 'Diploma' programs, we also offer three 'General Interest' courses (Rubies, Sapphires and Emeralds, Opals and Jade and Organic Gems).

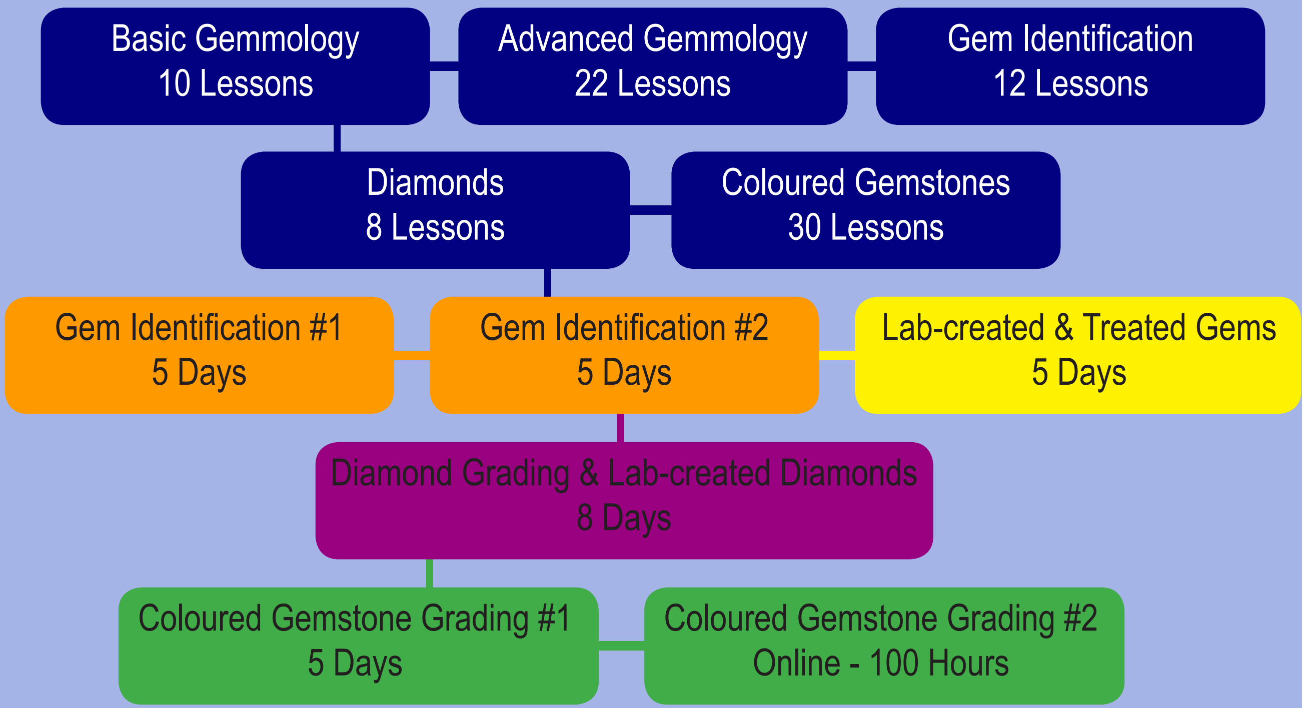
GEMMOLOGY SEVEN PROGRAM





Career Gemmology Seven	Digital Fees			Printed Fees		
Course Name	**Euros**	**Pounds Sterling**	**USD**	**Euros**	**Pounds Sterling**	**USD**
Career Gemmology (Theory)	1400	1100	1600	1570	1235	1795
Gem Identification #1	500	400	550	500	400	550
Gem Identification #2	500	400	550	500	400	550
Coloured Gemstone Grading #1	500	400	550	500	400	550
Coloured Gemstone Grading #2	1000	800	1150	1000	800	1150
Diamond Grading/Lab-created Diamonds	1750	1400	2000	1750	1400	2000
Lab-created & Treated Gems	500	400	550	500	400	550
Examinations Fees (Final Exam)	250	200	280	250	200	280
Total Cost	6400	5100	7230	6570	5235	7425

GEMMOLOGY ELEVEN PROGRAM

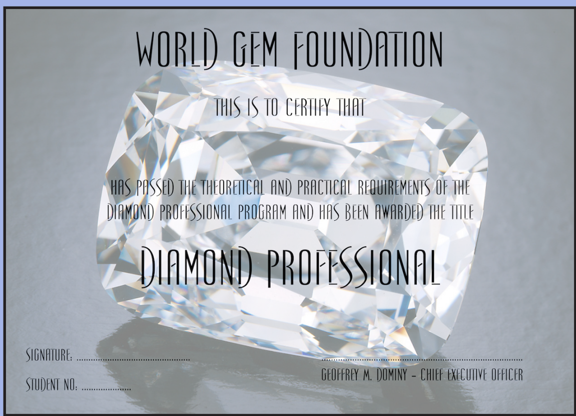


Career Gemmology Eleven	Digital Fees			Printed Fees		
Course Name	Euros	Pounds Sterling	USD	Euros	Pounds Sterling	USD
Basic Gemmology (Theory)	200	150	225	235	180	265
Advanced Gemmology (Theory)	400	300	450	430	325	485
Gem Identification (Theory)	225	175	250	255	200	285
Diamonds (Theory)	225	175	250	255	200	285
Coloured Gemstones (Theory)	500	400	550	565	450	625
Gem Identification #1	500	400	550	500	400	550
Gem Identification #2	500	400	550	500	400	550
Coloured Gemstone Grading #1	500	400	550	500	400	550
Coloured Gemstone Grading #2	1000	800	1150	1000	800	1150
Diamond Grading/Lab-created Diamonds	1750	1400	2000	1750	1400	2000
Lab-created & Treated Gems	500	400	550	500	400	550
Examinations Fees (Final Exam)	250	200	280	250	200	280
Total Cost	6550	5200	7355	6740	5355	7575

DIAMOND PROFESSIONAL

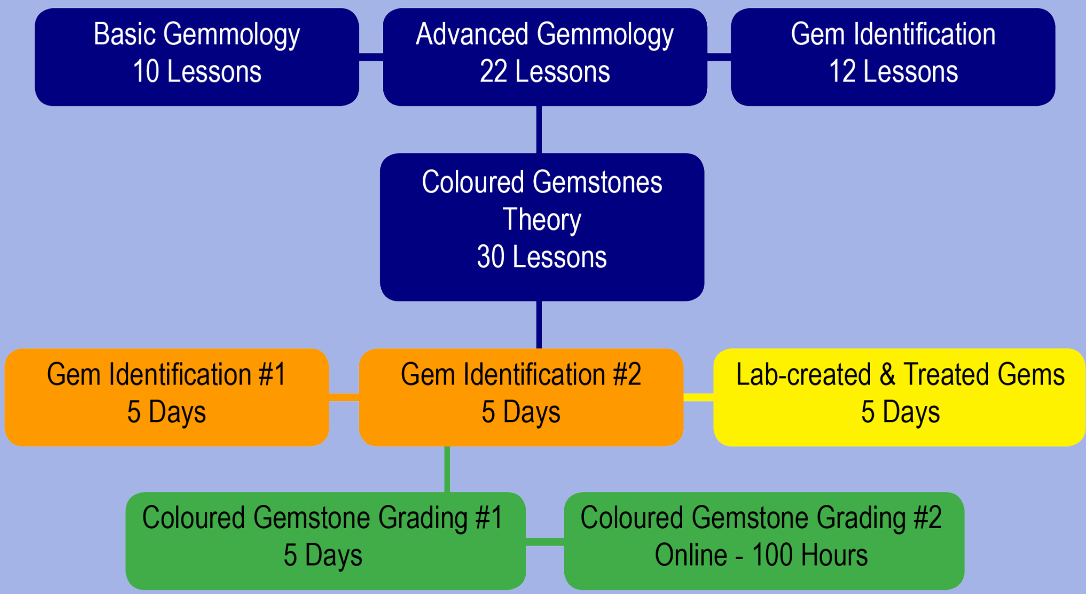
Diamonds
Theory
8 Lessons

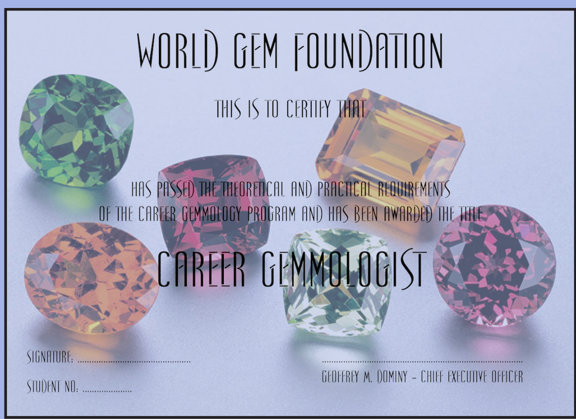
Diamond Grading & Lab-created Diamonds
Practical Workshop
8 Days



Diamond Professional	Digital Fees			Printed Fees		
Course Name	**Euros**	**Pounds Sterling**	**USD**	**Euros**	**Pounds Sterling**	**USD**
Diamonds (Theory)	225	175	250	255	200	285
Diamond Grading/Lab-created Diamonds	1750	1400	2000	1750	1400	2000
Examinations Fees (Final Exam)	250	200	280	250	200	280
Total Cost	2225	1775	2530	2255	1800	2565

COLOURED GEMSTONE PROFESSIONAL





Coloured Gemstone Professional	Digital Fees			Printed Fees		
Course Name	**Euros**	**Pounds Sterling**	**USD**	**Euros**	**Pounds Sterling**	**USD**
Basic Gemmology (Theory)	200	150	225	235	180	265
Advanced Gemmology (Theory)	400	300	450	430	325	485
Gem Identification (Theory)	225	175	250	255	200	285
Coloured Gemstones (Theory)	500	400	550	565	450	625
Gem Identification #1	500	400	550	500	400	550
Gem Identification #2	500	400	550	500	400	550
Coloured Gemstone Grading #1	500	400	550	500	400	550
Coloured Gemstone Grading #2	1000	800	1150	1000	800	1150
Lab-created & Treated Gems	500	400	550	500	400	550
Examinations Fees (Final Exam)	250	200	280	250	200	280
Total Cost	4575	3625	5105	4735	3755	5290

Rubies, Sapphires & Emeralds

This course focuses on three coloured gemstones (rubies, sapphires and emeralds) that individually and collectively are considered the cornerstones of the coloured gemstone trade. Lessons include a complete overview of their physical and optical properties, principal sources, mining, how they can be identified from gemstones that can be deceptively similar in appearance and their lab-created counterparts, common treatments and enhancements, pricing guidelines, what constitutes the best quality and how to properly care for them.

Opals and Jade

This course looks at two of the most fascinating and complex gemstones in the science of gemmology. The lessons on opal cover their physical and optical properties, their geology, localities, crystal system, chemical composition and classification, varieties, cause of colour, absorption spectra and pleochroism, inclusions, fluorescence, principal mines, opal mining in Australia, opal grading, synthesis of opal, gem identification, common treatments and enhancements, opal doublets and triplets, cleaning and care and pricing.

The section on jade follows a similar format with lessons covering their physical and optical properties, their geology, localities, crystal system, chemical composition, absorption spectra and pleochroism, inclusions, fluorescence, mining, principal mines, evaluating the rough, jadeite cutting, jadeite nomenclature, grading jadeite, synthesis of jadeite, gem identification, common treatments and enhancements, cleaning and care and pricing.

Organic Gems

This course explores a very select group of gemstones (coral, jet, amber, ivory and pearls), formed through organic processes rather than through geological forces deep within the earth's surface. Lessons cover their physical and optical properties, geological formation, crystal systems, chemical composition, varieties and classification, causes of colour, common inclusions and internal characteristics, fluorescence, pearl grading criteria, methods of synthesis, gem identification, common treatments and enhancements, and cleaning and care instructions.

Online Tutoring

While clearly the ideal way to learn a particular subject is with one-on-one tutoring, we appreciate that this is difficult when you enrol in a long distance study program.

Fortunately, new distance learning technologies are changing. Now teachers can connect with their students virtually using a variety of virtual tutoring tools, such as Skype.

The chart below outlines the number of online tutoring hours that are included in your course price. If you require more online instructional tutoring, please contact your education coordinator to discuss availability and pricing.

Course Name	Hours
Basic Gemmology - Theory	2
Advanced Gemmology - Theory	4
Gem Identification - Theory	2
Diamonds - Theory	2
Coloured Gemstones - Theory	5
Career Gemmology - Theory	14

We strongly suggest that you contact your instructor beforehand by email with your questions so that you will derive maximum benefit from your online session. Please remember that these sessions are designed to provide you with 'coaching' rather than direct instruction.

Course Fees

Fees charged by the individual gem academies are charged in the prevailing currency for that particular area (i.e. Euros in Europe, Pounds Sterling in Britain). Please note that shipping charges apply to any courses provided in print.

Practical Workshops

Dates: Sept 25th to 28th, 2019
Venue: Naarden, Holland
Please Note: To accommodate overseas students and meet the 30 hour requirement, this workshop will be held over four days (7 1/2 hours per day).

Course Cost € 500

Reserve Your Place Now

Gem Identification #1

This five day (30 hour) practical workshop focuses on the study and identification of six colour groupings (colourless/white, red, pink, orange, yellow and green) and basic crystallography. Gemstones covered in this workshop include:

Natural Diamond, Natural Ruby, Natural Sapphire, Emerald, Beryl, Garnets (Spessartite, Almandite Rhodolite, Pyrope, Colour Change, Hessonite, Demantoid, Tsavorite and Grossular), Spinel, Tourmaline, Topaz, Beryl, Quartz, Zircon, Alexandrite, Chrysoberyl, Apatite, Kunzite, Sunstone, Sphalerite, Sphene, Phenakite, Brazilianite, Scapolite, Hiddenite, Danburite, Benitoite, Diaspore, Epidote, Kyanite, Idocrase, Sinhalite, Diopside, Kornerupine, Enstatite, Euclase, Andalusite, Ekanite, Idocrase, Moldavite, Obsidian, Chrome Chalcedony, Amazonite, Jadeite, Nephrite, Chalcedony, Dyed Jasper, Chrysoprase, Maw-Sit Sit, Rhodonite, Rhodochrosite, Amber, Coral, Fire Opal, Lab-created Moissanite, Cubic Zirconia, GGG, YAG, Lab-created Rutile, Strontium Titanate, Lithium Niobate, Lab-created Spinel, Glass, Lab-created Alexandrite, Garnet-topped Doublet, Spinel Triplet, Copal Resin, Bakelite and Imitation Coral.

Prerequisites: Basic Gemmology or Equivalent

Dates: Sept 30th to Oct 3rd, 2019
Venue: Naarden, Holland
Please Note: To accommodate overseas students and meet the 30 hour requirement, this workshop will be held over four days (7 1/2 hours per day).

Course Cost € 500

Reserve Your Place Now

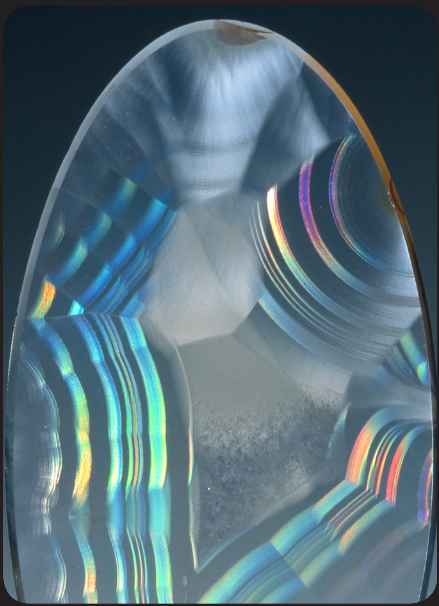
Gem Identification #2

This five day (30 hour) practical workshop focuses on the study and identification of four colour groupings (blue, violet/purple, brown and black) plus unusual and phenomenal gemstones. Gemstones covered in this workshop include:

Sapphire, Benitoite, Spinel, Tanzanite, Apatite, Tourmaline, Topaz, Aquamarine, Quartz, Iolite, Zircon, Scapolite, Garnet (Grape, Rhodolite and Hessonite), Chrysoberyl, Taafeite, Idocrase, Ekanite, Sinhalite, Kornerupine, Andalusite, Kyanite, Euclase, Smithsonite, Sugilite, Charoite, Lapis Lazuli, Sodalite, Turquoise, Odontolite, Serpentine, Chrysocolla, Petrified Wood, Hematite, Marcasite, Pyrite, Jadeite, Jet, Chalcedony, Jasper, Coral, Obsidian, Cubic Zirconia, Bakelite, Dyed Jasper, Lab-created Forsterite, Lab-created Spinel, Lab-created Quartz, Glass, Gilson Lapis Lazuli, Gilson Turquoise, Stained Howlite, Star Sapphire, Star Ruby, Star Almandite Garnet, Star Diopside, Cat's Eye Chrysoberyl, Cat's Eye Tourmaline, Cat's-Eye Quartz, Hawk's Eye Quartz, Tiger's-Eye Quartz, Bi-Colour Tanzanite, Bi-Colour Tourmaline, Ametrine Quartz, Watermelon Tourmaline, Usambara Tourmaline, Trapiche Emerald, Labradorite, Moonstone, Bloodstone, Tortoiseshell, Shell Cameo, Hardstone Cameo, Lava Cameo, Ammolite, Fire Agate, Black Opal, Crystal Opal, Semi-Crystal Opal, Larimar, Malachite, Lab-created Cat's Eye Chrysoberyl and Imitation Cameo.

Prerequisites: Gem Identification #1 or Equivalent

Practical Workshops



Dates & Venues: TBA

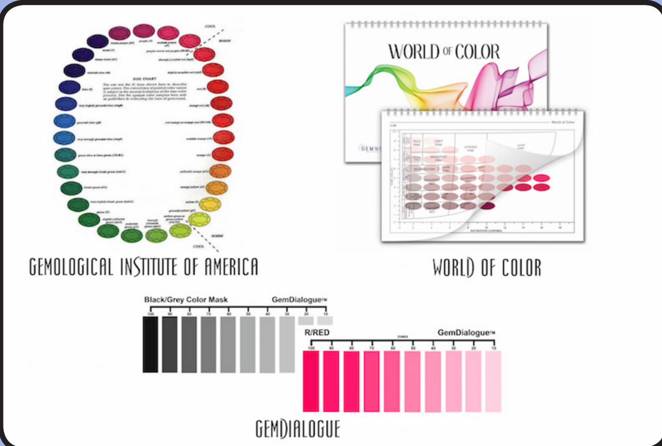
Course Cost € 500

Reserve Your Place Now

Coloured Gemstone Grading #1

This five-day (30 hours) workshop includes practical instruction on how to access the hue, tone and saturation of coloured gemstones using three popular colour grading systems (Gemological Institute of America, GemDialogue and World of Color) and how to grade pearls, jadeite and opals.

Prerequisites: None



Online Course

Course Cost € 1000

Reserve Your Place Now

Coloured Gemstone Grading #2

This 100 hour online course consists of a comprehensive overview of the GemeWizard Colour Grading System including colour theory (hue, tone and saturation), how they impact on the value of gemstones, practical exercises that are completed online, and a six month subscription to the Gemewizard program.

Prerequisites: None

Practical Workshops

Dates & Venues: TBA

Course Cost € 500

Reserve Your Place Now

Lab-created & Treated Gems

This five day (30 hour) practical workshop focuses on lab-created gemstones (specifically rubies, sapphires and emeralds) and the many treatments and enhancements that are used to improve the appearance and/or value of gemstones, including:

- Heat treatment
- Surface and Sub-surface Diffusion
- Irradiation
- Fracture Filling
- HPHT Treatment
- Oiling
- Waxes & Dyes
- Sugar/Acid & Smoke Inhalation
- Quench-crackling with Dyes
- Coating & Foil Backs
- Laser Drilling

Prerequisites: Advanced Gemmology or Equivalent

Dates: November 11th to 18th, 2019
Venue: Madrid, Spain

Course Cost € 1750

Reserve Your Place Now

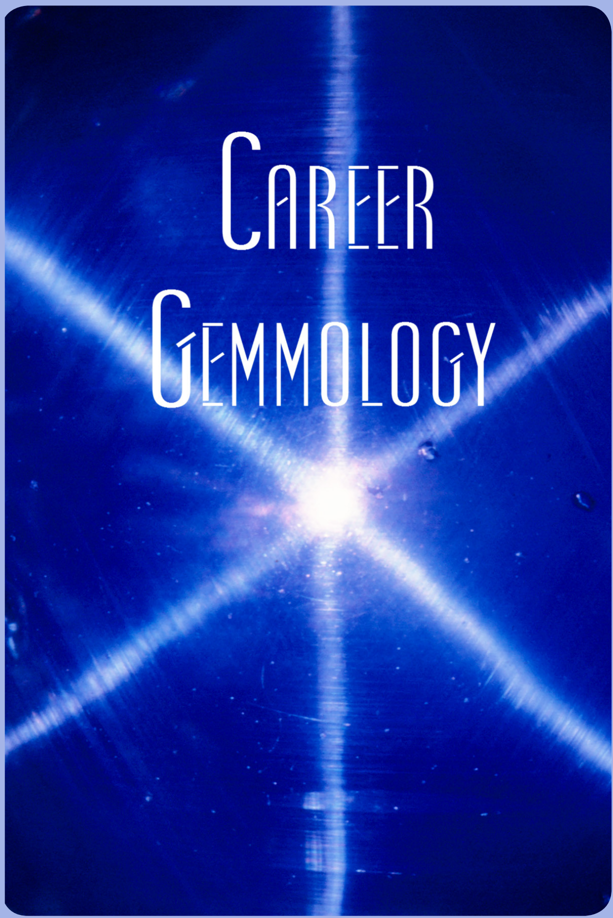
Diamond Grading & Lab-created Diamonds

This eight day (48 hour) practical workshop focuses on the clarity and colour grading of diamonds, how to measure the proportions and how to distinguish natural from HPHT and CVD diamonds.

Topics covered include:

- Clarity Grading
- Colour Grading
- Calculating Table Percentage
- Calculating Crown Angle
- Calculating Pavilion Percentage
- Estimating Girdle Thickness
- Assessing Symmetry & Polish
- Lab-Created Diamonds
- Practical Review

Prerequisites: Diamonds or Equivalent



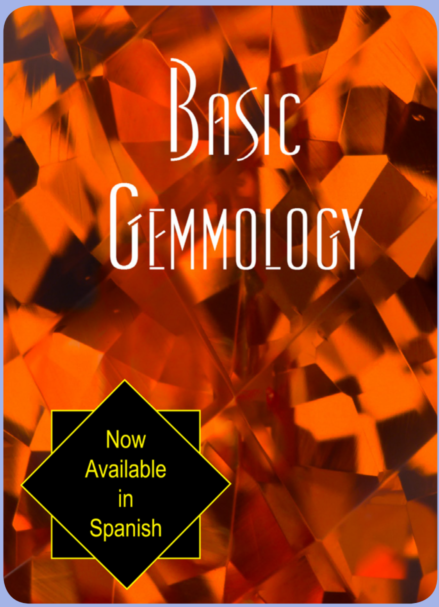
Course Content

The chemical nature of gemstones, their physical and optical properties, basic crystallography, the absorption of light, the spectroscope, refraction, reflection and the refractometer, polarized light, the polariscope, pleochroism, the dichroscope, colour filters, specific gravity, luminescence, magnification, thermal conductivity, imitation, assembled and lab-created gemstones, the methods used to manufacture lab-created gemstones including Verneuil, Czochralski, flux melt, hydrothermal, skull crucible, zone melt, horizontally oriented crystallization, high pressure, high temperature (HPHT), chemical vapour deposition (CVD), detonation, ultrasonic cavitation, sublimation method, and modified Stober method, their unique identifying features, treatments and enhancements including heat treatment, surface and sub-surface diffusion, lead glass fracture filling, flux assisted partial fissure healing, glass fracture filling, cobalt doped glass filled sapphires, clarity enhanced diamonds, high pressure, high temperature (HPHT), quench-crackling, surface modifications, coatings and foil backs, laser drilling, and irradiation, gem mining and cutting, diamond and coloured gemstone grading, gem identification by colour and transparency, advanced gem testing techniques and a comprehensive overview of the twenty-seven most common groups, species and varieties including diamonds, corundum (rubies and sapphires), beryl (emeralds, aquamarines and other precious beryls), chrysoberyl (alexandrite and other chrysoberyl), spinel, zircon, topaz, tourmaline, peridot, quartz, garnet, tanzanite, lapis lazuli, turquoise, opal, jadeite, kunzite and hiddenite, feldspars, iolite, andalusite, diopside, apatite, pearls, coral, jet, ivory and amber.

Course Cost: € 1400

Prerequisites: None

Please Note: This course includes all the information contained in the Basic Gemmology, Advanced Gemmology, Gem Identification, Diamonds and Coloured Gemstones courses.



Course Content

The chemical nature of gemstones, physical and optical properties, basic crystallography, the absorption of light, the spectroscope, refraction and reflection, the refractometer, optical character and sign, dispersion, reflectivity meters, polarized light, the polariscope, pleochroism, the dichroscope, colour filters, specific gravity, luminescence, magnification and thermal conductivity.

Course Cost: € 200

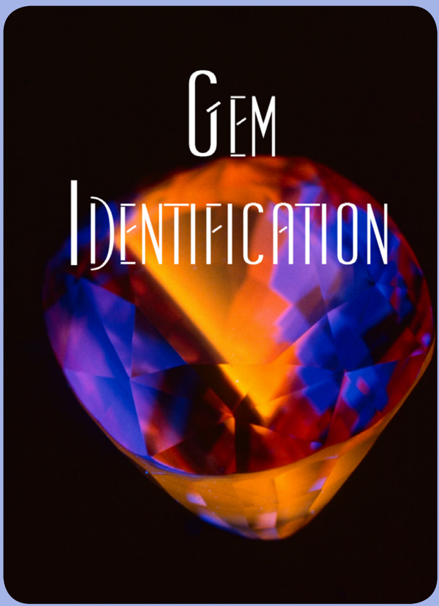
Prerequisites: None

Course Content

Imitation and composite gemstones, methods used to manufacture lab-created gemstones including Verneuil, Czochralski, Flux Melt, Hydrothermal, Skull Crucible, Zone Melt, Horizontally Oriented Crystallization, HPHT, CVD, Detonation, Ultrasonic Cavitation, Sublimation Method, and Modified Stober Method, their unique identifying features, treatments and enhancements including heat treatment, surface and sub-surface diffusion, lead glass fracture filling, flux assisted partial fissure healing, glass fracture filling, cobalt doped glass filled sapphires, clarity enhanced diamonds, HPHT, quench-crackling, surface modifications, coatings and foil backs, laser drilling, irradiation, and advanced gem testing techniques.

Course Cost: € 400

Prerequisites: Basic Gemmology or Equivalent

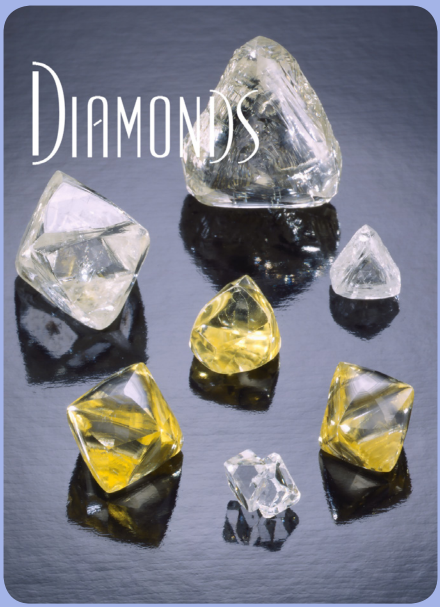


Course Content

Introduction to gem identification and the tests that are commonly used to identify gemstones. An in-depth look at each of the ten colour groupings (colourless or white, red, pink, orange, yellow, blue, green, violet or purple, brown, black or grey) plus phenomenal or unusual gemstones. Important varieties and species of gemstones that commonly occur within each colour grouping. How to distinguish gemstones that are commonly confused with each other (i.e. aquamarine and blue topaz, emerald and chrome tourmaline, diamond and lab-created moissanite) or have physical and optical properties that are similar (i.e amethyst quartz and purple scapolite). All lab-created, imitation, treated and enhanced gemstones that are found in each colour grouping.

Course Cost: € 225

Prerequisites: Basic & Advanced Gemmology or Equivalent

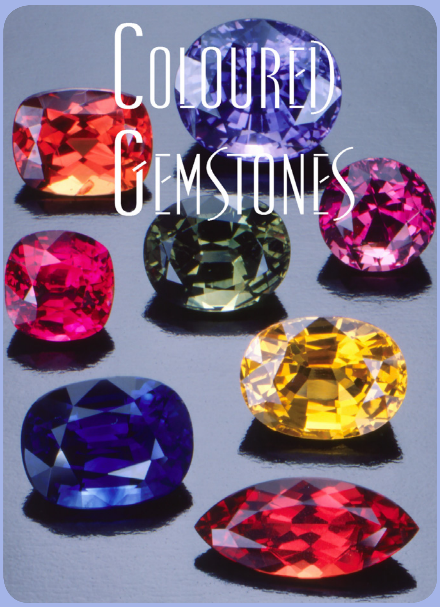


Course Content

Physical properties, geology, localities, principle mines, crystal system, chemical composition and classification, fancy colours, causes of colour, absorption spectra, pleochroism, inclusions, fluorescence, mining, gem identification, methods of synthesis, common treatments and enhancements. You will learn all about the 4 C's (colour, clarity, cut and carat weight) and how they are measured and assessed. We will also compare the various 'Cut' criteria for the Gemological Institute of America (GIA), the American Gem Society (AGS), Hoge Raad Diamant (HRD), International Gemological Institute (IGI), the European Gemological Laboratory (EGL), and Accredited Gem Appraisers (AGA) and explain how the estimated weight of a 'mounted' gemstone is calculated.

Course Cost: € 225

Prerequisites: None

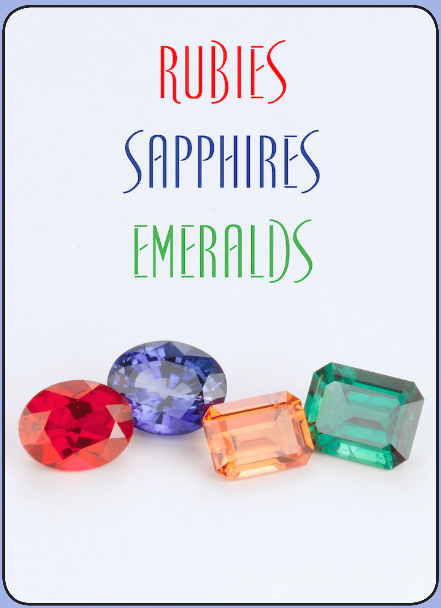


Course Content

Physical properties, geology, localities, crystal system, chemical composition and causes of colour, varieties, absorption spectra, pleochroism, inclusions, fluorescence, gem identification, synthesis, treatments and enhancements, and care guidelines. Gemstones covered in this course include rubies and sapphires, emeralds, aquamarines and other precious beryls, alexandrite and other chrysoberyls, spinel, zircon, topaz, tourmaline, peridot, quartz, garnet, tanzanite, lapis lazuli, turquoise, kunzite, hiddenite, feldspars, iolite, andalusite, diopside, apatite, pearls, coral, jet, ivory, and amber. You will learn how to accurately describe colour, the various colour grading systems currently used by professionals, the clarity classification of gemstones based on their geological environments, how cut is assessed, and how to grade opals, jadeite and pearls.

Course Cost: € 500

Prerequisites: None



Course Content

Topics covered include a complete overview of their physical and optical properties, principal sources, mining, how they can be identified from gemstones that can be deceptively similar in appearance and their lab-created counterparts, common treatments and enhancements, pricing guidelines, what constitutes the best quality and how to properly care for them.

Course Cost: € 95

Prerequisites: None

Course Content

Topics covered in the course include their physical and optical properties, geological formation, crystal systems, chemical composition, varieties and classification, cause of colour, absorption spectra, common inclusions, fluorescence, mining, grading criteria, methods of synthesis, gem identification, common treatments and enhancements, cleaning and care instructions, and pricing.

Course Cost: € 75

Prerequisites: None

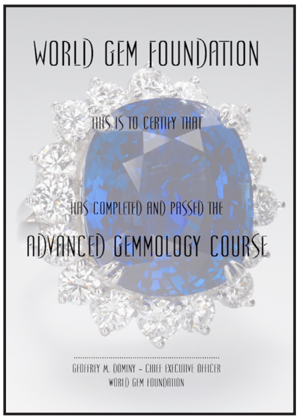
Course Content

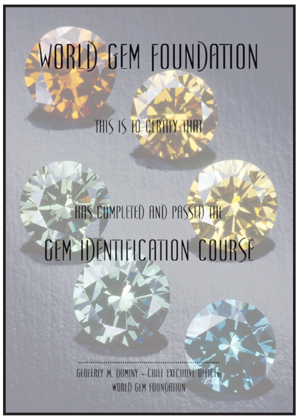
Topics covered include their physical and optical properties, geological formation, crystal systems, chemical composition, varieties and classification, cause of colour, common inclusions and internal characteristics, fluorescence, pearl grading criteria, methods of synthesis, gem identification, common treatments and enhancements, and cleaning and care instructions.

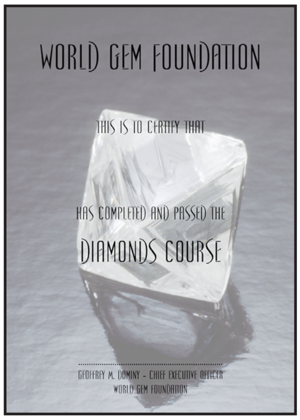
Course Cost: € 50

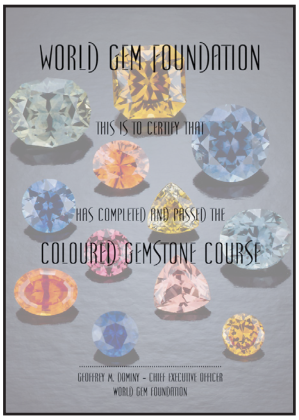
Prerequisites: None

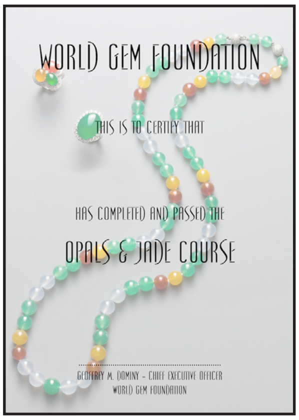
Theory Courses - Letters of Completion

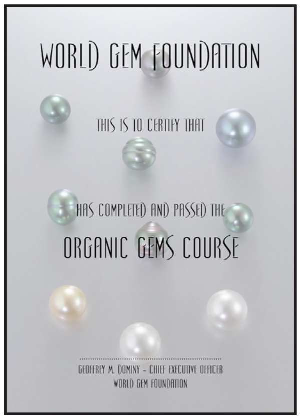




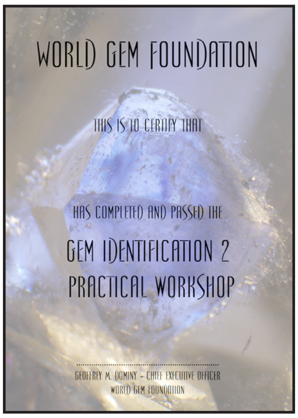


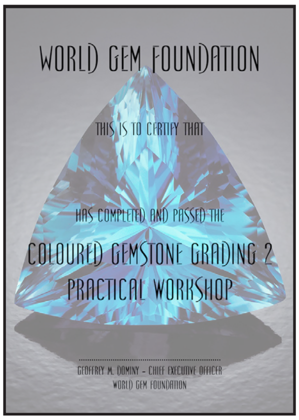


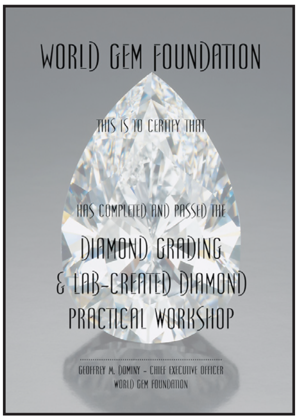


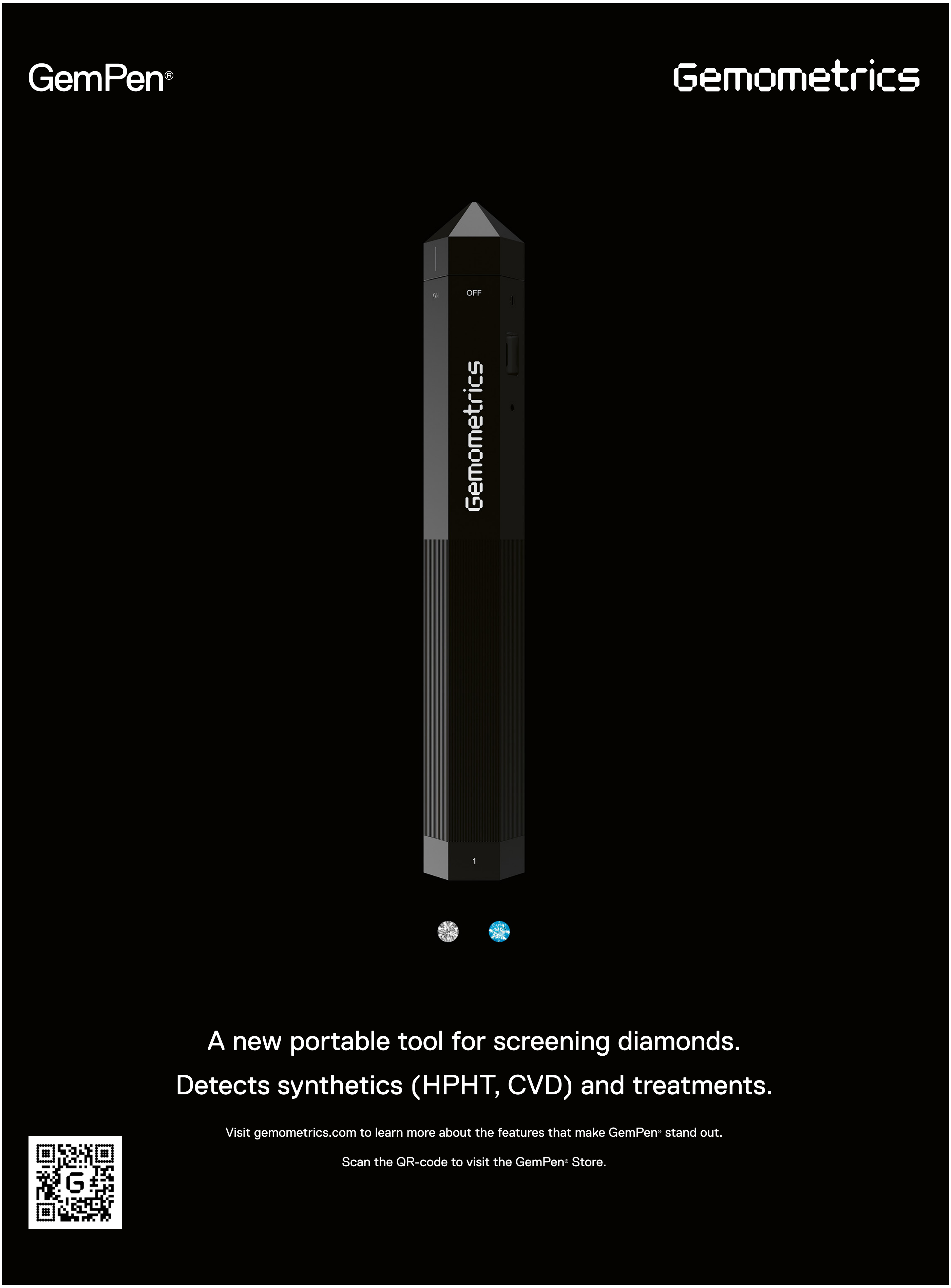


Practical Workshop - Letters of Completion





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Meet our team of dedicated professionals who all share a common philosophy, a common goal and a passion and commitment to gemmology and education.

Geoffrey M. Dominy
WGF Founder

Geoffrey Dominy is an author, independent gemmologist and former jewellery appraiser who appeared on the Canadian Antiques Roadshow for four seasons. He received his F.G.A through the Gemmological Association of Great Britain (Gem-A) in 1987 passing the diploma examinations with distinction.

Throughout the 1990's, Geoff developed and taught the 'Gemmology' program at Red River Community College and The University of Manitoba in Winnipeg, Canada, worked for the Canadian Institute of Gemmology, was President and Founder of the Jewellery Appraisers Association of Canada and was a contributing author for the 5th & 6th Editions of Robert Webster's 'Gems' which even today is considered one of the most authoritative textbooks in Gemmology.

In 2013, he released the first digital gemmological textbook entitled 'The Handbook of Gemmology' in collaboration with world famous gem photographer Tino Hammid. Now in its fourth edition, the handbook has been sold or downloaded in fifty-three countries, is used by fourteen schools, colleges, universities and gemmological organizations as their recommended textbook and now features photographic contributions by other award winning photographers including Jeff Scovil.

Geoff has just released a 5th Anniversary Printed Edition (Two Volumes) and hopes to publish Gemología Para Todos (the first 14 chapters of the Handbook of Gemmology) in Spanish in 2019.

He currently lives in Palma, Mallorca, Spain and in addition to lecturing and promoting his book, is the founder of the World Gem Foundation and Mi Isla También.

Leone Langeslag
Dutch Gem Academy

Leone Langeslag is a graduate of the Federation for European Education in Gemmology (FEEG) (2006), an independent gemmological consultant and is actively involved with the Gemma Association in Holland offering lectures and workshops. Her desire to provide accessible gemmological training in the Netherlands has lead to the formation of the Dutch Gem Academy.

Leone is a frequent visitor to international symposiums, exhibitions and trade shows where she continues her own gemmological education and passion for collecting gemstones and minerals.

Deborah Mazza
British Gem Academy

Deborah Mazza is half Italian and half British, and started her journey through the world of gemstones in Germany in 1984, where she studied at the Deutsche Gemmologische Gesellschaft attaining her gemmology and diamond diploma; she subsequently gained her FGA in 1986.

Deborah then went to work for the trade in Idar-Oberstein, buying and selling wholesale gems and diamonds, working as a gemmologist and teaching gemmology at the DGemG, this lead on to carrying out jewellery valuations for an insurance company in Germany. She later got a Bachelor in Business in Germany, and returned to the UK in 2010, where she became a tutor for the Gem-A's online courses. Deborah, keen to add to her knowledge, started to study again and passed the NAJ/IRV's CAT jewellery valuation diploma, and is now studying History of Art at Goldsmiths University. Deborah has her own valuation business and works part-time for an online auction house. She contributed several written pieces for Yavorskyy's new book, Terra Connoisseur: Gemstones. She is currently the Director of Education for the British Gem Academy.

Conny Forsberg
Scandinavian Gem Academy

Conny Forsberg has over thirty years experience as a gemmologist and precision gem cutter. He received his FGA in 1986 through Gem-A, his diamond grading diploma through Hoge Raad voor Diamant (HRD) in 1994 and is an Accredited Senior Gemologist with the Accredited Gemologist Association (AGA).

He is currently the owner of the Swedish Gem AB, a modern and accomplished gem lab as well as a precision cutting facility. He has twice received 'Honourable' mention in the Gem-A photo competition for his photomicrography (2011 & 2013) and is a valued contributor to the Handbook of Gemmology, with a large collection of his photomicrographies planned for the upcoming 4th Edition. Conny is also an Accredited PRINCE2 Practitioner (Project Management), experienced in public procurement and contracting (EU law) and the initiator and organizer of the Scandinavian Gem Symposium. He is currently the auditor for the Swedish Gemmological Association.

Jan Asplund is a gemmological consultant specializing primarily in the identification and valuation of diamonds, both cut and rough, as well as coloured gemstones and jewellery.

Jan Asplund
Scandinavian Gem Academy

He received his FGA & DGA (Gem Diamond Diploma) through Gem-A in 2011, his BA in History from the Mälardalens University in 2000 and studied geology and gemmology at Luleå Technical University (2005 – 2007), cultural and industrial history at the Uppsala University (1998 – 2000), and archival science at Karlstads University (1998 – 1999). Jan also took his Accredited Jewelry Professional – AJP (Gemological Institute of America 2011), Introduction to Watches (International School of Gemology 2012), Jewellers Education Foundation – Graduate Sales Associate (American Gem Society 2011), Blacksmithing (Säterglantan 2002) and Silversmithing (Tärna Folkhögskola 1996).

He is a board member of the Swedish Gemmological Association, fellow and diamond member of Gem-A and initiator and organizer of the Scandinavian Gem Symposium.

Leroy Bakelmun
Gem Academy of Canada

Leroy Bakelmun started his gemmological career after receiving his certificate in gem cutting and polishing at the Lapidary Training Centre Sri Lanka in 1995. In the same year he also received his certificate in Gem Identification, through the A.K. Institute of Gemmology in Sri Lanka.

In 2006 he received his 'Gemmologist' certificate through the Canadian Institute of Gemmology (C.I.G.)

Leroy has extensive experience buying and selling gemstones. From 1997 to 2014, he owned and operated GeoGem Jewellers in Langley, British Columbia, Canada and from 2012 to 2014, he also owned the 925 House of Silver in Fort Langley, British Columbia, Canada.

Gérard Raphaël Quintin was born in Paris France where he studied Art and Design and graduated from Ecole Boulle. His taste for the diamond world may have been inherited from an uncle who worked in the diamond business.

Gérard Raphaël Quintin
South American Gem Academy

In 1978 he took the gemology colored stone and diamond course with GIA while he was mining diamonds in the Sewa River in Sierra Leone and where he started the first diamond cutting center in West Africa.

In Abidjan Côte d'Ivoire in 1992 Gérard founded the diamond cutting formation center with a gemological laboratory 'Hardy's', followed by the installation of the colored stone and diamond cutting facilities in the jewelry school EIBMA.

Continuing his tour in the world of gemstones, Gérard went to Madagascar as an expert for a French Government project to develop the organization and skill of the gems sector.

Professor of Gemology in the Jean Guehenno Jewelry School in Saint-Amand-Montrond France, he then moved to Bolivia to fund and manage the 'Instituto Gemologico Boliviano' where students learn gemology and the art of gem cutting.

Since 1997 Gérard has been a member of the Organisation Internationale des Experts based in Geneva, Switzerland.

Cristina Rzepka de Lombas
Central American and Caribbean Gem Academies

Cristina Rzepka de Lombas is a geologist, gemmologist, appraiser of gemstones and jewellery and an expert in diamond and coloured gemstone grading.

Currently Cristine serves on the Board of Directors of the Instituto Gemológico Español (IGE) in Madrid, Spain where she also teaches their 'Gems of Organic Origin' course.

She is also the Director of Education for the Central American and Caribbean Gem Academies.

Kyalo Kiilu
East African Gem Academy

Kyalo Kiilu is a fellow of the Gemmological Association of Great Britain (Gem-A) and an Alumnus of Birmingham City University where he obtained his BSc with honours in Gemmology and Jewellery Studies in 2017.

His passion for gemstones can be traced back forty years to his late grandmother's village in rural Kenya and the prospecting trench dug by the first British gemstone explorers in the early part of the 20th Century.

While pursuing his pharmaceutical studies, his interest in gemstones never diminished. Unfortunately in 2003 there were no colleges in Kenya offering gemmological courses so he decided to relocate to England and enrolled in Gem-A's Diamond Diploma program in 2004; the start of his gemmological journey.

Kyalo is a licenced gemstone prospector in Kenya and in 2015 made a discovery of a very unique sapphire, resembling another Kenyan sapphire marketed as 'Goldsheen Sapphire' that he will hopefully share with the gemmological community very soon.

He comes to the World Gem Foundation and specifically the East African Gem Academy with a strong desire and ambition to share his knowledge of gemstones with his fellow East Africans, particularly those involved in the production of gemstones, gemstone lovers and aspiring gemmologists, to provide support and encouragement that was so lacking in the industry when he was growing up in Kenya.

Salomon Lutumba
Gem Academy of DR Congo

Salomon Lutumba is an alumnus of Birmingham City University where he graduated with a Bachelor in Science with honours in Gemmology and Jewellery studies in 2016. He also holds a Diamond Diploma and Gemmology certificate from Gem-A. He is originally from the Democratic Republic of Congo.

In 2002 he relocated to England where, ten years later, he found the opportunity to fulfil his dream of studying gemmology at the Birmingham City University. In 2012, he started his High National Diploma in Gemmology combined with Gem-A's Diamond and Gemmology program which led to a degree program, introduced for the first time in 2015, at the BCU.

Today, by embracing the World Gem Foundation's concept and philosophy of gemmological education, and through the Gem Academy of DR Congo, he would like to share his passion and knowledge of gems with his fellow Congolese; particularly jewellers, aspiring gemmologist and gemstone lovers.

His personal goal is to promote the science of gemmology in his country, by providing information and support to empower people in the jewellery business and those trading in stones.

Jack Ghazalian
American Gem Academy
Director of Corporate & Career Development

Jack Ghazalian has thirty-eight years of experience in the jewelry industry. He is a graduate gemologist through the Gemological Institute of America (1992), was an instructor for GIA (1993) and was officially Certified-by-the-State of California Education Code 94311(a) to teach Gemology & Jewelry Manufacturing-Arts (1993).

In October 2015, he was honored by the International Distinguished Scholars – Academic Honor Society as an 'International Distinguished Scholar' and in 2017 was granted membership in Kappa Delta Pi. He is currently the owner of Isometric Gemological Appraisal Services in Southern California: IsometricGems.com, speaks five languages and is passionate about education.

Barickeh Charles Kholifa Koroma is a freelance gemmologist, diamond grader/valuer, a member of the Gemmological Association of Great Britain and a member of the Scottish Gemmological Association. He was born in Liberia to Sierra Leonean parents and raised in the mineral rich country of Sierra Leone where he survived a devastating brutal civil war which lasted for almost 12 years.

Barickeh Charles Kholifa Koroma
West African Gem Academy

He relocated to the United Kingdom in 2004 and received help on how to cope with Post Traumatic Stress Disorder (PTSD), which now proves pivotal in his approach to life.

He attended the coveted School of Jewellery, Birmingham City University (BCU) where he studied a diploma in diamonds (Gem-A) and a BSc (Hons) in Gemmology and Jewellery Studies. He graduated with a first-class degree in 2018 and was awarded the prestigious Scottish Gemmological Association Prize for Gemmology. He then moved back to Sierra Leone to pursue his dreams. His greatest achievement so far is working as a student mentor during his time at the university, he was able to give advice and guidance to some students that were struggling to cope with the demands of higher education and being away from home.

Like Kyalo, he comes to the World Gem Foundation and specifically the West African Gem Academy with a strong desire and ambition to share his knowledge of gemstones with his fellow West Africans, particularly those involved in the production of gemstones, gemstone lovers and aspiring gemmologists, to provide support and encouragement that was so lacking in the industry when he was growing up in Sierra Leone.

Article Submissions

The deadline for the next issue is

August 15th, 2019

Guidelines:

- We do not accept highly scientific articles. These are better suited for either the Journal of Gemmology or Gems & Gemology
- All articles should be a minimum of one page.
- All accompanying photographs must be high resolution.
- All photographs must be accompanied by written permission from the copyright holder unless the author owns the rights.
- Wherever possible please try to supply images from the same photographic source or one that are at least compatible with each other. This will ensure that the article is aesthetically pleasing as well as informative.
- We reserve the right to refuse articles

E-mail all submissions to:

information@worldgemfoundation.com

The Spice of Life
Coloured Gemstones

LEONE LANGESLAG is the CEO of the Dutch Gem Academy and owner of Sole Leone. She received her European Gemmologist (E.G.) diploma from the Federation for European Education in Gemmology (FEEG) in 2006.

Topaz - Tapas Anyone?

Pink Topaz (Photo by Tino Hammid)

Like zircon (see Gemmology Today – March 2019 issue), topaz suffers not only from an identity crisis (in this case the propensity for any yellow or brown stone to be sold as topaz or any topaz to be sold as 'Imperial') and by the over-saturation of blue topaz on the market.

Clearly the primary driving force behind the incorrect use of the term 'topaz' and the 'Imperial' classification are simply to add 'perceived value' to a gemstone and while looks can be deceiving, from a purely scientific perspective, chemically, physically and optically, topaz bears little resemblance to yellow or brown quartz and there are well established guidelines as to what constitutes an 'Imperial Topaz'.

While it has a hardness of '8' on the Moh's Hardness Scale, it's pronounced cleavage (a tendency for a crystalline substance to split parallel to certain definite crystallographic directions, when force is applied, producing more or less smooth surfaces) is a characteristic that goldsmiths and wearers of topaz need to be cautious of. However, diamond also exhibits this same characteristic and one would have to agree that this has not been an inhibiting factor, far from it.

Etymology

Etymologically, there is some confusion regarding the name topaz. Some believe that topaz came from the island of Topazos in the Red Sea (and is therefore derived from the Greek word 'topazos' meaning 'to seek'), however it is highly likely that the so-called 'topaz' were in fact chrysoberyl or peridot and not topaz. Others suggest that the name may in fact be a derivative of the Sanskrit word 'tapas', meaning fire. We do know that the modern day term 'topaz' is attributable to the German mineralogist and metallurgist Johann Friedrich Henckel in 1734 who was the first to term 'topaz' a fluorosilicate.

Geology

Topaz occurs commonly in igneous rocks such as granites, granite pegmatites and rhyolites, occupying veins or cavities. Resulting most often from late-stage pneumatolytic action (hydrothermal processes), topaz is commonly found in greisen (a light-coloured rock containing quartz, mica, and fluorine-rich minerals, resulting from the alteration of granite by hot vapour from magma). They are also found in secondary alluvial deposits as water-worn rolled pebbles.

Gem Deposits

The most important sources of topaz are the Minas Gerais region of Brazil and the Ukraine. Other deposits include Myanmar, Sri Lanka, Nigeria, Madagascar, Namibia, Russia, China, Afghanistan, Australia, Japan, Mexico, Zimbabwe and the U.S.

Topaz belongs to the orthorhombic crystal system and is found in prisms terminated by domes and /or pyramids. It is not uncommon to find enormous crystals due to the geological conditions they are formed in. A natural light blue topaz is found in Northern Ireland and the UK.

Assorted Topaz (Photo by Tino Hammid)

The most famous topaz is the giant specimen in the Portuguese crown, called the Braganza that weighs 1,680 carats and was at first thought to be a diamond.

Characteristics

Topaz is a aluminium silicate mineral with fluorine (F) and hydroxyl (OH) and has a chemical formula of Al_2SiO_4 $(F,OH)_2$.

Topaz is classified as 'allochromatic' meaning that in its purest form, it is colourless. Typically the colour is caused by 'hole colour centres', which are created by displaced electrons within the crystal lattice.

Topaz is normally transparent to translucent, exhibits high clarity and is typically 'eye clean'.

Varieties

Topaz is found in a wide range of colours (colourless, yellow, orange, brown, light to dark blue, pink, red, violet and light green) with the different varieties often identified simply by the hue name (i.e. blue topaz). There are however certain 'trade' names that are used.

Imperial topaz is the most valuable variety of topaz and it can only be classified as such when the colour is either yellowish orange, orange yellow or yellow orange with slightly purplish red, red, orange red, reddish orange or pink overtones.

Sherry topaz is a variety that shows a yellowish brown, brownish yellow to orange colour that resembles the colour of sherry wine.

To help further the distinction between topaz and citrine or smoky quartz dealers often refer to topaz as 'precious' topaz.

Red and pink topaz crystals are rare and highly prized and owe their colour to the presence of chromium.

Physical Properties

Depending on the fluorine content (Hoover), the refractive indices of topaz will vary with readings for colourless, blue, brown and yellow topaz in the 1.61 - 1.62 range while red, pink and orange topaz will have a slightly higher range of 1.63 - 1.64.

While topaz can be confused with tourmaline, the polariscope can be very useful in determining the optical character since topaz is biaxial whereas tourmaline is uniaxial.

Topaz can exhibit pleochroism, which means that the stone will display different colours when viewed in different crystal directions. In the case of blue topaz, colours displayed range from colourless to pale or pink/blue while yellow topaz can show colours ranging from honey-yellow to straw yellow and pinkish-yellow. Pink topaz can exhibit colourless to very pale pink to pink dichroism, while green topaz may show pale green to dark green when viewed through the dichroscope.

Physical & Optical Properties	Topaz
Crystal System	Orthorhombic
Chemical Composition	$Al_2SiO_4(F,OH)_2$
Colour Range	All Colours
Refractive Index	1.609 – 1.643
Birefringence	.008 – .016
Dispersion	.014
Optic Character	Biaxial
Optic Sign	Positive
Pleochroism	Yes
Specific Gravity	3.49 – 3.57
Hardness	8
Cleavage	Perfect
Fracture	Sub-conchoidal to Uneven
Lustre	Vitreous
Transparency	Transparent to Translucent
Colour Streak	White

While the majority of topaz do not have an absorption spectrum, 'pinked' topaz and natural pink topaz from Pakistan will show a faint line at 682 nm, due to traces of chromium.

Red, pink and orange topaz may fluoresce orange to yellow under long wave UV light and orange, green or blue under X-rays.

Inclusions

Although Topaz is a 'Type 1' gemstone and is often found without any inclusions, there are a number of mineral inclusions that can be found in topaz including monazite, muscovite mica, spessartite garnet, albite feldspar, brookite and quartz or cavities containing two nonhomogeneous liquids. Liquid inclusions, two and three-phase inclusions, and healing cracks can also be found.

Cut

Since topaz crystals are usually elongated or columnar, they are often cut as pear shapes or elongated ovals to improve the overall yield. However since there is an abundance of topaz (particularly in irradiated blue stones), most stones are cut in a variety of shapes and in calibrated sizes.

Treatments

Topaz is routinely treated to change or enhance its colour. While natural blue topaz does exist, the vast majority of blue topaz is the result of colourless topaz being irradiated (and then annealed) using three different types of radiation. Gamma rays from a cobalt-60 source (light blue), high-speed electrons from a linear accelerator (medium blue) and high-energy neutrons from a nuclear reactor for darker London blue stones.

Irradiation is also used to produce yellow, orange, red, brownish, pinkish and greenish colours, although unlike blue topaz, the treatment is often unstable and may fade when exposed to direct sunlight. Common yellow topaz is often irradiated and converted to pink topaz (termed 'pinked').

Topaz can also be 'diffusion' treated to produce a greenish colouration or 'coated'. The latter involves a process called 'vacuum sputtering', where the stones are placed in a vacuum with a positive electrical charge attached to the stone to create an anode, and then evaporating various metals at the negatively charged cathode so that they are attracted across the vacuum and deposited on the stones creating a multi-coloured sheen on the surface of the stone. 'Mystic Topaz' is one example of this process.

While diffusion treated stones are relatively stable, coated stones are not since the treatment imparts only a superficial coating that can be removed either through normal wear or in the event of a damaged stone, through repolishing.

Synthetics

At this moment there is no commercial 'synthesis' of topaz on the market due to the plentiful supply of natural topaz.

Misnomers

Quartz is often sold as Spanish Topaz, Madeira Topaz, Scottish Topaz or Rio Topaz, while Indian Topaz, King Topaz and Star Topaz are actually sapphires!

Conclusion

While admittedly the perception of topaz has suffered over the years due to misrepresentation and the use of treatments and enhancements, it does offer great diversity in terms of colour and price.

References:

Handbook of Gemmology
Gems and Jewelry
Gemdat.org

Lilac Topaz Regal Radiant ™ 14.44 carats - cut by John Dyer
(Photo by David Dyer)

Red Topaz Regal Radiant ™ 2.30 carats - cut by John Dyer
(Photo by David Dyer)

Tino Hammid Memorial Gemmological Scholarship

The World Gem Foundation is delighted to offer five more scholarships this year. These scholarships cover the theoretical components of our Career Gemmology Diploma Program.

Tino Hammid Memorial Gemmological Scholarship

In every industry there are iconic individuals, giants who stand head and shoulders above the rest. In the field of jewellery and gemstone photography, there is little debate that Tino Hammid was a visionary, a rare talent who possessed the unique ability to capture the true beauty of gemstones. For almost forty years his photography adorned the pages of every important publication around the world, showcasing his unrivalled ability to inject realism into his work.

Tino started his career as a staff gem photographer at the Gemological Institute of America (GIA) in Santa Monica, California (1980 to 1982). In 1983 he started his freelance career in gem and jewellery photography and began a 25-year association with David Federman providing photographs for Modern Jeweler's monthly Gem Profile column. During this period they jointly won two Jesse H. Neal awards from the Association of Business Publishers. In 1987 he acquired Christie's Auction house as a client and photographed more than a hundred of their jewellery sales catalogues. In 2012, Tino joined forces with gemmologist Geoffrey M. Dominy and provided the exquisite photographs for The Handbook of Gemmology, the first digitized gemmological textbook released in 2013.

Sadly, Tino passed away in 2015 after a two-year battle with cancer, however through the Handbook of Gemmology and now the World Gem Foundation courses, his legacy and monumental contribution to our industry will live on for future generations to appreciate and admire.

In 2020, the World Gem Foundation will award five scholarships allowing deserving students to take the World Gem Foundation theoretical 'Career Gemmology' course.

The deadline for submitting your application is December 31st, 2019. All applications will be judged by Tino's wife Petra and his oldest daughter Evelyn with the mandate to select those five candidates who, in their opinion, best epitomize the spirit of Tino.

To download the application form, please click on the image below:

Scholarship Application PDF


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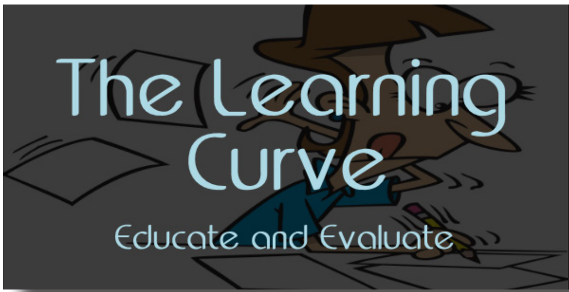
Gemmology Today
Quiz #11
Let's see how attentive
you have been?
CLICK ON THE IMAGE TO START



A meeting of the minds as Michael Cowing, Raymond Mason, Bill Korst, Bill Hoefer, Kirk Feral, Bear and Cara Williams and Richard Hughes look at two lab-created blue sapphires.

Natural or Synthetic? - Hmmmmm

Introduction

This article was begun to stimulate discussion among gemologist-appraisers about the separation of lab grown/ synthetic (hereafter called synthetic) from natural (meaning heated or unheated) blue sapphire. Two stones submitted for identification and valuation were the motivation and primary subject examples. Although a small part of the large field of gem identification, blue sapphire's great popularity among the big three colored gemstones elevates the importance of this separation and identification. This discussion is limited to blue sapphire, and use of sapphire alone refers to blue sapphire. After discussions with and advice from several gemologist-appraisers and lab owners, the article's scope widened into not only additional identification techniques for the example blue sapphires, but also into a discussion of typical gemologist/appraiser gem testing limitations, and the necessary client counsel and disclosure required in an appraisal report. This conversation is presented in roughly chronological fashion, as it developed. At any point the reader may wish to skip to the conclusions for a summary, and return later for the discussion details.

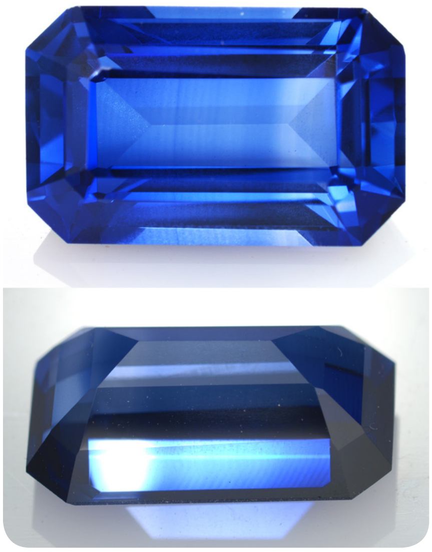


Figure 1: Loupe clean 15.59 carat blue sapphire. Is it natural unheated, natural heated, or lab grown/synthetic? Answer: synthetic, proven by observation of curved growth striae.

Figure 2: Loupe clean 5.59 carat blue sapphire. Is it natural or synthetic?

Gem Identification Question

When a large good looking blue sapphire like the example, loupe clean, 15.59 carat emerald-cut gem, Figure 1, comes to the lab for identification, the first thought is Verneuil–type synthetic, because of the absence of natural hexagonal color zoning and lack of inclusions diagnostic of either natural or synthetic. Most often, as with this first gem, observation of curved growth striae confirms Verneuil flame-fusion synthetic.

Presenting more of a diagnostic challenge is this loupe clean 5.59 carat blue sapphire, Figure 2. Is it natural or lab grown/ synthetic?

This is a more difficult determination due to an apparent absence of curved striae or diagnostic inclusions.

Initial thinking again leaned toward synthetic due to absence of natural inclusions, and no natural hexagonal color zoning in such a clean, sizable, valuable-if-natural sapphire. In this case, curved striae or other inclusion indicators of synthetic appear absent at first examination. The only internal feature was an indistinct, hazy, broad, color-band perpendicular to the oval's length, as seen in Figure 2B. Diffuse backlighting in Figure 2C reveals some variation in the band which looks curved in Figures 2B and 2C. Finally, a tilt along the length, Figure 2D, revealed three dark, light, and dark bands that appear straight and perpendicular to the stone's length. Because this is similar to the typical gem orientation (parallel to the C-axis) of Verneuil synthetics, such as resulted in the perpendicularly oriented curved striae in the 15.59 carat emerald cut, the suspicion of synthetic was increased.

The question for discussion: Is this evidence sufficient to make a definitive call of synthetic? Or is other, more sophisticated instrumentation analysis (such as FTIR, UV-Vis-NIR or some other analysis method) required to make a positive determination?

Enlisted to aid in answering this question, and generously contributing their knowledge, advice and cautions were three gemologist-appraisers, Raymond Mason GG who operates an AGA Certified Lab as does the author, Bill Korst, AiSCV-AVS, GG and president World Gem Resources, Ltd., and Bill Hoefer GG,editor of AppraisrUnderOath.com, along with gemologist-researcher Kirk Feral, and gem lab owners and operators, Bear and Cara Williams of Stone Group Laboratories, LLC, and Richard Hughes of Lotus Gemology Co. Ltd.

Their contributions and insight not only enabled the definitive answer to the identification question posed, but lead to discussion of 1. What higher level of gemological instrumentation and necessary knowledge of their use, over and above those traditionally taught by gemology schools, are required these days for this gem identification assignment? 2. When should referral to labs with greater diagnostic capability be required and suggested to the client? 3. If identification and valuation must proceed without such advanced assistance, how should the appraisal be worded with respect to disclosure of information and conditions in order to properly meet the needs of the client and any relevant third parties, such as insurers?

While the 15.59 carat identification was clear-cut, both Bill Korst and Ray Mason cautioned against a positive diagnosis of synthetic from the images presented and the information given. If further testing methods are not available both suggested recommending to the client submitting the gem to a lab with more advanced instrumentation and capability.

Short Wave Ultra Violet Fluorescence Test

Bill additionally suggested short wave UV examination looking for the presence of chalky whitish to bluish or greenish fluorescence. Bill had been using SWUV for many years as a solid indicator for synthetic as opposed to natural

Figure 3: Eight Flame Fusion Synthetic Sapphires (Photo by Bill Korst)

for such totally clean sapphires. Synthetic sapphires like the 8 examples in Figure 3 are low iron and typically exhibit a strong chalky whitish-bluish or greenish fluorescence in SWUV as seen in Figure 4.

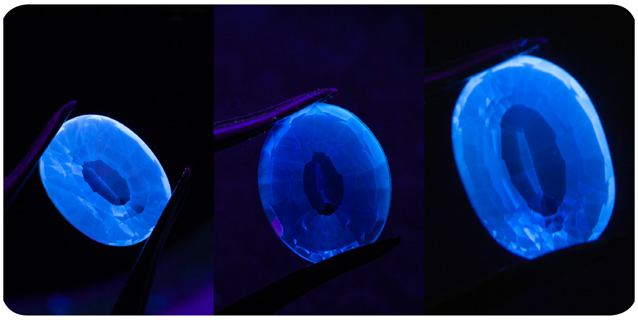
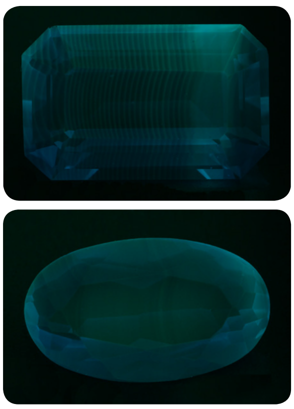


Figure 4: Chalky bluish fluorescence seen in flame fusion Synthetic Sapphires (Photo by Bill Korst)

This fluorescence under SWUV is indicative of synthetic, but is not sufficiently diagnostic by itself, as it may be present in low iron, heat treated natural sapphires. Because there is sufficient iron in most natural blue sapphire (heated or not), which 'quenches' this SWUV fluorescence, a traditional test diagnostic of natural (either heated or unheated) is through detection of iron absorption lines with spectroscopic or UV-Vis-NIR spectral analysis, or with other techniques such as magnetic analysis. Detection of iron spectral absorption is indicative of natural, either heated or unheated, whereas lack of iron detection is a synthetic indicator, except for the infrequently encountered low-iron natural sapphire.



Figures 5 & 6: Under SWUV - Chalky greenish-whitish fluorescence

Following Bill's advice, the two sapphires were photographed in illumination from a traditional 254nm woods-glass-filtered, SWUV, mercury vapor lamp with the results shown in Figure 5 and 6. Not only was this chalky SWUV photoluminescence in evidence, but it brought out the curved striae banding in the oval, an unexpected diagnostic bonus, proving the identification of flame fusion synthetic.

After identifying in this unexpected fashion both sapphires as Verneuil synthetics without the need for additional or more advanced diagnostic methods, the opportunity was taken to explore and compare SWUV photoluminescent and magnetic properties of the two synthetics with those of four natural sapphires.

These natural sapphires are photographed face-up in Figure 7, and then illuminated under the same SWUV used in Figures 5 & 6. None of the four natural sapphires exhibited any response to the SWUV indicating their natural origin.

Figure 7: Four natural sapphires chosen to compare their properties to the example synthetic gems. Each exhibited no fluorescence response under SWUV illumination indicative of their natural origin.

Observation in Immersion Liquid With Diffuse Background Illumination

These sapphires are also photographed face down in Figure 8 with water as the immersion liquid. As is seen in this photograph, immersion, even in a low R.I. liquid like water, is an aid in revealing the gems interior by lessoning the exterior reflection and refraction distortion at the air-pavilion-facet boundary. Immersion also serves to reduce the pavilion curvature distortion, a source of confusion when examining for straight or curved striae. For comparison, another photo of the two example synthetics, immersed in water is shown in Figure 9.

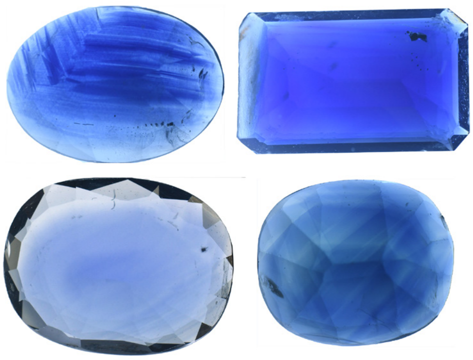


Figure 8: The four natural sapphires face down in water as the immersion liquid.

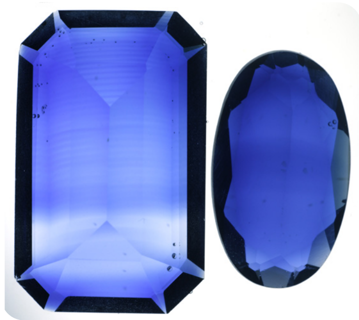


Figure 9: Synthetic sapphires face down immersed in water.

Exceptions to synthetic diagnosis from observation of chalky SWUV fluorescence

Bill Korst explored exceptions to the diagnosis of synthetic by observation of chalky SWUV fluorescence. These exceptions are the heat-treated, low-iron natural sapphires which also exhibit chalky SW fluorescence. He examined over 100 natural sapphires from Sri Lanka (Ceylon), Madagascar, Australia, Kenya, Tanzania, Montana, Thailand and Burma. Only eight of these sapphires, all heated Sri Lankan material, exhibited this chalky fluorescence under SWUV. Eight out of thirty-six heated Ceylons (~22%) showed the fluorescence. The question is: can this low percentage of SW fluorescing natural exceptions be distinguished from the fluorescence of flame fusion synthetics avoiding possible misidentification?

Figure 10: Eight Ceylon heated sapphires that fluoresced in zones under SWUV (1.39 to 5.54 carats) (Photo by Bill Korst)

The answer is yes. As seen in the images Figures 4, 5 and 6, the flame fusion synthetics fluoresce evenly, and some show curved striae confirming synthetic as a bonus.

Unlike the synthetics, the chalky fluorescence of the Ceylon heated blue sapphires was confined to zones, Figure 11, as others have reported in gemological literature. This difference in fluorescent appearance enables differentiation between flame fusion synthetics and low-iron, heated, natural blue sapphires.

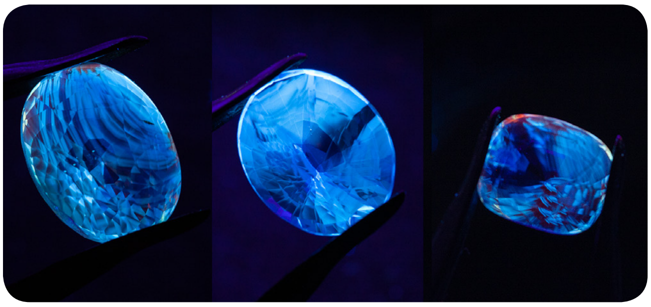


Figure 11: Three of the eight heated Ceylon Sapphires showing fluorescence in zones (Photo by Bill Korst)

Magnetism as a diagnostic tool in sapphire identification

Having heard of, but never having studied the use of magnetism in gem identification, the author took the opportunity to compare the magnetic properties of synthetic and natural blue sapphire. An outstanding treatment of magnetism for gem identification by Kirk Feral is found at https://www.gemstonemagnetism.com.

The page at: https://www.gemstonemagnetism.com/sapphire_and_ruby.html deals with blue sapphire.

There it is learned: 'Natural vs. Synthetic: .....natural blue sapphires most often do show a weak to moderate magnetic response (attraction) due to iron, and such responses definitively separate them from synthetic blue sapphires, which are always inert or diamagnetic. We can say (at present) that any magnetic attraction rules out synthetic origin for blue sapphire, but a diamagnetic (repulsion) response does not rule out natural origin. Additional iron not involved in Fe^{2+}- Ti^{4+} charge transfer or Fe^{2+}- Fe^{3+} charge transfer is likely responsible for all of the detectable (para) magnetic attraction seen in most natural blue sapphires. This extra iron can also be detected with a spectrometer. In synthetic sapphires, there is no detectable 'excess' iron present, only a small amount of iron in Fe^{2+}-Ti^{4+} charge transfer, and therefore we see no attraction (instead, a weak diamagnetic repulsion to a strong neodymium magnet is found)'.

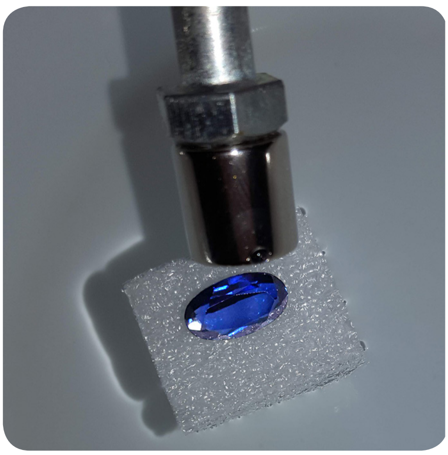


Figure 12: Floating a sapphire on a foam 'raft' to observe reaction to a strong N52 neodymium magnet

The author floated each sapphire on a small foam 'raft' in a large diameter bowl of water, and observed magnetic attraction or repulsion by bringing a strong N52 grade, 1/2" x 1/2", neodymium magnet within a few millimeters of each sapphire, Figure 12. As predicted, both synthetics were weakly repulsed by the magnet (diamagnetic), while all the natural sapphires were weakly attracted to the magnet (paramagnetic). This experiment verified the diagnostic utility of magnetic analysis of blue sapphire. According to Kirk's website, magnetic testing can also be applied to gems mounted in fine jewelry, since high-quality gold and silver mounts are seldom magnetic and do not interfere with the test. Attraction to an N52 grade magnet is a good alternative to the spectroscope or spectrometer in detecting iron to confirm natural origin.

To gain additional support for use of magnetism in blue sapphire identification, Bill Korst checked all of 100+ natural sapphires and the flame fusions, Figure 3, for magnetic responsiveness using a 1/2" x 1/2", N52 magnet, and floating each stone on water on a small foam 'raft'. All of the stones from Montana, Australia, Kenya, Tanzania and Thailand (basaltic material), no-heat and heated were attracted to the magnet (paramagnetic). All of the thirty-six Ceylon /Sri Lankan (metamorphic material) heated stones were repelled (diamagnetic). Other no-heat Ceylons were also repelled (diamagnetic). All of the flame fusion synthetics were repelled (diamagnetic) indicating the low iron content of synthetic sapphire. Bill also tested for magnetic responsiveness for sapphires set in 14K yellow gold. Since most gold alloys are not magnetic he was able to get the same results mounted as loose. These results support the diagnosis of natural (heated or unheated) with the finding of magnetic attraction (paramagnetism). Magnetic response is a diagnostic alternative to and substitution for the detection of iron absorption lines in the spectrum.

Answers and Advice from Richard Hughes of Lotus Gemology Co. Ltd

Richard Hughes responded to this natural-synthetic identification question with the following advice and methodology for testing blue sapphire, which is contained in his latest book, on page 721.

'These are the steps you should take:

First determine that it is corundum (R.I., Optic Character & Sign, S.G.).

Now you have to separate natural from synthetic. Check the visible spectrum with a spectroscope (I recommend the OPL teaching spectroscope with stand and a fiber-optic light to illuminate the stone. See this link: http://www.lotusgemology.com/index.php/library/articles/282-the-hand-spectroscope-for-testing-ruby-sapphire).

If you see even a faint line at 450 nm, it is probably natural. No 450 line can be natural or synthetic.

Better than a hand spectroscope is a UV-Vis-NIR spectrophotometer. We use the Gemmosphere made by Mikko and Alberto and love it. Natural low iron sapphire (metamorphic) has a distinctive spectrum (see Chapter 4 of my book). High Fe (iron) shows an 880 band and you'll see the Fe lines in the blue.

Check the SW UV fluorescence. Heated natural sapphire may show angular chalky zoning. Verneuil synthetics show chalky zoning in curved bands. Use the magnifier off the GIA refractometer to examine it carefully. http://www.lotusgemology.com/index.php/library/articles/156-heat-seeker-uv-fluorescence-as-a-gemological-tool.

Check the inclusions and look for natural inclusions (angular zoning, silk, crystals, etc.) or synthetic (gas bubbles, curved growth zoning, Plato twinning). See more here: http://www.lotusgemology.com/index.php/library/articles/273-dangerous-curves-a-reexamination-of-verneuil-synthetic-corundum.

If you can't find any zoning, immerse the stone in methylene iodide with a white plastic filter under the immersion cell. This should quickly resolve the growth zoning (straight or curved), but make sure to check the stone in all directions, as the zoning in some natural stones may appear curved in some directions. Use a frosted blue filter if the stone is yellow or orange. If you don't have MI, use water.

If you have an FTIR, check the spectrum as per the article on the HT+P sapphires.

Review the various images we have on our Hyperion database. http://www.lotusgemology.com/index.php/library/inclusion-gallery

Synthetic manufacturers are unable to put Fe into corundum and have it contribute to the color easily. This is why the synthetic yellow sapphire is typically doped with nickel (orange is Ni + Cr). See pages 124 –125 of my latest book and also page 115 for more on Fe in corundum. That section is largely the work of John Emmett.

In my life, I've seen only one or two Verneuil sapphires that show a very weak 450 line. So when you see it, it's a good indication of natural origin.'

Answers and Advice from Bear and Cara Williams of Stone Group Laboratories

Bear and Cara Williams responded to this identification question with the following suggestions, thoughts and advice.

Bear Williams:

'Your summary appears very sound. Cara feels the 5.59 is also typical of synthetic.

When something like that stone hits my desk however, I am cautious not to judge based on cut or shape. On other stones, I have seen what may appear to be a curved line, but turned out to be a deception based on the somewhat rounded nature of pavilions. You don't always see the 60° angled zoning, only a series of straight lines. As you have commented, the opposite can also be true. Curved striae inside a sapphire might also appear like a natural straight line when you turn it just right.

There are a number of things that can be done with equipment. Raman is good at giving an 'indicator' in the photo luminescent portion of the reading. Usually, I first employ a UV-Vis-NIR. The full spectrum of the visible will be strongly suggestive of its nature. Another is transmission of UV, using a deuterium energy source and looking at it with a UV spectrometer.

Another thing to consider is technique with microscopy. A lot of times if there is no curving, there may be areas of small bubbles, typical of the melt. Remember to tell them to make full use of fiber optics and immersion to augment visible signs.'

Cara Williams:

'Synthetic growers are using more diverse formulae today, however these are not yet commonly seen in the market, too few and new to have reached the resale-market where they are likely to cause the most misdiagnoses. The synthetic ruby in dark red is one that will fool many as it does not fluoresce like the more common, vivid red, synthetic ruby.

The cutting pattern of your more difficult to ID stone is so typical of synthetic, but nothing I see internally in the images would allow me to make a definitive call on it either way. As Bear said, the facets and angle of view can sometimes make curved banding appear straight and straight color zoning appear curved. This one is not a clear-cut case. I know cutters who imitate synthetic cutting styles. I saw a natural star sapphire that I almost made a bad call on because it was cut exactly like a Linde star. In our business, we see the rare and exceptional – and it keeps us on our toes.

People want nice little rules to go by, but there are always exceptions to every rule. It is important to avoid decisions based on single tests that have multiple possible interpretations.'

Conclusions

Traditional, and long-established gem identification techniques taught by gemological schools and economically available to most gemologist-appraisers, including SWUV fluorescence response, and the newer magnetic response test, most often prove adequate for positive identification of natural verses synthetic blue sapphire.

Addressing the original question: Is this loupe clean 5.59 carat blue sapphire, Figure 2, natural (unheated or heated), or lab grown/synthetic?

Answer: For this original identification example case, where immersion shows no diagnostic hexagonal zoning or curved striae, just hazy diffuse coloration, and no diagnostic inclusions, two tests together proved conclusive. 1. Chalky whitish/bluish/greenish fluorescence from SWUV indicates either synthetic or heat treated natural (an exception to be aware of is flux-grown synthetics, which don't show chalky SWUV fluorescence. They are identified by other means such as the nature of their inclusions). 2. Paramagnetism (magnetic attraction) or iron line detection in the absorption spectrum indicates natural, either heated or unheated (watch for metallic inclusions, which can sometimes be attracted in flux-grown synthetics despite their diamagnetic nature).

So, the original sapphire, lacking natural inclusions and lacking angular color zoning, with its chalky SWUV fluorescence and diamagnetism (repulsion) is proven synthetic (it's possible that a heated natural sapphire such as the 6 Ceylon sapphires, Figure 10, could show chalky SWUV fluorescence, be diamagnetic showing no distinct iron absorption features, but the different nature of the SWUV chalky and angular fluorescence will make the definitive distinction, as it did in the example cases, Figure 11.)

The four control sapphires in this example experiment all were paramagnetic and exhibited no chalky SWUV fluorescence. On this basis alone all are conclusively natural, either heated or unheated, no other evidence needed (except to separate natural from heat treated natural).

However, Cara Williams' caution should be heeded: 'Synthetic growers are using more diverse formulae today – they just are not yet commonly seen in the market, too few and new to have reached the resale-market where they are likely to cause the most misdiagnosis. In our business, we see the rare and exceptional – and it keeps us on our toes. People want nice little rules to go by but there are always exceptions to every rule.'

To borrow a line from a famous movie: A gemologist-appraiser has got to know his/her limitations.

Often the gemologist-appraiser's identification and grading is hampered by restrictions imposed by the mountings of the jewelry item, and available lighting and instrumentation. If positive identification cannot be confirmed in the mounting, it may be that the gem will have to be removed for positive identification to be made. In many cases this may not be practical or the client may wish the appraisal assignment to proceed without removal.

If there is identification uncertainty the client should be so informed, and the recommendation made to send the gem to a lab equipped with more advanced instrumentation. This step is necessary to establish a definitive identification in order for the appraisal assignment to proceed. 'If you are not sure, it is best to pass on the assignment, unless a qualified laboratory is utilized' advises Bill Hoefer.

Bill Korst points out: 'A Valuer-Appraiser needs to produce results that meet the needs of clients and any relevant third parties, such as insurers. This can be accomplished in-house, depending on gemologist-appraiser limitations, and or with consultation with outside labs. That's a discussion that needs to be held with the client, along with explaining and agreeing on any and all contingent and limiting conditions in establishing the appraisal 'Scope of Work', and then fully disclosing same in the reporting.'

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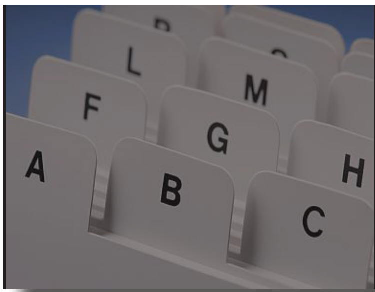

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