Gems & Jewellery

Spring 2018 / Volume 27 / No. 1

REVIVING GULF PEARLS

TREASURES OF TUCSON

CAT'S EYES IN SILLIMANITE

STAMPS WITH A STORY

BETTER WITH BLOCKCHAIN?

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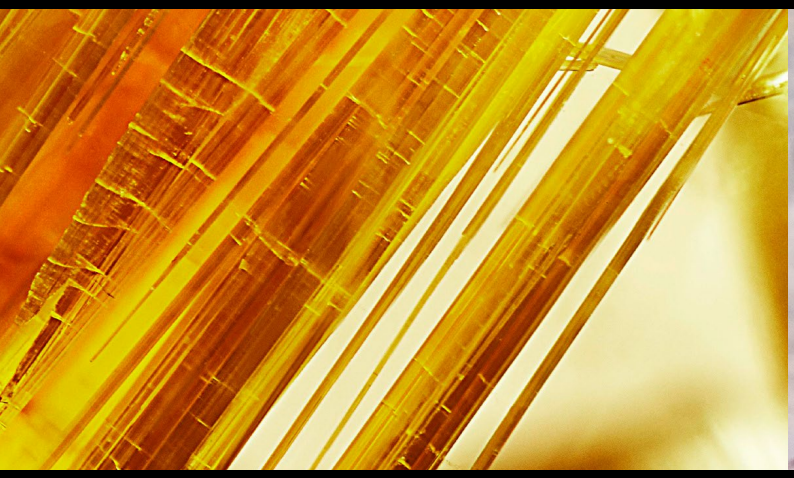

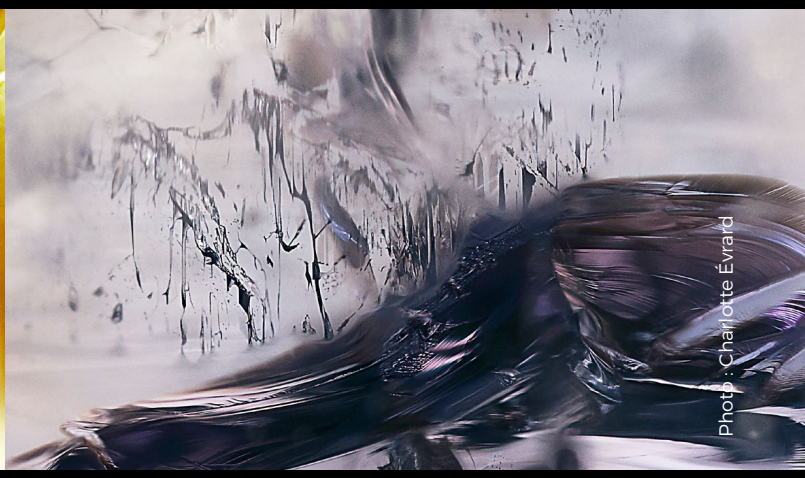

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Gems&Jewellery
SPRING 2018

RESURRECTING AN INDUSTRY

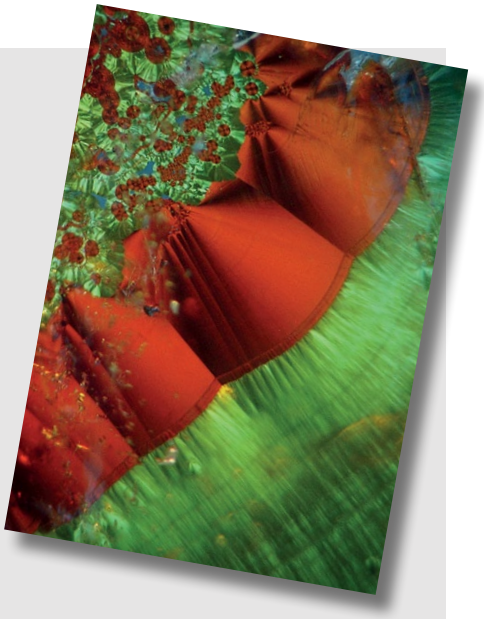
Christa Van Eerde MA MLitt FGA DGA explores the history of magnificent pearls from the Gulf region, and meets one business daring to revive the trade in the United Arab Emirates, once regarded as the heart of the pearling world.

THE ROCK STARS OF TUCSON

Olga Gonzáles FGA DGA, shares some of her insights from the 2018 Tucson Gem Fair, including special events, big announcements and exceptional jewellery, while Gem-A insiders share their Tucson experiences.

BRING ON BLOCKCHAIN

Miles Hoare MA, of Grapevine Media UK, explores if blockchain technology is the future of the jewellery supply chain. Sharing his back-to-basics guide, he explains why blockchain has the potential to revolutionise the way we trace the provenance of gems.



COVER PICTURE

Iron oxides in quartz

Iron oxides in quartz from Brazil — field of view 5.5 mm, image using microscope Hirox KH-3000 with polarised light. Image by Olivier Segura.

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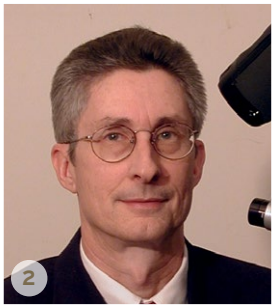
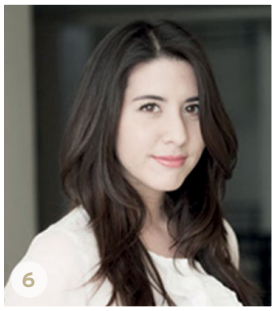
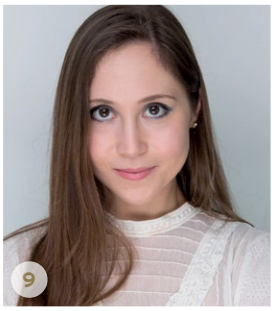






Gems&Jewellery

Spring 2018 featured contributors

1. PETER RICHARD CHEER

Peter Richard Cheer FGA DGA FIRV is a director of Studleys Jewellers in Somerset, a retail business selling modern and antique jewellery. He is currently undertaking a self-taught program in lapidary, and also writes articles for the Midlands Gemmological Focus and the UK Facet Cutter's Guide.

2. MICHAEL COWING

Michael D. Cowing FGA MSc is an educator, gemmologist and appraiser. He operates an AGA Certified Gem Laboratory. He is the author of *Objective Diamond Clarity Grading*, and several *Journal of Gemmology* articles, as well as contributions to *JCK Magazine*, *Modern Jeweler Magazine*, *NY Diamond Magazine* and *Israel Diamond Magazine*. His career in diamonds, gems, and gemmology spans three decades.

3. HAROLD KILLINGBACK

Harold Killingback FGA, BSc(Eng)Lond 1st Hons, took up silversmithing as a hobby following his retirement from the UK Atomic Energy Authority. This quickly led to an interest in gemmology and he qualified in 2002. Now 93 years old, he still takes a keen interest in the subject, particularly in asterism and chatoyancy.

4. RUI GALOPIM DE CARVALHO

Rui Galopim de Carvalho FGA DGA is editor of *Portugal Gemas*, associate editor of *The Journal of Gemmology*, Portuguese delegate at CIBJO and consultant to the Portuguese National Assay Office. He is also a lecturer and author of the history of gem materials in Portuguese jewellery.

5. MILES HOARE

Miles Hoare MA is the owner of Grapevine Media which provides digital, social and brand solutions to start-ups, small businesses and medium-sized organisations. He has over 10 years of experience in IT and web development working on design and development projects within third-sector organisations, as well as an interest in blockchain technologies.

6. BILLIE HUGHES

Billie Hughes is a gemmologist and founding member of Lotus Gemology laboratory in Thailand. Her gemmological work has appeared in *Gems & Gemology*, *The Gemguide*, *The Journal of the Gemmological Association of Hong Kong*, and *InColor* magazine. Her photographic work has been published in *Terra Spinel*, the *Wall Street Journal*, *Ruby & Sapphire: A Collector's Guide*, and *Ruby & Sapphire: A Gemologist's Guide*.

7. OLGA GONZÁLEZ

Olga González FGA DGA is the CEO/ founder of Pietra PR and has over 10 years of experience in the field of jewellery communications. She currently serves as president of PRSA-NY, is the networking director for the Women's Jewelry Association New York Metro Chapter Board, and is a regular contributor to consumer and trade publications on gem and jewellery-related topics.

8. HELEN SERRAS-HERMAN

Helen Serras-Herman FGA, a 2003 National Lapidary Hall of Fame inductee, is an acclaimed gem sculptor with over 34 years of experience in unique gem sculpture and jewellery art. Her award-winning artwork has been exhibited world-wide and published in over 200 trade magazine articles and books.

9. CHRISTA VAN EERDE

Christa Van Eerde MA MLitt Cert. FGA DGA is a gem lover and dance aficionado. She currently resides in the United Arab Emirates and is searching for her niche in the jewellery world. Christa received her Gemmology Diploma in 2017.

Straight from the heart

Opinion and comment from CEO, Alan Hart FGA DGA

After a particularly vicious cold snap in early March, we have all our fingers crossed at Gem-A HQ that spring has finally sprung. The first quarter of 2018 is an exciting one for the gemmology world, especially with the Tucson gem fair that never fails to disappoint. I would like to personally thank everyone who attended the Gem-A Big Gem Bash, which was a storming success, and those who found their way to our stand to say hello.

It was thrilling to be able to reveal the news of the collaboration between The RealReal and the University of Arizona to create a new degree program in gemmology. The RealReal is offering funding for an endowed chair in the UA College of Science, with undergraduate, master's degree and PhD courses in the pipeline. Gem-A is involved in this pioneering plan by offering students in the program the chance to obtain a Gemmology Diploma.

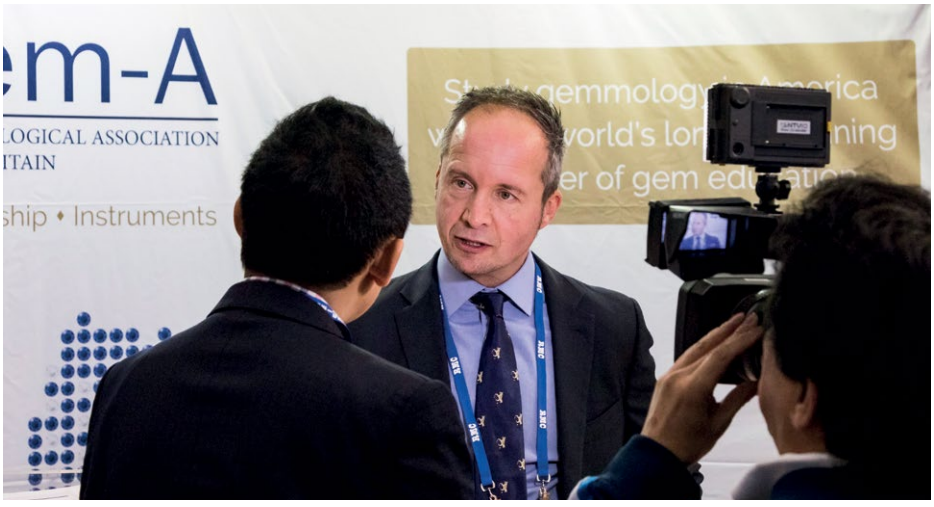
I hope you will agree that this is an exciting time for our industry.

This issue marks the first *Gems&Jewellery* of 2018 and a full year since we relaunched the magazine. Every piece of content and insightful feature in this issue, and those that have come before it, is kindly created by Gem-A members, friends and colleagues. Without your support we simply couldn't produce this fantastic resource, so please keep exploring and sharing your insights with us. In this season's issue, we travel to the United Arab Emirates to discover a Gulf pearl revival, see a snapshot of nephrite from China's Xinjiang province and head into outer-space with one of our talented alumni. There is also a fascinating look at chatoyancy in sillimanite by Harold Killingback FGA and a guide to diamond ray tracing by Michael Cowing FGA – both articles that you won't want to miss.

A new year also means a new Gem-A Conference! Yes, we know it is eight months away, but it is never too early to 'save the date'! Turn to page 23 to see the essential dates and information for your diary.

Speaking of November, our 2018 students across our Gemmology Foundation, Gemmology Diploma and Diamond Diploma courses are busy soaking up essential knowledge from our tutors. All of them will be no doubt striving for our special awards, presented every year at the Gem-A Graduation. These eight accolades are presented to the most exceptional and insightful students, looking at their practical and theoretical exam results and projects. The *Anderson Medal*, for example, recognises a stand-out student in the Gemmology Foundation examination, while the *Christie's Prize for Gemmology* is awarded to the best overall candidate in the Gemmology Diploma examination. These special prizes are an important part of studying at Gem-A, and we hope to spotlight them further over the coming months.

> These special prizes are an important part of studying at Gem-A



Don't forget to check our Event's Directory on page 45 to discover the dates for AGS Conclave and the Scottish Gemmological Conference, happening in April and May respectively. Both of these events are an important part of the Gem-A calendar, so we look forward to seeing you there.

All that is left to say is enjoy this issue of *Gems&Jewellery*. And don't forget, if you have an idea to share or an article you would like to submit, we would be thrilled to hear from you.

Best wishes
Alan Hart FGA DGA

Gem-A News

A round-up of the latest news from Gem-A

BACK IN STOCK

Gem-A Instruments assistant, Sophie Cox, spotlights a popular piece of equipment that has landed back on the shelves of Gem-A's physical and digital shop.

If you are looking to upgrade or replace your old (or missing!) loupe then look no further than Zeiss — a world-renowned manufacturer of some of the best loupes available on the market today and now back in stock at Gem-A Instruments. These loupes come highly recommended and are a brilliant investment for your instruments collection with two options available: single or double lenses and higher or lower magnification levels. The Zeiss 10x Loupe is a single magnifier with a 13mm aplanatic and achromatic lens that gives standard 10x magnification. In contrast, the Zeiss 9x Loupe is a double magnifier with a 22mm aplanatic and achromatic lens that provides 3x, 6x and 9x magnification levels. They are priced at £90 and £118.80 inc. VAT respectively. ■

For more information, please email instruments@gem-a.com

NEW FACES AT GEM-A

2018 has seen an influx of fresh faces at Ely Place. Here are some that you might encounter!

Sarah Bremner, Editorial Coordinator

Alex Herbert, ODL Design & Development

Beth West, Tutor Assistant

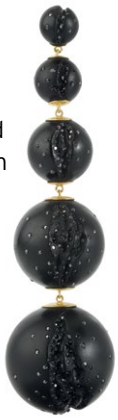
Linden Condon, Education Administrator

Natallia Barysavets, Accounts Assistant

GCDC AWARD WINNERS

Congratulations to the winners of the Gem-A Special Award at the Goldsmiths' Craft & Design Council Awards. Jacqueline Cullen and Huub Boekhorst (of Brillanza Jewellery) were named joint winners of the prize with a pair of Whitby Jet and diamond earrings and an Argentium silver hair pin respectively.

As their prize they will each receive a scholarship on the Gem-A Diamond Grading and Identification Course.



OBITUARIES

Robert Acker Holt, founder of Holts Gems and one of the longest-serving members of the London Diamond Bourse, sadly passed away on January 11, 2018. Just five days from his 95th birthday, Mr Holt was an inspiration to all who knew him. His charming loving nature and quiet humour made him one of the most respected members of the jewellery trade. He was a loving and dedicated family man to his wife Dorothy, two sons Jason and Stuart, and five grandchildren. Holts Gems has expressed its thanks to all its customers, colleagues and friends for the friendship and loyalty showed to Mr Holt over his 70 years in the trade.

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Head to the **News & Blogs** section of **gem-a.com**

CGA UNVEILS SPECIAL AWARDS FOR 60TH ANNIVERSARY

The Canadian Gemmological Association (CGA) has announced two awards to celebrate its 60th anniversary. The Diamond Award will reward one individual who has made a significant contribution to Canadian gemmology. Although entrants don't have to be Canadian or have studied with the CGA, only those who are members of the CGA or Gem-A will be considered. The Diamond Award winner will receive a cash prize of CA$2,000, in addition to worldwide recognition at the CGA Conference in October 2018.

CGA President, Donna Hawrelko, commented: "This award has been a long time coming and we are proud to be supporting this recognition of distinction in gemmology, not only in Canada but internationally. We want everyone to come to our conference on October 19-21 in Vancouver to help us celebrate the best and the brightest in the industry."

The 'First Annual Emerging Artist Jewellery Design Competition' is open to enrolled jewellery students or recent graduates from across Canada. Entries will be judged by a panel of experts and will be based on criteria such as wearability, workmanship and innovation.

Hawrelko added: "The jewellery industry is big business in Canada, over CA$3 billion and growing, so we are eager to showcase Canadian students and their designs in this exciting new format. We cannot wait to see what Canadian designers have to show. This is just one of many things the CGA has planned throughout the year to celebrate our Diamond Anniversary." ■

Nominations and full award details can be found on the CGA website: canadiangemmological.com

PAT DALY HOSTS PACKED WORKSHOP AT IJT 2018

The 29th International Jewellery Tokyo was a great success for Gem-A in January. Gemmology tutor Pat Daly FGA DGA hosted a popular workshop titled 'Seeing Gemstones' on January 26, with Gem-A ambassador in Japan, Ayako Naito FGA DGA, translating the talk for more than 160 audience members. During the show, Gem-A also hosted a members' party to network with our community of gemmologists and students from across Japan.

We would also like to thank the members and students that helped on the Gem-A booth during the show, including Misako Yoshimoto FGA, Eriko Ogita DGA, Emi Okubo FGA, Kaoru Tokuyama FGA, Kaori Iida FGA and Yu Hanaki FGA.

JESSICA HAN NAMED GEM-A's HEAD OF CHINA

With 13 ATCs in China to date, Gem-A is pleased to name Jessica Han as our head of China. Han will work with ATCs to support our Foundation and Diploma students, while also helping Gem-A to develop in the country.

Get in touch via jessicahan@gem-a.com.

NEW ATCS FOR GEM-A

Gem-A is pleased to welcome new international Accredited Teaching Centres (ATCs), including Chuang-En Gemology Consultant Institute (CGCI) in Taiwan, the National Gemological Training Centre in Shanghai, China, and the National Gemological Training Centre in Guangzhou, China.

We are proud to have 40 ATCs (including Gem-A HQ in London) across the globe, including Thailand, China, Japan, Sweden, Sri Lanka, France, Madagascar, Greece and Canada.

Mining for nephrite in Xinjiang province, China

Talented photographer and gemmologist, Billie Hughes, takes us behind-the-scenes of this fascinating image and shares stories from her trip to Xinjiang in western China.

Last summer we travelled to Xinjiang province, an autonomous region in western China, with a group of professors from China's Tongji University to visit jade mines. In China, jade has long been a treasured gem material. Among the most prized types of jade is nephrite, which can range in colour from greenish-white to more pure white. It is this latter type that is mined in Xinjiang.

Our group drove around the town of Hotan, along the White Jade River (Yurungkash), a famous jade deposit, and for hours we didn't see any activity. Finally, we spotted a few people with picks and shovels walking along the river, so we stopped to speak to them. We met one man who said he occasionally came down to the river to mine for jade when he had spare time. He then pulled the pictured nephrite boulder out of his pocket and explained how he had found it here along the riverside. One of the Tongji professors travelling with us confirmed that the boulder was a natural, untreated specimen.

Usually a piece like this will eventually be carved, with the artist incorporating the natural colour zoning, shape, and staining pattern into the final piece. Many people in China believe that jade can protect its wearer, so often people will buy such a piece as a gift for a loved one. ■

BE A GEM-A AWARD-WINNING PHOTOGRAPHER!

The Gem-A Photographer of the Year Competition takes place every autumn, with three category winners and one overall winner named at the Gem-A Conference in November. Billie Hughes was crowned the winner in 2016, followed by Jonathan Muyal FGA in 2017. To see your photography featured in *Gems&Jewellery*, simply enter one or more of your shots in the Internal, External and/or Humanity in Gems categories when the competition opens later this year. For more details, email *editor@gem-a.com*.

Photo Credit: E. Billie Hughes.

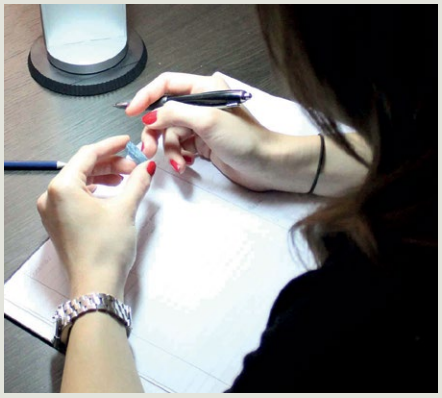
"Teaching offers a platform to explain things that fascinate me to people who are already interested — how could this be anything less than a joy?"

New Gem-A tutor manager, Rona Bierrum FGA DGA EG, talks about her approach to teaching and offers advice to those starting a course in gemmology.

I found myself in the jewellery field over 10 years ago purely by accident – I was supposed to be starting a PhD in Critical Fine Art Theory when I was offered a job helping out at a Mayfair jewellery office. After a month, I was running the office for the principle, and after four years of flying around the world, handling dazzling items of vintage and antique jewels, I had the opportunity to set up my own business in the same line of work. My first port of call was Gem-A, as I wanted the assurance of knowing exactly what I was buying, and that it was worth the money I was spending. I completed my Gemmology and Diamond Diplomas in the same year, winning the Bruton Medal and Deeks Diamond Prize, and was offered a job teaching the same courses the following year. The rest, as they say, is history.

When it comes to teaching the Gem-A course, you need to have a strong knowledge of the subject, combined with an understanding of how best to convey that information to a wide range of people in a way that makes it approachable, as well as enjoyable. I have found my love for the subject makes it easy to spend days discussing the finer points of light and colour. You also need to be able to get along with a lot of people, and not be hung up on getting things right the first time. If you don't expect it of your students, why expect it of yourself? The important thing is to recognise an error, correct it, and take the knowledge forward. A key aspect is having a desire to share your knowledge, and teaching offers a platform to explain things that fascinate me, to people who are already interested – how could this be anything less than a joy?

When it comes to studying and passing the Gem-A course, one of my top tips is to talk to people! Your tutor is there to guide you through the course and make the information more accessible. But it's important not to forget that your peers come to this course from all walks of gemmological life and may have a perspective on something that you are struggling with, which could make it all crystal clear. The most effective way of learning something is to teach someone else, so explain your knowledge to someone: family, friends, the cat! Their curiosity may help you clarify areas that you are finding difficult yourself.



Expanding our courses and workshops

At the moment, we are working on an expansion of our range of workshops and classes, including our newest offering of a **Foundation-to-Diploma five-day transfer workshop**. This is designed to support the transition from Foundation level to the more intense Diploma course, and includes a full review of all instruments as well as some of the science behind gemstones. This is especially valuable to those students who may have had to step away from their studies for a little while, and who might consequently feel less confident about returning to the classroom than they would like. It may also be taken by those who would just like a quick brush up of their practical and theoretical skills.

To succeed in gemmology, curiosity about the science behind gems, and a willingness to read around the subject, is a good starting point. Speaking from my own experience, dedication, hard work, and a level of stubbornness in the face of my own areas of adversity, have really helped! When it all gets a bit too much, I go to a jewellery auction or market, and play with pretty things until the joy of the subject comes back.

Active learning involves hard work, but embrace it and, above all, enjoy the journey. Gemmology is a gateway study – there are so many areas of work and learning which stem from it – and every day should be an opportunity to learn, and grow, within it. All gemmologists are passionate about shiny pretty things and studying gemmology at Gem-A is a wonderful way to learn more about the sparkling stones that you find intriguing. So if you are thinking of studying at Gem-A, get in touch – we have a course or workshop waiting for you! ■

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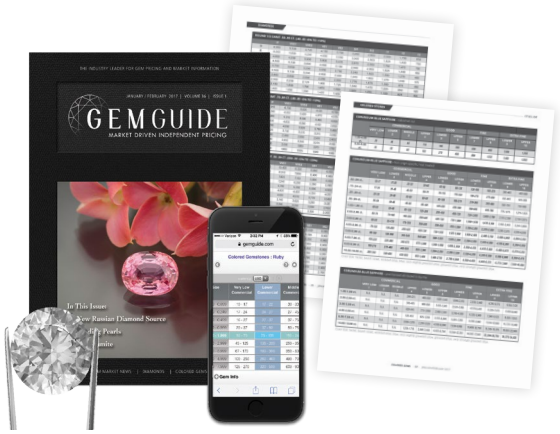

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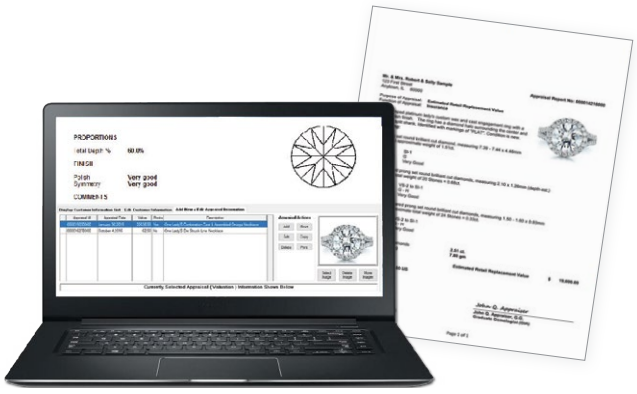

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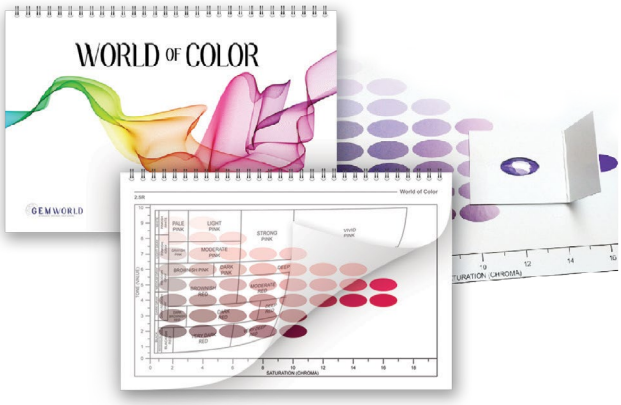

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Resurrecting an Industry

Christa Van Eerde MA MLitt FGA DGA explores the history of magnificent pearls from the Gulf region and meets one business daring to revive the trade in the United Arab Emirates.

Suwaidi Pearl founder Abdulla Al Suwaidi with a pinctada radiata oyster.

From the twelfth until the early twentieth century, the Gulf region (Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE) was regarded as the heart of the pearling world.

The region has relatively recently been released from hardship and brought to modernity by the discovery of oil, but for a long time the pearl was the source of wealth. As the Roman scholar Pliny the Elder said of Gulf pearls, they are "the most perfect and exquisite of all others, be that they are gotten about Arabia". The perfection of Gulf pearls is a result of the unique environmental conditions of the Arabian Peninsula. The water is unpolluted and rich in minerals and nutrients, ideal for nurturing the growth of pearls. That is why numerous key figures were drawn to Gulf pearls: notably Jacques Cartier, who voyaged to the region in 1912 with the mission of sourcing the world's most magnificent pearls.

Through the cultivation of the Gulf pearl oyster, Suwaidi Pearls hopes to

Maintained oyster rack.

Unmaintained oyster rack.

revive the UAE pearling industry. Located in Ras Al Khaimah, Suwaidi Pearls breeds the Pinctada Radiata oyster, from the family of the great natural pearl bearing oysters. The protected saltwater lagoon in Al Rams is primeval and wild with flora and fauna. It benefits from rainwater which comes from the surrounding Al Rams mountain, part of the Al Hajar mountain range which runs along the coast of Tangestan, and provides increased oxygen. The amount of oxygen present depends on the salinity and temperature of the water, and the more oxygen the oyster can get, the better it can filter the water.

For Suwaidi Pearl founder and prominent Emirati, Abdulla Al Suwaidi, the pearl farm connects him to his familial, societal and cultural roots. His grandfather, Mohammed Bin Abdulla Al-Suwaidi, was one of the last outstanding pearl divers, before natural pearl diving became unsustainable. The Al Suwaidi family's link to the pearling industry dates back centuries, and Abdulla sees it as his responsibility to protect this legacy. It is a time-consuming venture, and patience and dedication are essential, but the rewards can be great. When his grandfather, nose pegged with clips of turtle shell, ears plugged with wax and fingers bound in leather guards, dove for pearls, he would find a single natural pearl in every hundred oysters he collected. Abdulla finds approximately sixty cultured pearls in a batch of one hundred oysters, of which roughly ten may be of a high quality. Much better odds, but still unpredictable and random, as I would find out first-hand on my visit. Abdulla explained a strand of matching cultured pearls may take eight years to collect, but a strand of natural pearls can take a lifetime. It is no wonder that in 1917 the Cartier 5th Avenue Maison was purchased for one hundred dollars and a necklace comprising of two strands of natural pearls!

The perfection of Gulf pearls is a result of the unique environmental conditions of the Arabian Peninsula.

THE PEARL PROCESS

Oysters are solitary creatures that feed on plankton. Pearls form when an oyster protects itself from an irritant, covering the invader with layer upon layer of nacre, a smooth, crystalline mineral substance secreted by the epithelial cells of the mollusc's mantle tissue. In natural pearls, the un-expellable irritant might be a grain of sand, tiny organism or parasite, but in cultured pearls a small mother of pearl bead from a freshwater Mississippi oyster is implanted along with a 2 mm slice of a donor oyster's mantle, in order for it not to be rejected.

The nacre is the same material that forms the inside of the shell, made up of calcium carbonate, variety aragonite, and conchiolin, a tough, insoluble protein which is lighter and stronger than concrete. The strength comes from the juxtaposition of hexagonal platelets of aragonite in very thin layers with sheets of an organic matrix composed of elastic biopolymers. The aragonite platelets are similar in thickness to the wavelengths of visible light, creating iridescence, a lustrous rainbow-like play of colour caused by the differential refraction of light waves that change with the angle of view. The pearl's colour is therefore not

Opening oysters in search of pearls.

Exploring the oyster.

Discovering the treasure of the sea.

Rubbing the pearl in salt.

Collection of Arabian pearls.

caused by pigment, but rather structural colour resulting from interference effects. A pearl's colour will be the same as the molluscs' lips in which it grew, and Suwaidi pearls exhibit 13 hues.

PEARLS TODAY

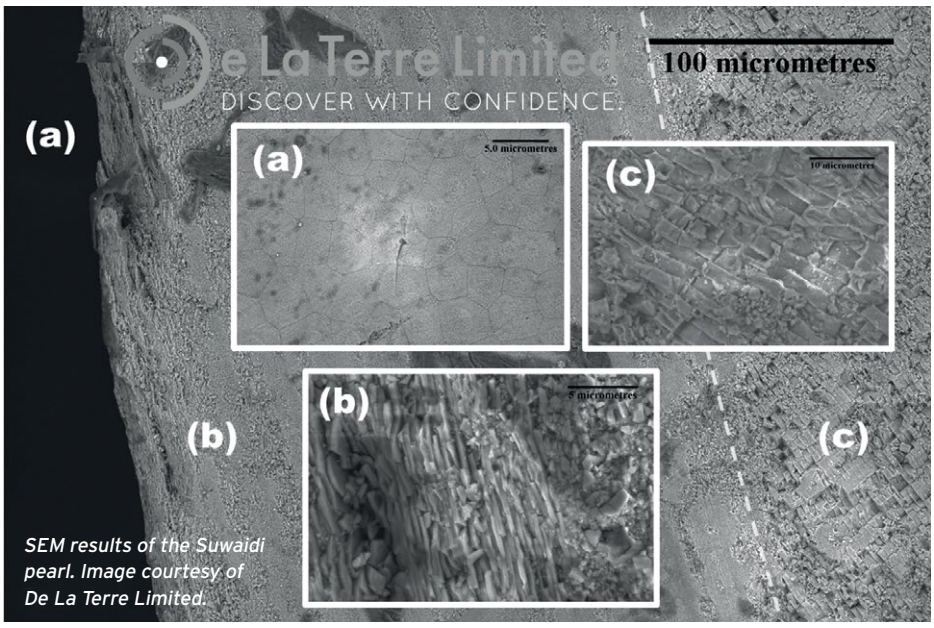
A cultured pearl represents a partnership between man and nature. Kokichi Mikimoto was the first to culture a spherical pearl in 1905. He said: "My dream is to adorn the necks of all women around the world with pearls." Today, over ninety percent of pearls on the market are cultured. What makes Suwaidi Pearls special is heritage and the use of molluscs from the shores of Al Rams. The quality and speed are distinctive, the first layer of nacre is produced after one month, as compared to Japanese cultured pearls in which the first layer is produced after six.

From 2018, Suwaidi Pearls will offer exclusive tours of its farm, providing the public with insight into cultured pearls and the history of Arabian pearls. They will open their state-of-the-art floating laboratory where one can witness the delicate seeding or nucleation process of the cultured Gulf pearl, and their off-site Pearl Art House, where craftsmen create jewellery. They will also offer diving enthusiasts the chance to explore the Al Rams lagoon and pearl beds at varying stages of development.

What struck me most on my visit was Abdulla's genuine passion for bringing the UAE pearling industry to a modern age. He is a vital link, bridging the past with the present and looking forward to the future. He demonstrated on equipment that has been passed down through generations, such as grating dishes and a balance counterweighted by agate beads. After pulling up a clean versus uncleaned oyster rack, which was literally squirting with life, he allowed me to chance my luck and after a generous few guesses, the magical moment occurred when he opened an oyster and a pearl was revealed. Absolutely nothing went to waste, the oyster proved an edible delight and the lustrous shell a decorative keepsake. My pearl had been inside the oyster for eight months and measured 6 mm, an average size. I watched with fascination as it received a rough salt bath to remove any surface imperfections. Abdulla does not dye, irradiate, or treat the pearls. What you see is what you get – a resplendent treasure.

The allure of pearls transcends nationalities, cultures and even earthly concerns. Pearls are organic, symbolise purity, generosity, integrity, fertility and loyalty, and are the subject of many myths and legends. In Roman mythology, Venus, the goddess of love, came from the sea like a pearl, and in Greek mythology, pearls were proclaimed to be tears of joy shed by the goddess Aphrodite. In the Bible, the Parable of the Pearl appears in Matthew, and in Islam the Holy Quran promises pearls in paradise. There is truly something magical about pearls and the Suwaidi pearl farm offers a unique hands-on experience in the midst of nature at its most majestic. It leaves you with not only knowledge, but memories that last a lifetime.

For more information or to book your visit, please search: **suwaidipearls.com**. ■



SEM results of the Suwaidi pearl. Image courtesy of De La Terre Limited.

All images ©Christa Van Eerde, unless otherwise stated.

"Times change, and research is a marvelous and exciting thing..."

Maggie Campbell Pedersen FGA ABIPP explores the most common misconceptions about Whitby jet and explains why new research around this gem material is so exciting for gemmologists and jewellers alike.

For a very long time we have been taught – and believed – that one of the things that makes Whitby jet so special is that it derives from one type of tree only, namely a form of *Araucaria*, akin to the monkey puzzle tree.

We now know this to be incorrect. Firstly, Whitby jet derives from six or more different species, and secondly, it seems that none of them were *Araucarias*.

As far back as the beginning of the twentieth century research was questioning the old belief, and at the end of the century research in Spain finally proved it to be wrong. Yet the new information was not widely known so even the most respected sources continued to perpetuate the old ideas because they knew no better — and I am as guilty as anyone, blithely repeating the old beliefs in ignorance of the true facts.

Research into jet has been sparse. Black materials were notoriously difficult to test, and anyhow, not many people were really interested. Jet is, however, of great interest to archaeologists, and today the most extensive research ever undertaken into jet is being carried out at Yale University in USA. Taking part in the research is Sarah Steele FGA DGA, who has written about jet testing in this magazine (*Gems&Jewellery* Sept/Oct 2016, Volume 25, No. 5), so we can look forward to being kept more up to date about it in future. Material from at least sixteen countries is being tested by methods such as isotope analysis, and we expect to learn a lot more about its origins.

New findings will make our Whitby jet no less special. The geological conditions that formed jet are unique, occurring only in small areas around the world and making the material rare. Further, Whitby jet is very homogenous – more so than many other jets – which is why it takes such a good polish and has such a beautiful, deep velvety-black colour.

Whitby jet bracelet by Jacqueline Cullen.

We have come far from believing that jet is black amber that changed colour because it was in the ground for longer. We clung onto the *Araucaria* story for a hundred years, possibly in part because it was a good story and good stories sell products. But times change, and research is a marvelous and exciting thing – even if we have to ditch some old theories and good stories, and rewrite the books. ■

For the love of diamonds

If your passion for diamonds is bordering on obsessive, there is a new professional trade event that is guaranteed to pique your interest.

CARAT+

The world's premier diamond event

It is safe to say the diamond industry is an international affair, with mines, manufacturing hubs, grading laboratories and fine jewellers spread across every corner of the globe. Gathering all these industry leaders, business owners and designers in one place is the guiding principle behind CARAT+ — a new trade-only diamond event with the aim of becoming an essential 'Diamond Destination' recognised across the world.

Now in its second year, CARAT+ brings diamond buyers, retailers and designers face-to-face with leading manufacturers and suppliers. Exhibitors will be offering loose diamonds ranging from melee sizes to exceptional showstoppers, plus a selection of gemstones, including Paraiba tourmalines, Burmese rubies, Kashmir sapphires and Colombian emeralds.

During the three-days of the show in May, CARAT+ will host a range of special events, including an interactive 'Antwerp Diamond Experience Dome' in partnership with the Antwerp World Diamond Centre (AWDC), and CARAT+ Night with special guest, British actress and model, Elizabeth Hurley.

Positioned right at the heart of Antwerp, CARAT+ is focused on facilitating conversations in the diamond sector, addressing challenges and offering opportunities to network. Guest speakers will comment on key trends, while exhibitors like Roberto Coin, Rosy Blue, Venus Jewel, Dali Diamond, Kunming Diamonds and Taché Diamonds will showcase their latest product offering and technologies.

If you are a lifelong devotee of diamonds or studying for your Gem-A Diamond Diploma, CARAT+ could be the weekend destination you are looking for.

CARAT+ 2018 takes place at Antwerp Expo in Antwerp, Belgium, from May 6-8.

Image top left courtesy of Shapiro Gems.

THE Rock Stars OF TUCSON

This year's Tucson gem shows were packed with special events, big announcements, gemstone trends and exceptional jewellery. Here, Olga González FGA DGA, shares some of her insights from the show floor, while Gem-A insiders give their feedback on the event.

When gemmologists from across the world descend on the Tucson shows, it is hard not to be reminded of a high school reunion, where old friends catch-up about what's new in their professional lives.

Unlike a high school reunion, however, Tucson provides an opportunity to discuss more interesting topics like rocks and geological formations, gemstone trends and jewellery designs with those who are equally exhilarated by the subject matter. If only this had been offered as a class at school! Now that the 2018 shows are well and truly behind us, here is the lowdown on what was found on the ground...

1: A 14g Shakiso Ethiopian emerald crystal. Image credit: Mayer & Watt.

2: Medium green cut Shakiso Ethiopian emeralds. Image credit: Mayer & Watt.

GREEN WITH ENVY

The talk of the town was Ethiopian emerald from the tribal lands of Shakiso — about 18 hours south of Addis Ababa (**1** & **2**). According to American gem dealers, Mayer & Watt, the deposit was discovered within the last year, and 40% of the emeralds are not oiled. They are also identifiable from other sources and look like they will soon be challenging Columbian emeralds in terms of prestige. This may sound like a grand statement, but it is hardly surprising when viewing their spectacular colour. In fact, all emeralds were enjoying attention in Tucson, with floral carvings and beads really turning heads.

DOUBLE TROUBLE

When walking between the booths, it was clear that designers are embracing the doublet again. Dana Bronfman impressed at JCK Tucson with her stunning lapis lazuli and gold rutile pieces (**3**). The gold in the quartz makes the pyrite in the lapis pop, bringing out the beauty in both stones.

Bronfman states: "For the new collection I was intrigued to create otherworldly designs using earthy stones, challenging traditional perspectives on high jewellery. I wanted each piece to have a bit of an element of surprise, like a secret between the piece and its owner. You'll see the pieces have a hidden detail; the pendants are backed with 18k gold pierced with my oculus design, as are parts of rings that can only be seen from certain angles."

LUSCIOUS LACQUER

Oh my pearl... these beauties are having a renaissance! "We are selling pearls again," says Joshua Israileff, vice president of operations for ASBA USA, a supplier of Tahitian cultured pearls and cultured pearl jewellery (**4**). "Consumers are enjoying the natural assortment of colours that can come naturally from a pearl. It's a unique and natural product, that's what people want."

Highlights include the Planete ring by French designer jewellery brand, Julie Genet Joaillerie, crafted in 18k white gold and set with indicolite tourmalines and a Tahitian grey pearl (**5**).

3: Pendant by Dana Bronfman with a large lapis and rutilated quartz doublet, and yellow and white diamonds set in 18k yellow gold. Image credit: Dana Bronfman.

4: 14k white gold and Tahitian Keshi pearl cufflinks by ASBA. Image credit: ASBA USA.

5: Planete ring from the Constellation collection by Julie Genet Joaillerie. Image credit: Julie Genet Joaillerie.

NEW KIDS ON THE BLOCK

One particular vendor caught my eye for having three materials I hadn't seen from Tanzania before. Ariel Treasures, a fine rock and mineral company based out of Livingston, New Jersey, was selling Kaleidoscope Sunstone, Cherry Tanzurine (a trademarked, natural cherry quartz), and a green quartz with exceptional colour. The latter two are perfect for beads (**6**).

'Gold Sheen' sapphire was also on my radar at the Tucson shows, as I hadn't seen the material in person since reading about it in the *Journal of Gemmology*. Brenda Smith Jewelry had some particularly stunning examples of untreated and unheated 'Golden Sheen' jewellery that's worth a second, and third, look (**7**).

Elsewhere, The Clam Shell also brought a new material buyers couldn't get their hands off. It was a petrified wood from the island of Garut in Indonesia with blue opal, native copper and chalcedony in the mix. Ten trays of the material were brought to AGTA and sold out in three days (**8** & **9**).

6: Cherry Tanzurine and green quartz beads from Ariel Treasures. Image credit: Olga González.

7: Trillion Earrings by Brenda Smith. Hand fabricated in 18k yellow gold with 'Gold Sheen' sapphires and champagne-colour diamond slices. Image credit: Brenda Smith Jewelry.

STACK IT

From a design perspective, companies were embracing the idea of perceived value. Designers experimented with enhancing the beauty of a stone, while keeping the price points lower to attract a variety of customers. Anit Dodhia, founder of Kaali Designs, said: "People are looking for delicate jewellery, and stackables are in demand, even in bridal. Trends continue towards the unique in bridal, including fancy shapes and rose cut stones."

Large brands have jumped on the stackable trend too, with Forevermark launching its first designer collection, Alchemy, alongside Jade Trau (**10**). Within the range, different diamond cuts have been linked to female characteristic, so marquise, for example, is said to represent 'The Maverick' who is adventurous, independent and spirited. Unsurprisingly, the Alchemy collection is targeted at women buying diamonds for themselves.

I am proud that our industry is continually innovating and discovering new and beautiful materials from around the world. This year's gem shows were exciting and suggest great things for JCK Las Vegas later this year. ■

9: Stones cut from petrified wood logs by The Clam Shell: Image credit: The Clam Shell.

8: A cross section of petrified wood with native copper, blue opal and chalcedony by The Clam Shell. Image credit: The Clam Shell.

10: Forevermark x Jade Trau Alchemy collection solitaire stackables in 18k rose gold, including Envoy, Vanguard, Maverick and Sophisticate. Image credit: Forevermark.

Opportunity is now a Reality

Gem-A North American manager, Eric Fritz FGA DGA, shares some of the pioneering developments in gemmological education that came out of this year's Tucson gem shows.

The University Gem and Mineral Museum in Tucson will relocate to the Pima County Courthouse building (pictured). Image credit: Charles Evans.

Tucson is always an exciting time, but this year the shows offered even more excitement. The University of Arizona made two announcements taking 'Gem Show Fever' to the next level. This was a special year and the culmination of five years of work between the University of Arizona, the Somewhere in the Rainbow (SITR) collection and myself.

The University Gem and Mineral Museum in Tucson will relocate soon into the historic, newly refurbished Pima County Courthouse building, and is scheduled to open in February 2020. Alan Norville, owner of the GJX show in Tucson, has donated, in memory of his wife Alfie, the gift of a gem hall; something currently absent at the museum. This will be a key attraction with gems adding the glitz that minerals do not for many. The spectacular gems and jewellery currently in the University Gem and Mineral Museum, provided by Shelly Sergent and the SITR, will remain for another year having shown the university and the mineral community at large the need to expand beyond minerals, while keeping them as the core of the collection. Gem-A will have a part in this exciting new venture as the museum develops and we currently have a display with SITR in the University's spectacular Flandrau Science Center & Planetarium.

The second announcement was the ground-breaking funding for an endowed chair in gemmology at the University of Arizona. The endowment is made possible through a gift from luxury consignment specialist, The RealReal, and now enables the long-awaited degree in geosciences based on a concentration of work in gemmology. This new professorship in gemmology at Arizona will offer a full curriculum of undergraduate, Masters and PhD programs, as well as scientific research. Gem-A will also have the opportunity to offer our diplomas as an option to students who would like to add a trade certification to their university experience.

When hired by Gem-A, Tucson was the city where I relocated, with the hope that there could be some type of collaboration with the University of Arizona. That early vision has now come to fruition and the opportunity is now a reality. Needless to say, this is a very exciting time for gemmology and the gemmological community.

Susi Smither FGA GIA JDT, designer and founder of The Rock Hound, shares her insights from a memorable trip to Tucson.

Some of the incredible gem and mineral specimens that caught the eye of The Rock Hound founder and designer, Susi Smither, at JCK Tucson.

Susi Smither of The Rock Hound at her JCK Tucson stand.

It all started with the breathtaking sight of a fireball meteor burning through the Arizona night sky, followed by the beauty of the super blue blood moon eclipse from our back porch. I knew from this that my 2018 Tucson gem show pilgrimage was going to be memorable. Spending every waking moment of two weeks seeing rocks, talking with friends about rocks, and being surrounded by so many rocks of all shapes, sizes, cuts and colours is my favourite time of year.

This year, The Rock Hound team decided to take part in our first international show at JCK Tucson at the JW Marriott Starr Pass. It is a feat of organisational skill to shrink the essence of The Rock Hound down to two display cabinets, but you certainly couldn't miss our bowler hats and bold jewellery (or should I say jewelry) when you walked through the door. We enjoyed it so much that we are gearing up to do it again at JCK Las Vegas as one of its 'Rising Stars' — if you're in town in June, come and say hi at Booth B18129.

Wavellite – I had no idea you existed!

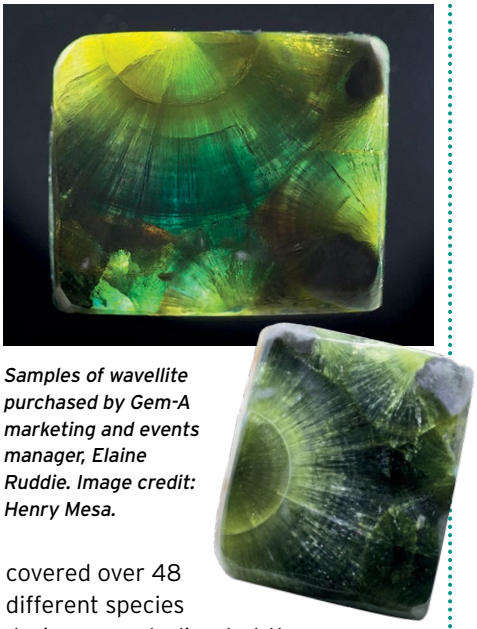
Gem-A marketing and events manager, Elaine Ruddie FGA DGA, shares her exciting discovery of wavellite in Tucson's bustling gem halls.

I am a bit of a reluctant gemmologist; I'm not a hard-core mineralogist or a geologist, I'm certainly no scientist. I enjoyed learning about gemstones and studying for the Gem-A Gemmology Diploma, but my real interest? Amazing stones that do cool stuff – no technical jargon required. So with that – how cool is wavellite?

This radiating mineral caught my eye as I walked down the aisle at JOGs during the Tucson gem fair. The mining company behind it is Avant Mining LLC, from Blue Springs Arkansas. They also mine quartz and turquoise but it was the different shades of green and the large radiating structure that had me mesmerised.

Of course in Tucson you can literally find anything, it is a magical place where hotel rooms become showrooms by day (beds pushed against the wall) and you will find vendors from far flung corners of the earth with the latest synthetics, fossils, plastics, whatever you desire.

As a gemmologist, your education does not end once you have completed the Gemmology Diploma. You may have covered over 48 different species during your studies, but there are literally thousands of gems and minerals that you might come across in life, some more obscure than others. So my advice to students and recent graduates is keep studying. Attend shows and conferences because there will always be something new to learn.



Samples of wavellite purchased by Gem-A marketing and events manager, Elaine Ruddie. Image credit: Henry Mesa.

Chemical Composition: $Al_3(PO_4)_2(OH, F)_3 \cdot 5H_2O$

Hardness: 3.5 – 4

Crystal System: Orthorhombic

Cleavage: Perfect

SG: 2.36

Localities: High Down quarry, Filleigh, South Molton, Devon, England and at the Hot Springs area of Arkansas, USA.

Information taken from Gems, Sixth Edition, Michael O'Donoghue (2016).

A new treasure for Gem Empathy

Gem-A has once again turned to renowned gem-cutter, John Dyer to select the ideal stone for our annual Gem Empathy competition, in association with International Jewellery London (IJL). This year's competition entrants, all of whom are IJL exhibitors, will be asked to design a piece to showcase a beautiful 18.28ct ametrine. The winning concept will receive the gem to bring their design to life. Check back later this year to discover how to enter.

Elaine Ruddie collecting the Gem Empathy stone from John Dyer.

The 18.28ct ametrine from Bolivia. Image credit: Henry Mesa.

Andrew Cody FGA (Hons), founder of leading Australian opal company, Cody Opal, was formally presented with his honorary fellowship at the Gem-A Big Gem Bash on February 1. The news was first announced at the Gem-A Conference in November 2017.

Cody's commitment to the industry has seen him take on a number of official positions, including president of the Australian Gem Industry, founding member and chairman of the Australian Jewellery and Gemstone Industry Council, and president of the International Colored Gemstone Association. Most recently, Cody has been working with a number of organisations on a review of opal classification.

Andrew Cody is presented with his honorary FGA by Richard Drucker FGA (Hons) GG at Gem-A's Big Gem Bash. Image credit: Bill Scott.

CHATOYANCY IN SILLIMANITE

Harold Killingback FGA explores chatoyancy in sillimanite cabochons, an optical phenomenon where a band of light, known as a 'cat's eye', appears to hover above the surface of a stone, resulting in a striking lustre and colour.

Figure 1 shows a sharp cat's eye in a sillimanite cabochon lit by a single point source (the sun) above the stone, i.e. from the same side from which it is viewed. There is also a sharp 'eye' when the light comes up through the stone, toward the viewer, as shown in Figure 2. One can even see the 'eye' when the cabochon, lit from below, is viewed horizontally along the line of the stone's major axis, see Figure 3. For these views, the single point of light was a fibre optic 'pipe', with an added tube 157 mm long and 10 mm in internal diameter, to fit the pipe. This acts as a collimator – a device that narrows a beam of particles or waves (including light).

It is less usual to see the effects in Figures **2** and **3** (dia-chatoyancy) than that in Figure 1 (epi-chatoyancy), partly because we normally admire gems when lit from above rather than from below, so we may simply miss seeing the effect. Partly, also, because many chatoyant stones are too opaque to let much light pass right through them. Epi-chatoyancy, by contrast, can be the result of reflection from parallel inclusions immediately below the surface, and so the light path within the stone can be shorter, resulting in less absorption. It helps, in this case, that the base of this cabochon is fairly smooth, rather than being left rough ground as is often the case, so more light from below can enter without being scattered.

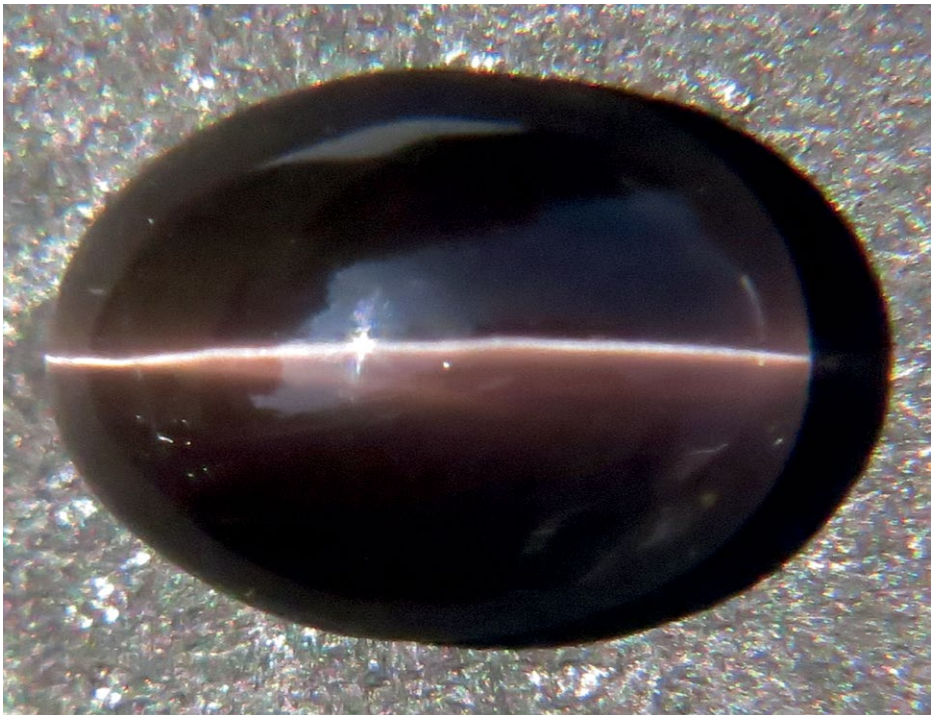


Figure 1: Epi-chatoyancy, plan view, lit by the sun. In addition to the 'eye' line, there are reflections of the sun and of surroundings from the top surface of the cabochon.

Sillimanite, with andalusite and kyanite, is a polymorph of aluminium silicate. Its RI is in the range 1.654 - 1.683 and DR 0.020 (**1**). A fibrous form, sometimes called Fibrolite, can exhibit chatoyancy due to its own structure. This example shows such a form. The chatoyancy of the brown sillimanite from Orissa, India, is said to be due to ultra-fine long and short ilmenite needles (**2**). The stone illustrated might well be from this source as the dealer said it was from India, but he could not be more precise. I have not, however, been able to see any needles in this example. I put it near a strong magnet, but no attraction was detected. This stone measures 8.5 x 6.1 x 3.7 mm and weighs 1.75 ct.

RAY DIAGRAM

The problem in drawing a ray diagram for chatoyancy is that one does not know where the relevant reflective surface is located within the stone, nor what angle it is orientated. The solution is to work backwards along the exit ray, and forwards along the incoming ray, and then to see what has to happen where their paths cross if they are to be parts of a single ray. The resultant diagram is shown in Figure 4, which represents a partial cross-section of the stone along its major axis as viewed from the side. In this example, I have chosen to examine the case of the dia-chatoyancy when the stone is viewed horizontally along the line of its major axis, as in Figure 3. Arbitrarily, I have selected the horizontal ray leaving the cabochon at the point where the normal to the surface rises at 30º to the horizontal.

As the exit ray is horizontal, the angle of refraction, r, must be 30º. The incident angle, i, was calculated using Snell's law, and an RI of 1.658. The resultant angle is 17.6º, and so the ray in the stone slopes up from horizontal at an angle of (r – i), which equals 12.4º in the case illustrated.

The arbitrarily chosen entrant ray is not refracted, as it is normal to the base. The angle between it and the exit ray just examined is 90 + (r – i). For these rays to be parts of a single path there must be a reflective surface where they meet. Let it be tilted at θ to the horizontal. As the incident ray at the

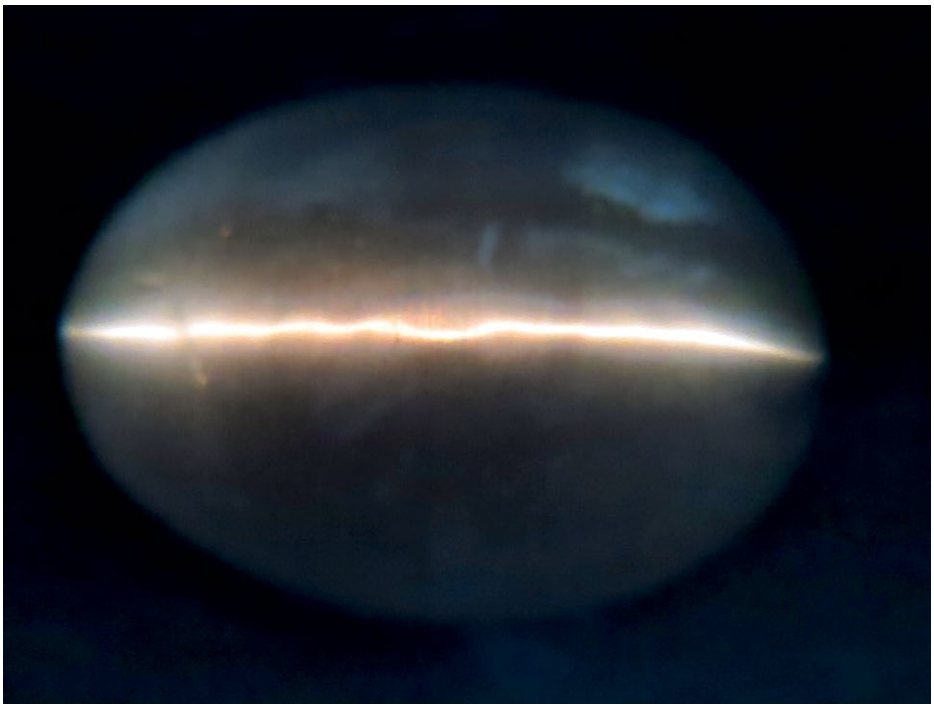


Figure 2. Dia-chatoyancy, plan view. Light from a fibre optic source below enters the stone through a suitably shaped hole in a black paper mask. There is a little general light on the stone so that its outline may be seen. As well as the 'eye' line, the fibrous nature of the stone is visible.

reflecting surface is vertical, the angle of incidence is also θ, and the angle of reflection must be the same. So 2θ = 90 + (r – i). In our example we get θ = 51.2º. This angle would be the same had I chosen any other ray in the vertical entrant beam.

We can repeat the calculation of θ corresponding to various exit points of horizontal rays from the stone as defined by the angle of the normal to the surface at these points. The results are shown below.

Angle of normal at exit point	15º	30º	45º	60º	70º
Angle of reflector	48.0	51.2	54.9	59.2	64.7

Figure 5 (shown overleaf) is included for fun, really, but it does illustrate the fact that multiple point sources produce multiple eye-lines. Here, there are but two sources and so two eyes. In the limit, a cloudy sky consists of infinite point sources and produces, not any lines at all, but so many that no individual line can be distinguished and the stone reflects an even glow.

CONCLUSIONS

I have calculated the angles of reflector surfaces for only one direction of view and only one of sillimanite's two values of RI. These reflector angles could all be provided if the reflecting inclusions were roundish in cross-section, whether hollow tubes or fibres. If, however, the inclusions are crystalline and polygonal in cross-section, one is forced to the conclusion that the orientation of the needles about their long axis must be random, in contrast to the fact that this axis must, in all cases, be orientated in the direction dictated by the structure of the material.

An alternative explanation is given by Moon and Phillips (**3**). They ascribe the effect as being due to Fraunhofer diffraction, applying Babinet's Principle of Complementary Apertures. The needles can then be regarded as apertures of the same size. The cross-section of the needles is then of no consequence.

This paper has also demonstrated that where, as here, it is not possible to trace a ray from start to finish, one can trace a known emergent ray backwards as far as possible, and then trace a known entry ray forward. If these rays cross, one can deduce what could unite these rays into a single path. ■

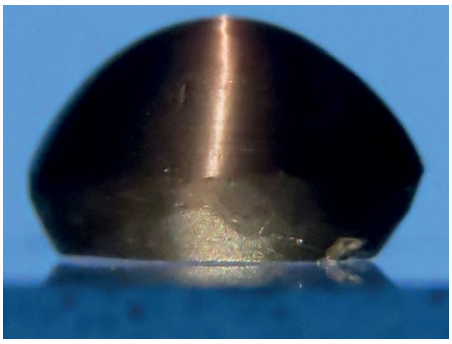


Figure 3. Dia-chatoyancy, end view. The cabochon is resting on a glass slide so that fibre optic light can enter from below. The background is illuminated by LED light, hence its blueness. Here, also, the fibrous structure of the stone can be seen, orientated at right angles to the bright line.

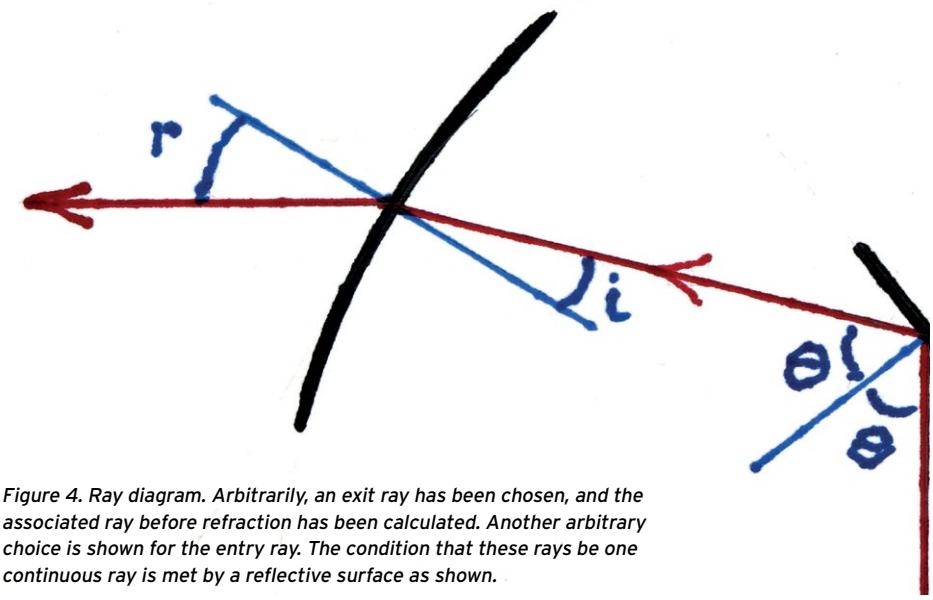


Figure 4. Ray diagram. Arbitrarily, an exit ray has been chosen, and the associated ray before refraction has been calculated. Another arbitrary choice is shown for the entry ray. The condition that these rays be one continuous ray is met by a reflective surface as shown.

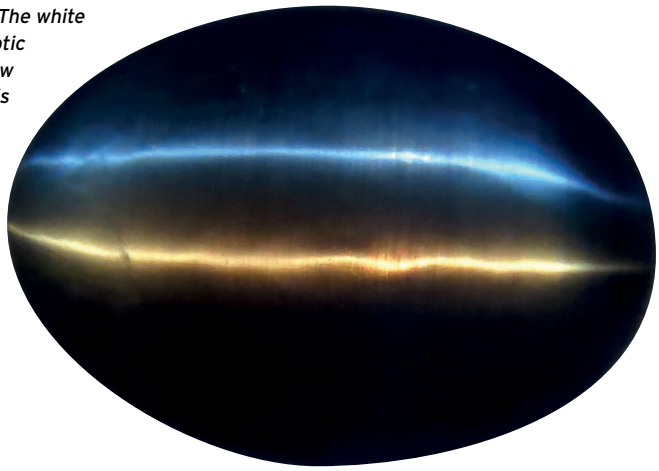


Figure 5. Bi-dia chatoyancy. The white line is produced by a fibre optic incandescent light from below the cabochon. The blue line is from a LED torch, also from below, but slightly to one side of the other source. The camera was set to correct for the red cast of tungsten light, so the LED ray looks very blue by comparison. Note the fibrous nature of the stone.

REFERENCES

1. *Identification of Gemstones*, pp 254-255. O'Donoghue and Joyner.
2. *Photoatlas of Inclusions in Gemstones*, Vol. 3, p 626. Gübellin, E. and Koivula, J. I.
3. A. R. Moon and M. R. Phillips, Schweiz. mineral. petrogr. Mitt. 64, 329-334, 1984.

All images courtesy of Harold Killingback FGA.

A STAR DIOPSIDE CUP AND PATEN

In 1996, before I started studying for my FGA, I already had some acquaintance with gemstones through my hobby of silversmithing. Black star diopside attracted me, partly because I liked the black shiny cabochon against silver, but also because the four-ray star could represent the Cross and so be of significance in a Christian church plate. I decided to make a Communion Cup (or Chalice) and Paten. The work was hallmarked at the London Assay Office, with my mark, in 1996 and it was completed in 1997.

The stem is left as raised. I felt this texture gave some feeling of the brutality of crucifixion. The globe shaped cup is planished but not smoothed. Asterism needs a single source of light, here the sun, and the thousands of facets on the cup, due to planishing, reflect individually. The depression in the paten is designed to fit in the mouth of the cup, so that they can be carried securely together.

In 2017, I heard that the Revd. Dr. Guli Francis-Dehqani was to be consecrated as the first Bishop of Loughborough, which is in the Diocese of Leicester. Guli is Iranian, the daughter of the exiled Bishop of Isfrahan. I know her because she is the wife of the priest in charge of our local group of parishes. I thought, new Bishopric, new Bishop... they might like to start off with a new set for Communion. So I offered my pieces to her, and she did me the honour of accepting them.

The Loughborough Chalice and Paten — Bishop Guli and Harold Killingback.

I formally presented my silverwork at the Service of Welcome to Guli in Leicester Cathedral on December 2, a couple of days after she was consecrated by the Archbishop of Canterbury. The picture shows Guli and me, a few days later, after the service at which my pieces were first used. The cup is now called The Loughborough Chalice.

It is very gratifying that my workmanship should be thought to be of sufficient standard to be acceptable. I am now 93 years old and have the inevitable sense of impermanence that grows with age, so my predominant pleasure is that my cup and paten will continue in use by Bishop Guli and her successors in perpetuity. ■

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1: Ideally proportioned round brilliant displaying its superior brilliance and fire. Note: the author's use of the term Ideal is restricted to mean the narrow range of angles and proportions in common between the diamond cut grades AGS 0 Ideal and GIA Excellent.

LET there be LIGHT

Get to grips with diamond optics, ray tracing and light performance with insights from Michael Cowing FGA.

The brilliant cut diamond evolved over several hundred years of diamond cutting and today it stands above all others in popularity. When fashioned with the best angles and proportions, traditionally called Ideal, the round brilliant displays the finest attributes of diamond beauty, brilliance (aspects of brightness and contrast), fire (rainbow colours of dispersion) and scintillation (sparkle with movement) (**1**).

A brilliant cut diamond's appearance is a kaleidoscopic pattern of internal reflections of surrounding light sources mirrored to the viewer from the diamond's pavilion facets.

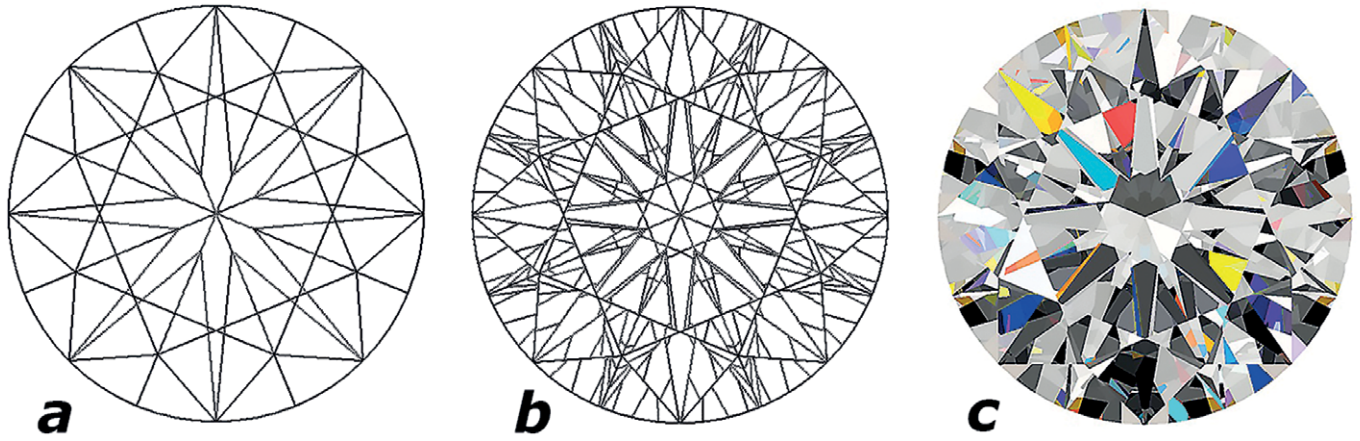
Shown in the face-up position in Figure **2a** is a wire frame model of the arrangement of the 57 facets making up the round brilliant cut diamond. Shown in Figure **2b** is a wire-frame pattern of 'virtual facets' resulting from the breakup and division of light by double internal reflection from the pavilion facets. This pattern of virtual facets was so named, because it gives a gemstone the appearance of having a lot more facets than are actually present. Figure **2c** is a photorealistic computer rendering of round brilliant light performance displaying brilliance and fire emanating from these virtual facets. Each virtual facet exhibits bright to dark brilliance or spectral fire dependent on its orientation to surrounding sources of light, and the properties of those light sources.

The pattern of virtual facets changes with each movement of the diamond or the observer. At any moment in time the arrangement of diamond and viewer results in a unique reflection pattern such as the one in Figures **2b** and **2c** where the view is looking at the diamond face-up, perpendicular to the table.

DIAMOND LIGHT PERFORMANCE ANALYSIS THROUGH RAY TRACING

Ray tracing is a technique used in the field of optics to analyse paths of light in any optical system. To analyse a diamond's light performance, rays of light are traced into, through and out of a model of the diamond using its properties of reflection and refraction.

For more than a century, ray tracing has been an important method used to analyse diamond optics in attempts to explain diamond light performance.



2: Face-up view of round brilliant. a: Wire frame of the diamonds 57 facets. b: Wire frame of 'virtual facets' resulting from double reflection from the pavilion. c: Photo realistic computer rendering of round brilliant displaying brilliance and fire emanating from these virtual facets.

Today, computer software systems like OctoNus DiamCalc not only automate ray tracing, they also provide photorealistic renderings of a diamond's light performance. Diamond photography is another valuable tool for studying diamond optics. Both DiamCalc and photography are the essential tools used throughout this article.

Almost everyone learning about diamonds and their cutting has seen ray tracing, as shown in Figure **3**. For more than 80 years, these ray trace diagrams have been used to graphically explain to the consumer the superior light performance of the Ideal round brilliant cut and the two examples of poor diamond cutting: the fish-eye and nail head.

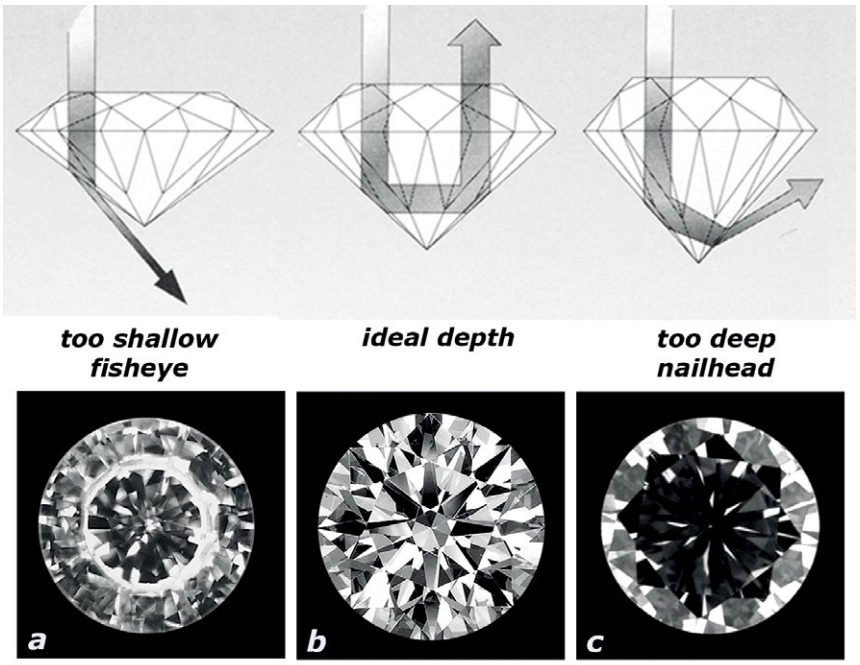
It will surprise many to learn that the ray trace diagrams in Figure **3**, which explain some aspects of light performance in gemstones with refractive indexes much lower than diamond, are inadequate, and do not explain the light performance in round brilliant, fish-eye and nail head diamond cuts. Shown in the work that follows is a unique way to use 3-dimensional ray tracing to test these conventional explanations.

REVERSE RAY TRACING

The method used is 'reverse ray tracing'. Employing this analytical technique will show that the ray tracing diagrams in Figure **4** offer better explanations for light performance, resulting in the appearance of these three diamond cut examples. Note that the directional arrows indicate light traveling from its source to the viewer's eye. To discover these ray paths we will reverse these directions and trace rays starting from the viewer's eye through the virtual facet locations being analysed.

Light rays originate from each source of light, and enter everywhere through the facets of the diamond facing those sources. After refracting and reflecting through the diamond the rays exit in many directions, most never reaching a particular observer's eyes. From among the confusing pattern of all these many rays, reverse ray tracing directly discovers only the paths of rays that actually reach the viewer's eyes from each virtual facet.

In face-up observation, each reverse ray begins at the eye, and enters perpendicularly through a virtual facet location in the crown. By following that ray into, through and out of the diamond, we discover the direction it takes upon exiting. That direction must be a source of light for the analysed virtual facet



3: Typical ray trace diagrams traditionally used to explain the appearance of;
a: Fish-eye diamond displaying the fish-eye like whitish ring just inside the diamond's table.
b: Ideal cut diamond displaying an even distribution of brilliance (both brightness and contrast).
c: Nail head diamond displaying dark star facets and a characteristically dark table.

location to be bright. In other words, for a particular configuration of diamond and observer that virtual facet is 'looking for light' in the direction of that exiting ray. In this way, reverse ray tracing discovers what the eye is seeing mirrored to the viewer from each virtual facet.

THE FISH-EYE DIAMOND

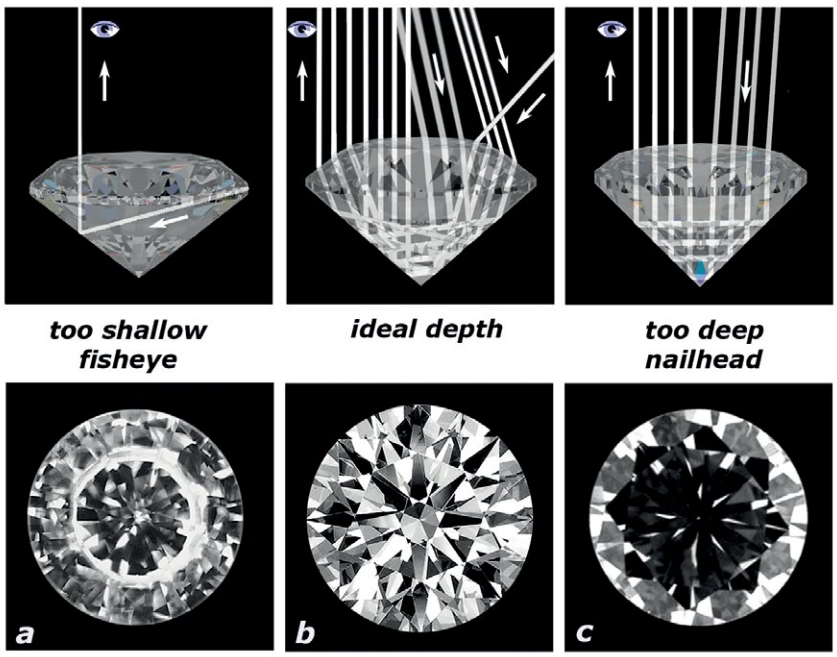
As a first example of reverse ray tracing analysis, we explore the appearance of the shallow pavilion fish-eye diamond. From Figure **3a** we see the conventional ray tracing diagram used to explain the fish-eye appearance. It shows a ray entering perpendicular into the stone's table that refracts out upon first contact with a pavilion facet.

This phenomenon called 'light leakage' occurs at the ray's first encounter with the pavilion. This leakage is also described as 'windowing' and occurs when pavilion facets are cut below the gem's critical angle. The central area of these shallow-cut gems appears to have a 'window' that the observer can see through. Notice the window in the table area of the pink sapphire in Figure **5** where the background is visible through the gem. However, diamond's critical angle is 24.4°. The fish-eye appearance in shallow cut diamonds occurs at pavilion angles around 37°, so light leakage is not the cause of the fish-eye diamond appearance. That appearance of a dead fish's eye is due to the whitish ring apparent just inside the table.

The cause of this appearance is discovered with reverse ray tracing starting from the viewer's eye and entering perpendicularly through one of the whitish ring's virtual facets (Figure **4a**). That ray enters through the ring inside the table and internally reflects off the pavilion to the diamond's girdle.

In this instance of the shallow pavilion fish-eye, the reverse ray tracing reveals that the whitish ring is an internal reflection from the pavilion, mirroring the whitish unpolished girdle. (Analysis of more virtual facets in the fish-eye shows no windowing.)

> In this way reverse ray tracing discovers what the eye is seeing mirrored to the viewer from each virtual facet.



4: Optically accurate ray trace diagrams to explain the appearance of;
a: Fish-eye diamond displaying the fish-eye like whitish ring just inside the diamond's table.
b: Ideal cut diamond displaying an even distribution of brilliance (both brightness and contrast).
c: Nail head diamond displaying dark star facets and a characteristically dark table.

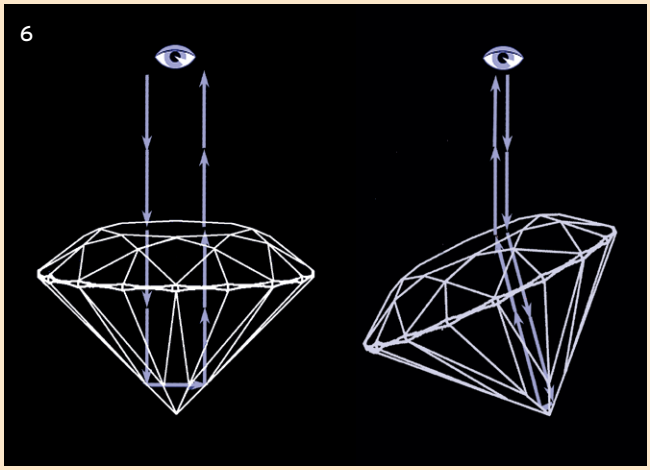
5: Example of 'windowing' in an oval, pink sapphire gemstone.

THE NAIL HEAD DIAMOND

The nail head diamond is the second often used example of poor diamond cutting. The distinctive dark table, Figure **3c**, is the characteristic feature of its appearance. Although it has since been corrected, the GIA Diamond Grading Course (1993) reflected conventional wisdom at the time when it stated, "If the pavilion is very deep, much of the light is leaking out. Then the table reflection and star facets look almost black, and the stone is called a 'nail head'".

As was the case with the first example of the shallow pavilion fish-eye, conventional ray trace diagrams like that in Figure **3c**, attribute the dark table to light leakage. However, this time the leakage is shown to occur at the ray's second encounter with pavilion facets after total internal reflection from the first point of internal contact. This form of leakage can occur in very deep pavilions. However, in the case of diamond it would require a pavilion angle greater than 52.5°. Since the nail head phenomenon occurs at pavilion angles approaching 45°, this form of light leakage is not an explanation for the dark table appearance of this type of poor cutting.

In this instance of the deep pavilion nail head, reverse ray trace analysis, Figure **4c**, shows that leakage is not what is causing the dark table appearance. (Light leakage is also not the explanation for the dark table nail head appearance in gems with refractive indexes much lower than diamond such as the colourless chrysoberyl in Figure **7**). Rather than leaking, these rays, Figure **4c**, are seen to doubly reflect and return through the table directly back toward



6: The nail head's retroreflection property results in the dark table appearance even when the diamond is tilted away from the viewer's direction.

7: Unusual colourless brilliant cut chrysoberyl with 45° pavilion retroreflecting the dark camera lens causing its dark table nail head appearance.

the viewer. The darkness seen in the table of the nail head is thus a reflection from and of the viewer, or in the case of photography, the lens and camera. The area of the viewer's head or the camera lens is dark relative to surrounding illumination, which is the explanation for the dark appearing table of the nail head.

The nail head diamond is acting in the table as a retroreflector when its pavilion is cut at angles approaching 45°. (Definition of a retroreflector: a device which serves to reflect incident light, back in the direction it came from so that the paths of the reflected rays are parallel to those of the incident rays.)

There can be light all around, but the table of the nail head diamond or other gemstone that is cut with pavilion close to 45° is reflecting from the vicinity of the viewer's eyes. The viewer is obstructing light from his or her direction thus leaving the table dark.

The ray tracing in Figure **6** reveals that this retroreflection property maintains the dark table appearance even when the diamond is tilted away from the viewer's direction to the extent shown.

THE IDEAL CUT DIAMOND

The conventional ray trace diagram used to explain the superior light performance of the Ideal cut diamond is illustrated in Figure **3b**. In an ironic twist, we observe that the correct ray trace diagram, Figure **4c**, for the dark table nail head is mistakenly employed in this conventional ray trace diagram, Figure **3b**, to explain the superior light performance of the Ideal cut diamond. This misunderstanding, which continues to be perpetuated by this traditional diagram, is due to the early belief that the best cuts returned light that entered vertically directly back vertically to the observer.

Reverse ray tracing, Figure **4b**, shows us that rather than coming from the vertical, the bright light that reaches our eyes from an Ideal cut diamond held face-up must come from an angle sufficiently off the vertical to avoid obstruction by our head. We see that the Ideal's sources of brilliance originate from medium angles and from high angles that are close, but not too close, to the viewer's line-of-sight and head.

This superior light performance is maintained, not only in face-up viewing, as in Figure 1, but also when tilted to a greater degree than is possible in poorer cutting. Figure **8** is a good example.

The Ideal's optics and light performance take best advantage of usual diamond viewing and lighting circumstances. Slight rocking or movement results in virtual facets flashing from bright to dark as they move in and out of the light and head obstruction, contributing to the Ideal cut's scintillation and fire.

There is much more to study and learn about the light performance properties of the Ideal cut diamond, especially its fire, which can be accomplished using the technique of reverse ray tracing. Overall, it is apparent that cutting to the narrow range of angles and proportions called Ideal results in the best combination of the attributes of diamond beauty – brilliance, fire, and sparkle. ■

References available upon request.

8: 1.83ct ideal round brilliant displaying its superior 'tilt brilliance and fire'.

All photographs, images and figures by the author.

Getting your facts right

Gems&Jewellery contributor and CIBJO delegate, Rui Galopim de Carvalho FGA DGA, explores how 'alternative facts' have resulted in an informal nomenclature that permeates the world of gemmology. Here, he offers some examples of these long-standing quirks in terminology...

A ca. 1960 Portuguese brooch in 19.2k gold with a flame fusion blue 'synthetic spinel'. According to trade regulations, one could not call the material a 'synthetic' but rather an artificial stone. Photo Carlos Pombo Monteiro © Arquidiocese de Évora/ Fundação Eugénio de Almeida.

In gemmology there are a number of trade names and expressions that lack accuracy. However, written or verbal tradition has given them a wide visibility and many have become part of our trade's informal nomenclature. Here are a few examples.

This article does not intend to set standards or correct any existing article or gemmological text. This review has resulted from the careful reading of multiple books and journals in the course of normal study processes and peer review editing to verify or validate information. More than pointing out apparent mistakes or erroneous information, this approach has shown there is a balance between purist or scientific lexicon and the more trade-orientated nomenclature, which is characteristic of gemmology that serves an industry and its consumers. It also demonstrates that there are terms that emerge from colloquial tradition and not necessarily from academia.

> ...there is a balance between purist or scientific lexicon and the more trade-orientated nomenclature...

For this article, a selected number of situations have been chosen to illustrate the misuse of expressions and names, although in some cases, tradition wins over picky nomenclature. These are 'alternative facts' in the sense that, for the more conservative and orthodox reader, they can be considered 'fake news'.

FLAME FUSION 'SYNTHETIC' SPINEL

One of the most popular artificial products that gemmologists learn how to identify in their education is the flame fusion, or Verneuil, synthetic spinel. These have been around for almost a century and were produced in many colours (except red) to imitate, not natural spinel, but rather other gem materials such as diamond, aquamarine or blue sapphire to name a few (O'Donoghue, 2005). The gem and jewellery community, and almost all literature, simply describes these products as 'synthetic spinel' (O'Donoghue, 2006, Matlins, 2003, Liddicoat, 1993, Hodgkinson, 2015).

The trade, however, has a very strict definition of 'synthetic' and CIBJO – The World Jewellery Confederation – defines synthetic stones as "artificial products having essentially the same chemical composition, physical properties and structure as that of their naturally occurring counterparts" (*CIBJO Gemstone Book, 2016*).

It happens that every gemmologist knows that the gemmological properties of natural spinel differ slightly from the properties of the flame fusion counterpart, due to the fact that they do not have the same chemical composition, with a different alumina to magnesia ratio (Al_2O_3 / MgO), that is 1/1 in natural spinel and usually 3.6/1 in the flame fusion product (Rinaudo, 1997).

In strict observation of the CIBJO rules, we could not call these products 'synthetic spinels' as they do not meet the criteria for a synthetic stone. This is, however, a typical case when a verbal or written tradition overtakes the formality of a nomenclature rule. Despite the non-compliance with the trade standards, it is widely accepted and tolerated that these products can be named, tagged and traded as 'synthetic spinel'.

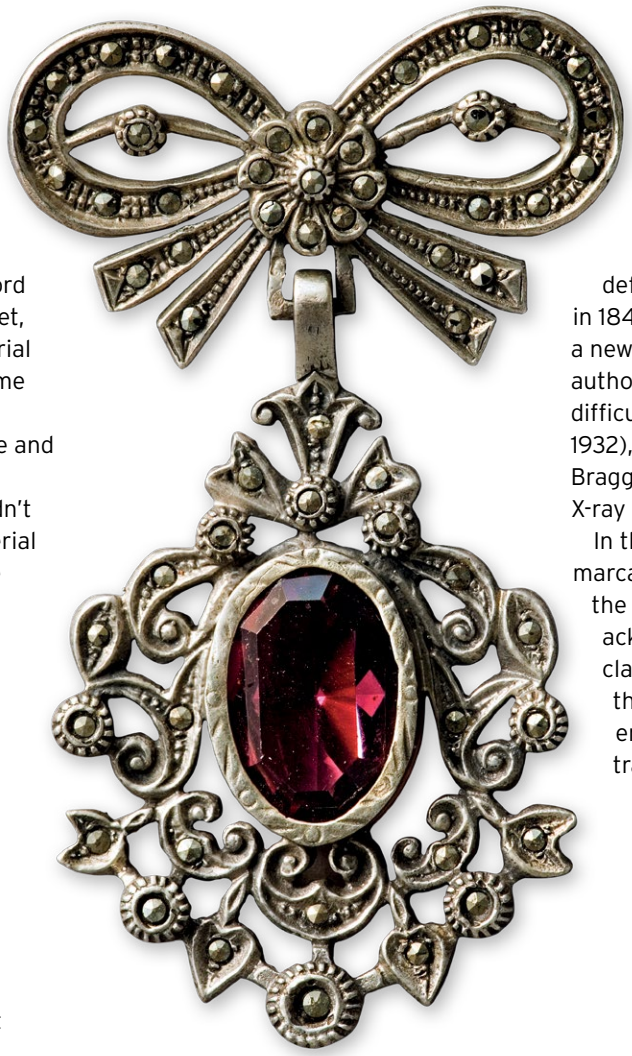
MARCASITE AS A GEM MATERIAL

In the gemmological world we refer to marcasite as an opaque, golden material with a metallic lustre, often cut in very small and simple rose-type pieces. Its first record goes back to the 18th century (Pouget, 1762) with its heyday as a gem material in the 1930s (Bartlett, 1997). The name marcasite drives from the Arabic or Moorish word used to describe pyrite and other minerals (Anthony, 1990).

As an actual fact, the name shouldn't be marcasite, but pyrite as this material is the well known cubic iron sulphide (FeS_2). Today, every major text book acknowledges the fact that the material is pyrite and that marcasite is an accepted trade name in the jewellery community (Webster, 1994, Hodgkinson, 2015).

Marcasite is in fact the IMA — International Mineralogical Association's approved name for a distinct mineral that has no use in jewellery whatsoever, occasionally causing confusion to a more scientifically-educated public. Marcasite and pyrite are two distinct materials in spite of being polymorphs of iron sulphide, with marcasite crystallising in the orthorhombic system and pyrite in the cubic system (Klein, 1993). These polymorphs were defined as separate mineral species in 1845 when marcasite was proposed as a new species (Heidiger, 1845) but some authors and museums reportedly had difficulty in separating them (Bannister, 1932), a task that was greatly solved by Bragg in 1914 with the introduction of X-ray diffraction in mineral identification.

In the jewellery world, the word marcasite kept being used in the traditional way despite the acknowledgment of its true mineral classification as pyrite, which makes this another typical case of an erroneous name kept due to trade tradition (Bartlett, 1997).



A ca. 1940 silver pin set with a paste and small round shaped marcasites, known as pyrite in the scientific community. Photo Carlos Pombo Monteiro © Arquidiocese de Évora/Fundação Eugénio de Almeida.

Pearls, like these natural colour bead-nucleated cultured pearls from Fiji, are examples of gem materials that should be named biogenic and not organic due to their composition. © JHunter Pearls Fiji.

'ORGANIC' GEMS?

Since the dawn of gemmological education in the second quarter of the 20th century, gem materials have been commonly organised into separate categories, like diamonds, coloured gemstones and organics. Within organics we see a list of gem materials that originate from the activity of living organisms, e.g. ivory, bone, coral, tortoiseshell, pearl, mother-of-pearl, shell, horn, corozo (vegetable ivory) and copal just to name the most important ones (Pedersen, 2004).

It happens though that the word 'organic' has specific meanings, rather than simply being the broader statement of material generated by a living organism (e.g. a carbon based compound). Moreover, some of the gem materials grouped as organics are not, in any sense, organic in composition and that is the case of precious corals, pearls, cultured pearls, mother-of-pearl and shell. The major composition of the materiais is bio-mineralised calcium carbonate in aragonitic and/or calcitic structures. Carbonates, as crystal matter, are strictly speaking considered inorganic matter, not organic (Strack, 2006).

At the 2016 CIBJO Congress, these arguments were discussed and there was a consensus that a better word to describe gem materials that originate from living organisms would be 'biogenic', literally meaning that they result from biological activity. ■

A full list of references is available upon request. Images by Rui Galopim de Carvalho.

A Passion for PURPLE

Gem sculptor, jeweller and gemmologist, Helen Serras-Herman FGA, gets into the spirit of this year's Pantone Colour of the Year with a look back at some of her most vibrant, violet-hued carvings.

*1. **Pisces-watermelon sapphire:** Watermelon sapphire from Pakistan has a deep violet-purple-pink sapphire centre surrounded by green muscovite mica 'skin'. The carving takes advantage of the colour zoning of the gemstone. Photo by M.J. Colella.*

Violet gemstones have recently found themselves in the fashion spotlight thanks to the famous Pantone Color Institute naming 'Ultra Violet' as its 'Colour of the Year 2018'. Yet while there are endless gemstone varieties that fall into the green and blue shades of the spectrum, there are only a handful of gemstones that fall in the violet segment of the rainbow.

Among them, the most classic representation since ancient times is amethyst, but charoite, sugilite, purple sapphire, lavender jade, tanzanite, iolite, kunzite, fluorite, lavender chalcedony, black opal with purple flash, and tiffany stone fill the top spots for purple gems.

*2. **Apollo's Rays:** The pendant, in this necklace and earrings titled 'Apollo's Rays', is carved in watermelon sapphire from Pakistan, set with a violet faceted sapphire from Montana, on a detachable strand of deep purple star sapphire beads. Photo by M.J. Colella.*

THE VIOLET SPECTRUM OF GEMSTONES

Over the years, I have used a number of the aforementioned violet palette gemstones for my carvings and jewellery art. I have enjoyed carving the rather rare watermelon sapphire from Pakistan. It all started many years ago, when Gary Bowersox, the famous gemstone hunter, dealer and expert of gemstones from Afghanistan, asked me to carve a hippopotamus as an intaglio on a watermelon sapphire. Later I carved 'Pisces' and 'Apollo's Rays' on other crystals from the same material, each time taking advantage of the colour zoning of the gemstone (**1** & **2**). This watermelon sapphire, although somewhat similar in look to the bright red ruby in green zoisite material from Tanzania, or the ruby in green fuchsite (chromium muscovite) mica from India, has a deep violet-purple-pink sapphire center surrounded by green muscovite mica 'skin'.

This material is mined near West Village, Timargara, Dir District, Malakand Agency, Northwest Frontier Province, in Pakistan. It was identified as purple-pink sapphire and muscovite mica, with RI: 1.76 for the center, 1.70 for the perimeter, after examination and analysis performed by the GIA West Coast Gem Trade Laboratory (*Gems & Gemology*, Summer 1991, p.120), which showed the center with an absorption pattern typical of ruby and purple sapphire, numerous twining planes and some whitish veining in the rim, with the final X-ray diffraction analysis matching the standard pattern for muscovite mica.

Another purple gem that I have enjoyed carving is the lavender jadeite from Guatemala, mined in the Montagua River Valley (**3**). Although it may be my personal favourite among the Guatemalan jades, the ancient Maya carvers and culture revered the green varieties. We don't know if they did not find the lavender boulders back then, or they simply did not appreciate the colour.

*3. **Lavender Guatemala jade:** Another purple gem that I have enjoyed carving is the lavender jadeite from Guatemala, which pairs well with tanzanite, another purple gem. Photo by M.J. Colella.*

*4. **Sugar Plum necklace:** The soft, pastel colour of the lavender jadeite from Guatemala harmonises well with deep-violet star sapphire beads. Photo by M.J. Colella.*

The lavender jadeite has a granular physical appearance with a greasy luster, but it takes an easy and good polish (Maya Jade, Helen Serras-Herman, *Gems&Jewellery*, August 2015).

With both gem materials – the watermelon sapphire and the lavender jade – I have found that deep purple star sapphire beads make a great match to those violet-purple tones (**4**). Over the years, I have also carved amethyst for gem sculptures, but have not used a lot of amethyst, or charoite, in my jewellery until recently. It all happened by accident, trying to pair some of my pendants with new, detachable necklaces.

EXPLORING CHAROITE

It all started with a unique charoite pendant that featured a natural, almost geometric pattern dividing the stone into purple charoite on the left and golden tinaksite on the right -one of the associate minerals that charoite occurs with (**5**). I wanted to create a detachable necklace with peach natural-colour cultured pearls, and trying to tap into the purple tones for in-between stones, I found the perfect match in some lilac amethyst beads, known as 'Rose de France'.

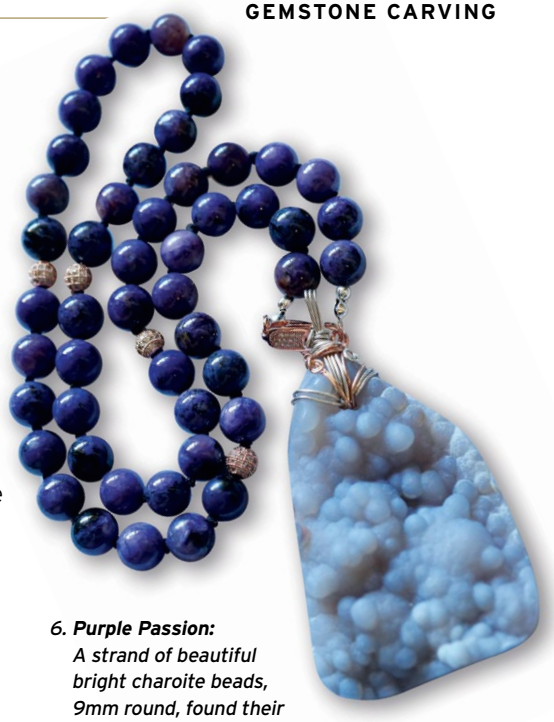
Charoite is a rare silicate mineral $[K(Ca, Na)_2Si_4O_{10}(OH,F)]$ with a deep lilac-violet or lavender to purple colour. It occurs only in massive form, not as crystals. It is named after the place of its discovery, at the Murunskii Massif, at the confluence of the Chara River and the Tokko River in the Sakha Republic, Yakutia, of Eastern Siberia, in Russia, and it is the only known charoite deposit in the world.

Charoite occurs along with other minerals in altered limestone deposits creating a rock more accurately called charoitite. Associate minerals are canasite and carbonates, quartz, microcline, aegirine (dark green, often star-shaped inclusions), tinaksite (golden chatoyant blades), sphene and fedorite (raspberry red). The purple colour is attributed to the coexistence of Mn^{3+} and Fe^{3+} (similar to sugilite). When charoite is iron rich and manganese poor, it is brown. It is often irregular in composition resulting to a wide range of colour hues and patterns.

Charoite at its best is highly translucent, with beautiful swirling patterns. White fibrous asbestos-charoite displays a silky chatoyancy – a cat's eye effect – and a pearly luster. Its distinctive interlocking, fibrous texture and conchoidal fracture are at times problematic for the lapidary, and correct orientation is often paramount to avoid splintering.

Ironically, the much-sought after charoite of today, when it was first discovered in the 1940's while constructing a rail tunnel, it was considered dark and unattractive, and was mis-identified as lilac cummingtonite. Soon after 1962, it was called Sirenyevyi Kamen (Lilac stone), but it was not known to the outside world until its description in 1978 (*Charoite, a new mineral and a new jewelry stone*, Rogova, V.P., Y.G. Rogov, V.A. Drits, and N.N. Kutnetsova, 1978).

*5. **Purple Rivers:** This pendant features a natural, almost geometric pattern dividing the stone into purple charoite on the left and golden tinaksite on the right, 87.0 carats. The detachable 4-strand necklace comprises peach natural-colour cultured pearls and 'rose de France' amethyst beads.*



*6. **Purple Passion:** A strand of beautiful bright charoite beads, 9mm round, found their perfect match with a pendant with purple botryoidal chalcedony from the Bradshaw mountains near Prescott in northern Arizona.*

INSIGHTS INTO BOTRYOIDAL CHALCEDONY

While in my 'purple zone', I pulled out of my drawer a strand of beautiful bright charoite beads, 9mm round, which I purchased over a decade ago. They found their perfect match in a pendant with purple botryoidal chalcedony from the Bradshaw Mountains near Prescott, in northern Arizona (**6**). Botryoidal is a globular external mineral habit or grape-like structure of chalcedony. Botryoidal chalcedony, also known as grape agate, has been recently found at Manakarra Beach, Mamuju Area, in West Sulawesi in Indonesia, and has been a big hit on the market among lapidaries, designers and collectors. The Arizona material is more compact and pastel in colour compared to the new Indonesian material. I chose to wire wrap the pendant with rose gold wire, as the warm rose gold tone is another big trend now.

I hope that I have inspired you to utilise some violet or purple gems in your lapidary and jewellery creations. But, should violet and purple gemstones not be in your personal favourite palette, don't despair. Pantone's seasonal colour picks always offer a wide array of complimentary colour shades to the 'hero' colour, ranging from neutral to bright, pastel to deep, and metallic. ■

Images show gem carvings and jewellery designs by Helen Serras-Herman. All photos courtesy of the author unless otherwise stated.

IS SPACE OUR NEXT DIAMOND RESOURCE?

Having secured a distinction in her Diamond Diploma and the prestigious Deeks Diamond Prize at the Gem-A Graduation 2017, Anne Galmiche DGA shares her student project on the possibility of diamond prospecting beyond our solar system.

Space has an abundance of carbon so with the necessary equipment and technology, we might be able in the future to mine diamonds in space.

DIAMONDS IN ASTEROIDS

The discovery of the Novo-Urei meteorite in Russia on 4 September 1886 made us realise there might be other diamond origins than the Earth's mantle: the ureilite. This is a type of stony meteorite but unfortunately for us, its origin is unknown in comparison to other meteorites, which come from one single source. It has a unique mineralogical composition of olivine – pigeonite – achondrite and a high percentage of carbon, which explains why diamonds were found at the crash site, even if they were quite small (nanodiamonds of a few micrometres in diameter).

The recent discovery and study of the 2008 TC3 asteroid that fell in October 2008 in the Nubian Desert in Sudan (Almahata Sitta) showed the diamonds in this particular asteroid were much bigger than what was left after impact.

Three major environments are believed to account for the formation of diamond in a ureilite:

- Under the static high-pressure conditions in the deep interior of a ureilite parent-body (Urey, 1956).
- At low-pressure through chemical vapor deposition (CVD) (Fukunaga et al., 1987).
- Under transient high-pressure conditions during planetesimal (small rock fragments which when aggregated could form a planet) collisions i.e., when asteroids collided (Berkley et al., 1976, 1980; Nakamuta and Aoki, 2000; Nakamuta and Toh, 2013).

Although the last mechanism is widely accepted, the issue is still debated. Most individual diamonds included in previously studied ureilites were not more than ~3 µm in dimension. On the other hand, they recognised unexpectedly large diamond grains having a dimension of ~20 µm or more in one of the Almahata Sitta ureilite samples through a preliminary optical microscope observation. Such large diamonds had not been found in ureilites until this point.

In studying the diamond/graphite assemblages and crystal graining that were in the samples of Almahata Sitta, researchers were able to observe the octahedral and cubic habits typical of diamond; they studied the factures along the crystal planes and analysed the impurities within the crystal. Hydrogen, nitrogen and oxygen that we find in Earth natural diamonds and synthetic

diamonds, seemed distributed evenly in these samples, and the patterns discovered showed that all those nanodiamonds were in fact part of a much bigger diamond, one single larger crystal (almost 100 micrometres).

Authors think there are two ways those diamonds could have formed:

- Slow deposition of single carbon atoms, in the thin gases of outer space (but this seems unlikely).
- Or more likely inside a planetesimal, which, as noted by Michael Marshall for the BBC, "must have existed in the early days of the solar system, before the planets had properly formed and settled down into their orbits".

DIAMONDS IN OUR GAS PLANETS

In his 1981 article *The ice layer in Uranus and Neptune – Diamonds in the sky?* Marvin Ross observed that: "Current models of Uranus and Neptune (composed of 10% of carbon) describe a three-layer structure, consisting of an inner rocky core, a middle 'ice' layer of fluid, H_2O (water), CH_4 (methane), NH_3 (ammonia) and an outer hydrogen-helium layer of solar composition. The estimated pressures and temperatures of the ice layer ranges from about 6Mbar and 7,000 Kelvin (K) at the inner core-ice boundary, to ~0.2 Mbar and 2,200 K at the outer ice/hydrogen-helium boundary."

In 1981 Ross carried out shockwave experiments on these liquids as well as theoretical studies, which seemed to imply that the H_2O and NH_3 in the ice layer were almost totally ionized and the CH_4 had been pyrolysed to carbon, possibly in the diamond form.

Other scientists, such as Laura Robin Benedetti in 1999, experimented and showed CH_4 breaks down to form diamond at pressures between 10 and 50 gigapascals and temperatures of about 2,000 to 3,000 K.

Based on those assumptions, in 2009, Dr Eggert of the Laser Shock Equation of State (EOS) group in the Department of Physical and Life Sciences Directorate at Lawrence Livermore National Laboratory (California), and his team undertook shock-compression experiments and blasted a ~500 µm-thick diamond disk to determine the melting temperature of carbon at pressures of 0.6–1.1 TPa (6–11 Mbar). From this, we know the

THIS SUBJECT IS BECOMING MORE AND MORE POPULAR, WITH THE DEVELOPMENT OF SEVERAL SPACE-MINING COMPANIES, SUCH AS DEEP SPACE INDUSTRIES, OR PLANETARY RESOURCES, WHICH ARE GROWING AND SECURING LOTS OF INVESTMENT.

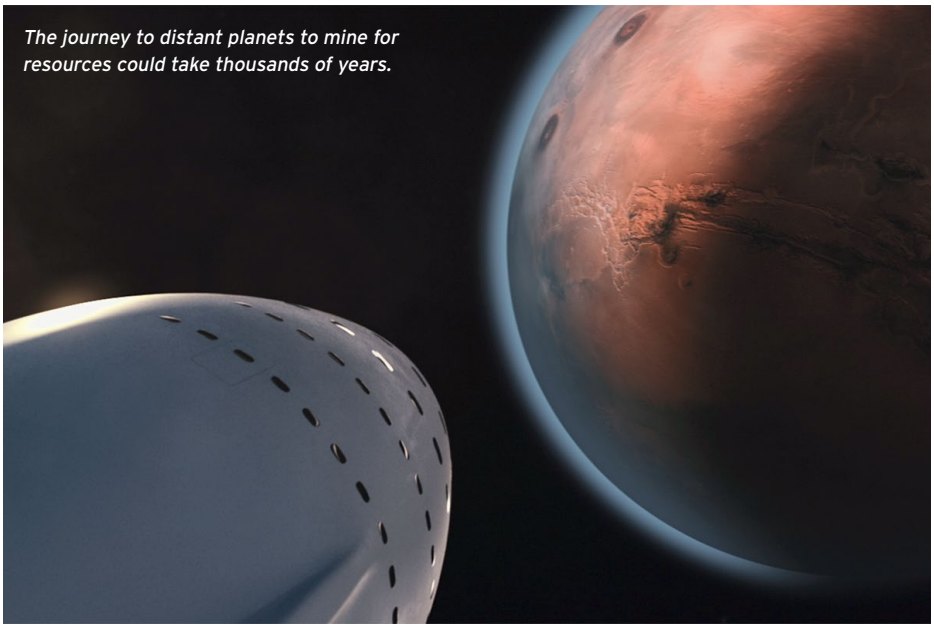
Sending miners into space would require significant advances in technology.

melting point of diamond varies with pressure, reaching a high of ~8000 K at 500 GPa (5 Mbar). But his studies showed that pure carbon could be solid at all depths and crystalline diamond could be stable deep inside these planets, although it is possible that a hotter deep interior may exist, which would mean this pure carbon existing in liquid metallic state. As Eggert concludes, before temperature data at still higher pressures suggest that "diamond melts to a complex fluid state, which dissociates at shock pressures between 1.1 and 2.5 TPa (11–25 Mbar) as the temperatures increase above 50,000 K".

In 2013, Uranus and Neptune were not the only ones to be thought as potential diamond producers, researchers announced that as much as 10 million tons of diamonds may be stored in Saturn and Jupiter, in a 30,000-kilometer-thick diamond-containing layer. The study was presented at the 45th annual meeting of the Division of Planetary Sciences of the American Astronomical Society by Kevin Baines (planetary scientist — University of Wisconsin–Madison) and Mona L. Delitsky (California Specialty Engineering, Flintridge). They endeavoured to determine the altitude at which diamond would melt on Jupiter and Saturn using known data and shockwave experiments mentioned above. Using this information, they believe diamond may be a stable layer of the atmospheres of Jupiter and Saturn dependent on the density of the different layers. They studied the energetic lightning storms and hypothesised that CH_4 will dissociate during those storms as soot particles. Those soot particles then descend through the atmosphere and convert to graphite then diamond.

Andrew Fazekas, in his 2013 *National Geographic* article, noted that the planetary scientist, William Hubbard (University of Arizona) is sceptical about this carbon chemistry, especially about the amount of soot produced by Saturn's lightning storms, which he believes too small and most probably destroyed by the increasing pressure and temperature as it descends to deeper layers of the atmosphere.

> THE DIAMOND IS ESTIMATED TO BE 2,500 MILES ACROSS AND WEIGHS APPROXIMATELY 10 BILLION-TRILLION-TRILLION-CARATS (1 FOLLOWED BY 34 ZEROS).



The journey to distant planets to mine for resources could take thousands of years.

"The pyrolyzed [broken down due to heat] carbon might just form a solution with the hydrogen, and not precipitate out [into diamonds]," Hubbard says.

Fazekas continued: "The possible size of these cosmic diamonds is subject to speculation. Delitsky thinks they may start out one micron in size as lightning-generated soot. Those particles grow as they fall, much like raindrops, into the deeper interior of the planet, eventually forming gems at least pea size, with some growing so large that they could be called 'diamondbergs'."

A DIAMOND PLANET

In 2004, the Harvard-Smithsonian Centre for Astrophysics estimated that BPM 37093 (named 'Lucy' in reference to The Beatles' song), a white dwarf located 50 light-years from Earth in the constellation Centaurus is the "biggest diamond ever found" (1 light-year = 9,460,730,472,580,800 metres). It is estimated to be 2,500 miles across and weighs approximately 10 billion-trillion-trillion-carats (1 followed by 34 zeros).

As Barnes noted in a *Rapaport* report in February 2014, technically, a white dwarf is the hot core of a star, left over after the star uses up its nuclear fuel and dies. It is made mostly of carbon and coated by a thin layer of hydrogen and helium gases.

From the 1960s, astronomers predicted that the cores of white dwarfs should crystalise over time and cool down over billions of years, starting from the centre. In 1992, Lucy was first observed to be pulsating but it was only in 2004 that Metcalfe, Montgomery, and Antonio Kanaan estimated that 90% of the stellar mass was now crystallised by analysing those pulsations using asteroseismological models.

"By measuring those pulsations, we were able to study the hidden interior of the white dwarf, just like seismograph measurements of earthquakes allow geologists to study the interior of the Earth. We figured out that the carbon interior of this white dwarf has solidified to form the galaxy's largest diamond," said Metcalfe.

In a typical model, crystallisation does not begin until the surface temperature reaches 6000-8000 K. In more massive white dwarf models the effect begins at higher surface temperatures, which is the case of Lucy (11,730 K = 6,000°C)

Research is being done to discover the composition of the gas planets in our solar system.

Our Sun will become a white dwarf when it dies five billion years from now and around two billion years after that, its core will crystallise, leaving a giant diamond in the centre of our solar system.

There is still more work to be done to confirm this theory and some are still saying there is not enough evidence to be 100% conclusive and determine whether the diamond would be gem quality.

MINING IN SPACE

Assuming studies are proven right, we then need to mine in space. This subject is becoming more and more popular, with the development of several space-mining companies, such as deep space industries, or planetary resources, which are growing and securing lots of investment.

As Wilkinson noted in 2013 on Open NASA: "There is an exoplanet called '55 Cancri e' which orbits a start ~41 light-years away from Earth... it weighs about 8.63 times the mass of the Earth and there is a good chance that about a third of that mass is diamond."

Assuming we had the technology to mine '55 Cancri e', one would still need to travel there. As Wilkinson continued: "Voyager 1, which recently left our solar system, is 18,812,796,028 km away from Earth," is travelling fast, but is "only 0.00198 light-years from Earth (and that took 36 years). It would therefore take 20,707 years for a spacecraft travelling at the same speed as Voyager 1 to get to the '55 Cancri e' from Earth". And another issue, according to William Edelstein of the Johns Hopkins University School of Medicine (Baltimore), is that even if we managed to create something capable of travelling at light speed, the hydrogen present would turn into a death ray and expose the crew to lethal radiation.

One thing sounds promising though: 75% of the asteroids we have in our asteroid belt gravitating around our Sun are carbonaceous. There could be a big profit and opportunity to mine them. The Keck Institute for Space Studies estimated the cost of identifying and returning a 500 tonnes asteroid to a low Earth orbit at 2.6 billion dollars.

Before mining, ground-based infrared telescopes and lasers, and spectrometers would be used to assess materials and minerals present within the asteroid, and radars to study the surface features. The waves absorbed or not would be a clue.

In 2013, NASA introduced an asteroid capture mission called ARM. The goal is to capture and drag an asteroid of a reasonable size into the orbit of the moon, and then to send out astronauts to work on it. A sort of balloon would surround the asteroid and stop it spinning whilst deflating. In 2015, the mission plan evolved and NASA decided that picking up a piece of an asteroid to begin with might be enough and within budget. This should happen within the next few years.

However to really send people in space to mine asteroids, a lot of things have to be improved, such as the astronauts' suits, the tools we use, transportation etc. With regards to our big gas planets; so far they're only talking about atmosphere mining for helium and hydrogen, but who is to say we won't have the technology to actually go on their surface one day.

CONCLUSION

Mining asteroids would change life on Earth and also life in space. We would have almost unlimited resources for some materials (for example platinum). If we were able to use the hydrogen and oxygen of asteroids or our gas planets, we could use them as gas stations for rockets travelling in space. Only time will tell whether advancements in technology and new discoveries will result in a galactic 'diamond rush'. ■

An unabridged version of this project is available upon request. All images from Pexels.

Yield of the Earth

Having come across this incredible mineralogical stamp collection, Peter Richard Cheer FGA DGA FIRV, director of Studleys Jewellers in Somerset, just had to share it. Here Peter and collection owner Mary Atwood reveal the story behind the stamps and what makes them so fascinating.

Like all good passion projects, Mary Atwood's stamp collection has a story behind it. A chance meeting with a stamp collector at the St. Thomas Church Young Wives' group in 1968 sparked Mary and her husband, Brian Atwood's interest in collecting themselves. They later joined the Wells Philatelic Society, dedicated to philately, otherwise known as the collection and study of postage stamps.

But stamp collecting wasn't Mary's only interest. She says: "I have always had a keen interest in minerals and gemstones dating back to the Second World War, when I collected bits of coloured glass from the bombed sites of Brislington where I grew up.

"Later in the early fifties when, as a family, we went on holiday to Cornwall, I was always on the lookout for different rocks and minerals, dragging them home on the train to Bristol Temple Meads in brown paper carrier bags that always broke under the weight!"

Years later, Mary was under pressure to create a fantastic entry for her philatelic society's annual competition, which featured a 'themed' stamp collection category. Drawing on her passion for gems and minerals, Mary embarked on a five-month quest to create her 'The Yield of the Earth' collection, featuring stamps from the United States, Russia, Europe, Australia and some of the world's largest mining nations.

Mary continues: "A gemstone and mineral display to accompany the stamp sheets appealed to me but, understandably, I knew I would be short of precious stones. At the time, I had a jeweller friend in Bristol who bought diamonds, rubies, opals and sapphires for investment. I was allowed to have loan of his stones to complete the display, including star sapphires, fire opals and a small test tube of diamonds in various colours. Alongside these jewels were my assorted minerals, and I unwittingly displayed galena, erythrite and asbestos. This was a long time ago and wouldn't be permitted now!"

Mary won her society's coveted Thematic Cup for her collection, proving that gems and minerals can capture the imagination in many different forms. In the following paragraphs, Peter Richard Cheer shares some of his highlights from Mary's collection and their fascinating history. ■

Russia

This first series of stamps (issued in 1963) demonstrates various gemstones and decorative hardstones found in a particular locality, the Ural Mountains — a length of approximately 1,600 miles stretching from across western Russia, which has provided the various regions with a significant mineral economy since the 18th century.

Malachite and jasper feature in many Russian art objects, along with amethyst in antique Russian jewellery (often described as 'Serbian' by dealers), and of course emerald, which is sometimes differentiated from other localities due to actinolite inclusions along with other amphibolite mineral assemblages.

Russian stamps titled 'Precious Stones of the Urals' issued in 1963, featuring topaz, jasper, amethyst, emerald, ruby and malachite.

Australia

The wide variety of landscapes and geological conditions in Australia give rise to various gem quality minerals such as: chrysoprase, rhodonite, and agate. The most famous of these gemstones, which has come to be celebrated as Australia's national gemstone, is of course opal. These stamps, issued in 1973, celebrate this gemstone history and heritage with a splash of artistry.

Australian stamps from 1973 featuring opal, chrysoprase, agate, rhodonite and star sapphire.

America

Similarly, America's great landmass means the probability of finding gem quality minerals is high. There is also growing demand for native gemstones from local consumers. These 'United States Mineral Heritage' stamps, issued in 1974, even include petrified wood.

Tourmaline on quartz, rhodochrosite, petrified wood and amethyst displayed on the 'United States Mineral Heritage' stamp series from 1974.

South Africa

Since the emergence of De Beers, the commercialisation of diamond mining has played a dominant role in diamond processing. It means South Africa is synonymous with the industry. These historic stamps highlight the importance of diamonds and precious gemstones, produced in southern Africa and South Africa, on the global economic stage between 1959 and 1970.

Clockwise from top left: rough and brilliant-cut diamonds, issued 1961; Rhodesia (as it was), issued 1966, emeralds; from rough diamond to cut stone, issued 1970.

Mining

Minerals of industrial importance are just as likely to be celebrated with postage stamps; the economic impact often creating increased employment for local communities, providing jobs in the extraction, processing, and distribution. When discoveries are made, particularly in poorer countries, it can provide the first significant trade routes to more wealthy nations.

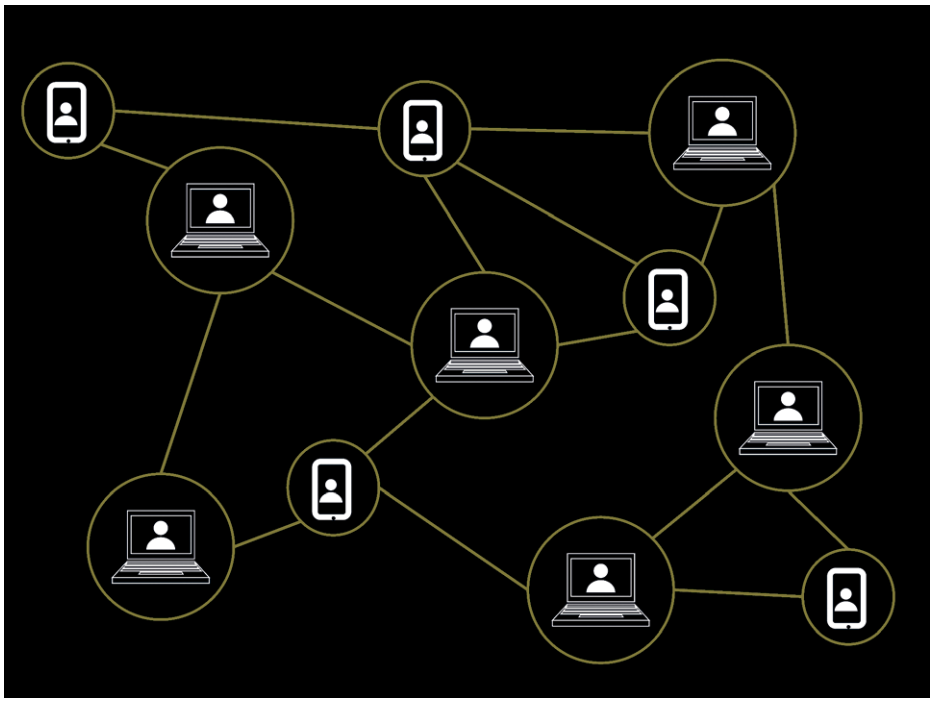
Clockwise from top left: Botswana, issued 1970, copper and nickel; Sierra Leone, issued 1956, iron; Nigeria, issued 1953, tin; Cyprus, issued 1955, copper pyrite; Australia, issued 1947, steel (from iron and carbon); Jamaica, issued 1964, gypsum.

Europe

European countries have tended to observe a decline in mineral production, with their significance now being cultural rather than economic. Switzerland and old East German postage stamps, with their highly accurate depiction of indigenous gems, express their postage value in currencies no longer in circulation.

'East German Minerals' stamps issued in 1969, showcasing native silver, smoky quartz, galena and fluorite.

Images and information courtesy of Mrs Mary Atwood.



BRING ON BLOCKCHAIN?

Is blockchain technology the future of the jewellery supply chain? Miles Hoare of Grapevine Media UK shares his back-to-basics guide to blockchain and explains why it has the potential to standardise and revolutionise the way we trace the provenance of gems.

The idea that a technology known for its role in powering cryptocurrencies like Bitcoin or Ethereum could change the way we control the supply of precious stones may seem like a misnomer to some. And I wouldn't blame you for thinking that.

Something associated with an 'anonymous' form of currency, used on the depths of the internet by an assortment of 'criminals and hackers' could never create an environment for transparent and immutable chain of transactions between miners, cutters, manufacturers and retailers, could it?

Blockchain technology has the potential to solve a number of problems that impede the road for change in the jewellery industry and provide the sector with opportunities to work towards a transparent supply chain. So what is blockchain, how does it work and what, if anything, does it mean for the jewellery supply chain?

BLOCKCHAIN: A DEFINITION

Blockchain, in its simplest form, is a continuous list of growing records that are recorded chronologically and publically, and secured using cryptography. These records are stored as blocks and updated based on a network protocol.

Where blockchain differs from any normal ledger or record keeping is that instead of being owned by one person or organisation, it is distributed across a network. Everyone on the network owns a copy of what is often called the 'public ledger' and is responsible for updating and maintaining the records within the ledger by allowing a complex set of algorithms to work together to ensure all copies of the ledger are the same.

Essentially this means that transactions can be facilitated peer-to-peer without a trusted third-party such as a bank, as the network works on an agreed strategy as to whether the transaction is valid.

CONSENSUS-BASED NETWORKS

Public blockchains allow transactions without a trusted third-party through what is called a 'consensus-based network'. What this essentially means is that the protocols or the rules that run the system are built by a consensus of the network. This is done through a process of public proposals which are then 'signalled' or voted on by the network.

BITCOIN AND DIGITAL ASSETS

Blockchain is the underlying technology for what are known as cryptocurrencies and these are the digital assets exchanged on a blockchain. They generally come in the form of tokens that can be exchanged between users across the network. These tokens look like a long string of random numbers and letters but actually contain key information about the transaction, value, sender and receiver.

Whilst tokens like Bitcoin are essentially seen as forms of cash or digitally stored value (similar to gold) other cryptocurrencies have different functions which allow for the exchange of information and the execution of contracts.

Images via Pexels.

SMART CONTRACTS

Ethereum was the first cryptocurrency to introduce this function when it originally launched in 2013, pioneering what are known as 'Dapps' or 'Decentralized Applications'. These decentralised applications allow for the exchange of more complex data and allow functions to be built into how value is exchanged.

For example, one of the simplest forms of Ethereum smart contract is a payment escrow, which can be set-up to trigger when either party completes or fails to complete an action. Smart contracts can not only be a form of asset class and to facilitate exchange, but can be linked to assets in the real world and represent a digital version of an asset exchange — like the deeds to a mortgage or a lab certificate, for example.

Where smart contracts become more complex is the ability to store and pass information about sourcing, ownership and transactions of these assets along an immutable chain of records and this, is where the jewellery supply chain comes in...

BLOCKCHAIN AND THE JEWELLERY SUPPLY CHAIN

Now imagine being able to use a smart contract to track a gemstone or mineral sample from prospecting, through cutting and certification to a retail store, and being able to present that information to customers in a readable online format, possibly linked to a certification.

Whilst such a vision seems a long way off, and the practical implications of implementing such systems are far-reaching and somewhat unfathomable, there are cases that offer positive insight into how blockchain technology is already changing how supply chains are tracked.

CASE STUDY: DIAMONDS ON THE BLOCKCHAIN

Everledger has placed more than 1.6million diamonds on its blockchain with each record including dozens of attributes for each diamond, including the colour, carat, and certificate number, which have been inscribed by laser on the crown or girdle of the stone.

The technology has enabled diamond suppliers (and intermediaries like border agents) to replace a paper certification process with a blockchain ledger.

Blockchain will inevitably change the way we trace diamonds from mine to market.

The process involves using computer scanning tools to access a 'digital vault' that determines the provenance of any diamond.

Everledger is first focusing on industrial supply chains before adapting its technology for retail and consumer use in 2018, meaning that a Tiffany & Co. shopper might soon be able to use their smartphone to determine a gem's provenance.

> ...THERE ARE CASES THAT OFFER POSITIVE INSIGHT INTO HOW BLOCKCHAIN TECHNOLOGY IS ALREADY CHANGING HOW SUPPLY CHAINS ARE TRACKED.

CASE STUDY: DE BEERS GROUP BLOCKCHAIN

In January, De Beers announced the launch of its own diamond certification blockchain in a press release stating it had created "a single, tamper-proof and permanent digital record for every diamond registered on the platform" with the hope of using the system to "underpin confidence in diamonds and the diamond industry by ensuring that all registered diamonds are conflict-free and natural, while also enhancing efficiency across the sector".

Following the success of an initial proof of concept trial that resulted in a working prototype, a pilot is now underway involving a small number of participants. The pilot will identify key insights and opportunities for enhancement and assess how the platform can be integrated with existing systems and processes, in advance of a full launch later this year.

Once fully established, it is anticipated that the blockchain will operate as an open platform, on top of which a range of applications that benefit the industry can be built.

THE FUTURE OF THE JEWELLERY SUPPLY CHAIN: BUILD TRUST OR BE DAMNED

Whilst these case studies lend some weight to the prospect of blockchain verified supply chains for newer stones, there are particular issues the jewellery industry will continue to face until agreements on nomenclature are reached. Unless the industry is building systems that draw consensus on terminology and technique we are stuck with what game theorists would call the Chinese or Byzantine Generals Problem — each institution trying its own method of attack.

The implementation of blockchain-type systems in the jewellery supply chain is inevitable. As trust in third-parties such as banking institutions and governments starts to fail, technology is filling the void with trust-based systems that minimise fraud. It will be up to different stakeholders in the industry as to when they start to act, but once the systems are set-up and running they will start to devour the industry. What do I mean by that? Well, those not able to prove the provenance of their product through an ethical supply chain — they'll be left behind. The technology powering that change will be blockchain. ■

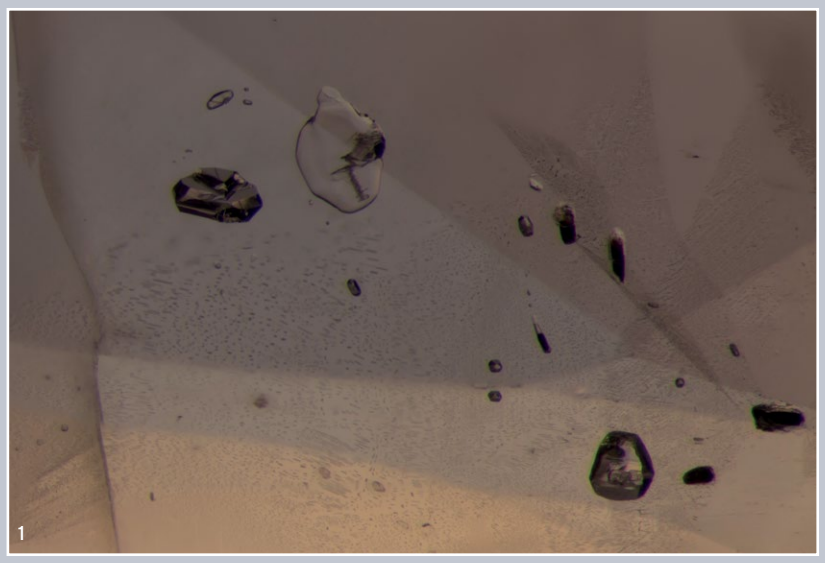
Grapevine Media is currently developing blockchain solutions for the jewellery and resource management sectors. Find out more via **info@gv-media.com**.

Discovering Crystal Types

In a new series for *Gems&Jewellery* magazine, Bangkok-based gem testing lab Lotus Gemology delves into its photomicrograph archive, Hyperion, to help gemmologists tackle tricky inclusions. In this inaugural column, we discover the difference between crystal types in ruby and sapphire.

Crystals and negative crystals are a commonly seen feature in ruby and sapphire, and often make for striking inclusion scenes. However, at times it can be hard to differentiate between the two.

One way to learn more about the world inside a stone is to view it under different lighting conditions, as in the example shown here. In the first image, we can see the inclusion scene in an untreated Sri Lankan sapphire when using light-field illumination (**1**). Here, the shape of the crystals is clearly visible, but you may still be left wondering about their identity. Therefore, we also examined the stone under plane polarised light.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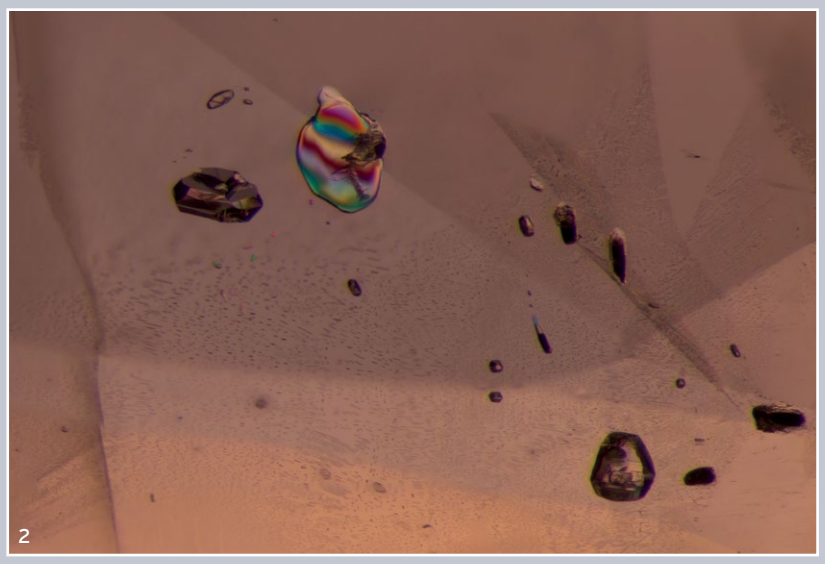

2

...LIGHT AND CAREFUL OBSERVATIONS ARE PARAMOUNT TO OUR UNDERSTANDING OF PRECIOUS STONES.

Under crossed polars we can discover more about the stone. Notice how the transparent crystal at the top now shows a rainbow of interference colours (**2**). This tells us that the crystal is a solid, birefringent crystal, distinguishing it from other negative crystals or singly refractive crystals in the stone that do not show this multi-coloured appearance.

By varying our lighting conditions, we are better able to identify and understand inclusions, and can also see beautiful features that are otherwise hidden within a gem. ■

Photos courtesy of E. Billie Hughes

A NOTE FROM LOTUS GEMOLOGY

In Greek mythology, Hyperion was the God of Light. It is said that, through careful observation, he was the first to understand the movements of the cosmos and freely shared his knowledge with others. The world of gemstones is no different, where light and careful observations are paramount to our understanding of precious stones.

At Lotus Gemology, we created a searchable gemstone inclusion database with hundreds of photomicrographs. In honour of the Greek God of Light, we dubbed it Hyperion. It is free to use and available on our website **lotusgemology.com**.

However, we realised there was still something missing. Some of the photos tell the full story best when they are grouped with others. By viewing them together, side-by-side, we begin to see the relationships that are not visible when viewed alone. To bridge this gap, we have paired a selection of photos that can be found in our database. Starting with this issue, we will bring a regular column of these inclusion pairs to *Gems&Jewellery* readers.

SURVIVORS – THE GEOLOGY OF DIAMONDS

Gem-A assistant tutor, Beth West FGA DGA, explores the remarkably epic journey of diamonds, and how their characteristic strength is rooted in their archaic origins and resilient survival.

Petra Diamonds' South African Mine, Finsch. Showing open pit with subsequent block cave extraction, tunnels visible. Image by Charles Evans.

Carbon is the fourth most abundant element in the universe. It is one of life's most important building blocks. We are made up of around 18% carbon. The diamond, however, is formed of pure carbon and bonded in such a way as to make it the earth's hardest naturally occurring substance.

But these magnificent gems extend far beyond their beauty and durability; they carry whispers of the beginnings of our world.

HOW OLD IS A DIAMOND?

It has been proven that the oldest diamonds formed around 3.5 billion years ago in an age known as the Archean Eon. At this point, it is believed that the planet had only existed for around 1 billion years. The surface of the earth was still settling.

HOW ARE THEY FORMED?

The earth is formed in layers. The outer most layer is known as the crust and ranges between 6km and 40km deep. It is divided into the thicker continental crust, making up the landmass, and oceanic crust — the ocean floors. Beneath the crust is the mantle. It accounts for eight tenths of the earth's volume and is predominantly composed of an igneous rock known as peridotite.

The uppermost portion of the mantle and the crust are known as the lithosphere ('rocky sphere' in Greek). This part of the earth is rigid, whereas the deeper parts of the mantle are in a permanent state of convection as the rock melts and cools. At the centre of the earth, the liquid core encases the solid inner core — the 5,500° C iron and nickel heart.

Diamond Crystal. Image by Pat Daly.

In the Archean Eon, as the crust shifted and split, portions of it found their place and settled. These archaic, unmoving pieces of crust are known as 'cratons'. Under each craton is a root or keel of lithospheric mantle that can descend up to 300 kilometres deep. These keels are cooler than the neighbouring convecting mantle, at around 1,200° C at its deeper points.

Diamond will start to form at around that temperature if the corresponding pressure is around 40,000 atmospheres. That equates to a depth of around 140km. These deep lithospheric keels beneath the cratons, away from the chaos of the convecting mantle, were perfect safe-houses for a growing diamond.

WHERE DID THE CARBON COME FROM?

The carbon would have derived from either a primordial source (extant from the birth of the earth) or from material pulled into the mantle when the ocean floor was pushed beneath colliding continental crust. The carbon would have been locked into compounds such as methane (CH_4) or carbonates (CO_3) travelling in melts or fluids around the convecting mantle.

When these fluids passed through the mantle keel, they would have reacted to the peridotite, freeing the carbon from their compounds and allowing it to crystallise as diamond. It is in these deep portions of the keel that the oldest diamonds formed.

HOW DID THEY GET TO US?

Diamonds resided in the keel for millions of years until, around the age of the dinosaurs (between an approximate age of 300 and 80 million years old), they were expelled from their plutonic residence via forceful, violent eruptions of magma produced deep in the mantle.

Kimberlite is the most abundant of the three types of known diamond bearing magma. This powerful magma blasted through to the surface producing a cone shaped hole called a 'pipe'. Those diamonds that were carried up with the blast were left shaken but intact in the magmatic debris that packed the hole or were forced to travel with the weathering surface of the earth — often for great distances, in rivers or in glaciers, and for millions of years.

From the depths of the earth to the ring on our fingers, these stones have certainly proved their strength. So when we are drenched by the sparkle and marketed bling of these gemstones, it is perhaps worth remembering their remarkable journey. ■

WEAPONS OF BEAUTY

In this fascinating extract from *Precious Indian Weapons and Other Princely Accoutrements* by Salam Kaoukji, we discover the exceptional artistry behind historic Indian weaponry and the techniques used to make them bejewelled works of art.

A jewelled Chilanum dagger and scabbard.

INTRODUCTION

For millennia humankind has had a fascination with edged weapons, an attraction that to a great extent, notwithstanding the primary importance of weapons in hunting and combat, arose from the custom of displaying them to magnify the status of the owner.

Among the assemblages of jewels and precious objects found in grave furniture of millennia-old royal cemeteries from Egypt and Sumer, jewelled weapons were included in burials to accompany deceased kings in the afterlife, and in ancient cultures throughout the world, monumental sculptures and commemorative reliefs routinely depicted sovereigns with weapons, representing them as conquerors and communicating their power to all who laid eyes on them.

Jewelled handle for a staff.

This trend endured over centuries, as magnificent weapons and accoutrements continued to play an essential role in displaying the splendour and wealth at the disposal of monarchs, princes and courtiers, both in asserting their authority at large and in eliciting the admiration of their personal entourages. The custom of portraying rulers wielding or wearing magnificent blades has persisted into modern times, demonstrating the timelessness of the association between authority and weapons.

The collection of outstanding precious weapons and accoutrements from the Indian subcontinent presented here was assembled over many years by Sheikh Nasser and Sheikha Hussah al-Sabah. It bears witness to the legendary wealth and opulence of the Indian courts and to their tradition for fine and artistic craftsmanship during the sixteenth to the eighteenth centuries CE. Only the exceptional refinement and elegance of these Indian courts, coupled with both the importance they allocated to martial arts and their connoisseurship of the jewelled arts, could have produced the marvellous objects that are presented in this volume.

These uniquely Indian weapons display decorative features derived from ancient and medieval traditions of Central Asia, the Iranian world and China, as well as from Renaissance Europe, as a result of centuries of contact through trade, travelling craftsmen and warfare. Although these contacts influenced the Indian art of weaponry, it was the long-standing Indian artistic traditions and native custom of fine craftsmanship for a class of enlightened patrons that raised this art to elevated heights, producing objects of sublime, uplifting beauty.

It is worth mentioning here that these jewelled weapons were functional and not just ceremonial or worn only for parade. This is revealed by the condition of some of their blades, which were heavily repolished on account of frequent usage, or replaced following breakage.

A jewelled rock crystal horse-head hilt with locket and chape.

THE DECORATIVE TECHNIQUES INVOLVED IN THE ART OF INDIAN WEAPONRY

Gemstone setting

Unique to India, and possibly dating as far back as the start of the first millennium CE, is the setting of gemstones in the *kundan* technique, which allowed Indian jewellers nearly limitless artistic freedom. In simple terms, the technique involves hyper-purifying flat strips of gold to the point at which the metal becomes malleable at room temperature.

Once these gold strips are applied to a surface and piled up to achieve the required thickness, tools are used to exert pressure, producing a molecular fusion that turns the gold strips into a single mass. The jeweller is then able to set gems on any part of the soft, gold-covered surface by packing additional gold foil around the stones to hold them in place. By virtue of this technique, which can be applied to any rigid surface, jewellers were able to dispense with setting gemstones in protruding and unwieldy collets, holding them in place with claws or by means of the more laborious ancient technique of

Ivory goat-head hilt.

Enamelled scabbard.

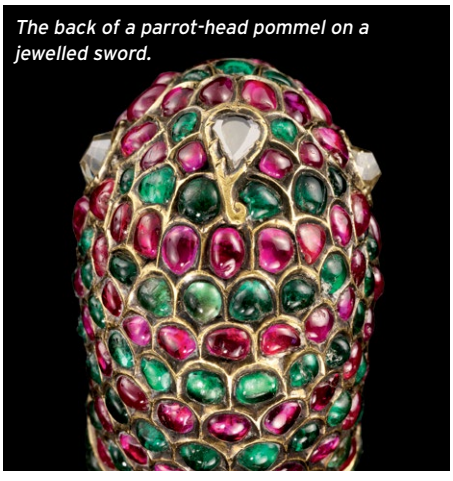
hammered-cloison settings. It also allowed craftsmen to set gemstones close together in the configuration they desired to enhance the gold surfaces surrounding them with engraved patterns.

Enamelling

India is just as famous for its highly decorative styles of enamelling as it is for gemstone setting, but it is interesting to note that neither champlevé nor basse-taille enamel, and for that matter any form of enamel work, existed in the area prior to the sixteenth century CE, except for a few scattered examples from the Graeco-Bactrian period (250-125 BCE).

> Only the exceptional refinement and elegance of these Indian courts, coupled with both the importance they allocated to martial arts and their connoisseurship of the jewelled arts, could have produced the marvellous objects that are presented in this volume.

Introduced to the Indian courts in the sixteenth and early seventeenth centuries by the European jewellers who had a fine command of the art, enamelling provided a new source of inspiration that stimulated the creativity of Indian jewellers. Although it has been said, without supporting evidence, that the art of enamelling was introduced to India by enamellers from Lahore and Punjab who migrated to Amber and



The back of a parrot-head pommel on a jewelled sword.

Jaipur, it is likely that this misleading assumption arose from nineteenth-century accounts on the subject, written when Jaipur was an important enamelling centre.

The two principal techniques utilised by Indian jewellers where champlevé and basse-taille enamelling. The champlevé technique involved carving depressions in the metal and filling them with enamel, often of the opaque variety, whereas in the basse-taille technique the recesses were chased and patterned and filled with transparent enamels, which produced a modelled effect. The two techniques could be used in combination, yielding tasteful, yet lively, results that exemplify the rapid absorption and mastery of the art by Indian jewellers.

Indian enamellers not only assimilated the basic techniques, but also became highly attuned to the nuances of colour modelling, and even produced such effects on very small objects such as archery rings. In addition, their first-hand observation and deep appreciation of nature, compounded with their native aesthetic sensibilities, drove them to decorate weapons with exquisite enamelled floral motifs that one would generally not expect to find on this type of object.

Jewelled jade rams-head knife.

Hardstone carving

India was duly celebrated for its ancient and distinguished achievements in sculptural arts and carving. The considerable body of exquisitely carved hardstone hilts, maces and archery rings in stylised non-representational, vegetal and animal forms that have come down to us testify to this prolific and refined hardstone carving tradition.

Indian artists skilfully utilised all the types of stone that were available to them in expressing their penchant for three-dimensional sculpture. Some of the most prized raw material for hardstone carving was not readily available in India and had to be transported from afar, but wealthy patrons spared no effort in obtaining it. These imported materials included emeralds, which are said to have originated in the South American Muzo and Chivor mines of Colombia, notwithstanding reports that some were mined in Panjshir or Siberia; nephrite jade that had to be carried from Khotan and Kashgar on the south-western and western ends of the Tarim Basin; and walrus ivory from the Northern Hemisphere.

Bearing in mind the Indian fascination with colour, manifest in the vibrant tones of stones associated with the gem-setting tradition, it is important to note that objects carved from more subtly coloured hardstones such as nephrite jade, rock crystal or agate were as prized as those set with rubies and emeralds, which says a great deal about the sophisticated and eclectic taste of Indian patrons.

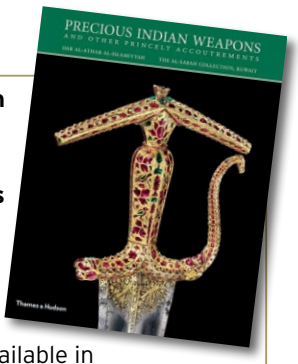
Carving most hardstone material was a laborious undertaking. Coarse and cryptocrystalline quartzes and jade were too hard to cut with steel tools, and could only be cut, carved, ground and polished by grits that were harder than the raw material. Abrasive grits and powders of corundum, garnet or diamond affixed on rotary wheels or rods were thus required to grind the stones to the desired form,

Enamelled dagger and scabbard.

and were worked in conjunction with water or oil to avoid overheating and cracking the material.

Despite the technically demanding and time-consuming nature of the process, Indian craftsmen produced many carved hardstone masterpieces. Some pieces, such as the cloven-pommel daggers, involved inlaying hardstones and setting them with gemstones, an even more painstaking process requiring superior control. It is clear from the skilfully carved examples that abound in this collection that the difficulties of hardstone carving did not deter the lapidaries, whose command of the raw material at hand allowed them to obtain the finest results. ■

Photography by Muhammad Ali and Robert Lorenzo, Courtesy of the al-Sabah Collection, Kuwait.



Precious Indian Weapons and Other Princely Accoutrements
By Salam Kaoukji.
Published by Thames and Hudson Ltd. Available in both hardcover and paperback.

Events Directory

Your essential guide to Gem-A events

EVENTS

American Gem Society Conclave 2018
23-26 April 2018
This year's conclave will gather in Nashville, Tennessee. Held in a new location each year, the AGS Conclave features celebrity speakers and jewellery industry experts, all tackling a variety of topics ranging from sales and leadership, to marketing and show business. Gem-A will present a variety of talks, including 'Spectacular Spectrums' (Monday 14:30-16:30), 'UV as Diagnostic in Gem Identification' (Tuesday 10:00-12:00), 'Coral: Gem Material over 5,000 years' (Tuesday 15:00-16:30) and 'Synthetics and Simulants: Separating the Real from the Sneaky' (Wednesday 10:00-12:00).

For more information visit the AGS Conclave 2018 website: americangemsociety.org

Scottish Gemmological Association (SGA) Conference 2018
4-6 May 2018, Westerwood Hotel at Dullatur, near Cumbernauld, Scotland.
Gem-A tutor, Lily Faber FGA EG, will host workshops at the annual SGA Conference, which boasts a fantastic line-up of global speakers. Lily's talks will include 'Identifying materials set in Pieta Dura Inlaid works of art', which explores the history of pietra dura ('hardstone') inlay, the various materials that have been used, as well as how to identify them using mainly observation and comparison. Lily will also lead 'Colours that Cause Confusion', an insightful talk on colour shifts and pleochroic gemstones, investigating the causes behind their many colours. This will lead into a discussion on how using these traits can assist in identifying alexandrite, colour-change spinel, garnet, sapphire, iolite, andalusite and tanzanite with practical, hands-on examples. Don't forget to visit the Gem-A table, where we will be selling gemmological instruments, and where you can collect your free 2018 pin badges!

For more information visit: scottishgemmology.org/conference/

GEM CENTRAL

20 May 2018
Held at Gem-A Headquarters in London, Gem Central is a practical gemmology evening for Gem-A members and students, giving attendees the opportunity to investigate and explore a variety of gem materials. The next Gem Central will be hosted by Dr. Leon Barron, senior lecturer in Forensic Science at King's College London. Dr. Barron will explore innovative ivory fingerprinting

technology and its implications for gemmologists, antique dealers, collectors and wildlife conservationists worldwide.

For more information contact us at events@gem-a.com

GEM-A ONLINE

Top stories from the Gem-A blog

Gemstone of Passion: Padparadscha Sapphire

Industry Leaders Unite for 'Diamond Terminology Guideline'

Birthstone Guide: Rock Crystal for Those Born in April

EDUCATIONAL WORKSHOPS

Whether you are a retailer, gem dealer, buyer, valuer, auctioneer or gemstone enthusiast, our workshops are designed to give students a thorough gemstone and diamond education in a short amount of time. Our range of 'Understanding' workshops offer students a hands-on introduction to the world of gemmology and diamonds, allowing them to learn new skills or brush up on the basic.

Workshops take place at Gem-A Headquarters, 21 Ely Place, London from 10:00-16:30 where all gemmological equipment is provided.

Investigating Gemstone Treatments (Intermediate)
20 April 2018

Investigating Gemstone Treatments
27 April 2018

For more information contact the Educational Department via: education@gem-a.com

Price: £135 for Gem-A members, students and NAJ members; £165 for non-members

Colourful Quartz

Long-standing Gem-A member and gemmologist, Anthony de Goutière, specialises in the photomicrography of gemstone inclusions. Here, he shares two striking images of quartz and beryl inclusions from his archives.

QUARTZ CRYSTAL WITH HAEMATITE AND RUTILE (main picture)

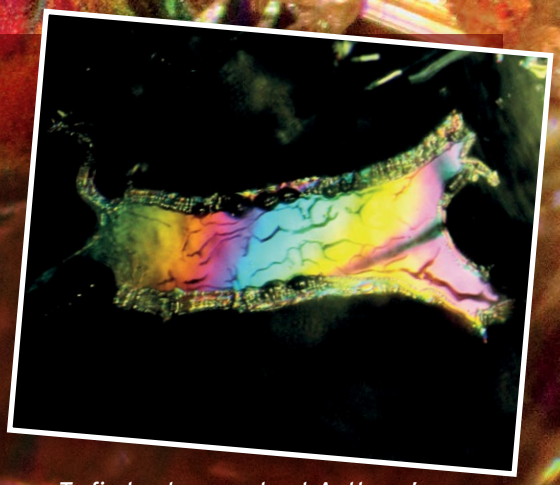
I found this colourful scene in a small quartz specimen. I used two fibre-optic pin-point illuminators; one to highlight the rutile needles and the other to bring out the remarkable colours in the large haematite inclusion in the background. Photographing this type of inclusion presents difficulties because of the shallow depth of field in photomicrography, yet this one worked well because the needles were very close to the haematite platelet. In this case, the area photographed is just 4 x 6 mm.

THIN-FILM INCLUSION IN BERYL (right)

I purchased a large beryl specimen at the Tucson Gem show a few years ago. It is a colourless slab but it has interesting surface features.

I recently discovered this thin-film inclusion, which brings to mind a cave drawing in colour.

I am not able to identify the black bead-like objects on the edge of the inclusion. They resemble burnt coffee beans. Could they be haematite? The area photographed is approximately 5 x 4 mm using oblique illumination.



To find out more about Anthony's photomicrographs and published works visit: anthonydegoutiere.com

Gem-A INSTRUMENTS

Current Gem-A members and students get a 10% discount

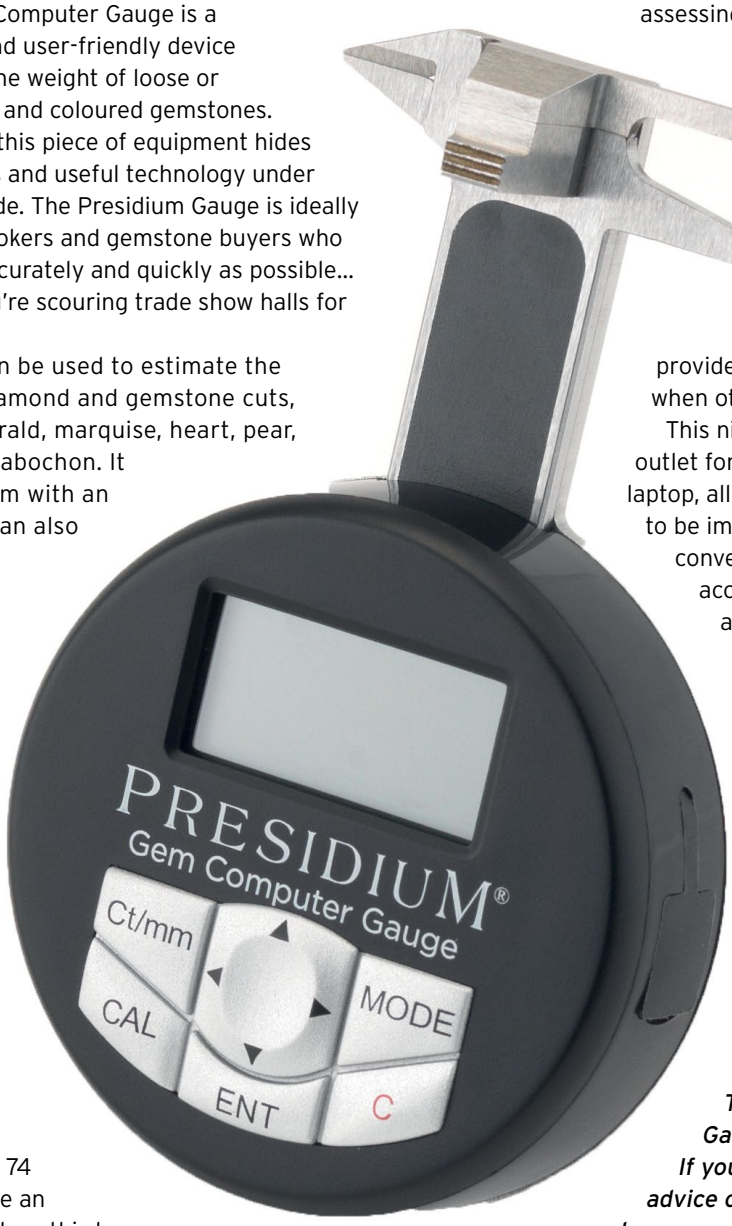
MADE TO MEASURE

Gem-A Instruments Assistant, Sophie Cox, explores the benefits of the Presidium Gem Computer Gauge – a must-have tool for on-the-go jewellers and gemmologists.

The Presidium Gem Computer Gauge is a precise, portable and user-friendly device that can estimate the weight of loose or mounted diamonds and coloured gemstones. With a clear digital display, this piece of equipment hides a number of clever features and useful technology under its refreshingly simple façade. The Presidium Gauge is ideally suited to jewellers, pawn brokers and gemstone buyers who want to know weights as accurately and quickly as possible... a very good thing when you're scouring trade show halls for that very special find.

The Presidium Gauge can be used to estimate the weights of nine popular diamond and gemstone cuts, including round, oval, emerald, marquise, heart, pear, cushion, rectangular and cabochon. It measures from 0.0-25.0 mm with an accuracy of 0.01mm, and can also be used when a gem or diamond is mounted in a tricky setting (an excellent option for vintage jewellery specialists and auctioneers). To do this, the Presidium Gauge comes with a special jewellery attachment that is just as easy to use.

What makes this small-but-mighty device especially interesting is the support it offers in gemstone identification. Need help identifying an oval-cut red stone? The Gauge will turn to its computer database of 74 different gemstones to make an estimated identification. It does this by assessing the specific gravity (SG) value based on the gemstone's weight and measurement, which can either be entered manually via a keypad or measured using the gauge itself. Although in some cases further testing will be required, it can provide essential information on-the-go when other information is in short supply.



This nifty bit of tech also has a USB outlet for connecting to your PC or laptop, allowing data and measurements to be imported, saved or printed at your convenience. It is presented with an accompanying CD that includes SG and RI values, plus hardness data, for 133 gemstones – a really useful, compact reference for the gemmologist on-the-road.

With an 80-hour battery life, one-year warranty and a case box provided, the Presidium Gem Computer Gauge helps to take the challenge out of on-the-go measurements and identification. For those making quick decisions, or tight on time, we highly recommend it.

The Presidium Gem Computer Gauge is priced at £414 inc. VAT. If you require any further information, advice or simply wish to make a purchase, please email: **instruments@gem-a.com** ■

Silver, Freiberg, Erzgebirge, Saxony, Germany
Specimen courtesy of Collector's Edge Minerals, Inc.