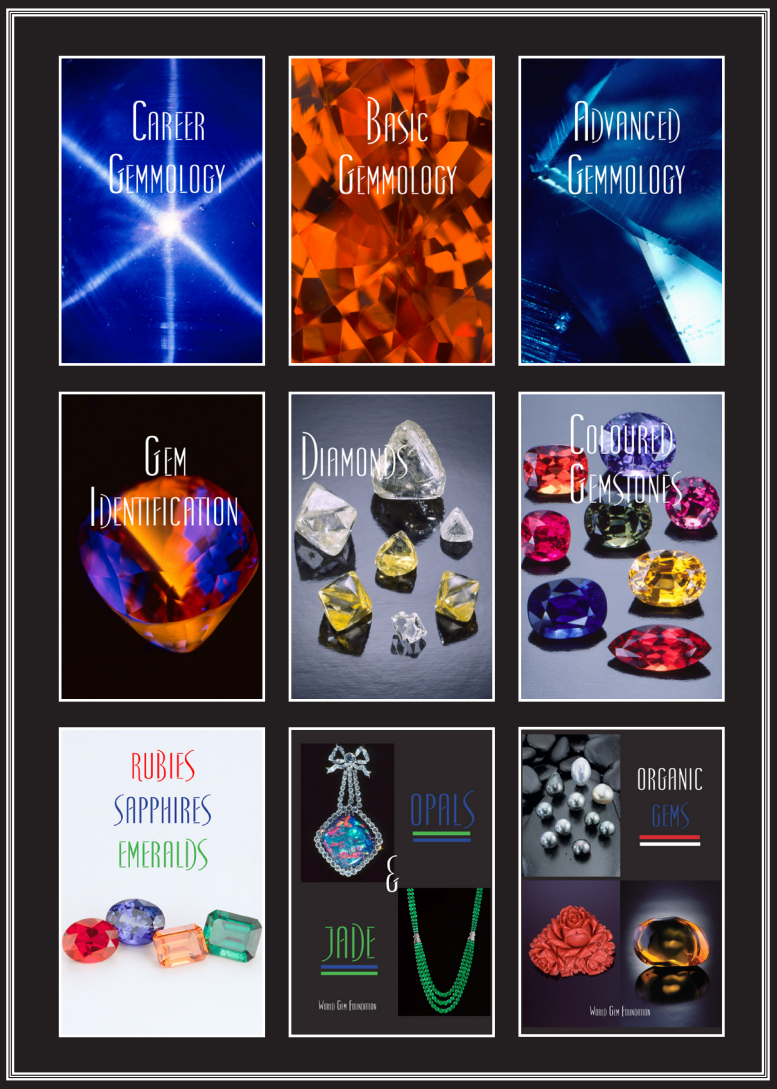
# Gemmology Today

December 2020
Quarterly Publication

## ADIÓS 2020

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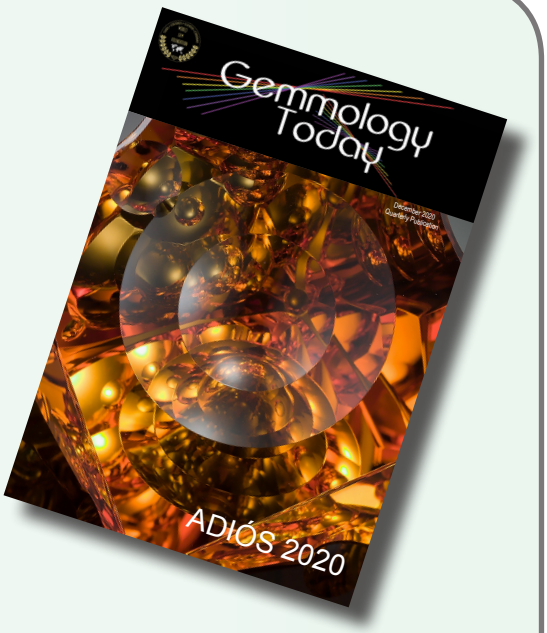
# In this issue






Citrine Quartz (360.71cts) by Michael Dyber (Photo by Tino Hammid)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**Editor** Geoffrey M. Dominy

**Advisory Council** Leone Langeslag, Gérard Quintin, Marie-Hélène Corbin, Dr. Laurent Massi, Ludovic Durand, Kyalo Kiilu, Barickeh Charles Kholifa Koroma, Deborah Mazza, Conny Forsberg, Jan Asplund, Cristina Rzepka de Lombas & Jack Ghazalian





September 2020 Issue


# Editor at Work

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

I used to watch a lot of quiz shows. I suppose it is part and parcel with being British. The British love quiz shows. University Challenge first aired on September 21st, 1962 and continued until December 31st, 1987. It was presented by Bamber Gascoigne. I always thought it was an odd name. Who calls their son 'Bamber'? The BBC revived the programme on September 21st, 1994 with Jeremy Paxman as the quizmaster. It is still running today.

On regular quiz shows, I always find it odd when a contestant is asked a history or a geography question. They almost always respond that it is not their best subject. I find this strange. Look at the world around us? How could you not be fascinated by what is out there, waiting to be explored? The different cultures, the food, the language, the different customs and traditions? Today we live in a world that is so connected (look at how quickly COVID-19 spread) yet we live in a world that feels so disconnected. Travelling enriches your soul, it fills you with a joy that is hard to describe. A awe of what is out there and a deep appreciation for what we have.

It is the same with history. Why would you not want to know about the world 100 years ago, 500 years ago or 2000 years ago? I almost choked when a contestant got a history question wrong and responded that 'it was before her time'.

By definition, history is a branch of knowledge dealing with past events. a continuous, systematic narrative of past events as relating to a particular people, country, period or person and is usually written as a chronological account. Of course it is 'before our time'. If it was not, it would not be history. It would be current events!

When Gérard Quintin, Director of Education for the South American Gem Academy and Founder/CEO of the Instituto Gemológico Boliviano (IGB) submitted his article on the examination of the Presidential Medal first awarded to South American liberator Simón Bolívar, my heart literally stopped. The opportunity to examine this important medal, especially in light of who it had been presented to, the chance to touch history, well to me it just does not get any better. Having spent a considerable amount of time in Peru, the significance of this article really struck a chord. I only wish I had been there!

Gérard included a lot of photos and it immediately became apparent that this article warranted as much 'real estate' as possible. I know the 'hoops' he had to jump through to get this opportunity and so this is his reward and our treat for a job well done.

Like all gemstones and jewellery of historical significance (look at the checkered past of the Hope Diamond), this medal also has an interesting tale to tell especially in Bolivia. Like Bolivia, it has changed hands many times, in turbulent times and in peace. I hope you are as captivated by it as I am.

There is lots more to discover in this issue, which is our largest issue to date. Dario Marchiori's 'The Gems of Thrones', Kim Rix discovering what exists in her own backyard, the phenomenal cutting of Glenn Lehrer, Gillian and Jean-Marie Arlabosse looking at Artificial Intelligence and machine learning, the micro-world of Nina Zolotukhina (aka Nina Gold) and Leone Langeslag exploring asterism.

This is not going to be a normal Christmas but then again, what is normal anyway? Happy holidays, please stay safe and please wear a mask.


Simón José Antonio de la Santísima Trinidad Bolívar y Palacios Ponte-Andrade y Blanco (24 July 1783 – 17 December 1830), generally known as Simón Bolívar and also colloquially as El Libertador or the Liberator, was a Venezuelan military and political leader who led Venezuela, Bolivia, Colombia, Ecuador, Peru and Panama to independence from the Spanish Empire.

# El Libertador - La Medalla Presidencial

Portrait of Simón Bolívar by Arturo Michelena

La Paz, August 9th, 2018. The general in charge of the military contingent attached to the office of the Bolivian President was fired over the theft of the presidential regalia from the car of an army officer as it was parked in the street. The items stolen included the priceless medal bequeathed to Bolivia by South American liberator Simón Bolívar but fortunately were recovered hours later. Armed Forces Chief Yamil Borda announced the dismissal of General Alberto Mansilla during a press conference. Mansilla and his team were responsible for the safekeeping of the presidential medal and sash after it was moved from the security vault of Bolivia's Central Bank, where the items are kept while not in use.

Two years later, after a rigorous selection and a long preparation, the Institute Gemologico Boliviano was selected by the Ministry of the Presidency to carry out the expertise of the presidential medal whose story is quite fascinating.

Alto Perú (originally corresponding in the western part to the Andean Altiplano or Puna and to the east including the lands corresponding to the plains and the Amazon Basin) at birth and to the life of the Independent Nations was baptized by the Deputies in the General Assembly of 1825 with the name of its Founder, titled the Bolivar Republic, as a tribute and gratitude to the man who gave its existence.

The same General Assembly also wanted to express its admiration to the Liberator with the offering of a material object that symbolized his feelings, and agreed in Article 8 of the aforementioned Decree that the Marshal of Ayacucho present him with a gold medal studded with diamonds, in which the obverse would include the Hill of Potosí with the Liberator standing at the top of the hill made up of rifles, swords, cannons and flags in an attitude of fixing with the Liberty Cap and on the reverse between a garland of olive and laurel, the following inscription 'The Bolívar Republic grateful to the Hero whose name it bears'.

The presidential medal is one of the most important symbols of the country and was created by a Bolivian artisan who took a year to finish it. It was sent to Lima, Perú to be delivered to Simón Bolívar.

Bolívar responded with a letter of thanks to Sucre and the Assembly, which the Bolivian newspaper El Cóndor published in 1826.

Bolívar expressed in his will of December 10, 1830, dictated at the Santa Marta (Colombia) hacienda, his decision to return to the Bolivian people the medal he had received from them. This is the literal text of that fragment of the testament in its sixth clause:

'It is my will that the Medal presented to me by the Bolivian Congress in the name of that people, be returned to them as I offered it, in proof of the true affection that even in my last moments I retain for that Republic.'

On the death of the Liberator, Bolívar's executor returned it to the Bolivian people, and something unusual happened with the medal. The General Constituent Congress resolved in 1831 to give it to the then President Andrés de Santa Cruz, for life, in recognition of his merits.

In 1839 a revolution broke out in Bolivia that overthrew President Santa Cruz and the new Revolutionary Government forced Santa Cruz's wife, Mrs Francisca

Cernadas, to return the Medal of the Liberator that she had kept since the Constituent Congress of 1831 had awarded it to her husband.

In recognition of Bolívar, the Revolutionary Government turned the Medal into a presidential symbol. President José Miguel de Velasco decided this through a decree dated October 28 of that year. Since then, it has been imposed on all the leaders who have reached the presidential seat by the citizen vote or by force of arms. In total there have been 63 presidents who have carried the Medal of the Liberator.

In August 1926, due to multiple rumours about the theft of the Medal, a certification process was carried out. The resulting information was terrifying. Twenty-four (24) of the South African diamonds that had been inlaid in the original Medal and parts of the gold chain (originally 22 Karat) had been replaced by lower grade diamonds or gold of a lesser karat. However, the worst part was the fact that in the heart of the Liberator's Medal, the golden oval, on whose reverse the great legend was engraved, had been removed from the mounting and replaced by another.

Three appraisals (1926, 1994 and 2002) carried out by experts certified the authenticity of the medal.
Upon his death, Bolívar expressed in his will of December 10, 1830, dictated at the Santa Marta (Colombia) hacienda, his desire to return to the Bolivian people the medal he had received from him. This is the literal text of that fragment of the testament in its sixth clause:

'It is my will that the medal presented to me by the Bolivian Congress in the name of that people, be returned to them as I offered it, in proof of the true affection that I still have for that Republic in my last moments.'

There are some recent anecdotes regarding the medal.

In 2002, the medal was the subject of a profound restoration including the redesign of the central part in 22 karat gold, the dismantling and reassembly of some of the surrounding stones and the expertise carried out by two jewellers in La Paz.

After the resignation of President Sánchez de Lozada on Friday October 17, 2003, the swearing in of Carlos D. Mesa Gisbert was organized in Congress for half past ten that night. The medal was requested from the President of the Central Bank, who explained that it was impossible to deliver it because at six o'clock on Friday afternoon the vault remains hermetically closed until Monday at 8 o'clock in the morning, through a computerized electronic mechanism that makes it impossible its opening.

Now the object of our consultation is to deny or confirm the reality of the medal given its disappearance on August 8 and 9, 2018, compared to the last report issued by jewellers in 2002 with the current state of the medal in a detailed description using photographs and videos.

The deadline requested by the Institute for this work was five days (of six hours) for the study of the medal plus 5 days for the production of the report including photographs and videos.

The team in charge of this work was made up of four gemology students from the South American Gem Academy/ Institute Gemologico Boliviano and an appointed photographer of the institute all under the direction and responsibility of the Director of Education of SAGA/IGB.

Due to the increased security around the medal, a team of five soldiers under the control of a colonel, attached to the military house at the ministry of the presidency, was in charge of the medal 24 hours a day during the five days reserved for the study of the medal.

The representative of the relevant department of the ministry was also present during this period.

The medal on the front has the image of Simón Bolívar climbing the Cerro Rico de Potosí, and on the back the motto: 'La república de Bolívar agradecida al héroe cuyo nombre lleva' (The Republic of Bolívar grateful to the hero whose name bears). The medal includes 234 diamonds for a total of 51.00 carats including one oval cut diamond weighing 12.00 carats, one triangular cut cognac diamond weighing 3.40 carats and 5 round diamonds with a total weight of 12.00 carats. The metal part of the medal consists of 18 and 22 karat gold while the chain is 18 karat.

During the five days the medal was at the disposal of the Institute, the group of four students, the photographer and the director of education studied, measured, weighed, verified, controlled, estimated, observed, photographed, drafted, drew and transcribed.

To carry out this work a wide variety of gemological instruments were used including the new GemPen by Geometrics AB.

The Institute produced an expert report of 94 pages that the students delivered to the Ministry of the Presidency located in the 'Casa Grande del Pueblo' in La Paz, right on time for the possession of the new President.

In this report the Institute suggested that a replica of the medal be made, so that the original is no longer used but kept in a museum to be exposed to the view of all visitors.

This gemological adventure truly represented the 'Holy Grail' for our students!

Photographs by Jaime Mauricio Rocabado Duran

Simon Bolivar and the medal (Photo Courtesy IGB)

One last photo before the departure of the medal (Photo Courtesy IGB)

The medal in its case (Photo Courtesy IGB)

The front of the medal (Photo Courtesy IGB)


The back of the medal (Photo Courtesy IGB)

Closer observation by Pablo (Photo Courtesy IGB)

Establishment of the medal identity card with UV (Photo Courtesy IGB)

The arrival of the medal in the hands of the Colonel Chief of Security with the intervention team (Photo Courtesy IGB)

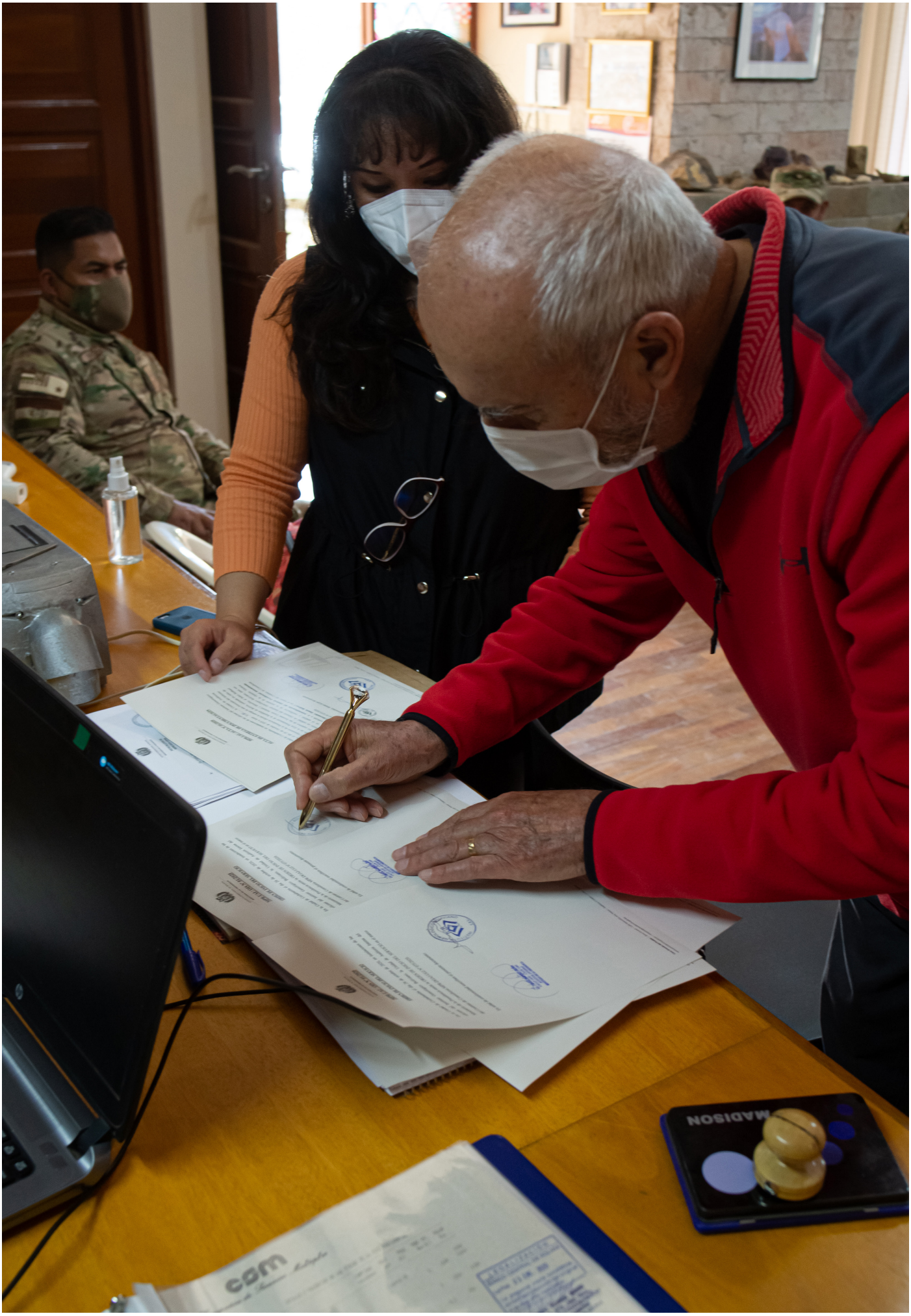
Mauricio the photographer in action (Photo Courtesy IGB)

The advantage of using computers (Photo Courtesy IGB)

The Colonel under observation (Photo Courtesy IGB)

The usefulness of the triplet loupe with Nelson (Photo Courtesy IGB)


The importance of measurements (Photo Courtesy IGB)

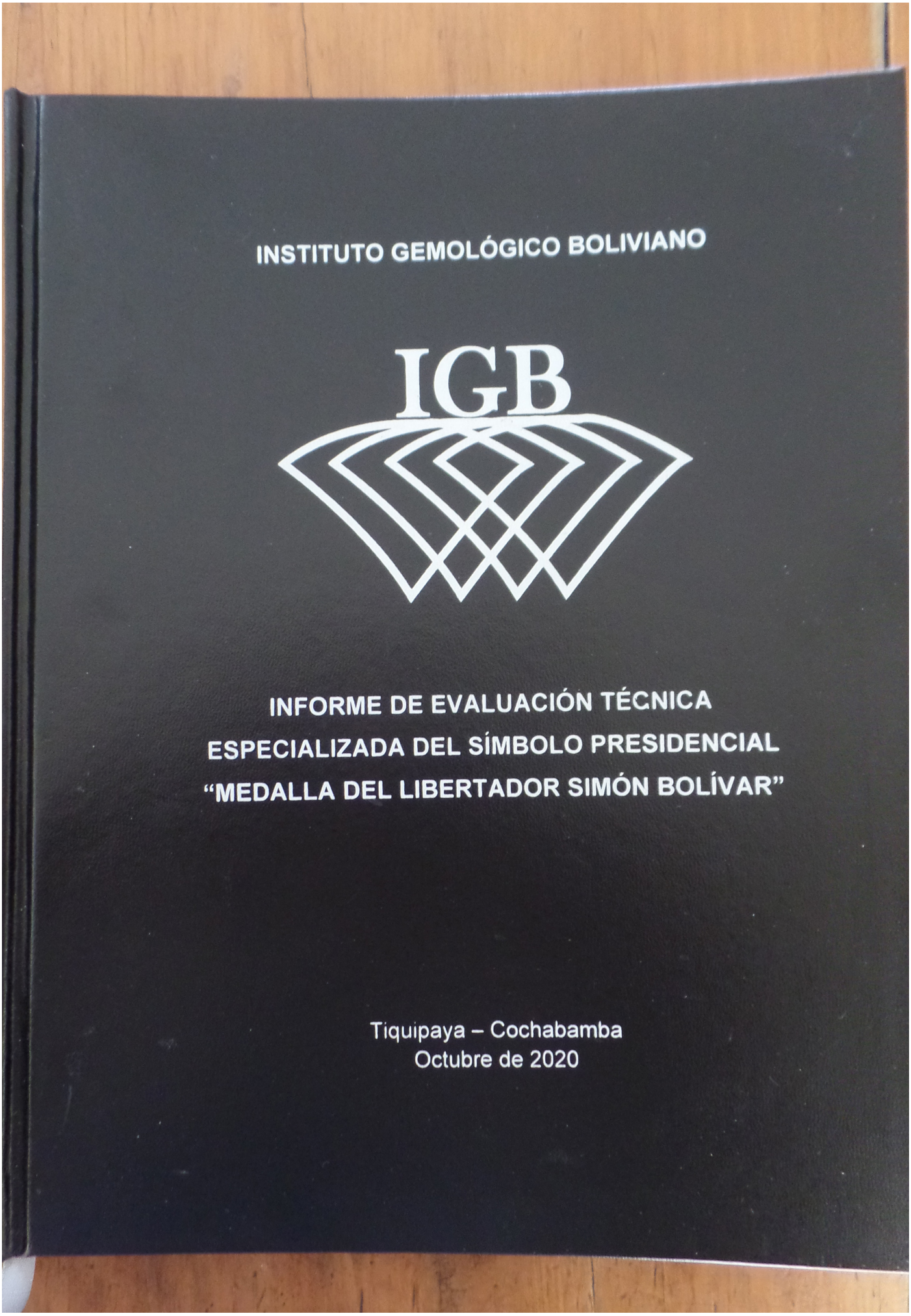



Signature of receipt of the medal (Photo Courtesy IGB)


First contact with the medal of Pablo and Guarino (Photo Courtesy IGB)

Nelson and the Medal (Photo Courtesy IGB)

From left to right, Guarino, Vladimir, Nelson, Pablo and Mauricio, in the great hall of the 'Casa Grande del Pueblo' in La Paz where the Ministry of the Presidency is located (Photo Courtesy IGB)




The Instituto Gemológico Boliviano 94 Page Report (Photo Courtesy IGB)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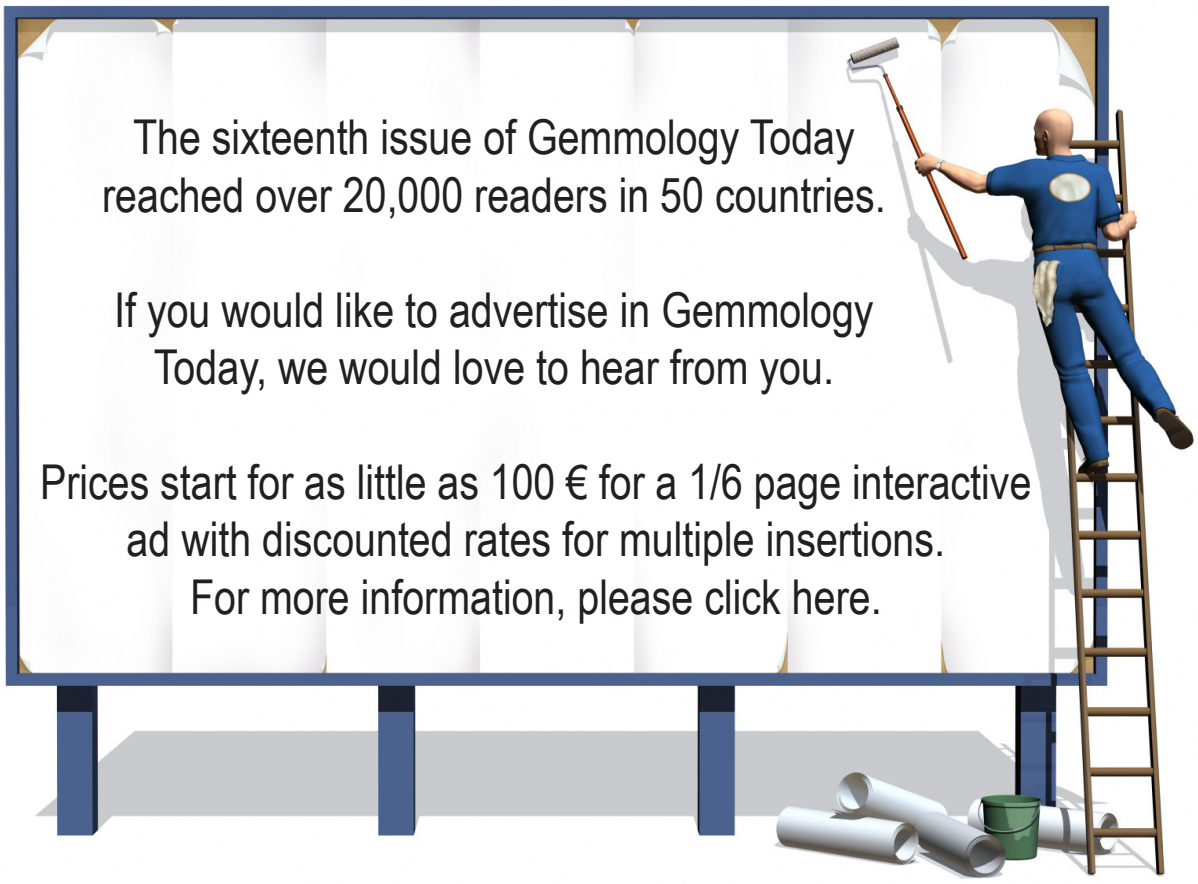

# GEMMOLOGY TODAY QUIZ #17

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This issue there are five anagrams that need to be solved. All are names of gemstones. There is a sixth anagram that is formed by the letters that correspond to the 'YELLOW' squares. All correct entries will go into a draw for a complimentary copy of 'The Handbook of Gemmology' 4th Edition (Digital Book). Entries must be submitted by January 15th, 2021.
GOOD LUCK!


For author and Gemstone Detective, the recent COVID-19 pandemic brought a small glimmer of sunshine into her life. The chance to explore her own island to see what treasures could be found close to home.

# Travels around Britain with the Gemstone Detective

Award winning beaches of the Isle of Harris (Outer Hebrides) (Photo: Kim Rix)

When worldwide travel is in your blood, what do you do when a global pandemic thwarts your plans? If you're Gemstone Detective Kim Rix, you look a little closer to home and find surprising treasures in the most unlikely of places.

Despite having to postpone both her gemstone tours to Mogok and Sri Lanka due to Covid-19 travel restrictions, Kim didn't stay put for long. Remembering how people had asked her about British gemstones, she began to wonder about the possibility of adding Great Britain to her series of gemstone-travel guidebooks.

'I hadn't realised before this how much variety there is in Britain' she said 'as it isn't really thought of as a gemstone destination.' But with possibilities for global travel at the very least uncertain over the next few months, Kim thought it was a prospect worth looking into. Confined to her own doorstep during the pandemic, many people living here have had their eyes opened to the beauty and variety in our little island. This book will introduce them to the joys of British gem hunting.

Trawling the internet, Kim found a map called 'Precious Scotland' created by her colleague and friend Alistir Wood Tate, a recently retired jeweller in Edinburgh. Using the information about Scottish gemstones to sketch out a tour itinerary, Kim set off from London to Derbyshire. In the East Midlands, about 125 miles from London, are the only two places in Britain where you can find Blue John – a local name for a variety of fluorite.

Treak Cliff Cavern and Blue John Cavern lie in a remote valley within the Peak District. Both mines are still active, using a combination of traditional methods and new technologies to coax this fragile mineral from the rock without damaging it. Once at the surface, the pieces are examined and the best specimens used for jewellery and other ornaments. Last year, some of these were snapped up by Fabergé, who turned them into a limited collection of 40 exquisite egg-shaped pendants.

Before the pandemic, the mines were popular tourist attractions offering guided tours of the excavations and caves. Though tours are off the menu at the moment, both caverns look forward to welcoming visitors back in less uncertain times.

Blue John is said to have been mined in Derbyshire since the Roman times, though there is no solid evidence that the Romans, who mined lead here, used the gemstone.

Blue John's heyday came much later, during the Georgian period, when goblets, vases and other ornaments made of the gemstone became popular. Not far from the Derbyshire mines lies Chatsworth, one of England's finest stately homes, where you can see several Blue John ornaments once belonging to the Duchess of Devonshire – a keen mineral collector.

Leaving the Peak District behind her, Kim then drove two hours north to Weardale in County Durham to meet Diana and Ian Bruce, Directors of UK Mining Ventures Ltd. They now have three mines in the area, with the most recent,

Inside the Weardale Fluorite Mine
(Photo by Kim Rix)

Lady Annabella mine, opening in October 2020. The fluorite mined here is typically a vivid emerald green with purple banding, cubic crystals and exhibits the most intense daylight fluorescence.

Having added a Weardale fluorite specimen to her collection, Kim then crossed the border into Scotland and headed for Elie Bay, on the East Coast between Edinburgh and St Andrews. Elie Bay is, enticingly, also known as 'Ruby Bay', although it is actually garnets that you can find nestling in the shingle on the beach. Garnet hunting in Elie Bay isn't something for the fair-weather beachcomber, however. 'I spent four hours on my hands and knees for my small handful of Elie Bay garnets!' says Kim.

You need to know what to look for – black and grey shingle washed in by the tide. As long as it's wet and you look hard, you should see the garnets glinting red among the stones.

Further north still, on the north-east coast of Scotland, lies Portsoy, famous for its serpentinite or 'Portsoy marble', as it is better known. The subtle play of reds and greens in this metamorphic rock caught the eye of Louis XIV, who ordered large quantities for use in the palace of Versailles. The softness of Portsoy marble makes it good for jewellery makers starting out as it's easy to carve, but some thought needs to go into the type of jewellery and setting to prevent damage to the stone.

Though Portsoy's quarry has been closed since the late 1700s, you can still find serpentinite on the beach, where the quarry spoils were emptied. There's no need to scuba dive or snorkel for it, just go where the waves and rain have made the pebbles wet and then look for colour.

One question that people always ask Kim is, 'Are there valuable gemstones to be found in Britain?' The final stage of Kim's first research trip took her to the Isle of Harris to answer this. Harris is part of the Outer Hebrides, a remote group of islands off the very north-west coast of Scotland. Kim visited Luskentyre beach on the west coast of South Harris, whilst she was there. In the past this beach has won numerous awards for its sheer beauty and it did not disappoint.

Back in the 1980s, several small, light blue sapphires were found during the construction of a farm path. Though an exciting discovery for the island of Harris, these were small fry compared with the 242 carat sapphire unearthed in 1995. Scottish sapphires tend to be small and not of the quality you'd expect to find in places like South-East Asia (that 242 carat monster sapphire was heavily fractured) but their rarity makes them a valuable and highly desirable gem.

If you're planning to go hunting for a Scottish sapphire on your own, though, Kim has one word for you – don't. Several of the Isle of Harris's beaches are now protected as Sites of Specific Scientific Interest and you're not allowed to remove anything from them. The exact location of the sapphire producing area is a closely guarded secret. 'I'm certainly not encouraging people to go and look,' says Kim, 'You could get yourself into a lot of trouble with the local constabulary!'

Entrance to the Weardale Mine
(Photo by Kim Rix)

Kim mining for Blue John in Treak Cliff Cavern (Photo by Kim Rix)

Weardale flourite specimen - inside the mine (Photo by Kim Rix)

Weardale flourite - inside the mine looking at clarity (Photo by Kim Rix)

Kim’s best find from Treak Cliff cavern - Blue John Flourite (Photo by Kim Rix)


Kim’s new accommodation (Photo courtesy of Kim Rix)

A second research trip is in the diary and it won't be long before Kim's off again. This time, she's planning to travel up to Whitby in North Yorkshire. Whitby is famous, not only for being the landing place of Dracula in Bram Stoker's novel (and hence the site of the renowned Whitby Goth Festival), but also for its jet. Here, Kim will meet Sarah Caldwell Steele, a UK expert on this intriguing gemstone.

Jet is an organic gemstone created when decaying wood is subjected to extreme pressure over millions of years. It's found in several countries, including China, Siberia, Germany and Spain, but the world's finest quality jet comes from a group of rocks called the Mulgrave Shale Member of the Whitby Mudstone Formation in the pretty North Yorkshire town of Whitby.

Though jet mining is now prohibited, there were at one time up to 300 jet mines in North Yorkshire. Traces of these can still be seen, though it is illegal to remove jet from them and highly dangerous even to enter. Collectors have traditionally combed the beach looking for jet washed up with the tide, or prised it out of the cliffs on the shoreline. This latter activity is illegal nowadays (not to mention inadvisable) due to the highly unstable nature of the shale cliffs, which have claimed many lives over the years. Modern-day jet hunters will need to be content with 'sea-washed' jet, which they can find by combing the beach.

Queen Victoria is responsible for the huge popularity of jet during her reign. Bereaved of her beloved husband, Prince Albert, she remained in formal mourning for the last 40 years of her life and used the gemstone in her jewellery. Otherwise known as 'black diamond' for its remarkably high lustre when polished, Whitby jet made a fitting mourning gemstone for a queen.

Whitby isn't the only seaside destination for Kim. Down in Suffolk, on the east coast of England, Kim will be stopping off to look for amber that washes up from the Baltics. Another of Britain's organic gemstones, Baltic amber can occasionally be found in the north of Scotland, but the best places to look are on the coast of Norfolk and the beaches of Southwold in Suffolk. This is thanks to the slowly moving ice sheets of the most recent ice age, which collected fossilised tree sap from the forests that covered what is now the Baltic sea and deposited them on the shoreline around England's east coast.

Also on Kim's agenda are Cornwall and Wales. As any fan of the BBC series Poldark knows, Cornwall was once peppered with copper mines – an industry that employed up to 30% of Cornwall's male workforce during the 18th century. Where there's copper, there's also the possibility of turquoise, whose blue to green colour is produced by the metal's presence, and it's Cornish turquoise that Kim is after.

Elie Bay Garnet (Photo by Kim Rix)

Then it's back to Wales, which Kim recently visited to investigate the Dolgellau Gold Belt in Snowdonia and the Dolaucothi gold mines in the south. Wales's capital city, Cardiff, has an excellent Mineralogy section in its Natural History Museum.

Along the way, Kim is hoping to meet up with local collectors and dealers to find out about their favourite spots for finding British treasures.

A less far-flung destination is not the only change to Kim's latest trip: she has also invested in a camper van. In previous trips, Kim has stayed in hotels or Airbnb accommodation. The pandemic, however, has made this difficult. The camper van gives Kim more freedom and security, and has proved to be an unexpected joy. 'With the camper van, I can park up in some stunning scenery and enjoy the view with a glass of wine while I write up the day's notes,' she says.

All being well, Kim hopes to publish in Spring 2021 – just in time for the holiday season!


Ever since I was a boy, I was always creating something as an art form in whatever medium was available to me. I have always strived to create something totally new and full of imagination. Anyone can copy, but to create something new, never seen before, to me this is true art. Something that's completely novel and unique, in the medium one expresses themselves in is what it is all about.

# Meet Glenn Lehrer

Glenn at play

**GT:** Artist or Gem Cutter; Gemstone or Art?

**GL:** I consider myself an artist first and foremost. You might say I approach the world with a creative mind looking for meaning and universal truths as a way to express my art. Ever since I was a boy, I was always creating something as an art form in whatever medium was available to me. I have always strived to create something totally new and full of imagination. Anyone can copy, but to create something new, never seen before, to me this is true art. Something that 's completely novel and unique, in the medium one expresses themselves in is what it is all about. I am an artist who has chosen 'Gem Cutting' and 'Carving' as my medium of expression.

Growing up, I was a very average student when it came to scholastic subjects, especially in math and science. I really struggled with these subjects. So as a young boy I turned to art and sports as a way to excel. It was in my teens where I really explored photography as an art form. I can look back now and see it was in photography where I explored light and texture creating black and white photographs.

It was not until my mid-twenties when I discovered gem carving as an incredible art medium. It became my muse where I could express my sense of beauty and light in form. Being completely captivated by gem carving, I went back to college to study mineralogy, geology, chemistry and mathematics. It was then that I discovered I was actually very versed in the subjects of science because I now had a desire and interest in the subject as it related to gem cutting. I then went on to get my gemology degree.

What really caught me, as an artist, when I first discovered gem artistry was the end result was always far greater than the initial vision of what I wanted to create. No other art medium ever captivated me this way. I discovered I could paint with light and form together with nature's amazing natural gemstone materials.

Being a gem artist requires well-grounded artist ability, a background in the science of gemology and mineralogy along with some mechanical machining abilities. One must have a basic grounding in the natural science of gemology along with some mineralogy. This means you need an understanding of gem properties such as the critical angle of light and reflection along with the physical properties of hardness, cleavage and color zoning in the full range of gemstone species. Mechanical ability refers to the ability to machine one's own lapidary tools, the ability to fix and modify one's equipment, most specifically the ability to make one's own carving tools. Many tools for carving do not exist over the counter. One has to create many of them if one wants to be able to do unique and creative carvings in gemstones.

**GT:** What is the most challenging gemstone you have ever cut?

**GL:** To be fortunate enough to cut one of the largest, rarest and finest gemstones on the planet in my lifetime as a Gem Artist is something I will always be grateful for. Though it has been the most challenging gemstone I've ever done, the end result is now one of the most famous gemstone sculptures in the world.

Bahia is an optical clear Rutile Quartz sculpture that weighs 425 lbs (192.7 kilos or close to 1 million carats) and is suspended from two 3/16" steel cables like a giant hanging pendant. How I was fortunate enough to be able to cut and carve this magnificent giant gemstone is the story I am about to tell.

Bahia is the world's largest hanging gemstone sculpture. It hangs permanently in the lobby of the Gemological Institute of America (GIA) in Carlsbad, California in the USA. The sculpture is 5 feet in length and hangs over 30 feet from the tall ceiling of the tower in which it is permanently displayed. A rare fine gemstone of this extraordinary size and clarity only comes along once in hundreds of years. I consider Bahia one of the greatest accolades, to date, in my 44-year career.

It took my colleague Lawrence Stoller and I, 5 ½ years to cut and carve it and then another 2 ½ years to fabricate the steel frame in which Bahia hangs from two 3/8" steel cables. In total, it took 8 years, from the beginning to end, to complete this huge gemstone.

There are several factors that made Bahia so difficult and challenging. First, because of its size, we needed to make many of the tools in order to saw, facet and polish such extremely large flat facets. It took months to machine and fabricate the tools we needed to cut and polish such a large gemstone.

Anyone who facets, knows that the larger the flat facet, the exponentially longer it takes to get a water clear polish. This alone took hundreds of hours. Also because of the size and weight we had to figure how to bring the equipment to the stone verses in normal gem cutting bringing the gemstone to the machine.

Bahia was extremely rare in that it was optical from tip to double terminated tip. Lawrence and I were determined to cut it as one piece and retain as much of the original size and weight. When the stone was uncrated in California you could not see its full clarity because a thick 1/2-inch layer of clay matrix was baked onto the surface of the stone. After 8 hours of sawing the first front cut, so as to reveal the clarity, we could see two parallel cleavage plane cracks along the rhombohedral direction of the quartz termination. Fortunately for us, the cleavages only partially entered the stone and were not severe enough that we felt we could not work with them.

If one looks up in any mineralogy book about cleavage in quartz, almost every one will wrongly state that quartz does not have cleavage. The truth is every cutter who works with quartz will tell you the opposite. It is not what is called a distinct cleavage where in most cases one can physically hammer to separate the stone along it's cleavage planes. A cleavage plane in minerals is where the molecules have the weakest electrical bond thus it tends to break in straight even flat planes when a physical shock is induced. One often thinks of a diamond cutter splitting a diamond evenly with a hammer, in quartz it is what we call 'indistinct cleavage' in that it is activated by thermal shock. This means that if the stone is very warm and you lower the temperature too quickly it will crack along these perfect planes. Inversely, if the stone is cold and you heat it up too fast it will also crack along the cleavage plane.

After removing the clay surface from the large prism face of the crystal we could see two parallel cleavages along the rhombohedral plane of the quartz. As we started grinding and sanding the large front face of the stone, one could see the cleavage cracks creep along inside the stone, getting worse as we proceeded. Because so much heat was generated on such a large gemstone, there was no way to control the cleavage from growing. This was such a major setback at the time. We were so focused on keeping it intact as one large gemstone that when the cleavage planes kept growing we were devastated. All of a sudden, we could feel our dream of cutting such a large stone being dashed. I often compare the emotion like the death of a loved one. You just have this most awful sinking painful feeling in your stomach. We just did not know what to do. For the time it appeared we were going to end up with three separate smaller less significant gem sculptures. After several months and hours and hours of work, we were looking at three stones instead of one. We were so upset at the time that we had to take a step back from the piece for over 6 months. We felt that we no longer had this great, very large gemstone.

This 6-month 'break' turned out to be a blessing in disguise. It was during this time when Lawrence, his wife Sunni along with my wife Sharon and I would sit around dreaming about what we should do next that we had an 'epiphany'. We concluded that we had to cut the stone into three sections while somehow keeping it as a single sculpture. This forced us to push the 'creative envelope' to a higher level and come up with a very imaginative solution, to sculpt a steel frame to bring the three pieces back together into one. The concept of hanging it from a ceiling, like a giant gemstone pendant, started the creative juices flowing again. It was just such a brilliant concept and it re-invigorated Lawrence and I to take back up the work and move forward. When we started working on Bahia, we envisioned an 18-month project. In reality it turned into an 8 year odyssey (5 ½ years to complete the cutting and polishing plus another 2 ½ years to work on the steel frame and the engineering required to hang the sculpture from a ceiling).

**GT:** What is the most enjoyable gemstone you have ever cut?

**GL:** The birth of the 'Fantasia' series. The major break in my apprenticeship came when I started travelling yearly to Idar-Oberstein and working alongside Bernard Becker and then later, Uli Pauly. With Bernard, my first piece was a red, green

and brown carved jasper that was fashioned as a grape leaf. Then onto a complex orchid two-piece flower in frosted quartz that I then had Bernard carve a hummingbird suckling from it.

From this point on I was charging out the gate. I now had the tools and the means to carve any wild dream I could visualize. Due to a lack of funds on my end, chalcedony became my medium to venture and create with, due to the very reasonable cost and sheer diversity. Thus, the 'Fantasia' series was born. I was inspired by the folds in the fabric that one would see in a Renaissance painting to the blurred images of Monet's Impressionism.

I would see images the way many people see clouds. From each individual viewpoint one would see a leaf, the fluttering of a butterfly wing or an angelic being in flight in the same carving. I would allow myself to see more than one image and fold them into one seamless carving. Each piece was unique, left to the viewer's imagination to interpret it. This was unique in that from the perspective of art for art's sake, an artist generally creates a whole image, to stand-alone and be a full expression of a vision or statement. I was creating art that I felt was only half done, but on purpose with regard to design. In other words, I would create just some of the expression, leaving lots of creative space for the jewelry designers or goldsmiths and their own inspirations. Each jeweler would see something completely different.

The 'Fantasia' series is the foundation where my recognition as a 'Gem Artist' came of age. I was beginning to win gem cutting awards in the US and abroad. So unique was my use of chalcedony and agate that I was beginning to be featured regularly on national and international trade magazine covers. This launched me as a professional 'Gem Artist' and an all-round lapidarist. To this day I still create this style, even though they are time consuming and are typically one-of-a-kind. The good news is that each piece is a stand-alone original, unique in material and style. The downside is, our industry is based on numbers of reproduction one can do with the same size gemstone in a multi produced precious metal setting. Thus, producing hundreds if not thousands of the same look. This is not possible with the 'Fantasia' series. Each piece is unique.

When it comes to the carving of gemstone materials, the most enjoyable is the banded agate and chalcedony that have 'drusy' pockets that often form in the agate or chalcedony. It comes in almost every color of the rainbow and variations in the banding of agate. It is relatively inexpensive compared to most transparent gemstone material allowing one the comfort of not having to worry that much about weight loss. It also comes in large sizes so one can do figurative and motif style carving.

The 'Fantasia Series' is very impressionistic, stylized after organic forms such as birds, leaves, animals and organic forms found in nature. Back in 1989, when I first came out with them, they were unique and revolutionary. To this day they have remained extremely popular with jewelry designers and my private collectors.

Rare natural transparent gem material is transformed into something greater than Nature created herself. She took it to 'Her' level of perfection by aligning elements to form molecules that then organized themselves into a 3D repeating pattern of geometry that creates something so transparent durable and clear. Then I came along, also a product of Nature, to innovate and take the knowledge of refraction to paint a prism of brilliant light and color. In some cases, I am co-creating with somebody else or a team of individuals but in another way, I am also co-creating with Nature herself.

As a 'Gem Artist' I feel and know I'm co-creating all the time. I'm considering the hardness, its angle of refraction, its durability with regards to how thick or thin I can carve it, constantly dancing with these natural properties as I wrap a dream into a creation.

**GT:** Talk us through the artistic process from the initial concept and design to the finished gemstone.

**GL:** There are three very different ways I approach cutting and carving a gemstone.

The first way is where I just start carving/cutting a gemstone with no clear idea as to what will be the end result. Often, when I carve within my 'Fantasia' series, I let the stone talk to me, revealing what lies within. As I'm carving, the image of an idea of the motif just appears during the actual working of the gemstone. This is very exciting to me because aside from being the carver/cutter during the process, I am also the viewer experiencing the excitement of the stone revealing what lies within it. It feels more like the stone is talking to me and leading me to where it wants to be in the final design. This is the most exciting and completely free way to carve and cut gemstones

The second way is where I have a clear concept of what I want to carve or cut like in the case of my opal seahorse or the rose quartz lotus flower.

I start out with a design that I sketch out on paper. From there, I look within my inventory for the perfect piece of rough that I feel will work best with the design I've drawn out. If I don't have the perfect piece of rough, then I reach out to the many rough gemstone supplies around the world to try and locate the perfect piece of rough. This happened with the lotus flower. It took me over 2 ½ years of reaching out to suppliers of rough from both Brazil and Madagascar

requesting size, clarity and color quality requirements. One of my best suppliers from Madagascar finally located a 3.8-kilo, top color and very clean piece of rough. Although ideally I only needed a piece of rough that weighed around 0.75 kilos, and measured around 80.0 millimeters for the lotus flower, I had to purchase the rough that was 5 times the weight in order to carve the flower I had designed for the carving. Of course I had lots of good rough left over for other projects but when you need just the right piece, one needs to be open to what is available since it is a natural substance that Mother Nature produces as a limited resource. When I finally have the right piece of rough in hand and begin to carve it, I also need to be open and sensitive to what this natural gem rough could actually produce. In other words, one may have a concept on paper but when working with a very rare natural gem material, one does need to be open to changes as the image emerges in the stone.

The third approach is when I'm working with very rare and valuable gemstone material such as sapphire, emerald or ruby. Here one needs to take the rough shape into consideration and decide the best shape to yield the maximum weight retention bearing in mind the high value of the gem material and the resulting per carat weight value. This approach is the most confining of all when it comes to executing gem cutting or carving.

**GT:** Art and economics don't always work hand in hand. There is often a fine line between the two. How do you approach it?

**GL:** There are two very different aspects in our gemstone industry. There is the excepted intrinsic value of precious gem material such as ruby, sapphire, emerald etc. in the gemstone industry. If I am cutting one of these types of gem material, I honor the current carat price of this type of material. It is here that I am very aware of the economics based on the perceived value within the gem industry.

The other aspect is governed by my brand recognition, my expertise as a renowned gem artist, with award winning cuts, numerous magazine covers and exhibits in museums. These all add 'value' to my work. Many collectors buy my work believing that when I am no longer producing, they will go up in value because of the limited number available. This is a perceived value based on name recognition that is similar to fine art. Like fine art, it is not the intrinsic value of the materials the object is composed of but what a collector is willing to pay for it. In my case, many of my carvings are a combination of the intrinsic value of the gem material along with name brand recognition. This ultimately determines the value.

**GT:** What was the defining moment when you decided to cut gemstones?

**GL:** Back in 1975 I had just returned from my 3 years of travel around the world where I had also lived in India for half of this time. Upon returning to America I had no idea what I wanted to do with my life. It was my older brother, who back in 1976 handed me a free form polished optical quartz. I had never been interested in gemstones or jewelry up to this point. When he handed it to me it was like a lightning bolt of electrical energy that ran up my arm and exploded in my heart and mind. Being an artist, I immediately wanted to know how to cut and carve it. Living in America back then, there were no teachers or schools so I went out and bought my own lapidary equipment and began to teach myself the art form. This was a solo ten-year journey of exploration. During this time, I really wanted to learn more about the material I was working on so I re-enrolled back in college in geology, mineralogy, chemistry and crystallography. I then went on to study gemology at the Gemological Institute of America (GIA) in residence to earn my degree. After graduating from GIA in 1986, I wanted to travel to Idar-Oberstein, Germany where there has been a 500-year tradition in the art form to meet gem carvers. I immediately met some of the most skilled and acclaimed carvers of the day.

I was invited back to study and co-create over the next 10 years with some of these masters of the art. It is there where my carving really excelled and took off. Along with my studying and co-creating with a couple of the masters, I was able to equip my studio with many of the tools available only in this acclaimed village.

**GT:** Natural artistic ability or a learned skill?

**GL:** I feel it is a combination of both artistic abilities along with years of practice and study in the discipline to facet and carve a gemstone. For sure one should have a very deep sense of natural artist ability. To be very accomplished in the art of gem cutting takes years of practice. That saying 'it takes over 10,000 hours to master a skill or discipline' and this is so very true in 'Gem Art'. It just takes that long to learn the skill of actual cutting and carving along with the dozens of difference gem species and their unique properties. This makes it a long learning curve in order to master the art.

The skill of faceting gemstones can come quickly in the ability to control the faceting machine along with learning the various steps of cutting and polishing in a particular range of gemstones (i.e. garnet). I feel one can become very proficient in faceting in the first year of faceting. In addition, there are many good books out there where one can learn via written instruction. With a few more years of practice cutting various facet patterns along with learning the various laps needed for different gem species, one can become quite expert in under 5 years.

Carving is a completely different skill in lapidary taking, in my opinion, anywhere from 5 to 8 years in order to become very skilled and proficient in this form of lapidary art depending on the type of carving one does. First it takes quite a lot of time to build up one's assortment of manufactured plated and sintered diamond tools of different coarseness as well as custom handmade soft steel carving tools. Making one's steel hand charged diamond tools is so critical to being able to have a versatile range of sizes and shapes to carve with. Secondly the hardest part of carving is learning to achieve a polish. It is not that hard to 'rough out' and carve the shape one desires. What takes years of skill is learning how to polish with expertise all the different types of gem species to achieve a water clear polish free of scratches and wheel marks. The range of different tools I have made, in soft steel, copper and different hard woods, has taken me years to build up in my tools assortment.

**GT:** Compared to when you started cutting, is there more awareness and acceptance now for what you are doing?

**GL:** Yes, back in the mid 1980's, this style of carving and fantasy cutting, which included a combination of faceting and carving to create completely unique styles in transparent gem material, was considered quite fringe in the gem industry. With a handful of Germany and American Gem artists, the style often call 'Fantasy' cutting was born.

Today, one can look to almost every continent and see many Gem Artists versed in this style of lapidary. Today it is now an established and excepted form of gem cutting and carving.

**GT:** What advice can you give to somebody who wants to start cutting gemstones? Where would they begin?

**GL:** If one is just beginning, it is always ideal to locate a teacher in the specific discipline one is interested in learning. One needs to remember that cutting and polishing a stone takes lots of patience in a step-by-step process. This is one art form you cannot rush into and expect immediate results. No matter how you look at it, or how accomplished you are, it still take patience to achieve the fine polish required for a gemstone to be considered a completed gemstone.

Cabochon cutting is probably the easiest place to start. One can purchase an all-in-one cabochon machine complete with all the grinding, sanding and polishing wheels needed. This is the simplest of acquired tools in order to cut a gemstone. There are many great machines available on the market that one can buy and start cabbing right away.

If one is interested in faceting, one can learn from the many good books out there, research the various faceting machines available on the market, find a teacher in your area and start faceting quite quickly. Here in the United States and the UK, there are many lapidary clubs and guilds where you can learn from a skilled faceter. There are also many great books that have hundreds of facet patterns. You can begin with inexpensive material such as quartz or synthetic gems and then progress to more expensive gem material when you have achieved a level of proficiency.

Gem carving is a whole different medium in lapidary. It is the most difficult to learn and master. If one were fortunate enough to locate a teacher to study under this would be ideal. It takes a long time to develop the skills along with the necessary machinery and tools to begin the process. For me I was self-taught for the first 10 years only because back in the 1970's, there were no teachers to study under. It was only after 10 years of self-teaching with trial and lots of error that I began to feel I was making real progress. You might say that I paid for my education through all my mistakes and the loss of valuable gem material! After 10 years of carving gems on my own and studying gemology at GIA, I was very fortunate to find masters in the famous Idar-Oberstein, Germany valley that were open to me working with them in their studios. This took me to a whole new level. But it still required more than 10,000 hours of practice before I felt I had mastered the art form of gem carving. In reality it can take 14 to 15 years before a gem carver comes into his/her own as a standout gem artist. It is a long road, so one needs lots of patience, passion and commitment in this form of lapidary to master and achieve a level of artistry in gem carving.

**GT:** If we were sitting down one year from now, what would you say constituted a good year for Glenn Lehrer?

**GL:** I have been working for over 11 years on a museum collection entitled, 'Synergy and Symbiosis' with the famous jewelry designer Paula Crevoshay. I have done all the gem carvings and she has finished all the jewelry designs. Many of my carvings in the collection have already won world international awards or have appeared on magazine covers or in articles about 'Gem Art'.

We have been collaborating on this collection with the clear intention that this twelve-piece collection, by two very renowned artists in their respective fields, would be a pinnacle in 'Gem and Jewelry' art and would then travel the world and be exhibited in museums worldwide.

The completed collection is a major accomplishment that we are both very excited about ('Ice Angel' and 'Georgia's Dream' are two fine examples of what the collection is comprised of).

Ultimately we hope to find a collector who wants to invest in and own the collection. This would make 2021 an exceptional year if we were able to achieve these two goals. A hardbound 83-page full color book is available upon request at this point for serious collectors or museum

curators who are interested in purchasing or exhibiting the collection. None the twelve pieces will be sold individually. The collection is to be purchased in its entirety. Eventually when the collection has gone on tour or has been acquired by a collector, we will publish the book with the intent of selling it worldwide.

Other successes for me would include my branded cuts in my jewelry designs finally being available on network TV here in the USA and in parts of Europe. I have been on a large TV jewelry sales channel in the U.K. for the past 9 years with amazing success that continues to this day. However, I would love to work with a well-known large American channel that I have been in discussion with and under consideration for the last 2 years. I am also finalizing a deal with a European channel that I have been working on for the last year and a half. Launching my brand on one or both of these channels would surely constitute a very successful year for me.

Lehrer Gem Silica Chrysocolla carving set in a Paula Crevoshay 18Kt yellow gold Necklace

Maine Phoenix Award Winner Carved Maine Watermelon Tourmaline (179.0 carats) set in 18Kt. Carving and Gold Fabrication by Lehrer


Award winning carving by Lehrer with an African Blue Chalcedony, Black Drusy Agate and Montana Golden Sapphire (4.02 carat) TorusRing

Bahia, Golden Rutile Quartz, weighing 193.3 Kilograms. 'Worlds Largest Hanging Pendant' (GIA) Collaboration L. Stoller & G. Lehrer.

Carved Dendritic Agate set in 18Kt yellow gold Paula Crevoshay Design

Carved Iris Agate

‘Georgia’s Dream’ part of the Crevoshay and Lehrer Synergy-Symbiosis Collection Gem Silica Chrysocolla carving in 18Kt gold

Carved Drusy Agate set in a Mark Schneider Design 18Kt ‘Ballerina Series’

Carved Dendritic Agate set in a Mark Schneider Design 18Kt ‘Angel Series’

‘Jingu’ part of the Crevoshay and Lehrer Synergy-Symbiosis Collection Dendritic Agate carving in 18Kt gold

Kent Raible Design with a Lehrer Tanzanite TorusRing cut with diamonds set in an 18Kt gold granulation necklace

‘Ice Angel’ part of the Crevoshay and Lehrer Synergy-Symbiosis Collection Facet carved 194 carat Aquamarine in 18Kt gold

‘Sentience’ bangle bracelet by Yael Designs set with an invisible set Tanzanite in an Aquamarine TorusRing cut

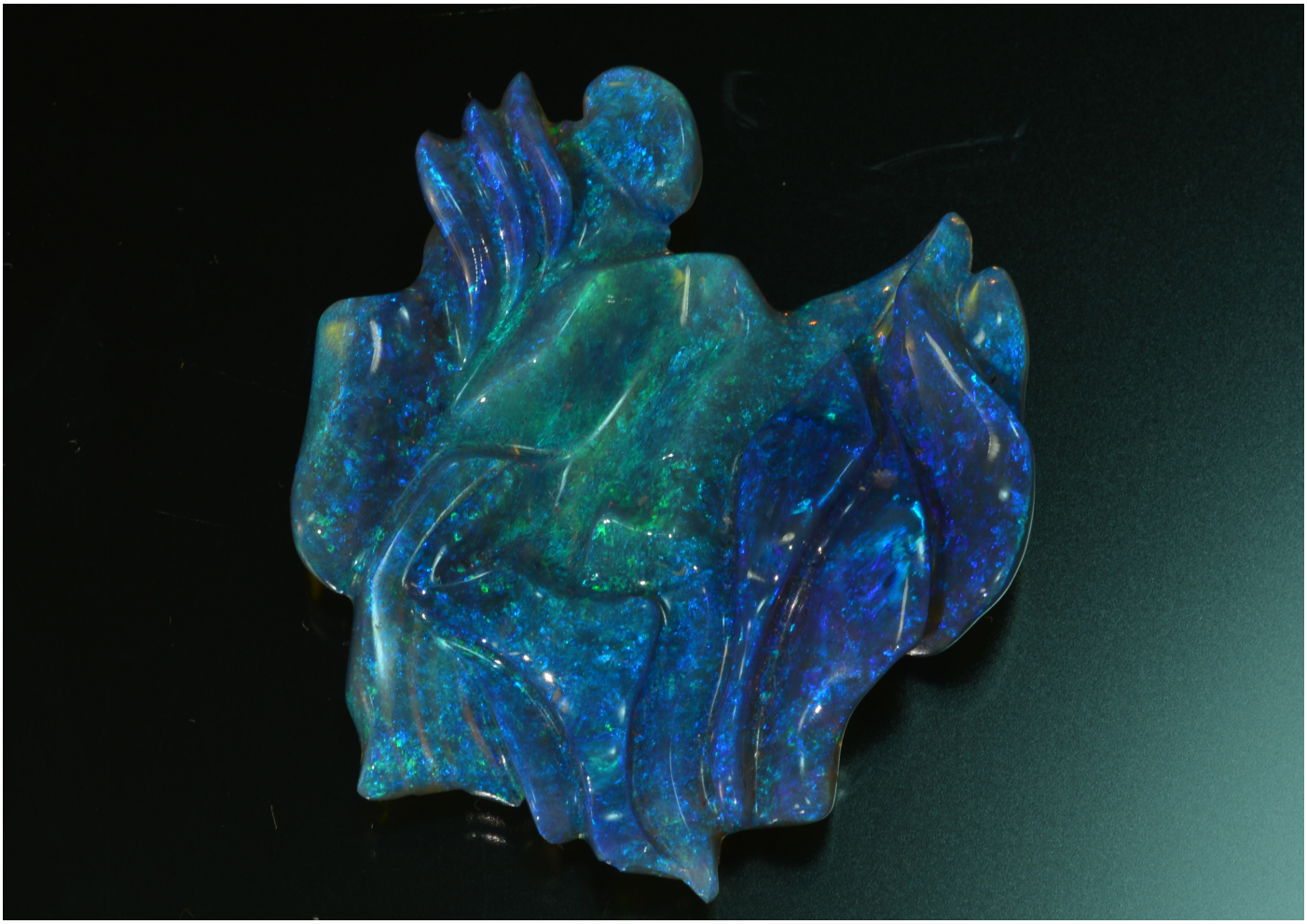
Gordon Aatlo Design in 18Kt gold and diamond ring set with a Lehrer Green Paraiba Tourmaline TorusRing cut

Carved Oregon Opal Sea Horse, weighing 64.61 carats with pink sapphire TorusRing cut for the eye

Award winning Gem Silica and Malachite Chalcedony carving, weighing 75.09 carats

Mojave Blue Drusy Chalcedony ‘Fantasia’ carving, weighing 98.19 carats and measuring 54.9mm x 44.8mm x 11.5 mm

Petrified Salmon Color Agate ‘Fantasia’ carving in a Paula Crevoshay Design, set in 18Kt



Lightning Ridge Grey-Black Crystal Opal Carving, weighing 28.76 carats and measuring 34.5mm x 31.1mm x 7.3 mm

‘Sacred Lotus’ carved Rose Quartz, weighing 322.7 carats, measuring 79.5mm x 69.8mm x 19.5 mm set with a Montana Blue Sapphire, weighing 5.56 carats and measuring 15.5 mm (in diameter) with a Padparadscha Sapphire (0.65 carats) and platinum

Lightning Ridge Crystal Fire Opal Carving (Paula Crevoshay Design)

‘Jingu’ Dendritic Agate carving in 18Kt gold (Paula Crevoshay Design)

# 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 (5 modules - 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 60 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, HPHT, CVD, Detonation, Ultrasonic Cavitation Skull Crucible, Zone Melt, Horizontally Oriented Crystallization, the Sublimation Method, and the Modified Stöber 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 module looks specifically at diamonds, their physical and optical properties, geology, localities, principle mines, crystal system, chemical composition and classification, causes of colour (fancy coloured diamonds), absorption spectra, inclusions, fluorescence, diamond cutting and mining 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, pricing 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 60 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 60 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 Coloured Gemstone Professional 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 60 hour online Coloured Gemstone Grading #2 course.

## Residency Programs

We are delighted to announce that our Career Gemmologist, Diamond Professional and Coloured Gemstone Professional Diploma Programs are now available as a full-time residency program through the French-Swiss Gem Academy in Nice, France and the Gem Academy of Canada in Montreal, Canada.

Integrating the theoretical and practical components of these programs, students can earn their Career Gemmologist Diploma in six-months, their Diamond Professional in one month and their Coloured Gemstone Professional Diploma in five months.

## Courses in Other Languages

All of our diploma courses are now available in English, Spanish & French. Our three general interest courses are also available in English & French and will be available in Spanish in early 2021.

## 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 five theoretical courses (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). Students taking any of the three 'General Interest' courses will receive a credit equal to the cost of the course if they upgrade to our Coloured Gemstones course.

### 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 world 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 in a classroom or 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 outlines the number of online tutoring hours that are included in our courses. If you require additional tutoring, you can talk to your tutor 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 |

### Once a Student, Always a Student

We appreciate that the science of gemmology is constantly evolving. Every year new lab-created gemstones and treatments and enhancements are emerging in the market place along with new techniques and advanced technology to detect them. While your knowledge in certain areas may be relevant today, it may be obsolete tomorrow.

To meet this challenge, the World Gem Foundation has introduced our 'One a Student, Always a Student' policy, an innovative program that is unique to the World Gem Foundation and our affiliated gem academies.

Once you register for one of our courses or programs, we provide you with lifetime access to your student page so that every two years when we update our courses, you will receive the latest digital course notes free of charge.

## Flexible Study Schedules

Benjamin Franklin once said 'An investment in knowledge pays the best interest' and this is as true today as it was back then. But how can we achieve this when we all lead such busy lives?

At the World Gem Foundation, we appreciate that we all have responsibilities and commitments that can make studying a challenge.

To meet this challenge, we offer a flexible study schedule that allows you to register at any time and study at your own pace.

Enrol in one of our three diploma programs, take the theory and practical diploma courses separately and receive course credits or take our general interest courses. The choice is yours! Our goal is to help you devise a study schedule that works for you!

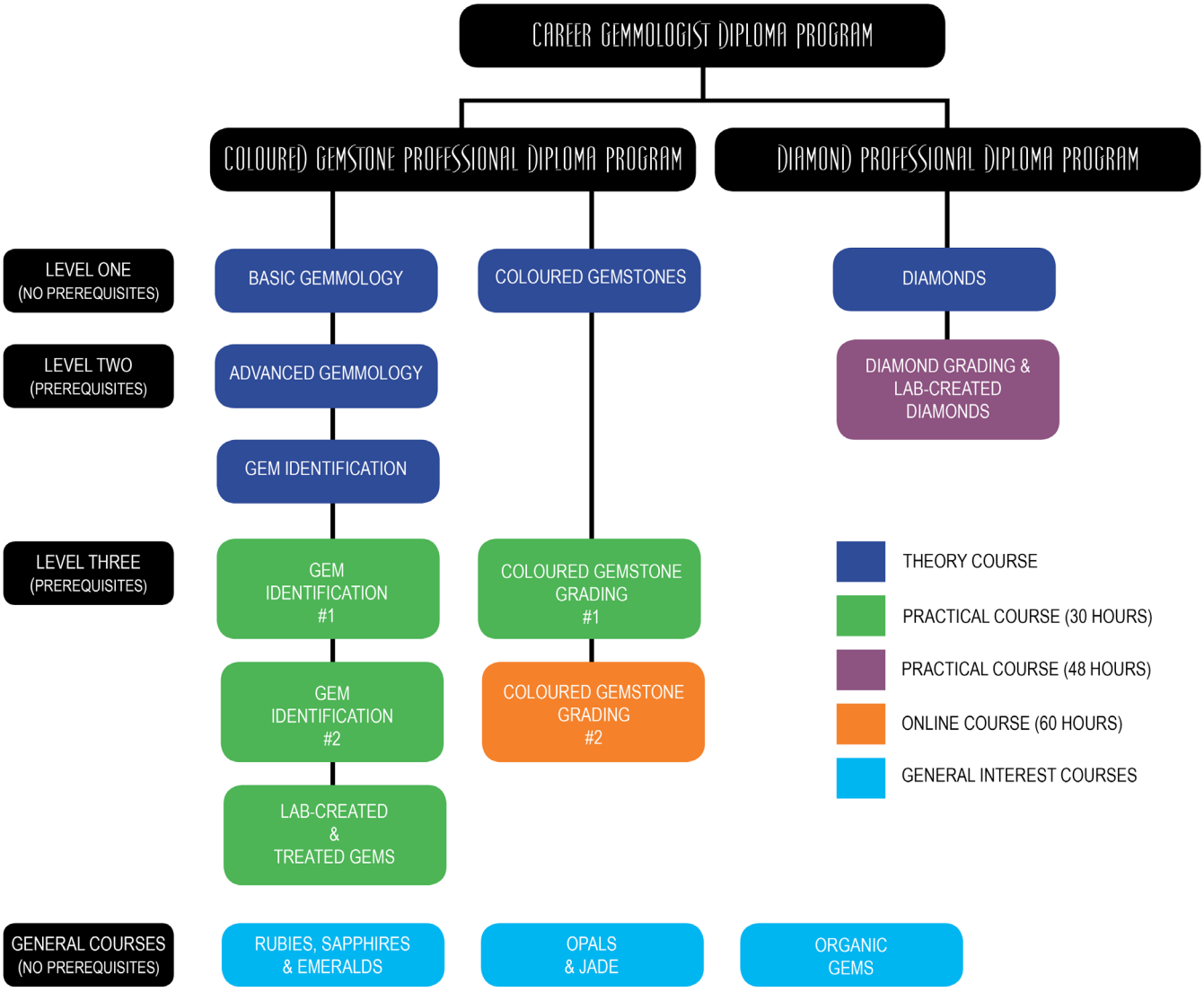
Whether you are taking our online tests, writing our final theoretical examinations or taking a practical test, we provide you with the flexibility to make it possible. Our students are our major stakeholders and we believe it is our responsibility to offer them every opportunity to achieve their educational goals.

## Available in Print

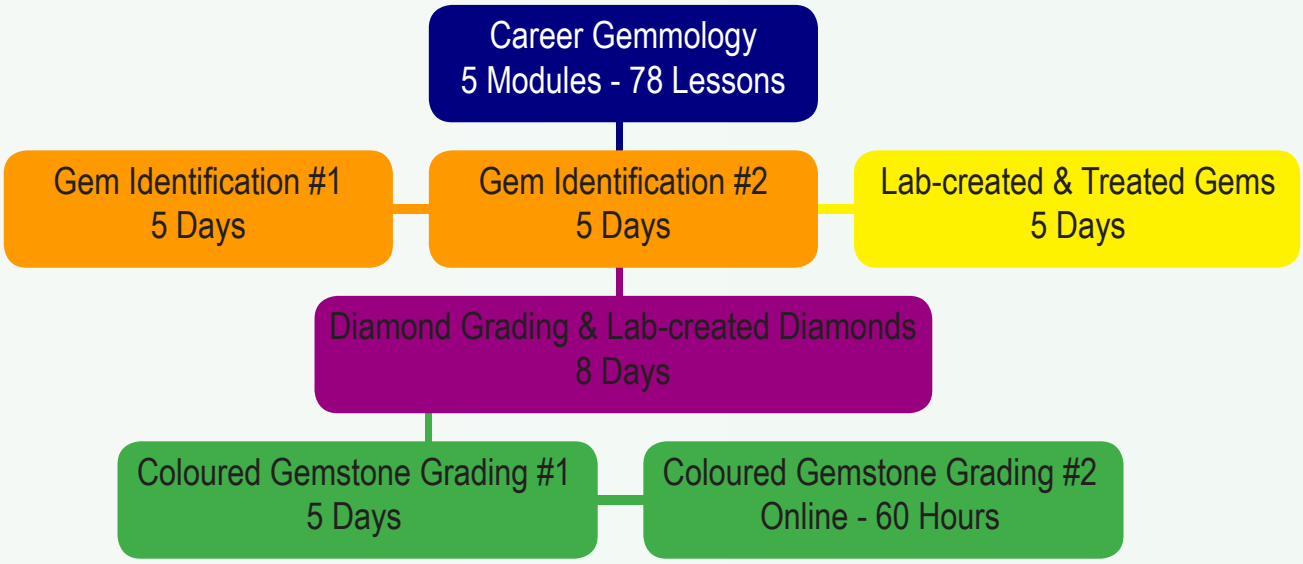
All our diploma theoretical courses are available in print.

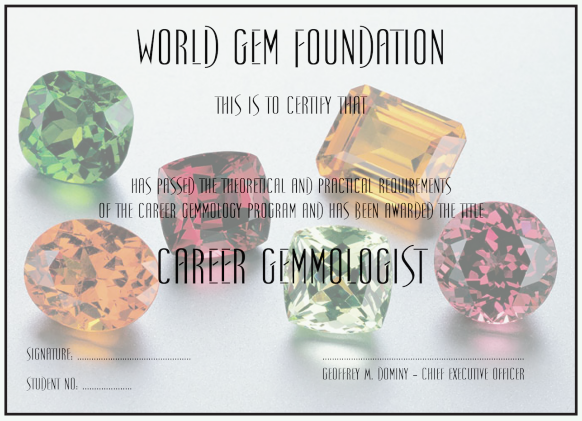
## Course Fees

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.



# GEMMOLOGY SEVEN PROGRAM

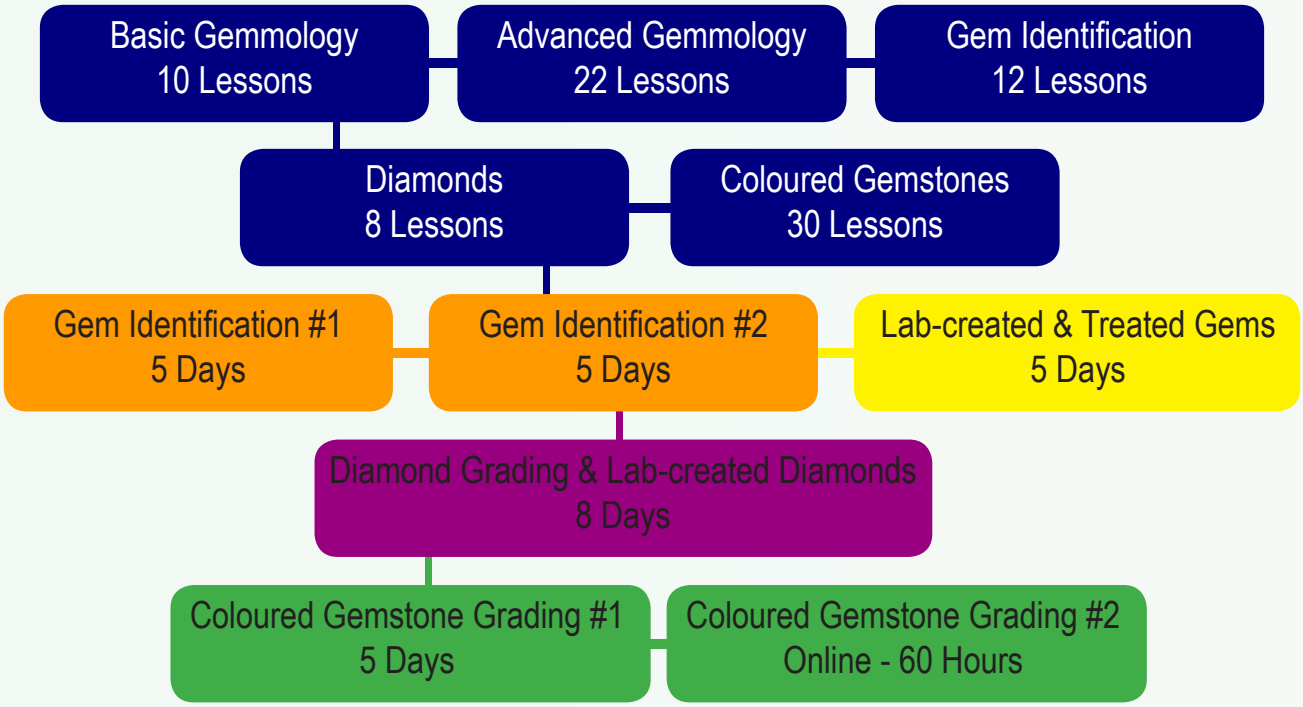



## Career Gemmology Seven — Digital Fees

| Course Name | Euros | Pounds Sterling | USD |
|---|---|---|---|
| Career Gemmology (Theory) | 1400 | 1250 | 1600 |
| Gem Identification #1 | 500 | 450 | 550 |
| Gem Identification #2 | 500 | 450 | 550 |
| Coloured Gemstone Grading #1 | 500 | 450 | 550 |
| Coloured Gemstone Grading #2 | 1000 | 900 | 1150 |
| Diamond Grading/Lab-created Diamonds | 1750 | 1575 | 2000 |
| Lab-created & Treated Gems | 500 | 450 | 550 |
| Examinations Fees ( Final Exam) | 250 | 225 | 280 |
| **Total Cost** | 6400 | 5750 | 7230 |

# GEMMOLOGY ELEVEN PROGRAM



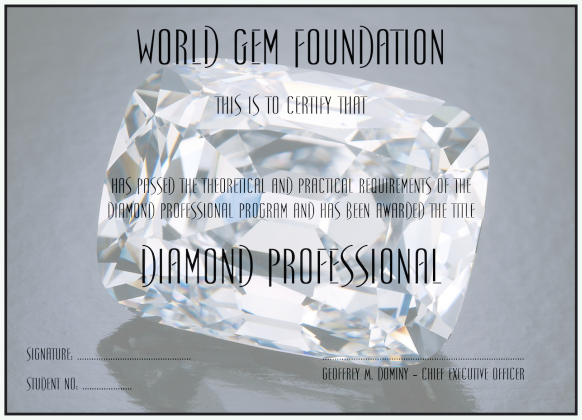

## Career Gemmology Eleven — Digital Fees

| Course Name | Euros | Pounds Sterling | USD |
|---|---|---|---|
| Basic Gemmology (Theory) | 200 | 180 | 225 |
| Advanced Gemmology (Theory) | 400 | 360 | 450 |
| Gem Identification (Theory) | 225 | 200 | 250 |
| Diamonds (Theory) | 225 | 200 | 250 |
| Coloured Gemstones (Theory) | 500 | 450 | 550 |
| Gem Identification #1 | 500 | 450 | 550 |
| Gem Identification #2 | 500 | 450 | 550 |
| Coloured Gemstone Grading #1 | 500 | 450 | 550 |
| Coloured Gemstone Grading #2 | 1000 | 900 | 1150 |
| Diamond Grading/Lab-created Diamonds | 1750 | 1575 | 2000 |
| Lab-created & Treated Gems | 500 | 450 | 550 |
| Examinations Fees ( Final Exam) | 250 | 225 | 280 |
| **Total Cost** | 6550 | 5890 | 7355 |

# DIAMOND PROFESSIONAL

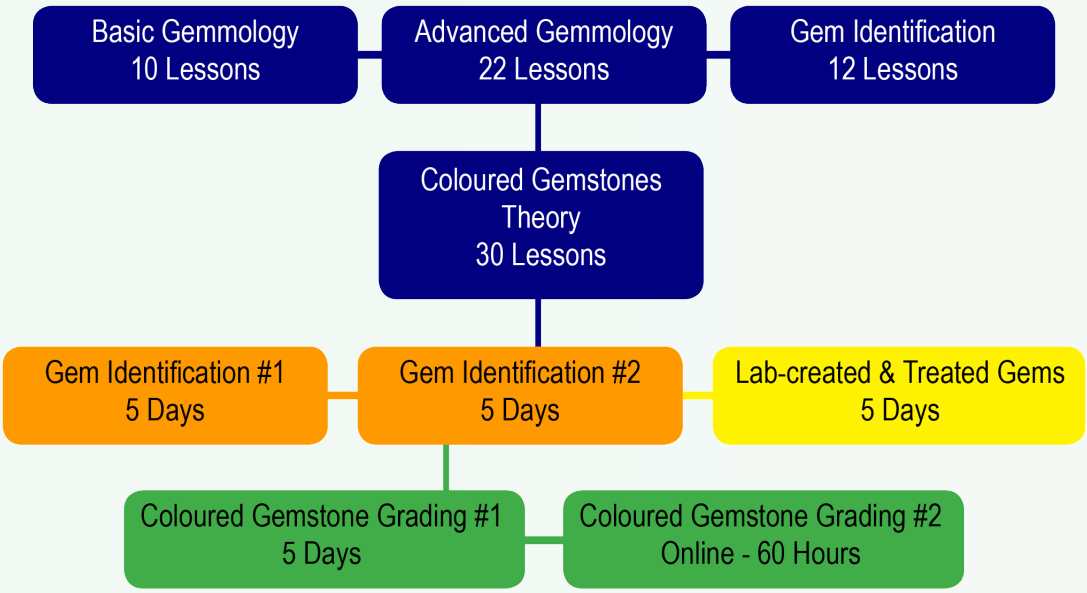
Diamonds
Theory
8 Lessons

Diamond Grading & Lab-created Diamonds
Practical Workshop
8 Days




| Diamond Professional | Digital Fees | | |
|---|---|---|---|
| **Course Name** | **Euros** | **Pounds Sterling** | **USD** |
| Diamonds (Theory) | 225 | 200 | 250 |
| Diamond Grading/Lab-created Diamonds | 1750 | 1575 | 2000 |
| Examinations Fees ( Final Exam) | 250 | 225 | 280 |
| **Total Cost** | 2225 | 2000 | 2530 |

# COLOURED GEMSTONE PROFESSIONAL

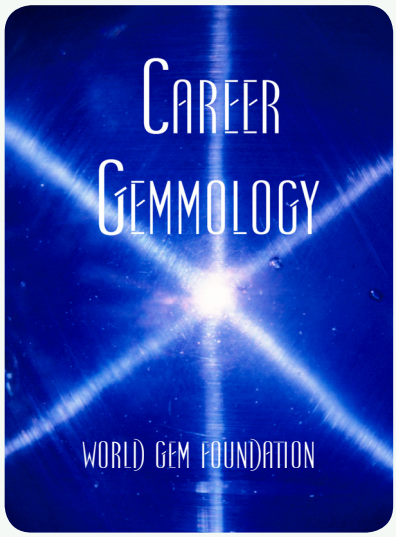


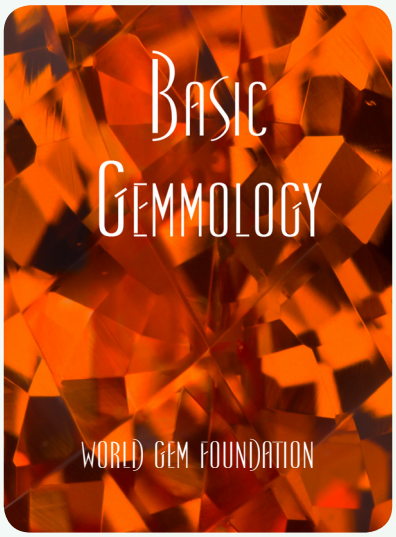


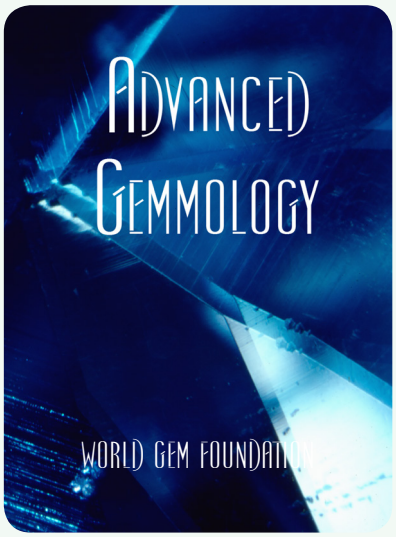
## Coloured Gemstone Professional — Digital Fees

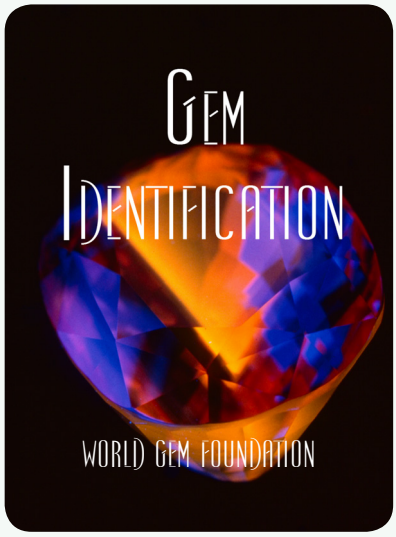
| Course Name | Euros | Pounds Sterling | USD |
|---|---|---|---|
| Basic Gemmology (Theory) | 200 | 180 | 225 |
| Advanced Gemmology (Theory) | 400 | 360 | 450 |
| Gem Identification (Theory) | 225 | 200 | 250 |
| Coloured Gemstones (Theory) | 500 | 450 | 550 |
| Gem Identification #1 | 500 | 450 | 550 |
| Gem Identification #2 | 500 | 450 | 550 |
| Coloured Gemstone Grading #1 | 500 | 450 | 550 |
| Coloured Gemstone Grading #2 | 1000 | 900 | 1150 |
| Lab-created & Treated Gems | 500 | 450 | 550 |
| Examinations Fees ( Final Exam) | 250 | 225 | 280 |
| **Total Cost** | 4575 | 4115 | 5105 |

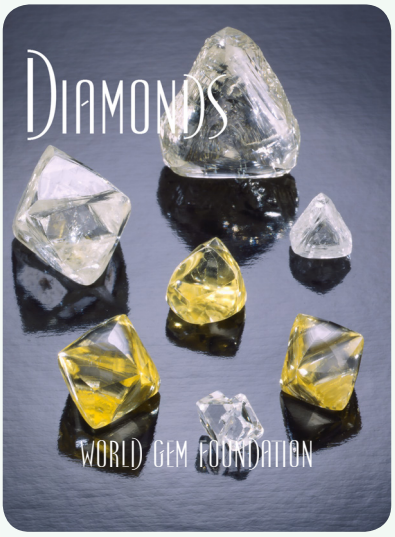
# Diploma Courses

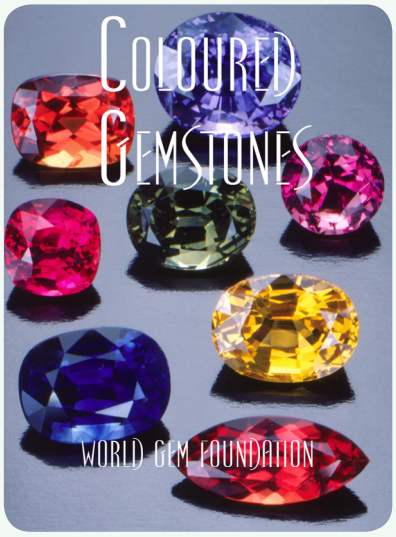


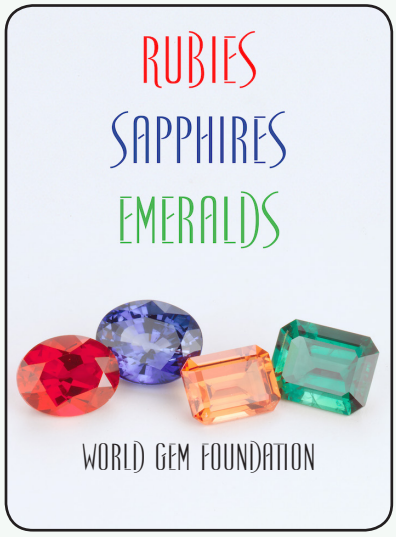



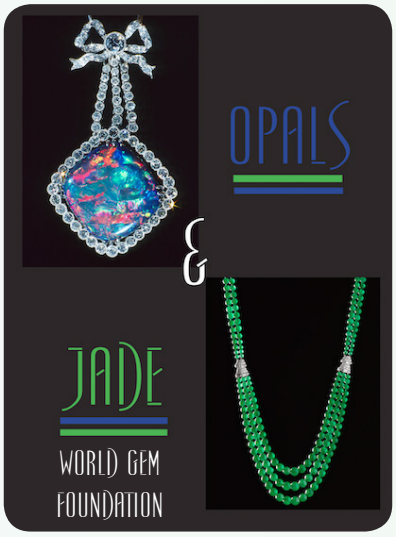



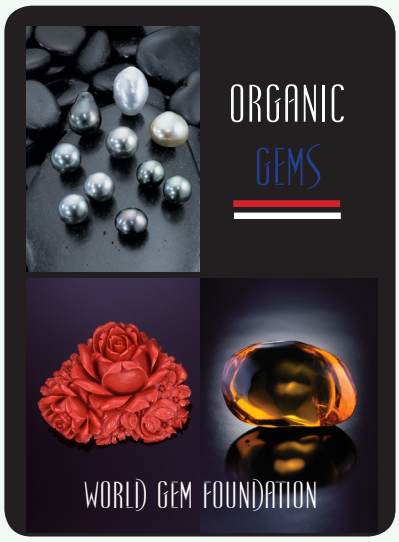




# General Interest Courses

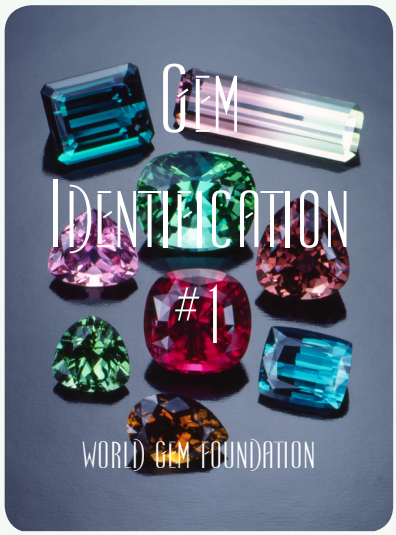


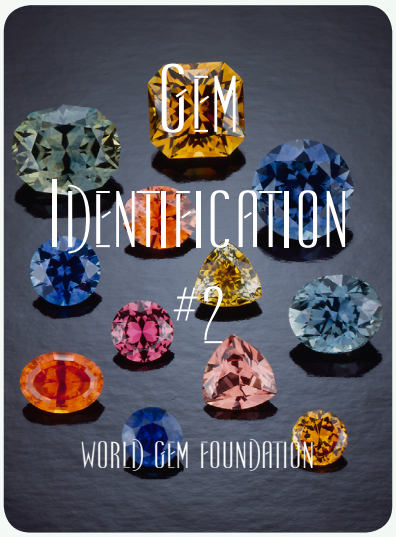



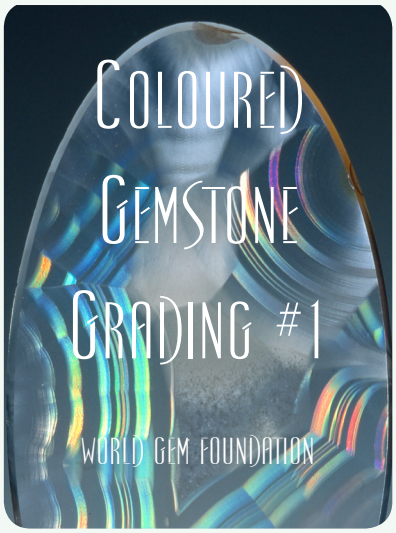



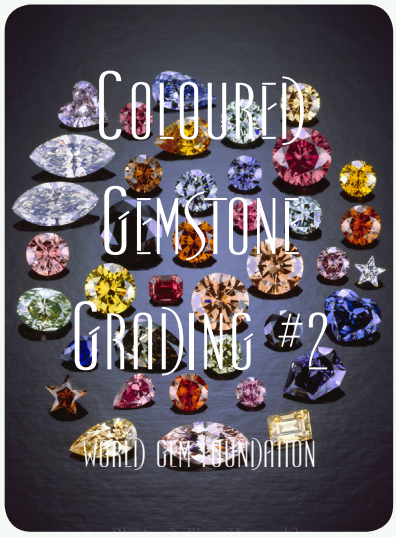

To learn more about our Diploma and General Interest courses, please click on the course icons above.
All of our diploma courses are available in English, Spanish & French.
Currently Rubies, Sapphires & Emeralds, Opals & Jade and Organic Gems are available in English & French.

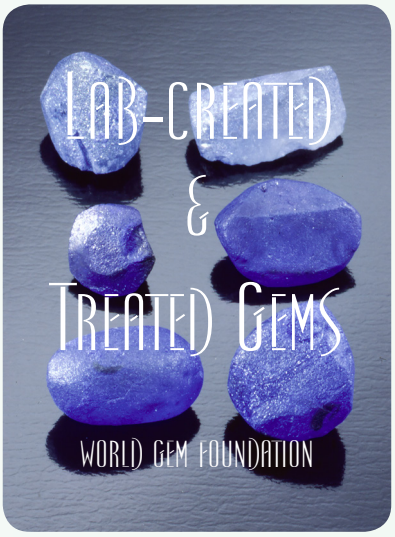
# Practical Workshops

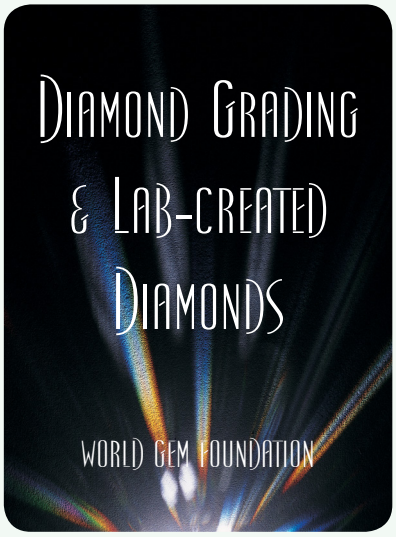
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This is one more reason to choose the World Gem Foundation, because to us, you should never stop learning!


JEAN-MARIE ARLABOSSE is a chemist and gemologist. He is the owner of an independent gemological laboratory-free-structure (Gem Solid-Phase GemLab) located on the French Riviera in France.

GILLIAN ARLABOSSE is Jean-Marie's son. He is an high school student in an informatics and mathematics speciality class.

# Coding Python Machine Learning to Help in Cr-Corundum Pink / Red Boundary Evaluation

**Introduction :**

AI (Artificial Intelligence) and machine learning are among the most important incoming breakthrough technologies in today informatics. Actually, AI already started to change our way to interact with machines (for example), while machine learning algorithms have improved, in a 'smart way', the deep evaluations and resolutions of complex problems.

As my son (GA) and I (JMA) are currently learning Python programming (for his high school program and for the enjoyment of learning), he showed to me (and explained at length) ) an exercise he did on knn (k nearest neighbours) algorithm. Indeed, this king of simple algorithm is often proposed for a scholar first approach of Python AI/machine learning.

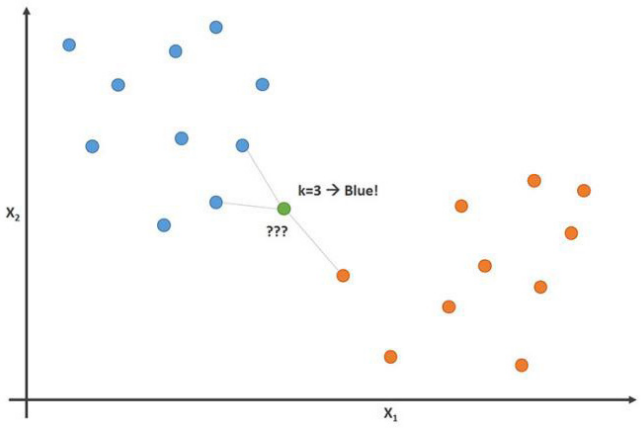
Very often, because of variations in human colour perception (and in commercial interests), chrome bearing corundum (Cr-Corundum) that are at the colour boundary between red and pink could lead to endless discussions in describing these Cr-Corundum as rubies or pink sapphires.

Between this human perception problem with the pink/red boundary in Cr-Corundum, and the knn algorithm, the rising idea was to create and to code, a knn algorithm working with a database containing 'describing-values' of objective red rubies and objective pink sapphires, so as to 'teach' the computer a way to 'discriminate' pink from the red boundary. This way, a describing-values-set, coming from an unknown 'Pink or Red Cr-Corundum', would be compared with describing-values-sets in a database. The mots recurrent colour within the k returned elements from the database will then tell us which colour the stone is… (from the knn algorithm point a view)

**Software Concept:**

The knn algorithm uses to calculate the Euclidean distances between several points (see bibliography 1). That roughly meant that if an 'object' possess an intrinsic property that can be described by a list of numeric values, knn can be used for comparing these 'describing-values' with others describing values contained in a database of previously described objects with known properties.

The knn algorithm will return the k nearest (most similar) objects from the database. Looking then, among these k returned objects, what is the most represented property will tell us the probable property of the studied object (Scheme 1, Insert 1).




Scheme 1: Simplified representation of knn concept (credit Rapidminer Bibliography 1). Two populations of points having properties blue and orange are represented in a two-dimension space for describing values along X1 and X2. In this example, we don't know if the green dot has a blue or orange property. There are 2 blues and 1 orange in the k=3 nearest neighbours. This suggests that the green dot has most probably a blue property. The same principle will be applied for Red and Pink populations of Cr-Corundum, in a seven-dimension space of describing values.

As absorption spectrum is an objective representation of a given stone colour, Cr-Corundum absorption spectrums will be used so as to generate 'colour-describing-values' to 'feed' the database and allow the knn algorithm to 'learn'.

Insert 1:

Studied object: [10, 20, 30, 40, 50, 60, 13, Unknown property]

Database: [11, 19, 28, 42, 50, 62, 12, IsRed]
[10, 23, 30, 41, 55, 58, 11, IsRed]
[30, 40, 50, 60, 70, 80, 11, IsPink]
[31, 39, 52, 61, 69, 80, 10, IsPink]

k : k=1

As k=1 has been chosen, only one of the nearest object found in data base will be returned.
Seven describing-values of the studied object (i.e. 10, 20, 30, 40, 50, 60, 13) are closer (Euclideanly speaking) of values that can be found in 'IsRed' objects in database.

The k=1 returned nearest object [11, 19, 28, 42, 50, 62, 12, IsRed] will indicate thus that our studied object has most probably an 'IsRed' property.

The spectrum image will be recorded (e.g. from a spectrometer software screenshot) then computerized. The obtained 'colour-describing-values' will then be appended to the database (a chunk of code will be dedicated for database appending).

The absorption band and transmission windows heights values will be used (Image 1). As well, full width at half medium (FWHM) of bands and transmissions windows. Likewise, thickness of continuum will be assessed. As Cr-Corundum can show red emission, the basal width of the emission peak will equally be taken into account in the building of our knn algorithm.

K value (number of returned records from database) should be set at approximately 10% of the number of database entries (e.g. if the database contained 30 id, k should be set at k=3) to a maximum of k=10. Thus, it will makes sense to have a 100 entries (at least) database.

Indeed a number of k=10 returned results will allow a representative statistical repartition for evaluation of the mostly returned property (i.e. colour in our case) within these 10 results.

Software interface should allow the user to load a spectrum image, drag lines on it ( so as to delineate the top of the peak, the bottom of the transmission window and the base line) then drag 'measuring-arrows' in order to have numeral values, which can then be computerized and transformed into spectrum-relative percentile data-set. This data set will then be evaluated (e.g. when evaluating ambiguous pink-red sample) or appended to the database (e.g. when building the database with objective red or pink reference samples).

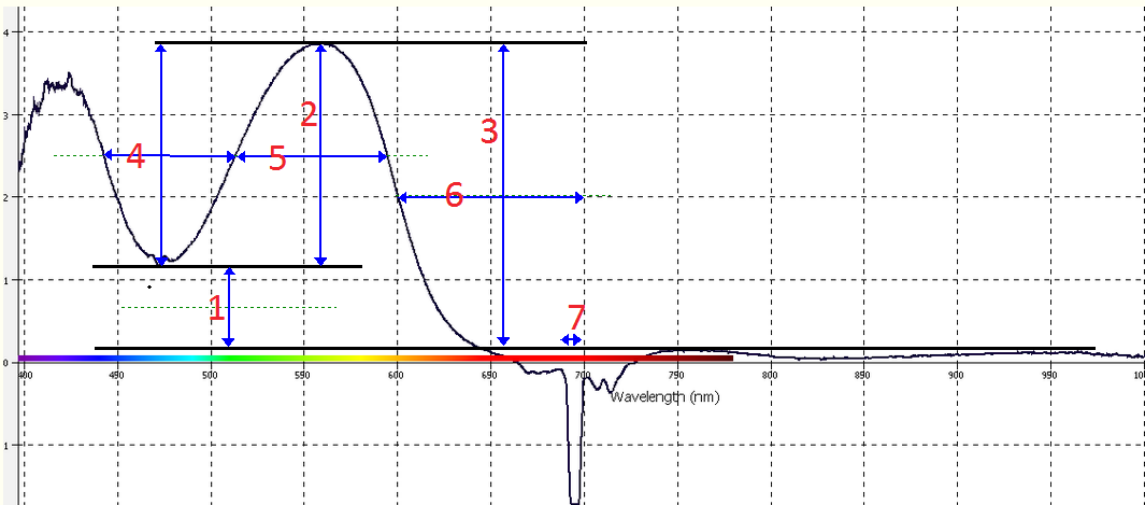



Image 1: Typical Cr-Corundum absorption spectrum with 7 measurement arrows used to set the describing values. 'Continuum thickness' will be measured (1) as well as ~550 nm absorption band height (2) and it FWHM (5). This in conjunction with FWHM of the transmission window located at ~470 nm (4) and the height of the red transmission windows at ~650 nm (3) with its 'virtual-FWHM' (6 - evaluated from absorption band edge to the 700 nm edge). Finally, the basal width of the emission peak (7) will be taken into account.

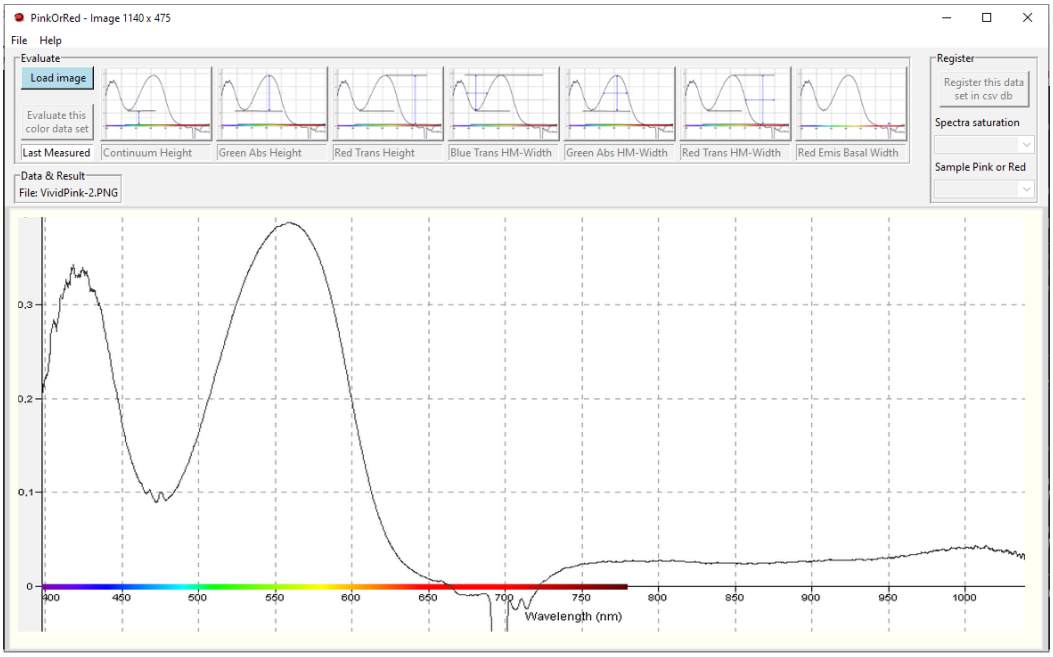
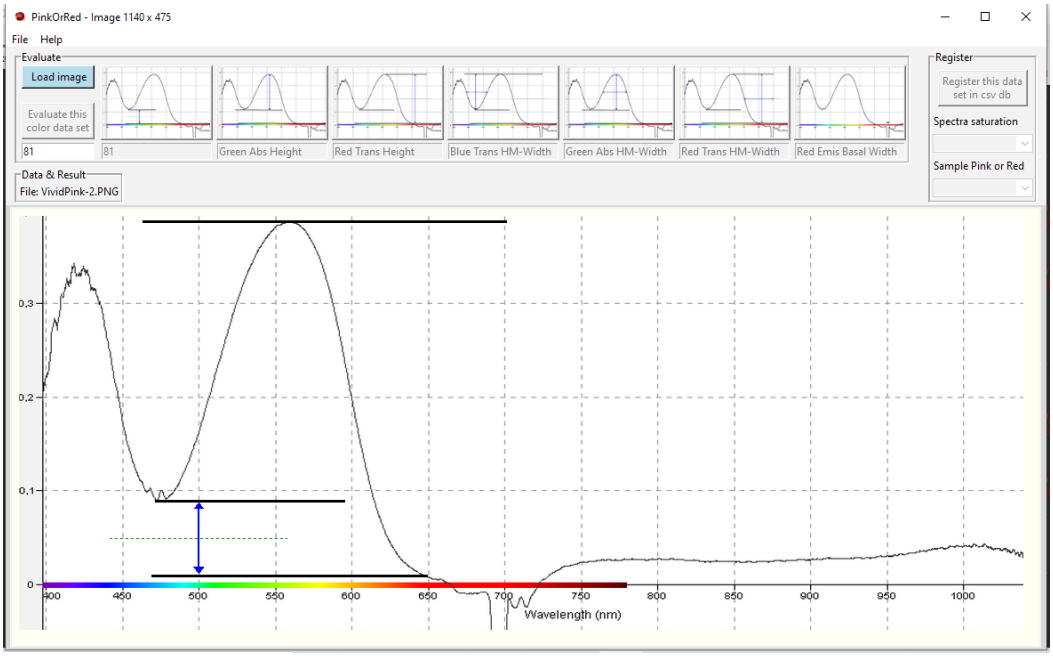
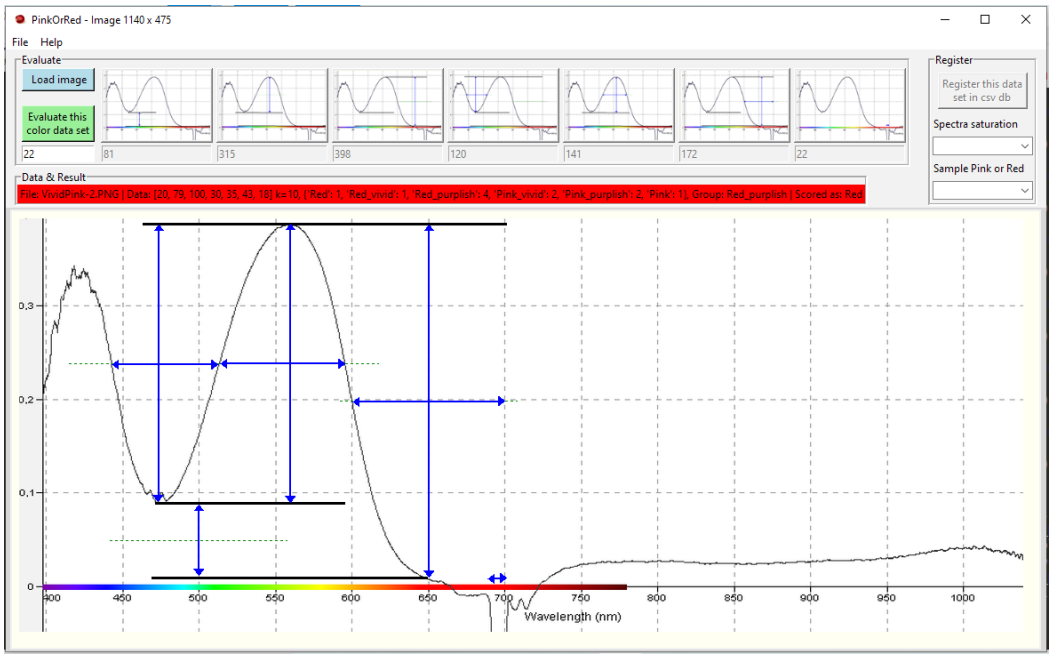



Image 2:

View of PinkOrRed-v1.1 software with a spectrum image loaded in.




The basal black lines have been dragged, the blue measurement arrow of the 'continuum thickness' has been dragged and the corresponding data entered (see 81 value under the first spectra-button).




View of PinkOrRed-v1.1 software after giving an evaluation result of the entire set of values (resulting evaluation data is covered with a red colour for ruby (this case) and pink colour for pink sapphire).

Note: The 'Register' label frame on the right part of the software window will be used to add the result data to the database. This way the database could be updatable, thus improved, by the user.

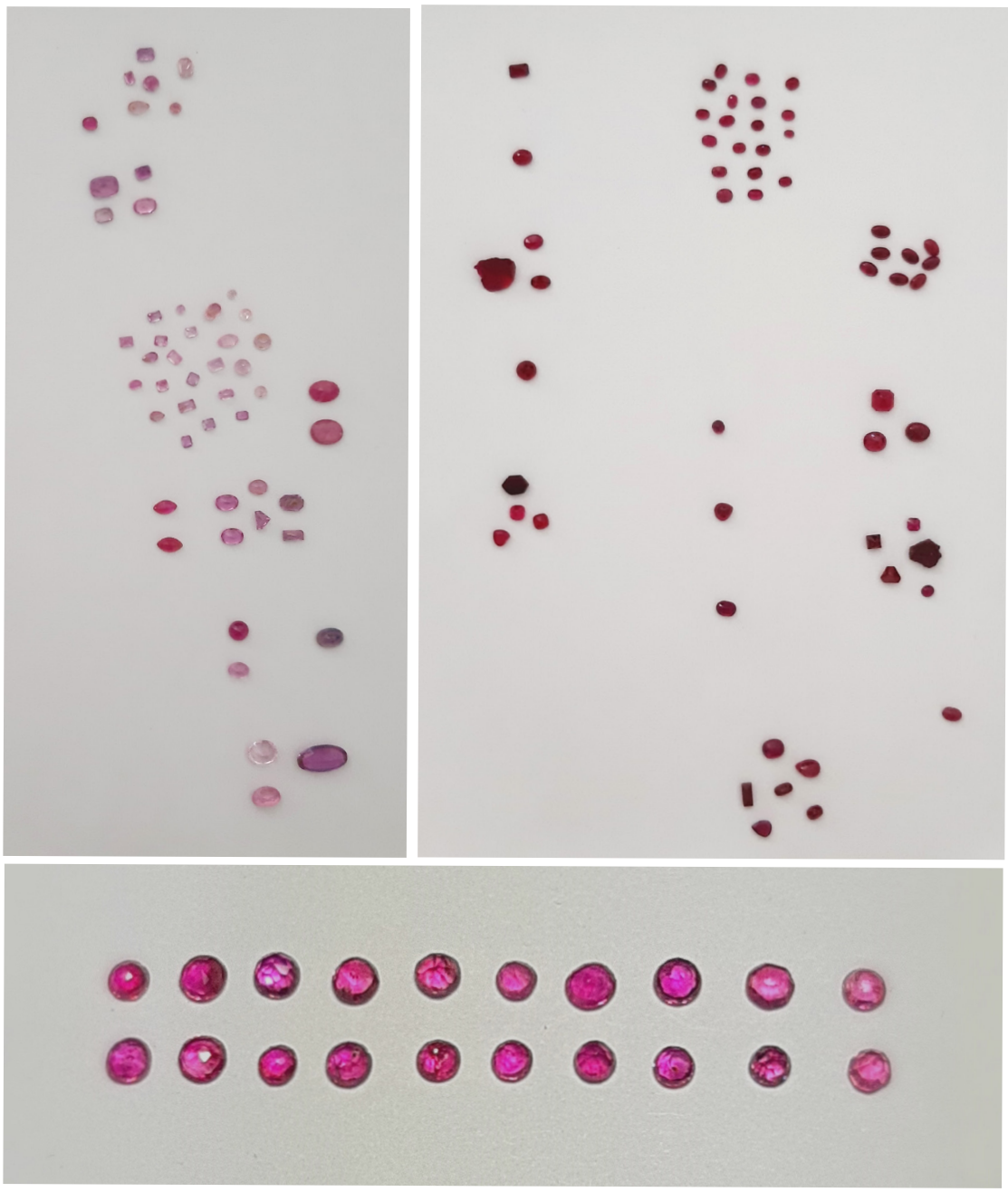


Image 3: Examples of samples used to 'teach the machine'. Upper left and right: Objective pink or red samples without possibility of confusion between red and pink (so as to have two distinct groups of 'describing-value' for the intrinsic property Red and the intrinsic property Pink). Bottom: 20 (out of the 30) intense-pink sapphire (under strong lighting) that were added to the database in order to make the fine-tuning of the pink-red boundary.

**Material and Method:**

Homemade Python-coded software (named 'PinkOrRed' – Image 2) in its version v1.1 (2020-08-01 tested for window 10) with its associated database file (csv file with 130 entries: 50 pink, 50 red, 30 'intense-pink' that were very close to the red-pink boundary). Programing was done under Python 3.8 with specific modules (Tkinter, Pillow, math, etc.)

Cr-corundum samples used to 'teach to the machine' included natural and synthetic stones, treated or untreated (Image 3).

50 samples with an objective red colour, 50 samples with an objective pink colour and 30 intense-pink samples were measured with an Ocean Optic USB4000 spectrometer equipped with an integration sphere.

So as to eliminate any pleochroism contribution (notably for deeply coloured brownish-red or purplish red stones), a light-polarization setting was added to the spectrometer so as to measure only the strongest pink or red colour component of each sample.

Image 4: Seven (7) ruby control samples (left bracket stones), Seven (7) pink sapphire control stones (right bracket stones) and 10 'questionable' stones that will be evaluated with the software (central line).

When the software had been 'taught' with the 130 entries of red and pink references, 7 red-control-samples and 7 pink-control-samples (Image 4 bracket stones) were measured so as to verify if algorithm was, as expected, able to recognized true red stones from true pink ones. Then, 10 'pink-red questionable' stones were submitted to the software for a colour evaluation (Image 4 centre line).

**Results:**

PinkOrRed-v1.1 software straightforwardly recognized the 7 objective pink control samples (those in Image 4 right bracket) from the 7 objective red samples (those in Image 4 left bracket). The software was thus able with 100% certainty to separate true red from true pink. From the 10 'questionable' samples, please see Table I for the results.

Table I: Results obtained on 10 'Questionable' samples

| Sample | Evaluated as | | | Remarks |
|---|---|---|---|---|
| | Pink | / | Red | |
| Eval_1 | | | x | Although the colours on the photo are not truly representative of the real colour (the one observed with the naked eye), separation was pretty good B-) |
| Eval_2 | x | | | |
| Eval_3 | | | x | |
| Eval_4 | | | x | |
| Eval_5 | x | | | |
| Eval_6 | | | x | |
| Eval_7 | | | x | |
| Eval_8 | x | | | |
| Eval_9 | x | | | |
| Eval_10 | x | | | |

**Conclusion:**

Although the software discussed here is more of an 'AI game for rookie coders' than a 'numeric revolution for gemmology', we did manage to create a new way to evaluate the pink/red boundaries, one that was not based on human subjectivity.

This new 'Learned machine tool' will join our previously developed 'Public statistical evaluation' tool since it is important to keep in mind that it is the duty of a gem lab to eliminate subjectivity wherever possible.

Moreover, the knn technique could be tested/developed/used for any problem of this kind (e.g. the evaluation of 'objective-Padparadscha' colour versus Pink and Orange, true Cobalt-blue spinel vs Blue-grey spinel, 'Paraiba blue' etc.).

The same with other difficult problems, like the gem-provenance indication, according to several space groups of trace-element dosages (e.g. those obtained by LA-ICP-MS).

It is obvious, from the author's points of view, that AI/machine learning will soon deeply penetrate the field of gemmology. This little 'homemade software' could be regarded as proof that this penetration is readily achievable and has already begun (…at least for us).

**Acknowledgments:**

Best thanks to E.Sternis for furnishing us with the ruby and pink sapphire samples for this study.

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*What People are Saying:*

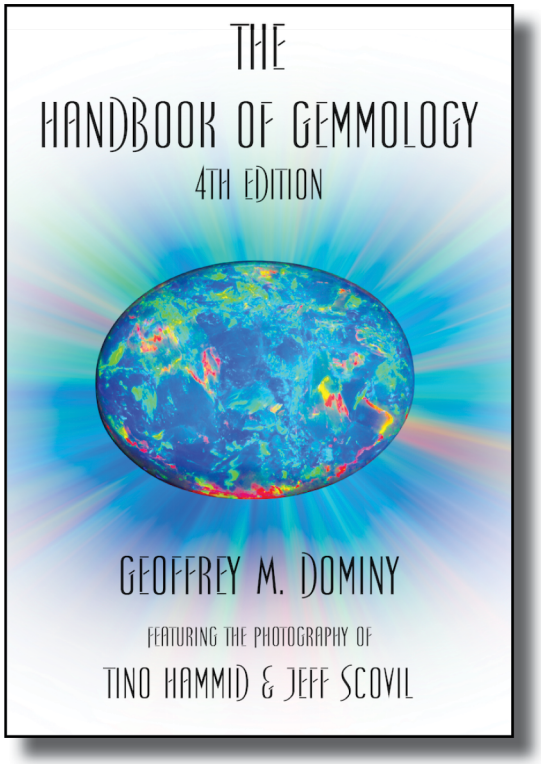
*'Leave it to Michael to grab on to the math of the 'Golden Spiral' and doggedly work it until he could present a mathematical method for consistent clarity grading'. Gary Roskin - Executive Director of ICA*

*'Any diamond professional or anyone interested in diamonds and diamond grading will be enriched by reading this' Peter Yantzer - Former Executive Director of AGS*

*'You have developed a first class method to objectively clarity grade a diamond' Tom Tashey - Owner & President of Professional Gem Services Laboratory*

$ 19.95 USD (Digital Version)

***The DEFINITIVE BOOK on Diamond Clarity Grading***




*What People are Saying:*

*'Your work will be marked as a watershed in the history of Gemology by the source of knowledge, the beauty of the photos and mainly the sharing, detachment and financial disinterest for your work'.*

*'What a tremendous contribution to Gemmology!'*

*'I must say with every issue I have thought you won't be able to improve on them but you always seem to be able to! Great dedication!'*

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***The DEFINITIVE BOOK on the Science of Gemmology***

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.

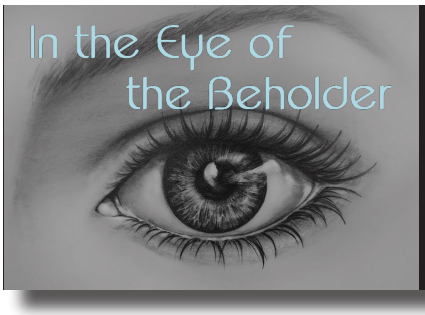
Sadly, Tino passed away in 2015 after a two-year battle with cancer, however through the Handbook of Gemmology and now the World Gem Foundation courses, his legacy and monumental contribution to our industry will live on for future generations to appreciate and admire.

In 2021, 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, 2020. 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:

WORLD GEM FOUNDATION Scholarship Application PDF




In 'The Gems of Thrones', gemmologist and author Dario Marchiori looks at Diamonds and Rubies, their relationship in the hierarchy of the gem kingdom, their similarities/differences and most importantly how the different marketing strategies have affected their stature in the eyes of the consumer.

# The 'Gems' of Thrones

Gems should be rare, beautiful and durable, however, what truly determines their price is the law of supply and demand. Diamond and Ruby are often referred to as the Kings of all Gems, but there cannot be 2 monarchs in the same realm, and in the last century, it's quite clear which one is the actual ruler. In sheer numbers the diamond's slice of the jewellery pie dwarves that of the ruby, the value of diamond sales is around ten times that of all other precious and semi-precious stones combined. This indicates that the former (of which every possible numerical aspect of the trade, from production to retail prices for single countries, is known) is around 50-100 times more 'popular' than the latter (of which it's virtually impossible to trace the precise figures, as no one is really keeping any rigorous records of the transactions related to the red gem). There are dozens of associations linked to the study, protection and promotion of the colourless sparkler, none for its softer competitor.

Why is there such massive discrepancy in the way these two champions of the gem world are treated?

For starters, no one ever said 'A ruby is forever', and to be honest corundum (the type of mineral/crystal that ruby is made of), is not nearly as hard as diamond (9 versus 10 on the Mohs scale, but 400 versus 1500 in absolute hardness). Diamonds are now walking in ruby's shoes, feeling the heat from the advent of alluring, conflict-free and eco-friendlier (some believe) manmade alternatives, a situation familiar to rubies for a hundred years or so; flame-fusion synthetic rubies have, in fact, been around since the beginning of the 20th century. The most royal, among the red gems, has surprisingly been able to coexist with its lab-created, cheaper alter-ego, without having really to face much competition from it. Natural rubies are now as popular as ever. On the other hand, earth-mined diamonds have only been challenged by their gem-quality HPHT/CVD counterparts for a decade. Many wonder whether they are going to retain their crown, as the most precious of all gems, or are they set to diminish and become just one of the over one-hundred gem species that grace rings, necklaces and earrings out there.

**Centuries Ago**

In Middle Age Europe, diamonds, tough rocks no other material could scratch, were mostly regarded for their symbolic value, their hardness, their purity and lustre, not so much for their beauty. There are several indications of this. For example, in 1487, Pope Innocent VIII (1339 -1406), in a letter to Lorenzo de' Medici (1469 -1492), apologised for sending only a diamond ring, as a wedding gift for the Magnificent's daughter, Maddalena, not having been able to find a worthier gem, like a ruby or an emerald.

In 1568 Benvenuto Cellini, a renowned Florentine goldsmith and gem cutter, gave some important details about the prices of the best precious stones of his era. Perhaps diamonds were not his favourite gems, his enemies had tried to poison him using diamond powder (an unusual but aristocratic way to deal with upper-class foes), but he did confirm that ruby and emerald were far more sought-after than diamonds (respectively eight to four times pricier).

1. Ruby 800 Scudi d'Oro (Golden Scudi is the name of the currency)
2. Emerald 400 Scudi d'Oro
3. Diamond 100 Scudi d'Oro
4. Sapphire 10 Scudi d'Oro

Those were years when diamonds still hadn't undergone the little evolution/revolution brought about by the brilliant cut. Only after the XIII-XIV centuries did precious stones started being faceted. The Venitian Diamanteri dared break the unbreakable first, then the trend spread to Paris (I have found documents that report a variety of fashioning styles from 1360 onwards), and gradually it became a world standard. From the breakthroughs of Van Bercken, Peruzzi, and Cardinal Mazzarino, (although it's still debated whether they were the real creators of the innovative fashioning styles) first, to the mathematical models and proportions of Tolkowsky, diamonds morphed from pretty-looking gems to amazing, sparkling brilliants.

Diamond ‘Drop’ Earrings (Photo by Tino Hammid)

Ruby & Diamond ‘Drop’ Earrings (Photo by Tino Hammid)

For thousands of years they were rare, truly rare; the global production, which relied solely on Indian and later on Brazilian deposits, was around 50,000-100,000 carats. This meagre amount included both pure and not so pure crystals. Nowadays each and every significant source churns out millions of carats every year, and the world's total output fares steadily between 130 and 150 millions of carats (around 30-50% of which are stones ready be placed on fancy jewellery pieces).

**'Money' speaks louder than words:**

The amount of funds poured into the commerce of diamonds has no equal in the jewellery realm. De Beers alone, invests millions of dollars in various publicity campaigns to make sure diamonds are constantly remembered, and to portray them as an aspect of everyone's life that connects dreams with reality. They are also promoted as the stone of election, when it's time to say the most import 'Yes', on the wedding day, a relatively recent habit that many see as a long-standing tradition. Ruby, on the other hand, has been backed by a far less generous advertising promotion, although it still enjoys its high status among precious stones, and it enjoys more mentions than lesser gems, such as topaz, aquamarine or tsavorite garnet (to name a few).

**Many Cs for the diamonds, and few for the rubies - the illusory value of letters and numbers.**

The creation of the 4Cs gave in the '40s the extra boost to the diamond market. In reality, the 4 characteristics (which are already subdivided into several factors), can only provide a mere idea of the amount of dollars/Euros/Pounds one has to shell out to obtain one of these miniaturised treasures. Figures vary pretty wildly from one seller to another, and the factors that affect the final cost are more than just the canonical 4.

Here are a few extra 'hidden features' that can add a few zeros to the price. 'Cut' doesn't appear on many reports, but the tiny variations in angles and proportions may provide some of the most significant price jumps

**1. C for Categories:** While many rely on the 3 XXXs, the Rappaport price lists translates these into fifteen (15) categories (from A1 to C5)

**2. C for Certificates:** To GIA or not to GIA, this is the question. If the answer is 'Yes', prepare a few extra banknotes, certificates from different reputable labs add extra value to the gems.

**3. C for Company:** wanting to have Tiffany, Cartier or Bulgari marked on your jewellery piece doesn't come for free.

**4. C for Computer:** online sparklers are often sold at much lower prices than those that appear in traditional brick-and-mortar shops, but caution is a must when dealing with people and items you cannot see and touch directly.

**5. C for Conflict:** many consumers are aware of the improper use of diamonds in war-plagued nations and now require KP certified gems.

**6. C for Characteristics:** Fancy Shapes and Magic Sizes: round-cut brilliants are far more popular than all other shapes and thus can cost much more. Oval, Princess, Heart-shaped stones all come at different prices. Physiology plays a role in all of this too, between a 0.99-carat stone and a 1.01-carat one (the difference is only 2 points) can add 20-30% to the price tag.

**7. C for Carbon Footprint:** Whether the impact on the environment is greater when extracting diamonds from the ground or creating them in special factories, with very high consumption of electricity and water, is still being debated, both methods certainly require a great deal of natural resources.

**8. C for Currency:** The US $ is the standard exchange currency for diamond purchases, as such it's bound to have an influence over the cost of the stones throughout the entire pipeline, from mining to retail price tags.

**9. C for Contingency:** The up and downturns of national economies can also influence diamond prices. Diamonds are a luxury item; demand for them follows GDP trends. Economic booms typically lead to better salaries and availability of additional cash; extra money, in turn, translates into more frequent gemstones purchases or in the acquisition of gems with a higher value; while crises go the opposite way, resulting in depressed sales.

**10. C for Credit:** There are roughly 250,000 to 300,000 jewellery retailers worldwide, most of them operating locally. Those among them who can access better credit (thus they can obtain more stones on 'memo' or 'consignment') can also offer a wider selection of stones at more competitive prices. Diamonds and bank regulations don't seem to share direct points of contact, at first glance, but banks worldwide, under the pressure due to the recent economic downturn, have become extremely careful about lending to the murky diamond industry. The resulting squeeze on credit is wreaking havoc in the market, sometimes with serious consequences for gem wholesalers, as well as mining companies. De Beers has responded to the tougher credit standards by imposing new requirements on its sightholders, the 118 companies (104 international brands, 3 industrial companies and 11 accredited buyers in 2018, up from 93 in 2006) authorized to buy rough gems directly from the company.

| Diamond (Colourless) | | | Ruby | |
|---|---|---|---|---|
| **Colour** | | | | |
| **GIA:** the conditions under which a diamond is assessed are very strict. Light type, intensity and background are of a set value. These variations are impossible to notice to the untrained eye. | | | **GIA and others** Each gem can be evaluated according to Hue, Tone and Saturation | **NGTC – GIT – Eu Labs** Hue and Chroma (saturation) |
| D | Colourless | Top Quality. Carat weight (larger stones display more colour) and fluorescence can affect the grade | Red to purplish-red-medium tone - highest saturation (with fluorescence) The 'Pigeon Blood' hue would fall into this category. | R (Red) C > 90 (deep) |
| E | Colourless with a very faint amount of colour | | | |
| F | Colourless with just a bit more than E | | | |
| G - J | Near Colourless: colourless face-up, faintly coloured when seen face down | Colour difference is only obvious when there's a big jump in the GIA scale (from D to K for example) | | pR (purplish Red) C = 80-89 (vivid) The 'Pigeon Blood' hue would fall into this category. |
| K - M | Faint colour from both positions | Not so common in many markets | If a ruby's tone is too light, it might be considered a pink sapphire, even if the saturation is high. | oR (orangy Red) C = 50 -79 (intense) |
| N - R S - Z | Light yellow to yellow - The Fancy Colour Diamond scale begins after 'Z' | | | C = 30 - 49 (-) |

| Diamond (Colourless) | | Ruby | |
|---|---|---|---|
| **Clarity** | | | |
| | **GIA** | **GIA and others Ruby is a type II gem: Inclusions are to be expected** | **NGTC – GIT – Eu Labs** |
| Flawless F- IF | No visible inclusions to the naked eye/ loupe | Loupe Clean/inclusion free (there may still be tiny inclusions) | C1 Super Pure |
| VVS-1 & VVS-2 VS-1 & VS-2 | Minute and minor inclusions, not visible to the naked eye. | Included: Small but obvious inclusions, larger or numerous under 10X. | C2 Pure |
| SI-1 & SI-2 | SI inclusions are somehow visible to the unaided eye. Typically, in low relief. | Inclusions are apparent to the unaided eye. | C3 Relatively Pure |
| I-1 I-2 I-3 | Inclusions with moderate to severe effect on appearance or durability. | Moderate to severe effect on appearance. | C4 Normal |
| Industrial | Not used in jewellery | Translucent pieces still found on some jewellery pieces | Guild and other labs have also created new grading systems. |

| Diamond (Colourless) | | | Ruby | |
|---|---|---|---|---|
| **Cut** | | | | |
| **GIA:** Rapaport is mainly based on GIA's 4 Cs on round brilliant stones (there is a separate chart for all other shapes), but it doesn't quote differences for the cut (maintained as excellent, or 3ex, for all the quoted prices, however in 2016, it introduced 15 categories based on small variations in angles and proportions. | | **AGS** and other Labs use their own nomenclature | **Other Labs** Many important rubies are not cut as round brilliants, but in a variety of fancy shapes, assessing their fashioning quality is somewhat trickier. | **NGTC – GIT – Eu Labs** (brilliance grading) |
| Excellent | GIA uses a combination of face-up appearance, design and craftsmanship elements. They include: Brightness, fire, scintillation, the weight relative to its diameter, girdle thickness, symmetry, polish, proportions and angles of all the facets. | Many companies now use electronic devices to assess the cut quality (such as the ones created by Sarine Technologies) | Some labs state that cutting quality can account for 10 - 20% of the overall price. The system is not nearly as elaborate as that used to evaluate diamonds. | B1 Excellent |
| Very Good | | | | B2 Very Good |
| Good | | | | B3 Good |
| Fair | | | | B4 Normal |
| Poor | | | | |

| Diamond (Colourless) | Ruby |
|---|---|
| **Carat Weight and Price** | |
| GIA does not provide prices; most dealers rely on the Rapaport lists. | No standardised system |
| The Tavernier or Indian Law: if one carat costs 1, 2 carats costs 4 (not 2) and so on.<br>If the Law was completely true then:<br>1 carat: US $19,000 (per carat)<br>2 carats: US $ 38,000 (per carat)<br>4 carats US $72,000 (per carat)<br>8 carats US $144,000 (per carat) | US $10,000- US $18,000 USD per carat (where total size is 0.5 -1.00 carat). |
| The Tavernier or Indian Law is well reflected in the Rapaport Price Lists: (approximation - 2019) D-Flawless stones (A3 category, Round, GIA certificate) | Prices depend heavily on the market where the stones are acquired. The majority of rubies are cut in their country of origin, however, a significant amount of them are traded in Thailand. Since there is not a unified system/guideline for prices, sellers rely on their experience, ability to estimate quality and their negotiation skills. Natural, unheated-untreated stones are very hard to find and command a premium. Larger top gem-quality stones are normally more valuable than comparably sized diamonds and are certainly rarer. |
| 1 carat: US $19,000 (per carat)<br>2 carats: US $38,000 (per carat)<br>4 carats US $90,000 (per carat)<br>8 carats US $180,000 (per carat, 5 -10.99 carat bracket, the last one)<br>Larger stones are priced individually, just like rubies, however, it is clear that they don't follow the same rule, as US $ 260,000 is the highest per-carat price ever paid. | |

| Diamond (Colourless) | Ruby |
|---|---|
| **Treatments** | |
| Generally untreated, on occasion laser-drilled/ fracture-filled - mostly disclosed.<br><br>Heat and irradiation treatments may be gaining traction. | Heating - prevalent: around 95% of all rubies are heat treated - disclosure is compulsory but not always given.<br>Fracture filling (glass-borax etc): common, not always disclosed.These gems are normally not classed as rubies.<br>Diffusion/coating: occasional: not always disclosed.<br>Many enhancements/treatments are not even known to gem labs. |
| **Origin** | |
| Difficult to impossible to determine.<br>It doesn't affect the value, but it may create a different perception in consumers if the gems come from conflict - stricken countries. | It may appear on the certificate.<br>It can have a great impact on the final price, making the Burmese stones (from Myanmar) the most expensive ones. |

## Most Expensive Gems (by Respective Categories)

| Diamond | | Ruby | |
|---|---|---|---|
| **Year, Name and Size** | **Price - Price per Carat** | **Year, Name and Size** | **Price - Price per Carat** |
| 2018 D - colour Flawless Type IIa Oval Diamond 118.28 carats | US $30.6 million<br>Around US $260,000 per carat | 2015 -The Sunrise Ruby and Diamond Ring by Cartier – 25.59 carat Mogok Burmese Ruby | US $30,335,698 USD (including gold and diamonds)<br>Around US $1.2 M per carat |
| 2015 - 100 carat (unnamed) Diamond | US $22.1 million<br>Around US $220,000 per carat | 2014 - The Graff Ruby Ring – 8.62 carats | US $8,600,410 USD (including gold and diamonds)<br>Around US $1 M per carat |
| **Fancy Coloured Diamonds**<br>2016 – Oppenheimer Fancy Vivid Blue -14.62 carats | US $57,541,779 US<br>$4+M (highest per carat price ever for any gemstone) | 2014 The Queen of Burma Ring - 23.66 carats | US$6,084,559 USD (including gold and diamonds)<br>Around US $250K per carat |
| 2018 5.03 carat Aurora Green at Christie's in 2016. | US $3.3 million per carat | 2012 - The Patiño Ruby and Diamond Ring – 32.08 carats | US $6,736,750 USD (including gold and diamonds)<br>Around US $200K per carat |
| 2018 The Pink Star/ CTF Pink, Internally Flawless Vivid Pink 59.6 carats | US $71.2 million (Gem only) | | |

## The other face of the story: the Lab-grown gems

| Diamond | Ruby |
|---|---|
| Diamond from Major Sources: US $ 3000+ per carat | Ruby: quality of lab-grown gems can vary greatly, and so can the price. |
| De Beers Lightbox: US $ 800 per carat (Indian Law is not applied to these gems, 2 carats would cost US$ 1600) | Flame Fusion (Verneuil)<br>Few dollars per carat upwards |
| Chinese Producers: HTHP US $30 to 500 per carat, CVD US $1000+<br>Indian Producers: around 20% of the Rap(aport) prices for natural stones. | Pulled Rubies: starting at US $ 50 per carat<br>Flux and Hydrothermal Rubies: can cost tens, hundreds or even thousands of dollars. |

**11. C for Cost/Consumer:** The finest gems are never available in quantities that meet the demand for them. Demand is always strong for certain types; buying trends can affect availability and ultimately drastically alter, worldwide, prices for a certain range of diamonds. Consumers, with their (more or less educated) choices, can create market trends, and while heavy advertisement and popular items can greatly influence general preferences, buyers still have the last word.

**12. C for Convenience:** many people don't have time, desire or resources to do some research when it comes to buying a diamond. Obtaining the coveted gem, in the most comfortable way, may translate into higher numbers on its price tag.

There is no agreement in the trade as far as specific terminology goes, when it comes to assessing ruby's qualities. Some organisations have tried to create a global system, but no one to date has been able to impose their standards on a global level. Some of the factors that affect diamond prices are having the same effect on rubies, however, it is quite clear that the red gems belong to a pricing system that is far less complex than the one that regulates diamonds. This, again, results in a very different perception from a consumers' standpoint. Having a dedicated terminology gives diamonds a special status, unique and altogether higher than any other gem.

Some people use the GIA nomenclature (F-IF-VVS-VS-SI-I) for coloured stones as well. Others, like the Gemmological Institute of Thailand, some European Laboratories and the National Gemstone Testing Centre in China have created their own systems. In reality, there is no agreement in the market over the standard quality.

**Conclusion**

Gem-quality lab-created diamonds have been available to the global market for just over a decade. Originally their prices were very close to those of natural diamonds. However, in only a few years, their cost has fallen dramatically to just a fraction of what it was.

De Beers and others emphasise the idea that the diamond market could follow in the footsteps of ruby where there is a clear separation between top natural gems (expensive, set in top brand jewellery designs) and manmade/lower quality stones (affordable, set in novelty jewellery pieces), where the two segments are complementary, instead of competing with each another. They both simultaneously promote the ruby, in all price ranges, making it affordable to buyers with opposite purchasing capabilities.

In terms of rarity, untreated top-quality rubies of large sizes are far scarcer than diamonds.

Whereas diamonds are linked to certain global traditions (i.e. typically associated with engagement and wedding rings), rubies are not. While diamonds have been heavily promoted at all levels; rubies have not, relying instead on their own centuries-old appeal.

In terms of sheer prices, 1 carat top-notch rubies are in the same prcie range as the best colourless diamonds. When it comes to larger sizes, the value of diamonds is comparably easier to calculate, while with rubies, there is no set standard.

In the battle for supremacy, Ruby may still be the 'King of Gems', but it only rules over a small portion of the land; a land where Diamond controls a larger empire.

**About the Author**

Dario Marchiori is a gemmologist and author of the book 'Diamonds are for now (2017). It is available through Amazon.com for $ 55 USD.

https://www.amazon.com/DiamondZ-are-now-journey-through/dp/1641366419

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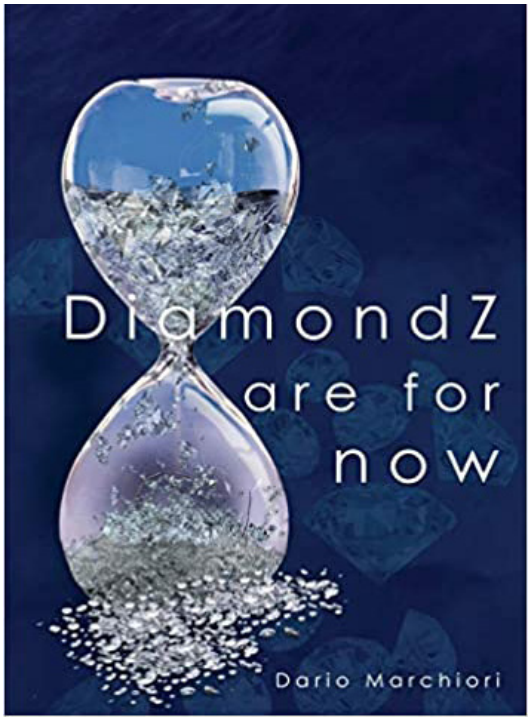
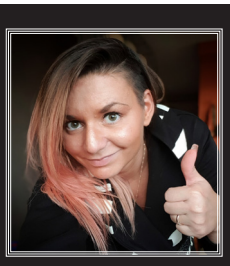



In this issue, NINA ZOLOTUKHINA looks at the 'Secret World' of minerals. Hidden treasures that have been formed through the forces of nature and are just waiting to be discovered.



# How to enter the 'Micro World'

Quartz and Pyrite from Bulgaria (Photo by Nina Gold)

Did you know that inside every small mineral hides a micro-world and the price of admission can be as little as a simple magnifying glass? Imagine something so basic and yet it will open up a world filled with beauty, uniqueness and harmony! Imagine being able to capture it so that it can be remembered and enjoyed forever and can also be shared with your friends and colleagues. They say a picture is worth a thousand words. It is true. Why talk about it for hours, trying to explain what you are seeing when an image can speak for itself?

I want to invite you to join this stunning journey with me! We will open various doors to the Micro World trying different techniques. I will explain each technique, its strengths, its weaknesses and some of the secrets I have discovered based on my own experiences.

I would like to thank Pavel Martynov for his assistance with the technical information included in this article. Without his input this article would not be as detailed or complete.

Before we start our journey, I would like to clear up some important things that cannot be ignored.

Do you know what is the difference between Macro photography and Photomicrography?

There is a lot of information connected to this subject on the Internet. Basically the main differences are the size of the picture and the size of the objects being captured, in other words – magnification. Macro pictures usually have FOV (Field of View) ranging from 36mm to 20mm and are captured using a macro lens, while Photomicrography - smaller FOV and smaller objects are captured by micro objectives.

And what is magnification?

We used to connect the power of magnification with Xs – more X = more magnification. It sounds easy at first glance but are all the Xs created equal? In truth, the answer is no. It simply makes the magnification detection system complex and confusing, more often providing us with inaccurate information, which is very far from what we see in reality.

In fact, many different manufactures, in different fields, have their own system of X magnification calculus and it usually causes great confusion. The magnification designation used for the zoom of a digital camera, the objectives of a camera, optical microscopes, digital microscopes, changeable microscope objectives and magnifying glasses are not the same. This is why you can find a digital microscope with 600x magnification, giving the same picture as an optical microscope using 50x magnification, and at the same time, 10x microscope objectives giving you magnification you could never see using an optical microscope with 50x magnification!

To avoid this confusion, magnification designations in optics usually use a 'NA' dimension system instead of 'X'. The abbreviation 'NA' stands for 'Numerical Aperture' – a dimensionless number that characterizes the range of angles over which the optical system can accept or emit

light, where 'N' represents the refractive index of the medium between the objective front lens and the specimen and 'A' is the one-half angular aperture of the objective. Usually 'NA' is written on the changeable microscope objective lenses and has got its own binding to the 'X' system, which is, in my opinion, the most correct and accurate one.

According to the NA / X system, magnification that is more than 20x with NA = 0,42 is not practically used for observing or photographing minerals and inclusions. In super rare circumstances, more for research purposes, 50x with NA 0,55 can be used, because its FOV will be equal to 0,7mm. When the NA coefficient is more or less equal to 1,00, these micro objective lenses with magnifications of 40x, 60x and 100x can be used only with immersion liquids to capture more light and to improve the sharpness of the specimen being observed.

So, when we talk about photomicrography, we usually mean magnification up to 20x with NA = 0,42 and the maximum FOV or the longest side of the uncropped image = 2mm.

Please don't confuse nominal zoom of the objective and optional zoom: one is the fixed zoom; the other is simply the stretched image.

Finally, it is important to note that when you start to make macro and micro pictures, please keep in mind not to mention the magnification used but the FOV of the final image. It will be the most correct way to show the size of the object you captured and the magnification used.

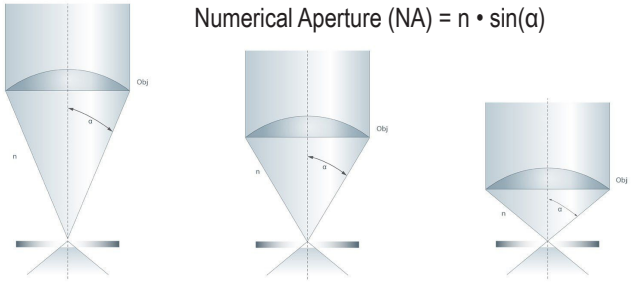



Figure 1: In the equation, 'n' is the refractive index of the medium between the cover glass and the front lens of the objective (for example; air, water or oil). The 'α' symbol relates to half of the angle of the cone of light which can be collected by the lens (i.e. the angular aperture) (Photo courtesy of Leica Microsystems)

**Let there be light!**

Besides the magnifying lens and the capturing device, you need a light installation that will highlight your specimen showing its best side with the most detail.

It is better to use a daylight light source with a light temperature range of 5000K to 6200K (Kelvins) and to avoid too much yellowish or bluish light because it can affect the color rendering and distort the real color of the captured object.

**Objective Numerical Apertures**

| Magnification | Plan Achromat (NA) | Plan Fluorite (NA) | Plan Apochromat (NA) |
|---|---|---|---|
| 0.5x | 0.025 | n/a | n/a |
| 1x | 0.04 | n/a | n/a |
| 2x | 0.06 | n/a | 0.10 |
| 4x | 0.10 | 0.13 | 0.20 |
| 10x | 0.25 | 0.30 | 0.45 |
| 20x | 0.40 | 0.50 | 0.75 |
| 40x | 0.65 | 0.75 | 0.95 |
| 40x (Oil) | n/a | 1.30 | 1.00 |
| 60x | 0.75 | 0.85 | 0.95 |
| 60x (Oil) | n/a | n/a | 1.40 |
| 100x (Oil) | 1.25 | 1.30 | 1.40 |
| 150x | n/a | n/a | 0.90 |

It is also important to understand that on higher magnifications, you need to pay more attention to the type of light: sometimes it needs to be reflected, sometimes diffused, and sometimes it should be more direct (fiber optic). You should 'draw' with the light if you want to get an interesting, volumetric and life like image without unpleasant reflections and dark zones.

The power of the light can vary but you should remember one important thing: the more magnification you have – the more light you will need.

Light – is a very powerful source: it can totally change the appearance of your object, influence its' sharpness and even change the color of your background.

I recommend that you avoid using flash because it will make your images appear flat. Flash will also affect the light temperature = final color of the mineral on the picture and produce flashes and shadows that can spoil the general appearance of the image.

Another important consideration that should be mentioned is focus length. When we increase the magnification this can be detrimental to the focus depth. That's why we need to use stacking software. For example, on a smaller magnification you'll need to have 10 pictures stacked on the different focus depths, while on a higher magnification, the quantity of pictures needed for each completed image can increase to between 150 - 250 pictures so that all the desired focus depths are covered.

There is an opinion that taking micro pictures is a privilege of rich people or scientists and this is partly true. However, I want to show you that this process may be far from expensive.

In this article I will help you to enter the 'Micro World' and I will describe different ways you can do it, starting from the cheapest and easiest and finishing with the most expensive and complicated.

So that I can make the information more accessible and understandable, I have divided all macro and microphotography techniques into five categories: Starter, Amateur, Professional, Guru and God.

Please understand that these categories and my 'comic' descriptions are quite subjective, so please don't take them too seriously. So, let's start…

## Level: Starter

### Phones and Magnifying Glasses

One of the cheapest and easiest ways to take micro pictures is by using your phone and a magnifying glass. The quality of the picture will depend on three main factors: the light, your camera on the phone and the quality of the magnifying glass.

Magnifying glasses with achromat - aplanat lenses will help to reduce chromatic and spherical aberrations. Please don't forget about the light - it should be bright enough and of the right temperature. The position of the light depends on what you want to show but the main thing here is to avoid flashes on the magnifying glass and unpleasant shadows on the object.

The quality of the camera on your mobile phone will play an important role, however nowadays nearly every mobile phone comes with cameras that are quite good quality. You should avoid using gadgets with multiple cameras that will definitely start to switch one to another during capturing.

To take a good photo, you should keep the magnifying glass with your forefinger next to the camera of the phone and keep your elbows and hands on the table, in the stable position, to reduce any vibrations.

The main disadvantages of this method are the small resolution and the limited magnification of the magnifying glass lenses.

## Level: Amateurs or Professional Users

### Phones and Microscopes

If you want to capture objects more closely and you have a microscope, you should try to take pictures using you phone. The principle of capturing an image is similar to using a magnifying glass but here the process can be a bit tricky.

Positioning the phone so that you can see the image will require some manoeuvering. With this technique, you cannot just touch the eyepiece with the camera. It should be held 1 cm from the eyepiece and will need to be rotated, not only in vertical and horizontal positions but also around its axis. It will be easier if you remove the rubber eye guards.

When you take the photograph, you will need to fix this position and keep it fixed. You can use your point finger to have some support touching the eyepiece.

Please note that if you are using a microscope with an ABBE optical system, images visible through the right and left eyepiece can be slightly different, so it is best to check both to decide which one you like the best.

On the subject of mobile phone cameras, there are some options you must take into account. Firstly, voice control will make your life much easier because when you find the


Magnifying Glass (Photo by Nina Gold)


Mobile Phone and Microscope (Photo by Nina Gold)

correct position for the phone to capture the picture in the eyepiece, you will only have a few seconds to make the shot and any slight movement, like pressing the 'Capture' button, can spoil the image.

Secondly, you will need additional camera settings in the process of capturing, such as exposition and manually fixing the point of focus. When taking pictures through the microscope using a mobile phone camera, you will notice that objects appear much lighter and you will need to close the diaphragm of the camera to minimize extra light so that you have a clearer and more contrasted image.

Focus fixing is also needed to catch the object you want to capture so as not to lose it again in the process of applying the settings and taking the shot.

Finally, a third useful option is the optical zoom. It will help you to capture the object closely and to avoid black frames on the sides, which are usually the main indicator and companion of phone pictures taken through the microscope.

To free your hands and to play with the stacking, you can find special adaptors for mobile phones on the market or just make one yourself.

**Portable Digital Microscope**

Today we can find lots of different types of portable digital microscopes on the market with prices ranging from as little as $ 20 USD to $ 1,200 USD depending on the quality. Needless to say, you will not get a good picture with a cheaper version. However, we can't ignore this category of devices because, in fact, they can give us everything we need: magnification and pictures reflected directly onto your computer, tablet or mobile phone display, where we can capture it by just tapping on the screen.

Portable Digital Microscope (Photo courtesy of Vevor)

You should be aware that the magnification written on these types of devices, for example those that state 600x to 1200x, are far from reality and cannot give decent quality images even on their maximum magnifications.

Digital microscopes also cannot compete for resolution with optical ones. However, they are attractive because of their compact size and user-friendliness. If you are interested in these types of devices, you should keep in mind that the best digital sensors are usually made by Sony.

## Level: Professional

**CMOS Microscope Digital Cameras**

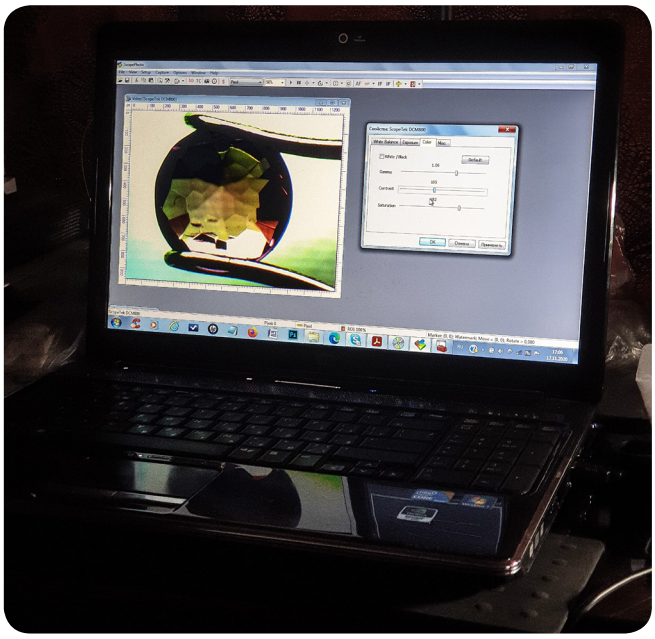
The next level includes special digital cameras for microscopes called CMOS that fit into the eyepiece of the microscope or to the trinocular port. Usually they have a special construction to make them easy to fit.

The CMOS abbreviation stands for Completely Metal Oxide Semiconductor image sensors. Please keep in mind that the latter's mega pixel limit of a digital CMOS microscope camera ends somewhere at 9 megapixels.

These cameras vary significantly in terms of quality and price. Most of them use special software. It is better to use well-known brand cameras instead of no-name brands; otherwise, it will just be a waste of money. So, to avoid poor quality, you should choose one of the well known CMOS camera brands such as: Leica, Olympus, Levenchuk or Oxford instruments.

You should carefully check how many Mega pixel sensors these cameras have (usually it is 0.3mp - 9.0mp), how much RAM it has and how much high dynamic range they can produce.

CMOS Microscope Digital Camera (Photo by Nina Gold)



CMOS Software (Photo by Nina Gold)

Digital Camera and Microscope (Photo by Nina Gold)

If you are looking for a good CMOS microscope camera, you should pay attention to High Definition CMOS cameras. These types of cameras are very sensitive to the light. You should use diffusers to avoid over lighting the image. Due to their light sensitivity, it will be very hard to capture objects in transmitted light. You should also set the white balance before every shot, even after making insignificant changes.

It is important to look if there are any additional setting options on the camera itself or in the software. With CMOS cameras, they will tend to work better on flat objects rather than with volumetric ones.

Since they are very sensitive to light, you will need to set the exposure carefully so as not to overexpose one side and blackout the other. CMOS cameras will never give as higher a resolution as a DSLR camera.

The main advantage of these cameras is the extra magnification they offer.

**Portable Digital Camera and Microscope**

To produce better quality pictures, you can try taking pictures using a portable digital camera.

Please be aware that not every cam will cope with this task because several conditions have to be met. First of all this camera should have a macro mode to reach the right view of the picture, otherwise you will see a black frame caused by the body of the microscope.

Secondly, its matrix should be very light sensitive with some manual settings that will allow you to set the ISO, size of the diaphragm and the shutter speed. The quantity of megapixels will also affect the resolution of your pictures.

You will also need an adaptor to free your hands and to avoid any vibrations during photographing. Of course, the price of the adaptors will depend on the model of your microscope and the portable digital camera but they can be very affordable.

Please remember that in this case the standard photography rule ‘smaller aperture – larger focus’ does not work and you will need to open the diaphragm as wide as possible and let the matrix collect as much light as possible to improve the maximum sharpness of the picture.

Regarding zoom, it will be better if you use an optical zoom because a digital zoom will spoil the resolution of the picture.

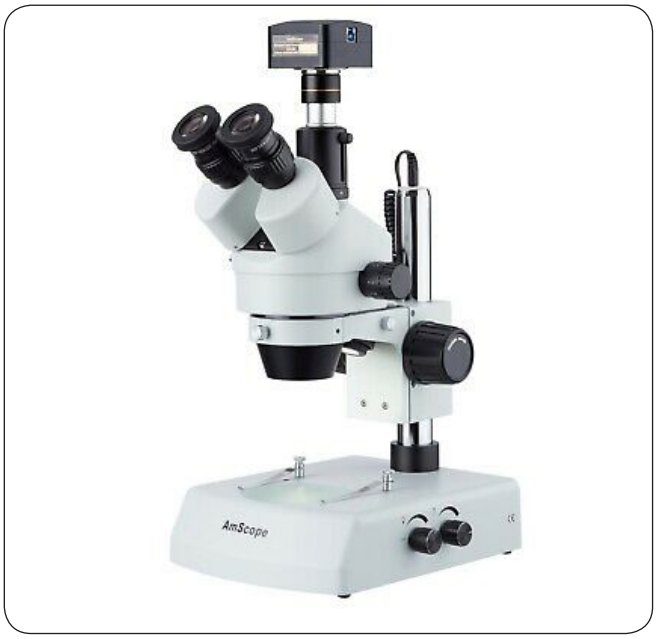
**DSLR Camera and Microscope**

These types of devices are commonly used in laboratories. There are at least three different ways you can attach your DSLR camera to the microscope.

You can connect it to the eyepiece, using special connector rings that are available on eBay. In order to find the right connector, you will need the model of your camera and the diameter of the eyepiece. The main disadvantage of this technique is that you can’t observe the object simultaneously through the eyepiece and on the screen.

Alternatively you can use a camera adapter that is connected directly to the microscope body by an additional camera adapter before the main objective.

Finally, the most expensive option requires the purchase of a trinocular microscope head and connecting a camera directly to the trinocular port.




Trinocular Microscope (Photo courtesy of Amscope)

DSLR/Teleconverter/Microscope Objective (Photo by Nina Gold)

Lighting here is crucial. You don't just need a lot of light, but you will need to tackle it very gently and delicately in order to arrive at the correct light scheme, showing the object you are photographing in the right light, without unwanted shadows and flashes on its surfaces.

Because of the narrow focus range, this technique can be used in conjunction with stacking technology. To fit the object in the focus range you will need to overlay anywhere from 2 to 30 pictures, taken on different focus lengths and then you will need special stacking software such as Photoshop, Helicon Focus or Zeren to combine these pictures together.

Usually this method can cover wider tasks, such as capturing objects on a wide range of magnifications (from optical to electron microscopy), providing excellent quality pictures while capturing objects in a darkened background, oblique, transmitted, polarized and UV light, and also objects in immersion liquids.

Prices will vary substantially and will depend on the various components. The type of microscope and camera you choose will determine the main cost.

Top of the line microscopes (with top optical characteristics) include Carl Zeiss, Wild and Leica followed by Nikon, Olympus, Motic, American Optical (AO) and KRUSS. There are also other low-cost options but they will not reach the quality of the aforementioned microscopes.

## Level: Guru

### Microscope Head with Camera and Macro Rails

For more precise photography, you will need a special macro rail unit to make sure all the images are stacked together correctly with a minimum loss in quality.

The macro rails will allow you to program the focus distance for each shot and make these shots in equal steps on a program level. You don't need to turn the focus ring on your microscope anymore, simply make all the settings you need on the controller.

The main disadvantage of this technique is that you can't use the microscope for standard research and you can only observe the image via the computer screen.

Using this technique you can take more shots (usually 5 to 15 shots are needed per one stacked image) of the same object in different focus distances.

To be honest, this method is not widely used because it is quite complicated and gives results equal to the previous one, where the DSLR camera is connected directly to the microscope.

## Level: God

### Macro Rails and DSLR Camera with Microscope Objective

The most complicated but also the most powerful technique, in my opinion, uses a micro photo setting system with a DSLR Camera with macro or changeable microscope objectives and macro rails.

Using this technique involves essentially building your own system based on your own personal needs and preferences.

The main details in this system are: DSLR camera, macro or microscope objective, connector, macro rails, object plate and light sources.

Let's start with the DSLR Camera. You can use any DSLR camera you like, but it will be better, if the camera has good resolution. Certainly, you will need an objective to take a good shot! From here it is vital to know what magnification you want to have while photographing.

If you need to have magnification in the range of 1x to 5x (FOV = 24mm), you can use Macro objectives.

To reduce the cost of the macro lens, you can try to use an inverted low cost objective. You will need several connector rings to fix it to the camera from the other side. In this case you can use objectives with the focus length 50mm or lower.

To estimate the approximate magnification you'll get, you need to divide 200mm (nominal focus length) by the focus length of the inverted objective.

For example:

- 50mm inverted objective will give approximately 4x magnification (200/50 = 4x)
- 42mm inverted objective will give approximately 4,76x magnification.
- 35mm inverted objective will give approximately 5,7x magnification and etc.

Some people use cameras from scanners that produce magnification up to 3x and fairly good results.

In case you need more magnification, you should use a microscopic objective connected to you DSLR camera body with a connector. Their magnification will vary from 1x to 150x but the most widely used magnification sizes in photomicrography are 3x, 5x, 10x, 15x and 20x. Nikon and Mitutoyo manufacture the sharpest microscope objectives. It is important to note that only objectives with a long working distance will work with photomicrography because objectives with short working distances will totally block out the light and you won't be able to build the right light scheme.

A connector is only needed while using microscope objectives at the other end of your device.

Due to optical laws, there should be a focus distance that is equal to 200mm range. This lets you get a normal image using microscope objectives at their nominal magnification.

Any teleconverter objective with a 200mm focus length, photo furs or a special system of pipe connectors fixed one to another via a pipe thread can be used as connectors.

Playing with the focus length, for example using a teleconverter objective with 300mm focus length instead of 200mm, you can magnify or stretch the image even more, however the resolution and optical aberrations will be poorer.

An important element of any of these micro photo units is the macro rails. The price varies from 100 to 1600 euros depending on the type (motorized or mechanic), length (100mm or 200mm), precision and brand.

Macro rails in this type of device are extremely important because on the higher magnifications (20x for example), where the focus length is negligible, you will need to take up to 250 shots to cover the whole depth of the object and its background.

The most popular brands of macro rails are Stack Shot, MJKZZ, Wemacro and Zeapon.

Another important consideration is the object plate - the place where the object is placed for photographing. It should be easily rotatable in different directions, in the horizontal, vertical axis and have the ability to spin around. The smaller the object you are dealing with – the more delicate you should move it so as to place it in the right position.

What about light sources? Unfortunately with all these devices you will be forced to create a new light scheme each time you start to photograph a new object.

The same light sources, diffusers and backgrounds can be used that were discussed under the microscope settings.

On higher magnifications, even a small change in the position of the light source (or light beam) can totally change the appearance of the object and change to background to black. Similarly, a white background can play the role of the reflector and give more light in transparent sections of the object.

The price for this device starts at around 2000 euros and has no limits, depending on the model of DSLR camera you choose, the model and type of the objectives, their quantity, quantity of adapters, the object plate, power, quantity and flexibility of the light sources and the remote control.

## Conclusions

As you can see, there are a lot of ways for you to enter the Micro World! However, before you start, you need to establish your overall goal. Are you just starting out with a new hobby or do you want to photograph images for scientific or research purposes or perhaps even as an artist.

Do you want to dive headlong into photomicrography or is this just something you plan to do from time to time and therefore prefer to find the easiest and fastest route.

You will need to take inventory of the equipment you already have and what can be used for photographing; the budget you are willing to spend on macro photography or

photomicrography; how much time you can spend (i.e. when using a photomicrography unit, some pictures can take up to 2 days of photographing and even more time for post production).

Having answered all these questions, you can now find the most appropriate system for taking macro and micro pictures based on your own personal needs. Don't chase magnification or resolution, especially in the beginning. You can easily take a good shot by using your telephone and a magnifying glass!

The rules of the Micro World are very unpredictable and each object will dictate what magnification is needed to make it look the most attractive.

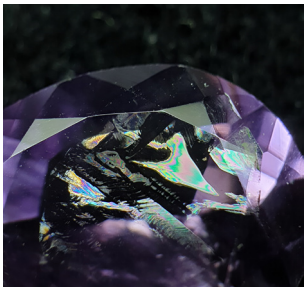
**WARNING**

Please be careful: once you enter the Micro World, it will mesmerize you, cast a spell over you and change your perception of the 'usual things' around you.

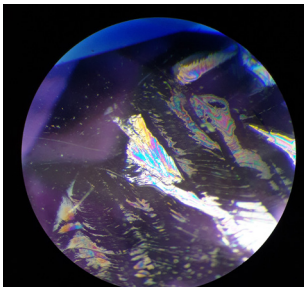
I wish you luck!

## Different Equipment - Different Results

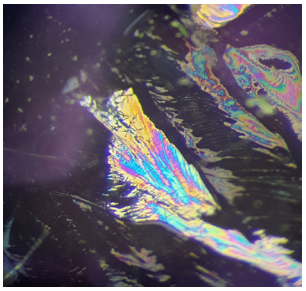
Telephone & Loupe 10x
One Shot



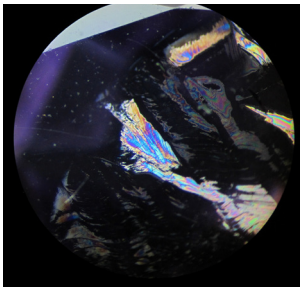
Telephone Zoom & Loupe 10x
One Shot



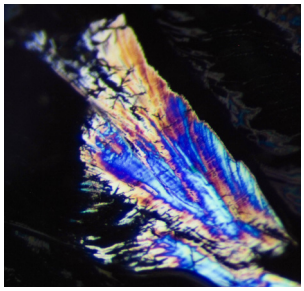
Telephone & Microscope
One Shot



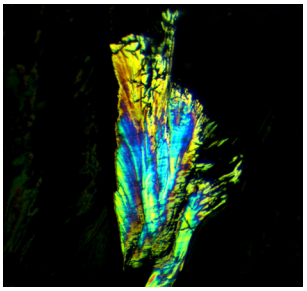
Telephone Zoom & Microscope
One Shot



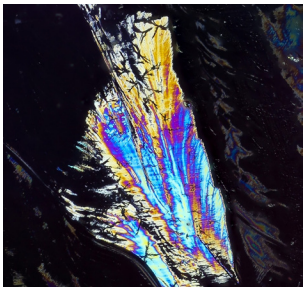
Digital Camera & Microscope
One Shot



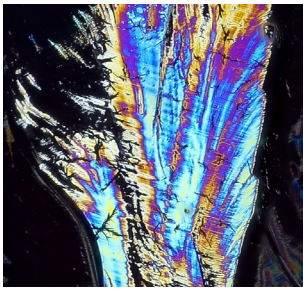
Digital Camera Zoom &
Microscope One Shot



CMOS Camera & Microscope
One Shot

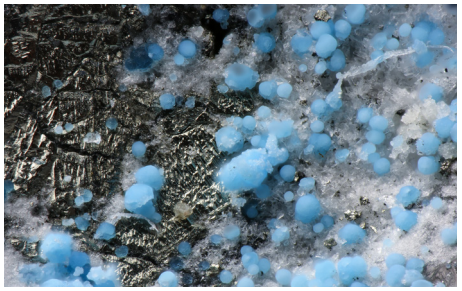


DSLR Camera & Macro Objective
Stacked



DSLR Camera & Microscope
Objective Stacked

DSLR Camera & Microscope Objective 20x
1 shot from Stack 230 shots



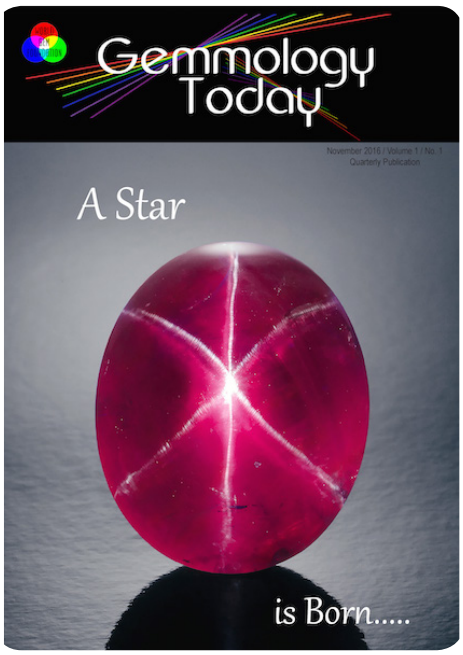
DSLR Camera & Microscope Objective 20x
Full Stack 230 shots

All Photographs by Nina Gold

# 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.

# Twinkle, Twinkle Little Star




The 1st Issue of Gemmology Today featuring the Rosser-Reeves Star Ruby (Photo by Tino Hammid)

The wonderful 'a star of light' effect found in certain gemstones is called asterism, coming from the ancient Greek word meaning 'star'. This optical phenomenon is similar to chatoyancy and can only be seen when a stone is cut 'en cabochon', and is viewed under certain lighting conditions.

The usual rule of thumb with gemstones is, the less inclusions the better. But for asterism we need the needle-like inclusions and how they are positioned will have an effect on the overall value especially if they produce a sharp and well-defined star.

### Characteristics

Most natural 'star' gemstones are translucent or opaque and typically display a weaker star in diffused light but when they are viewed under sunlight or a strong focused artificial light, their true nature will be revealed. They love the spotlight! As the light moves across the stone, the star will also move creating a truly remarkable effect.

Stones exhibiting asterism are typically cut with unfinished bases (bottoms). This is normal in 'star' gemstones because of their translucency or opaqueness. They are prized for their asterism, not their brilliance. Besides, unfinished bases add weight to the stone and this obviously adds value.

### Geology

To fully explain asterism, we need to dive into geology and discuss 'Epigenetic' inclusions. During the geological process, certain high temperature homogeneous solid solutions can become unstable and separate (exsolve) into at least two divergent crystalline minerals upon cooling below the temperature of mutual solubility or stability of the solution. This is due to an expansion of the crystal lattice at high temperatures, which creates more defects, which are better equipped to absorb certain impurities. As the crystal cools, the lattice becomes more constricted forcing certain impurities to crystallize as tiny needles or particles. The beautiful thing is that these exsolved inclusions always form certain patterns, oriented in at least two different directions. They may actually differ from mineral to mineral even within the same host.

There are two ways 'Asterism' can be exhibited:

Diasterism - when light is directed through the back of the stone (transmitted light).

Epiasterism - when light is reflected from the stone.

### Gemstones with Asterism

#### Star Ruby and Sapphire

The most well know gemstones that exhibit asterism are ruby and sapphire, which can show 6 or 12 rayed stars. In these two species of corundum, the rutile (titanium dioxide impurities) and hematite/ilmenite inclusions form along the basal plane in three directions, crossing at 60 and 120 degrees. These tiny fibres of rutile are also known as silk. In black star sapphire hematite needles formed parallel to the faces of the second order prism produce asterism.

Occasionally, a 12-rayed star can occur in Thai sapphires due to the presence of both rutile and hematite, the former parallel to the faces of the first-order hexagonal prism while the latter forms parallel faces of the second-order hexagonal prism.

For identification purposes, star rubies with exhibit 6-rayed stars, will give a reading on a refractometer (you will need to use the 'Distant' or 'Spot' method due to the cutting style), will fluoresce under UV light and display a bright blue appearance under a Hanneman ruby filter. The absorption spectrum of the ruby will show prominent lines at 694,693,476,465 and 468nm.

Natural star sapphires come in variety of hues (including black), tones and saturations. Generally speaking, the more blue the more valuable, however, the sharpest of the star also plays a very important factor.

**Star Almandine Garnet**

The star displayed by almandine garnet consists of 4 rays, however, the depth of colour can be more pronounced than in star ruby. Star almandine garnet will appear grayish under the Hanneman filter and due to the iron content, will exhibit a 'pick-up' response when using an N52 magnet. The spectroscope will also help to identify star almandine garnet with strong bands at 576, 517 and 505 and weaker lines at 617 and 462nm.

**Star Diopside**

Most gems are opaque and black in colour and can be identified by the very brilliant 4-rayed star. They consist of characteristic rod-like inclusions of magnetite, and will show a strong ferromagnetic response to a N52 magnet. The arms of the star will intersect at an angle of approximately 75 degrees.

**Star Rose Quartz**

Star rose quartz can be identified easily by its refractive index, even when obtained by the distant vision or spot method. If unset the star rose quartz will float in a solution of un-diluted diiodomethane. Dual stars can occur and are rare.

**Star Moonstone**

The combination of adularescence and asterism in a single stone is exceptionally rare. Star moonstone will exhibit a 4-rayed star with top quality stones exhibiting a 'three-dimensional colour', owing to the adularescence.

**Famous 'Star' Stones**

The 'Star of India' is one of the world's most famous blue star sapphires due to its enormous size, the intense blue

Stunning Multi-Star Quartz (Photo by Tino Hammid)

colour and of course the wonderful star, which is perfectly centred in the stone. The Star of India weighs 563 carats and is displayed in the Hall of Gems at the Americana Museum of Natural History in New York.

The 'Neelanjali Star Ruby' is believed to be the largest star gemstone in the world. It weighs 1370 carats and is famous for its unusual 12-point double star asterism. This star ruby is also listed in the Guinness Book of World Records. G. Vidyaraj of Bangalore, India privately owns it.

The 'Rosser Reeves Star Ruby' is named after its owner, Rosser Reeves, weighs 138 carats and comes from Sri Lanka. The translucency, centrally-aligned high quality star and the beautiful colour of the ruby makes this star gemstone one of the most luminous wonders of nature. The stone was donated to the Smithsonian National Museum of Natural History in Washington in 1965.

**Synthetic Stars Stones**

Lab-created stars are produced from high temperature melts such as the Verneuil and Czochralski methods. Linde, a division of Union Carbide in the United States in the late 1940's, first produced them. They are characterized by their perfect colour, stars that are so vivid and straight that they appear to be painted onto the stone, gas bubbles just under the surface of the stone, curved growth bands, their diamagnetism and perfectly flat bases.

Star rubies produced by Kyocera are characterized by their smoke-like bluish-white wispy streamers between the rays of the star and by spherical or distorted gas bubbles.

Due to the necessity of adding titanium dioxide to produce asterism, lab-created star sapphires are not found in yellow and green.

**Surface Diffusion Treatment**

It is possible to produce asterism through diffusion. This treated material has been available since the 1950's and is used on natural and synthetic corundum. Commercially, this treatment started in the 1970's and is still produced by different companies worldwide.

In synthetic ruby and sapphire, asterism is produced through a two-step process:

1. Growth of a non-asteriated crystal that contains distinct amounts of titanium in the corundum lattice.

2. Heat treatment of the homogeneous titanium-bearing sample to form needle-like precipitates of a titanium-bearing phase.

The formation of dual-colour double stars is related to needle-like inclusions or rutile precipitates in the most outer layers or the entire body of natural or synthetic stones. The reflection and scattering of the inclusions near the dome creates the white star and the reflection and scattering of the inclusions at or near the base produces the body-coloured second star.

**Conclusion**

The following general tips can be helpful in identifying the differences between natural and synthetic star stones:

The combination of a perfect star and saturated colour should make you suspicious. Typically these stones are lab-created.

Natural star stones will display some imperfections within the stone and the base (bottom) is normally lumpy and unpolished.

Most natural stones do not have a perfect star with the 'legs' differing in brightness, length, width and straightness.

In natural stones the star will follow the light. If the star stays stationary then the stone is synthetic. However, the star can also move in lab-created stones.

A microscopic examination is one of the best ways of determining whether you have a natural star gemstone or a lab-created stone since the presence of gas bubbles and colour banding are tell-tale signs of lab-created stones.

Mother Nature never ceases to amaze us especially in the world of gemstones. Imagine gemstones with 'stars'? Perhaps these 'stars' will even guide you into the fascinating world of gemmology!

**Sources:**

Handbook of Gemmology
GIA Gems and Gemmology Summer 2015, Fall 2017
Gemselect.com


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 Dominy (World Gem Foundation)** 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.

In 2018, Geoff released a 5th Anniversary Printed Edition (Two Volumes) and on December 14th, 2019, released his first book in Spanish 'Gemología Para Todos' (the first 14 chapters of the Handbook of Gemmology).

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

**Leone Langeslag (Dutch Gem Academy)** 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)** 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.

**Conny Forsberg (Scandinavian Gem Academy)** 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 featured in the 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 (Scandinavian Gem Academy)** is a gemmological consultant specializing primarily in the identification and valuation of diamonds, both cut and rough, as well as coloured gemstones and jewellery.

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 (Säterglántan 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.

**Gérard Raphaël Quintin (South American Gem Academy)** 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.

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.

**Marie-Hélène Corbin (Gem Academy of Canada)** is an FGA gemmologist and accredited Senior Gemmologist through the AGA.

Following a busy career in real estate, she wanted to change her professional path and became interested in gemmology. This discovery of gemstones turned into a passion. Marie-Hélène studied at the EGM and successfully passed her Gemmology Diploma.

Guided by the desire to pass on her love for gems, she became the new Director of EGM in 2016, with a strong desire to modernize the school. As a teacher, she instills in her students the desire to learn more about the world of gemstones.

This passion for gems does not stop there, and Marie-Hélène created Quebec's first independent gem identification laboratory, Lelièvre Laboratoire de Gemmologie (LLG) in 2018. In order to offer the most complete service to her clients, she created the Gems and Jewelry Appraisal Center in 2019, also in Montreal.

**Kyalo Kiilu (East African Gem Academy)** 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)** 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)** 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 (West African Gem Academy)** 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.

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.

**Dr. Laurent Massi (French-Swiss Gem Academy)** completed his PhD studies on 'Atomic-scale Defects in Brown and Hydrogen-rich Diamonds' at the Department of Physics at Nantes University in France under the direction of Professor Emmanuel Fritsch. During his studies he also taught gemology in Paris at the French National Gemological Institute. Dr. Massi subsequently taught gemology and gave presentations at conferences in numerous countries all around the world. During his career he has also had the opportunity to publish a variety of scientific and educational articles on color-change corundum, hydrogen- and CO2-related optical centers in diamond, chameleon diamonds, clinohumite, color-change bastnäsite and on a new gem mineral: hibonite, one of the rarest gems on Earth.

Dr. Massi was the Director of the Asian Institute of Gemological Sciences (AIGS) Gem Laboratory and Gem School based in Bangkok - Thailand. He subsequently completed his Graduate Gemologist (GG) studies at the Gemological Institute of America (GIA) headquarters in Carlsbad, USA and then became the Director of the new GIA Thailand Campus located in Bangkok - Thailand.

With more than 20 years of experience in the Gems & Jewelry industry, Dr. Massi is now the head of both the new international gem academy AGAT (for 'Academy of Applied & Technical Gemology') as well as the co-founder of the French-Swiss Gem Academy (from the World Gem Foundation), both housed in the Majestic building - a former palace from the Belle Epoque - located on the French Riviera, in Nice - France.

**Ludovic Durand Oro (French-Swiss Gem Academy)** graduated from the Federation for European Education in Gemmology (FEEG) in 2012, has taught at the French Gemological Institute in Paris (France), was the Director of Education of a gem school based in Monaco and in 2019 co-founded the Academy of Applied & Technical Gemology (AGAT gem school) as well as the French-Swiss Gem Academy (FSGA), both based on the French Riviera in Nice, in the south of France.

A true gem enthusiast, he loves to organize gem field trips for his students to gem producing areas around the world while also acquiring top quality gemstones for his private clients.

**Cristina Rzepka de Lombas (Central American & Caribbean Gem Academies)** 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.


# Academy Directory & Contact Information

| Academy Name | Website Address | E-mail Addresses |
|---|---|---|
| World Gem Foundation | www.worldgemfoundation.com | information@worldgemfoundation.com |
| American | www.americangemacademy.com | info@americangemacademy.com |
| British | www.britishgemacademy.com | information@britishgemacademy.com |
| Canadian | www.gemacademyofcanada.com | infogemcanada@egmtl.com |
| Caribbean | www.caribbeangemacademy.com | info@caribbeangemacademy.com |
| Central American | www.centralamericangemacademy.com | info@centralamericangemacademy.com |
| Dutch | www.dutchgemacademy.com | information@dutchgemacademy.com |
| French-Swiss | www.frenchswissgemacademy.com | fsga@agat-gemology.com |
| East African | www.eastafricangemacademy.com | info@eastafricangemacademy.com |
| Indian | www.indiangemacademy.com | information@worldgemfoundation.com |
| Scandinavian | www.scandinaviangemacademy.com | info@scandinaviangemacademy.com |
| South American | www.southamericangemacademy.com | info@southamericangemacademy.com |
| South Central African | www.southcentralafricangemacademy.com | info@southcentralafricangemacademy.com |
| Spanish | www.spanishgemacademy.com | information@spanishgemacademy.com |
| West African | www.westafricangemacademy.com | info@westafricangemacademy.com |

## World Gem Foundation

Plaça de Quadrado 1,
Palma, Mallorca 07001
Spain

# Australian Opal Centre

The Australian Opal Centre (AOC) is a not-for-profit facility dedicated to opal-related scientific research, education, training, heritage, arts, travel, cultural and economic development. Based in the classic opal mining locality of Lightning Ridge, Australia, the AOC has developed its public collection and programs since 2004, while working towards construction of an innovative building that will be an international hub for opal-related knowledge and activity.

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