Gems & Jewellery

Autumn 2017 / Volume 26 / No. 3

GEMSTONE DISCOVERY IN ETHIOPIA

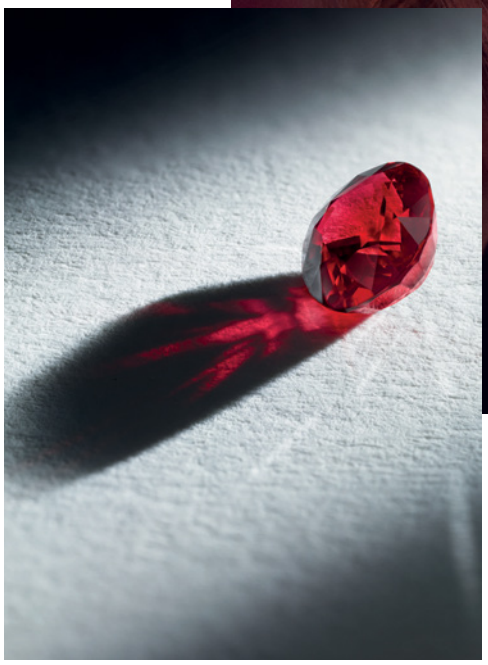
SAPPHIRE RUSH IN MADAGASCAR

SPOTLIGHT ON CORAL

THE ART OF DIAMOND PAINTING

ADVENTURES IN CEYLON

Gem-A
THE GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN



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THE FORBIDDEN ROAD TO CHILA

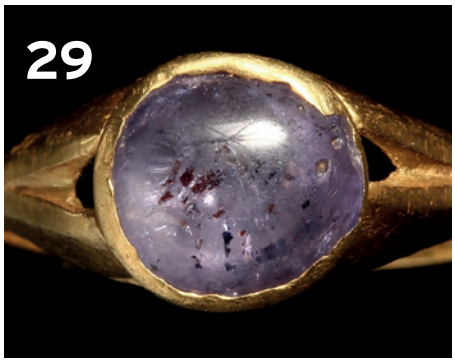
Simon Bruce-Lockhart FGA DGA EG travels to Ethiopia to uncover the truth behind the Aksum sapphire fields and find out why this restricted-access area is such a fascinating place for gemstone discovery.

A CONNECTION TO CORAL

Coral may not inspire the same emotional outpouring as ivory, but its delicate ecosystem needs to be protected, says Gem-A president Maggie Campbell Pedersen FGA ABIPP.

SAPPHIRES AND ADVENTURES IN CEYLON

Helen Molesworth FGA, managing director of the Gübelin Academy takes the reader back in time to Seilam, now Sri Lanka.



COVER PICTURE

Tiffany stone (opalized fluorite). Reflected light from a fibre optic source. Field of view 4.79mm. Image courtesy of Claire Ito.

Published by
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Registered charity no. 1109555

Gem-A is a company limited by guarantee, registered in England, number 01945780

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Zest Design +44 (0)20 7864 1504

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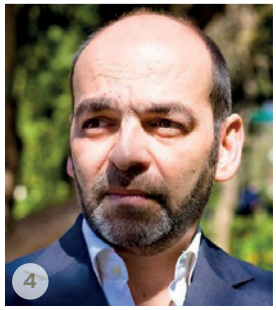
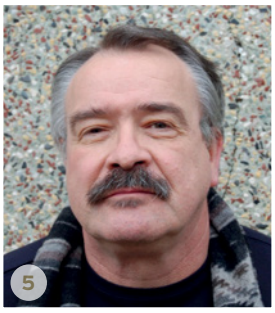
For editorial enquiries, mediapack and advertising rates please contact editor@gem-a.com.





Gems&Jewellery

Autumn 2017 featured contributors

1. SIMON BRUCE-LOCKHART

Since graduating from Gem-A in 2000, Simon Bruce-Lockhart FGA DGA EG has spent the last 17 years working in Thailand's main ruby and sapphire market, Chanthaburi. Having worked for early gemstone-internet pioneers Thaigem.com (GemsTV), Simon is now a syndicated buyer of ruby, sapphire and more on behalf of large gemstone and jewellery companies.

2. ROSEY PERKINS

Rosey Perkins GG is an independent gemmologist and gemmological photojournalist based in London. She is particularly fascinated by corundum and its origin. Previously she has joined Vincent Pardieu (fieldgemology.org) on field expeditions to Australia, Sri Lanka, Thailand, Cambodia, Vietnam, Tanzania and Mozambique as his assistant and cameraman. Her travels can be read about at: roseyperkins.com.

3. CARA WILLIAMS

Cara Williams FGA is a partner in Stone Group Laboratories and Bear Essentials with more than 40 years' experience in the gem and jewellery business. She has been an ODL tutor since 2003.

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. MARTIN P. STEINBACH

Martin P. Steinbach FGG AG graduated in 1982 as the first German gemmologist at AIGS, Thailand. As a gem merchant since 1983 and a lecturer, he travelled the world looking for stars and jadeite. Now, with his book *ASTERISM — Gems with a Star* (2017), he fulfills his life dream.

6. MAGGIE CAMPBELL PEDERSEN

Maggie Campbell Pedersen FGA is president of Gem-A and an associate of the British Institute of Professional Photography. She is an accredited lecturer for the Arts Society (formerly NADFAS). For many years she has specialised in organics and has published two books as well as numerous articles on the subject. Her lecturing has taken her round the world, as has her work in animal conservation.

7. HELEN MOLESWORTH

Helen Molesworth FGA is managing director of the Gubelin Academy, and has a broad commercial, international and academic background in the jewellery industry. Specialising in ancient gems at Oxford, Helen started her career in jewellery, moving into auction houses and becoming a professor of the history of jewellery while also running her own business.

8. OLGA GONZALEZ

Olga González FGA DGA is the CEO and 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 and is the networking director for the Women's Jewelry Association's New York Metro Chapter Board.

9. CARL ANTHONY SCHÜTZE

Carl Schütze is an accomplished bench jeweller working with emeralds and conch pearls for over 15 years. With experience in design, buying and selling gems, the expertise that Mr. Schütze employs in his field of work is delivered with passion and commitment to striving for integrity and excellence.

Straight from the heart

Opinion and comment from CEO, Alan Hart FGA DGA

September is one of those months that we look forward to and secretly dread at Gem-A. Of course, it is a fantastic few weeks packed with trade events, conferences and symposiums, but it is also a whirlwind of international flights that makes one's head spin.

Just before we dive into September, I must take a moment to mention the Dallas Mineral Collecting Symposium that took place at the tail-end of August. Gem-A is proud to sponsor this great event and this year's speaker line-up was particularly impressive, including the likes of Richard Hughes FGA, Bruce Bridges and Dr. Robert Hazen. If you have never had the pleasure of attending, I would recommend checking your diary for 2018...

International Jewellery London

Gem-A at the Hong Kong Jewellery & Gem Fair 2016

Back to September! We're starting the month at International Jewellery London, where the team will offer in-booth demonstrations, two insightful workshops and information on the latest equipment available through Gem-A Instruments. I am also excited to announce the winner of this year's Gem Empathy Award at IJL 2017, after all, who doesn't want to win a 4.14 carat green tourmaline with a zig-zag cut by John Dyer? Say hello to us on Stand J10.

As the doors to Olympia London close the Gem-A team will be hopping on a plane and heading to Hong Kong for the Jewellery & Gem Fair. This year, for the very first time, we will be hosting a members' gathering at the event, welcoming 80 friends and colleagues who continue to support Gem-A in this particular corner of the globe. For those attending the Fair, we look forward to meeting you at Hall 3CDE Concourse, Stand 3M044.

Back on home soil, we are also looking forward to the annual Loughborough Conference hosted by the National Association of Jewellers' Institute of Registered Valuers. As a sponsor of this event, Gem-A is supporting a long tradition of excellence, both in identifying and discovering the value of gemstones and gemstone jewellery, and nurturing the stories that are often wrapped up with spectacular pieces. It is this dual nature of the trade – the scientific and the emotive – that make it such a pleasure to work in.

Gem-A HQ is also busy with the impending arrival of new students, many of whom are taking their first steps into gemmology on our foundation courses. The team has also been working hard on our online distance learning platform, Moodle, which has been given a refresh for our students across the globe. As the world becomes ever-more digitally savvy, I hope you will agree that offering accurate gemmological information and learning via the web is our responsibility, especially for younger generations.

With all this jet-setting happening in the coming weeks, it is easy to forget that we have a brand new issue of *Gems&Jewellery* for you. This season's magazine focuses on sapphires, including two impressive field trips to Madagascar and Ethiopia, and an engaging feature by Helen Molesworth on Ceylon sapphires. We also delve into star gems, coral, Portuguese objets d'art, diamond portraiture and the most effective use of gemstone laboratories.

Also, don't miss page 36, which outlines some of the incredible speakers we have lined up for this year's Gem-A Conference in November. It is certainly shaping up to be a very exciting autumn.

Best wishes
Alan Hart FGA DGA

Gem-A News

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

MULTI-TESTER VS THE THERMAL DIAMOND TESTER

Have you ever needed an instant test to help determine if you have a diamond? Sophie Cox, Gem-A Instruments assistant, shares her must-haves for all gemmologists this season...

The Gem-A Multi-Tester and Gem-A Thermal Diamond Tester are both precision instruments for distinguishing between diamonds and simulants. There is one key difference to consider when making your choice; the Multi-Tester tests for all diamond simulants whereas the Thermal Diamond Tester tests for diamond simulants except for synthetic moissanite.

The Multi-Tester works by measuring electrical conductivity through the stone, and can distinguish between gemstones since diamond is not electrically conductive and synthetic moissanite is. In comparison, the Thermal Diamond Tester measures the thermal conductivity of the stone, and can distinguish between stones because diamond has a higher thermal conductivity than its simulants. This is true except for synthetic moissanite so, if a positive result is obtained with a Thermal Diamond Tester, further tests must be carried out to ensure the stone is not synthetic moissanite.

These testers are user-friendly with instant results, therefore making a brilliant addition to your instruments collection! A protective travel case and full instructions are included with all testers. ■

Gem-A Instruments stocks a range of equipment, including the Gem-A DIT0016 Multi-Tester (£145 + VAT) and the Gem-A DIT0011 Thermal Diamond Tester (£60 + VAT). See the Gem-A Instruments catalogue online or email instruments @gem-a.com for more information.

NEW ADDITION TO THE GEM-A TEAM

We are pleased to announce Gem-A's newest member of staff as of June 2017, Sarah Salmon. Sarah will support *Gems&Jewellery* and the *Journal of Gemmology*, while also creating content for the Gem-A Blog and social media. Contact her via *sarahsalmon@gem-a.com*.

GEM-A AGM 2017 — NEW COUNCIL MEMBERS

The 2017 Gem-A Annual General Meeting took place on July 27 at the Goldsmiths Centre. We are pleased to welcome new council members Joanna Hardy FGA DGA and Philip Sadler FGA DGA and also the reappointment of Kerry Gregory FGA DGA. Alan Hodgkinson FGA DGA and Richard Slater FGA DGA announced their retirements at the AGM after many years of dedicated involvement in Gem-A.

GEM EMPATHY WINNER TO BE UNVEILED AT IJL 2017

Gem-A CEO Alan Hart FGA DGA is gearing up to present this year's Gem Empathy competition winner with their gemstone prize at International Jewellery London (IJL). This year, Gem-A offered one Design Gallery exhibitor the chance to win a 4.14 carat green tourmaline with a zig zag cut, courtesy of world-renowned gem-cutter, John Dyer. Exhibitors were tasked with creating a hand-drawn design or CAD render that showcases the gemstone in the most imaginative and innovative way. The winning entry and designer will be revealed at IJL from September 3-5. Look out for the design in the winter issue of *Gems&Jewellery*, available in December.

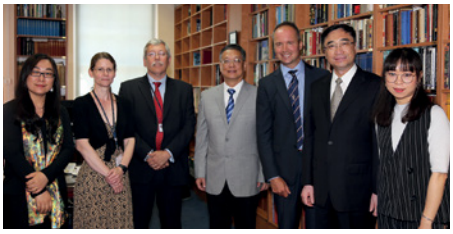
GEMS & JEWELLERY CORRECTION

The *Gems&Jewellery* team incorrectly captioned a picture in the Summer 2017 edition. In the article *Fossicking in the Outback* (pp.10-11), Figure 3 showcases boulder opals from Quilpie, mined and cut by Eddie Lunney.

The image shown here is of Lightning Ridge white and black opals mined and cut by Greg Armstrong.

AMBASSADORS VISIT GEM-A HQ

In June 2017 Gem-A welcomed the arrival of representatives from the Shanghai Jian Qiao University where exciting plans for the future were discussed in detail in a delegation meeting with Gem-A's CEO Alan Hart, COO Bill Scott and Director of education, Lorne Stather.



GEM-A HOSTS SUCCESSFUL WORKSHOPS AT ANNUAL JTV EVENT

Gem-A teaching manager, Claire Mitchell FGA DGA and Gem-A North America manager, Eric Fritz FGA DGA hosted insightful talks at this year's 'The JTV Experience', formerly known as the Gem Lovers' Conference, in Knoxville, Tennessee. The Jewelry Television event, which took place from July 16-18, also includes a 'Jewel School', where attendees learn to create their own designs. A Facebook Live session with Claire Mitchell and JTV host Jana Laurin is available to view online now.

GEM-A SPONSORS SUNDAY LUNCH AT NAJA CONFERENCE

Gem-A was proud to sponsor a special Sunday Lunch at the 48th ACE© IT Annual Mid-Year Conference in Indianapolis, Indiana, hosted by the National Association of Jewelry Appraisers (NAJA). The event, which took place from August 12-15, provided a valuable opportunity to network with leading experts, making it a must-attend for anyone wishing to expand their knowledge. Also at the event, Gem-A's Claire Mitchell and Eric Fritz presented talks, focused on 'The Essentials for Successful Spectroscopy' and 'Corals and Cameos... Gifts from the Sea'.

TOP TRENDS FROM JCK LAS VEGAS 2017

After seven days of hitting the aisles and talking to vendors, Olga Gonzalez FGA DGA reports on the biggest trends that are winning in the style stakes...

Ombré

The graduated colour look is a natural choice for gemstones, where pearls can ease from a classic black to white, and rings can feature colorful sapphires, intensifying in hue across the hand (**1**).

1. Fade Tahitian Pearl Strand by Mastolini.

Gems within Gems

Designers were taking interesting risks with the setting and placement of precious materials directly within one another, creating juxtapositions of color, line and function.

Samuel Rennes, sales and marketing manager of Gamma Creations says: "By mixing diamonds and sapphires with opaque and semi-precious gemstones, we provide a high end luxurious look, but with pieces that are wearable every day, yet unique." (**2** & **3**).

2. Six carved natural green jadeite discs set in 14K yellow gold bracelet by Mason Kay, with natural ice jadeite jade centre stones.

3. Rose gold, pink agate, pink sapphires and diamonds by Gamma Creations.

Edgy Design

Innovative, edgy elements were evident across many collections on display; from patented mechanisms redefining luxury to angles with attitude, surrealist motifs and a dreamer's imagination. It is safe to say the creativity was palpable.
At Jewellery Box, a new show to Vegas, Niki Grandics mixed 14K gold with agate to create edgy designs that are also a good introduction for millennials looking to make their first foray into fine jewellery.

Men Mix it Up

Having always taken a back seat in the jewellery department, the Vegas shows certainly did not disappointment in the men's jewellery category. From Equinox mixing contemporary twists into their classic saddle rings to lashbrook designs mixing surface textures, men's jewellery has had a facelift (**4**).

4. 14K rose gold band by Lashbrook Designs, featuring 1.5mm off-centre groove with blue Cerakote coating in the groove and inside the band.

Green with Envy

5. Merelani Mint Grossular Garnets.

Pantone's Colour of the Year 2017 'Greenery' was evident throughout, from emerald and tsavorite to green garnet and turquoise (**5** & **6**).

6. One of a kind platinum ring by Omi Prive. Featuring a 11.07 ct. Brazilian emerald cut.

Quartz crystal miners in Chapada Diamantina, Bahia, Brazil

The Bahia Golden Rutilated Quartz Initiative aims to create a model for artisanal small-scale mining communities, starting in the remote Chapada Diamantina region of Bahia, Brazil. Brian Cook, who is pioneering the initiative, shares his behind-the-scenes insight.

Image from bahiainitiative.org courtesy of Brian Cook.

"Here we see two men hauling, by primitive methods, either a rubber bucket full of rocks and tailings, or their mining buddy, who descends and ascends by manpower. Typically four to eight men join forces to create a mining team, but the risk is high. The opportunity of having something of value within grasp, from your own land, is an exciting treasure hunt, yet necessarily driven by the need for economic sustainability. It is basically endless days of hard toil with brief moments of joy and excitement. Shafts are sunk straight down, until crossing a quartz vein, then follow nearly horizontal in hopes of finding a productive zone and crystal pockets – mostly smoky and the much sought-after golden rutilated variety. Here, in the remote western edge of the Chapada Diamantina in Bahia, Brazil, three rare biomes merge, resulting in as many as 2,000 miners scattered across the mountains. This is where we will create a model for ASM communities to create more value and opportunity for the locals, and provide that elusive starting point in the chain of custody from the earth to the consumer."

WHAT IS THE BAHIA GOLDEN RUTILATED QUARTZ INITIATIVE?

Lead by Brian Cook, the Bahia Golden Rutilated Quartz Initiative is a responsible sourcing project designed to create an artisanal small-scale mining model of best practice in the village of Remedios, Chapada Diamantina, which can be replicated elsewhere. The initiative aims to teach skills, improve mine safety and educate about land and water stewardship. Cook aims to link ASM mining with organic food production; effectively balancing an artisanal extractive industry with regenerative agriculture. The initial task of gaining support from the community, federal, state, and municipal government in the region has already been achieved by Cook's efforts in formalising land and mining rights and legalising miners through cooperatives. Now the focus is on creating infrastructure to support the initiative, which will also address the need for more traceability along the supply chain to the source. ■

The Forbidden Road to Chila

Simon Bruce-Lockhart FGA DGA EG travels to Ethiopia to uncover the truth behind the Aksum sapphire fields and find out why this restricted-access area is such a fascinating place for gemstone discovery.

The Road to Chila. Sapphire miners head to the Saturday market on camels and donkeys.

A 12 gram / 60 carat blue sapphire being passed through a tightly-packed crowd in the restricted-sapphire areas in Tigray, northern Ethiopia.

You may be forgiven for thinking Africa's only 'Sperrgebiet', a restricted access wilderness of gemstone-bearing lands, is solely Namibia's claim to fame. It turns out however, in the remote Ethiopian Highlands, at a height of almost 8,000 feet, a large sapphire-field has been found in a remote, culturally-timeless area that is carefully administered by the authorities.

This new find, made in early 2017 at the north end of Africa's Great Rift Valley, was somewhat eclipsed by the 2016 discovery of a Madagascan sapphire deposit that occupied the sapphire industry's attention (see pp.14-15). This new Ethiopian sapphire deposit has emerged almost entirely unnoticed, and the scale is only just being understood.

To the north of Aksum, the ancient seat of Christian kings known for cultural jewels of millennia-old stelae and rock-hewn churches, is the dusty market-town of Chila — the gateway to the sapphire fields. Chila is a remote settlement, over 1,000km by road from the capital city, Addis Ababa, and is perilously close to the sensitive UN demarcated border with Eritrea. The sapphire-fields are in the middle of the strategic border areas and are part of the former conflict-zone between the two nations — access here is forbidden to foreigners.

I have come here with the Ethiopian Ministry of Mines, Petroleum & Natural Gas to verify the sapphire-fields, document what is going on, and prove the sapphire-types produced from Africa's highest sapphire mines that are likely to become a significant player in the global supply-chain over the next few years.

Heading to Chila from Aksum, fertile flatlands give way to winding mountainous dirt-roads. Mountain slopes of granite rocks are peppered with acacia trees, eucalypts and huge aloe-veras. Vast fields of time-worn boulders stretch for miles forming hills, outcrops and deeply-strewn valleys. The closer one gets to Chila, it is clear you are entering the debris-field of an ancient volcanic-landscape. This is the 'Adwa Plug', an 800km square granitic and basaltic-zone visible from space — much of which is sapphire-bearing.

Chila is a small town on a dusty plain, surrounded by granite. Home to several hundred ramshackle houses, the town's main draw is its once-a-week market. Thousands of rural people from surrounding areas come to town to trade the produce of subsistence-farming and purchase provisions. It was, until recently,

Thousands of farmers and sapphire miners walk to Chila market to trade sapphire.

The Chila sapphire mines.

> The sapphire-fields are in the middle of the strategic border areas and are part of the former conflict-zone between the two nations — access here is forbidden to foreigners.

not unlike any other remote market-town in Ethiopia's Highlands. However, since early 2017, the market has morphed into a lively and unusual trading post, where sapphire and zircon are sold alongside mangoes and live chickens, and garnets and tourmaline are traded next to goats, shallots and grains.

Untethered camels wander the streets in front of sapphire-dealing offices. Boys herding goats drift through side-alleys as men inspect sapphires. The streets of stone and dust throng with thousands of people looking to sell sapphires and more. Here in these streets, crowds press-up against you to show and sell their sapphires. The surrounding one-story stone buildings comprise of offices that provide relief from large, curious crowds eager to sell their sapphires.

The Saturday market attracts many of the 5,000 sapphire miners who work the current deposits. The isolated sapphire mines, some 10km outside of Chila, are accessible only by robust four-wheel drives along winding dirt-tracks with tyre-shredding pieces of rock. These arduous conditions and farmers' low-incomes, means no cars, trucks or motorbikes pass down these tracks — the traffic here belongs to a bygone age.

Thousands of people walk large distances to trade and barter sapphires and subsistence-farming produce. On Saturdays, long columns of people and livestock trudge the boulder-strewn valleys and hills. Most walk 10km or more to market with camels and donkeys to trade their sapphire, purchase a week's worth of provisions, load their beasts of burden and walk all the way back through valleys and hills at dusk.

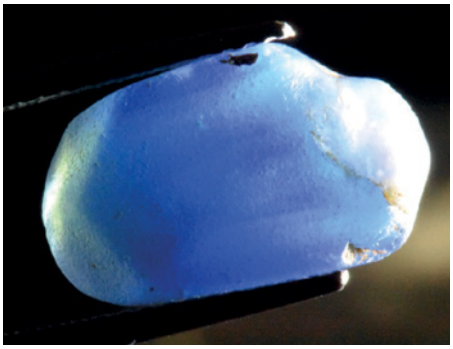
Small boys with donkeys packed with bales of goods and water-drums toil under their burden, ancient goat-herders walking their stock and camel-trains crowd the tracks in long snaking lines from valley-to-hill. Instead of the sound of engines, only the wind, chattering of voices and the braying of donkeys, camels and goats punctuate the soundscape as they march through the hills.

The sapphire mines are based in river-bed placer deposits. At the foot of the hills the river courses level out on the valley floors where slowing waters drop their heavy sapphires. Nestled in flat plains between arid hills, mining-activity takes place in creeks, river-courses and low-lying plains to yield sapphires placed by millions of years of ever-changing river courses.

Hundreds of men and women work the dry rivers with pick-axes and agricultural hoes. Donkeys idly watch the proceedings hiding from the withering sun under occasional trees and camels wander casually down the creeks as if inspecting the diggers' progress. The miners work the beds and banks sifting gravel and soil searching for anything that may be sapphire.

Upon finding something, yelps of delight and smiling faces erupt as miners leap across tailings to evaluate the find. Peering and squinting, they hold the sapphires up to the sky to allow the light to reveal colour, shape and internal features in an attempt to ascribe a value and foretell the potential riches that await them on Saturday. Voices of animated, excitable conversations and opinions ring out through the mines. Some finds are jealously kept until market day; others

Lemma Kahsay of the Ministry of Mines (MoMPNG) inspects a freshly found sapphire.



A rough low-iron cornflower blue Ethiopian sapphire.

To The Light Of The Sun. An Ethiopian miner peers into a sapphire.

Approximately 10% of Chila sapphire is a pleasing soft, yet intense mid-blue colour, low in iron-content and appears to be similar to metamorphic-type sapphire[1].

are instantly sold to other miners or speculators within the mines.

Currently, three large-scale mining locations in the central areas of the Adwa Plug are being mined. A newer mine in the eastern areas of the sapphire-fields near Rama is starting to be exploited. Given the perfect geology across such a large area, one would expect new mines to continue being found all over the Adwa Plug.

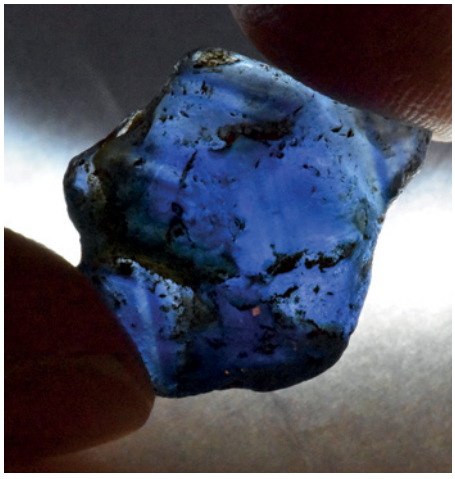
However, in such a large, remote and low-population density area, lack of man-power is likely to be an issue hindering output volume. The colour-range of Chila sapphire is in the blue-yellow-green series of sapphire. 90% of the material is typical of basaltic sapphire[1] with the colour tending to be quite dark. Much of this material will need to be lightened via high temperature heat-treatment. It is likely that these darker colours are due to a high-iron content and form a series of blues, yellows and greens in a plethora of mono-chrome and parti-colour combinations and saturations that will do well as commercial sapphire.

Approximately 10% of Chila sapphire is a pleasing soft, yet intense mid-blue colour, low in iron-content and appears to be similar to metamorphic-type sapphire[1]. This material is a fine colour and this 10% will be keenly sought-after by the international markets. It appears there is a 'habit' of sizes, with the darker iron-rich types frequently having very large sizes, and conversely, the top-colour low-iron-content blues are generally smaller.

Exports to the global gemstone industry are starting to create substantial foreign capital inflows and taxation revenues for Ethiopia. The money spent by the first-line buyers in northern Ethiopia gets placed directly into the miners' hands — local families. The sapphire-rush currently being experienced in the baking valleys and hills will inevitably lead to increased wealth in a region where opportunities are limited. As the gem and jewellery trade starts to incorporate Ethiopian sapphire into its supply chains and finished jewellery, we can all look forward to working with its wide range of colour, sizes and price points. ■

All images by Simon Bruce-Lockhart.

Local Ethiopian dealer AbdiAziz Yousef inspects a parcel of sapphire.

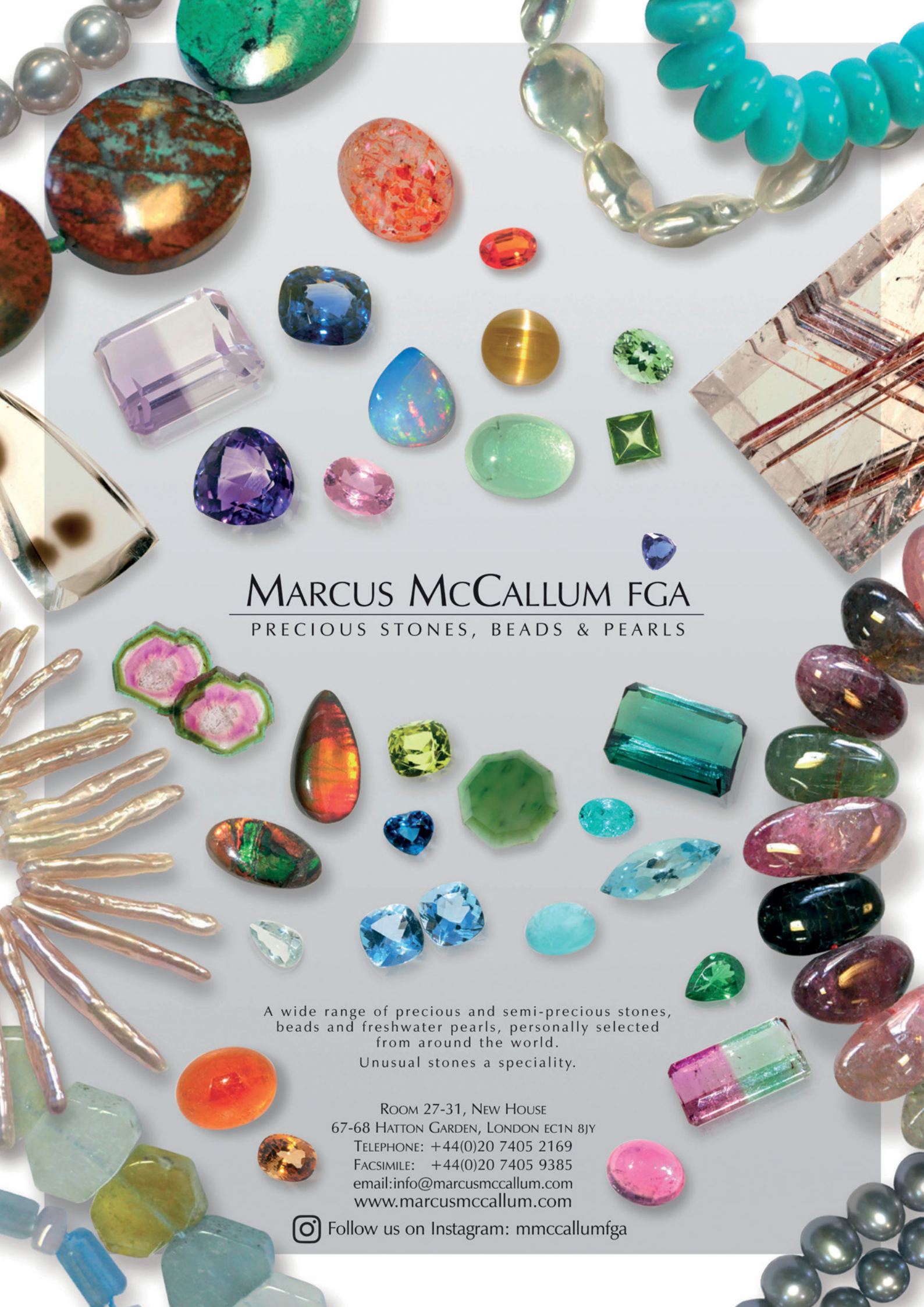


A higher-iron sapphire from Chila, Tigray Province, Ethiopia.

ACKNOWLEDGMENTS

Many thanks to State Minister Tewodros Gebregziabher, Biniyam Bekele, Teweldbrhan Abay, Lemma Kahsay and Fittwi Weldu of the Ethiopian Ministry of Mines Petroleum & Natural Gas for permitting me to enter the Chila area. Also, special thanks to Abdi-Aziz Yousef.

[1] At the time of writing the highly complex geology of the area is not yet fully understood.



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Our team walking from Ansevabe towards the mines. Two gendarmes (local police) joined us as a security measure. In October 2016, I had counted 1,000 people travelling towards the mine. In May 2017 we passed less than 50.

THE LIFECYCLE OF A SAPPHIRE RUSH

In the last 12 months, an exceptional sapphire rush in eastern Madagascar saw thousands of people searching for precious treasures in one of the poorest places on earth. Rosey Perkins GG, an independent gemmologist based in London, shares this report from two visits to the island nation.

A sapphire rush that started in September 2016 has produced world class sapphires close to the village of Bemainty, in the wet forest of eastern Madagascar has reached upwards of 45,000 people. The mine site was in an area called Corridor Ankeliheny-Zahamena (CAZ), which is designated for conservation and managed by Conservation International on behalf of the Government of Madagascar.

I gained access to the mines near the village of Bemainty in October 2016 and May 2017 and was able to capture the lifecycle of the mine that has become known as 'Tananarive Carrier' (18°00'00"N 48°67'83").

'Tananarive', which is the capital city of Madagascar, refers to its size and 'carriere' is Malagasy for 'mine'. It lies 135km NE of the capital and is accessed via the nearest town of Ambatondrazaka. From here a motorbike can be taken to the trailhead at Ansevabe. On 21st October 2016, the President of Madagascar had declared the mining activity illegal because it was inside CAZ. I arrived at the mine the following day. There was a sense of urgency and camaraderie as the miners anticipated imminent government intervention.

The gendarme were present at the site to keep peace and monitor the mining activity. The mine was highly productive and in Ambatondrazaka, I was shown high-quality blue sapphire up to 50g, as well as desirably-coloured pink-orange sapphires, reportedly mined at Bemainty (**1**). However, in February, the Swiss Gemmological Institute (SSEF) issued a trade alert with the warning that sapphires from these mines were being misreported as Kashmiri (Krzemnicki, 2017). A preliminary study of sapphires from this deposit indicated that the origin of these sapphires would prove challenging for laboratories and that more in-depth analysis was needed (Pardieu, 2017). For this reason, Lotus Gemology needed samples and so it was thanks to them and Association Française Gemmologie that I returned on May 6, 2017.

At 5am, I started climbing the path towards the mine and 10 hours later, we reached the valley that had heaved with tens of thousands of people in October. It was a wide valley carved with pits but in May 2017 only about 500 miners remained. The southern end had been almost abandoned and work was concentrated in the more productive central and northern areas, where old pits two to three metres deep were being reworked. Miners had left due to illness, lack of funding or to return to their previous jobs. In the nearby valleys that had been explored, many groups hadn't found a stone for months (**2** & **3**).

However, the mining area had been a valuable source of income during the months that the local population had waited for the rains, which came later than usual. They arrived as miners, porters or cooks to feed the growing community. Soon the exploration had moved into

1: 100ct sapphire from Bemainty Mines.

the adjoining valleys, which were named Milliard 1-4. In May, shreds of blue tarpaulin attached to the top of poles marked abandoned claims and only the skeletons of abandoned huts remained. Morale was low in the valleys, but a few months earlier they had been a source of hope (**4**).

At Tananarive Carrier families lived in two story huts and many had tents on the first floor with shops beneath. These were stocked with beer, local rum, vegetables and plenty of meat. There was a hut for gambling, a cinema with a projector and a board of power sockets offering electricity to charge mobile phones. There were two churches and a mosque but still no school and no sanitation. A doctor had visited for the month of November but the gendarme (law enforcement) said another was needed.

Trading was open and the gendarme was relaxed. At the start of the rush there were many independent 'cooperatives' but in May 2017 most were from other mining areas in Madagascar, such as Diego Suarez, Sakahara and Fort Dauphin. Mining activity was mainly sponsored by businessmen from the major cities. They financed another 'sponsor' who stayed at the mine and hired men in groups, providing food and equipment in exchange for first refusal on the stones they found. At Tananarive Carrier I met an independent sponsor who employed 16 miners, eight security guards and a woman who cooked their meals. His miners formed two groups and shared the use of a motor pump. He supplied the equipment for digging, the fuel for their motor and food for the men. He said he spent approximately $35 per week on rice and meat for the miners and expected to sell a sapphire with 30%-40% profit.

Ambodipaiso and Sahambato were two mining communities that had sprung up by miners leaving Tananarive Carrier (**5**). They had stopped at a river, camped and dug a test pit or panned for gold and found sapphires. Movement between them was fluid and, as a large sapphire was found at one site, the response was an influx of people (**6**).

As miners continue to explore this gem-rich earth of eastern Madagascar, there may be a great many more rushes in the area (Pardieu 2017). While the Government of Madagascar has declared the mining activity illegal, they have not brought it to a halt. The media's coverage of this story has not portrayed the gem industry favourably and, as mining continues, pressure will be on the gem and jewellery industry to respond.

Impact assessments are being carried out by independent consultancies on behalf of businesses sourcing gemstones in Madagascar and the response is likely to be rehabilitation programs in areas of land damaged by mining activity. A collective effort to support conservation would help sustain Madagascar's biodiversity and also demonstrate the gem industry's commitment to responsible sourcing. ■

All images by Rosey Perkins, unless otherwise stated.

2 & 3: Tananrive Carrier facing North in October 2016 (left) and May 2017 (right).

4: Abandoned section of Milliard 3. 'Milliard' is French for 'Billion' and a billion ariary (the currency of Madagascar) worth of stones – approximately £300,000 – had been found in each.

5: Ambodipaiso on May 6th 2017. Courtesy of Zanaky Ny Lalana.

6: Sapphires from Sahambato which resulted in an influx of people to the area.

ACKNOWLEDGMENTS

Permission to enter CAZ was given by the Prefecture D'Ambatondrazaka, Direction Regionale de L'Environment De L'Ecologie et de Forets and the Bureau du Cadastre Minier de Madagascar. The gendarme permitted our team four days inside the area and gave us two policemen as security guards.
Thank you to Institute Gemmologie de Madagascar, Association Francaise de Gemmologie, Lotus Gemology and Vincent Pardieu for their time and support.

Navigating Coloured Gemstone Laboratories

Cara Williams FGA, staff gemologist at Stone Group Laboratories and Gem-A ODL tutor, takes an in-depth look at the changing face of gemmological laboratories, describing what to send for testing, what not to send, and those gemstones that need a careful second look.

1: Laboratory testing offers scientific evidence on which to base challenging identifications and treatment disclosures. The grading of gems, along with some country of origin calls may be more subjective.

The role of gemmological laboratories has changed dramatically over the past few decades. Once used largely for diamond grading and important gems, lab reports now routinely accompany diamonds under a quarter carat and coloured stones that are routinely enhanced, such as tanzanite.

Even stones that are typically untreated, such as spinel and opal, are now commonly accompanied by lab reports. While much of this is aimed at the consumer in order to build confidence, some is necessary between trade professionals due to the difficulty in detecting many newer synthetics and treatments when buying.

Greater awareness of gem treatments is increasingly affecting the value of gemstones, as is origin. Rare and soft stones that were once rarely seen, now regularly appear in jewellery. Few gemologists see most of these materials with sufficient frequency to become adept at their identification. Even an experienced gemmologist may be reluctant to make definitive calls with only standard desktop gemmological equipment.

It is an unfortunate circumstance that lab reports, to varying degrees, have become marketing tools. But besides the market effects, there is relevant need for objective facts when buying certain gems at all levels of the market. This has resulted in more laboratories entering the market.

Read on to discover how best to navigate and evaluate labs, and how best to work with them. For this article, a gem lab will be defined as those that specialise in the advanced testing of gemstones and their treatments rather than the grading or valuing of gems or jewellery. While origin will be mentioned where relevant, the focus will be on identification and treatment of coloured gemstones.

TYPES OF GEMMOLOGICAL LABS

Some labs test everything, while others specialise in diamond grading. Some Hong Kong labs may specialise in jade, while a Bangkok lab may specialise in corundum. If not certain, ask, and make sure the lab has in place the experience and proper equipment to test the item in question.

Jades, opals, and diamonds all require different experience and different equipment, utilising specific ranges of the electromagnetic spectrum. Always confirm the reputation of a lab. While some have well established international reputations, others may be better known within specific segments of the market or geographic regions. Ask for references, ask colleagues, check credentials and experience. All labs can make honest mistakes; most aim for impartiality while some have a reputation for consistently favouring sellers.

LAB EQUIPMENT

Instruments such as FTIR, Raman and XRF are important for any gemmological lab. Spectrometers that cover ultraviolet and into the near infrared (NIR) are important for determining origin and sophisticated synthetics. There are any number of newer instruments entering the market that are aimed at identifying the latest generation of synthetic diamonds. Jadeite testing requires FTIR at the minimum, but is best complemented with XRF and UV-VIS-NIR spectrometers to detect dye rather than just polymer impregnation.

LAB SERVICES

Keep lab price lists for reference, confirm current turnaround times, verify that a lab offers the service you need and is equipped for the necessary testing. This may be basic verbal identification, in order to create an accurate appraisal, to

*2: **Jades.** The manner of setting may offer clues to the inherent value of jade items, but can also be deliberately misleading. Polymer impregnation is not always accompanied by dyes and definitive treatment identification is elusive without advanced testing. Confirming dye with a spectroscope may be all or part of the story. UV fluorescence my provide evidence of treatment in some lower grade materials.*

various formats of written reports, which might include a gem's treatment, origin, and even its cut, color and clarity grade.

Some labs will allow you to ask for a preliminary result before deciding on the final report format. This prevents the full cost of a report should initial tests prove the stone to be synthetic or extensively treated. Include detailed instructions with each item to avoid wasting time. Mounted gems may cost more to test than un-set gemstones. They often require more time and can pose some limits to testing. Labs price services by the stone rather than by the piece of jewellery, so a multi-gem bracelet or strand of jade beads can be time consuming to test, and therefore costly. The lab has no way of confirming all items are alike without actually performing at least basic testing on all, and no reputable lab will create a report on stones they have not tested.

CONSIDERING WHAT TO SEND FOR OUTSIDE TESTING

Many inexpensive gems are seen with lab reports, the cost of which may exceed their value. To avoid this, be sure to exhaust all tests available before submitting. Gemmological labs frequently see unnecessary submissions, many preventable with basic testing. However, it is not uncommon to hear from frustrated gemmologists who have been unsuccessful in convincing a client that their uncle's ruby is synthetic, even if the curved color banding is easily visible. Deciding the value at which an item merits laboratory testing is for you and the client to agree, but a lab report should not expire like a valuation; the identity and treatment status should not change over time, changes in nomenclature and unstable treatments being noted exceptions.

From a lab's perspective, the stones that are most commonly problematic in terms of misidentification of imitations as well as inaccurate treatment disclosure are sapphire, ruby, jade, and turquoise. Forget the old rules of thumb like 'to good to be true' and 'so ugly it must be natural' — synthetics passing through labs are often convincingly included to a less-trained observer.

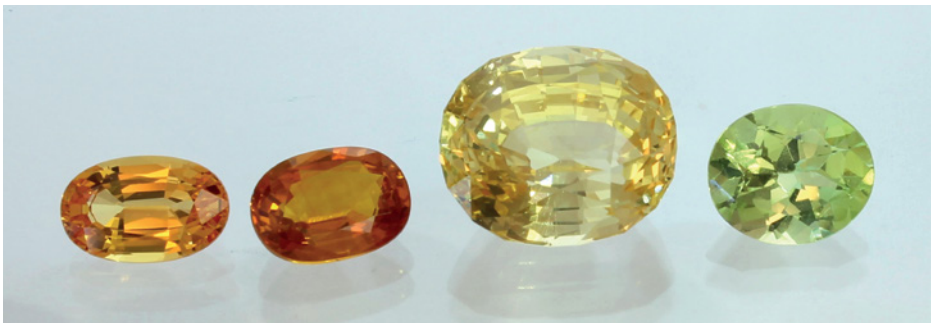
> Forget the old rules of thumb like 'to good to be true' and 'so ugly it must be natural' — synthetics passing through labs are often convincingly included to a less-trained observer.

SUGGESTIONS AND WHAT TO LOOK OUT FOR

For the Valuer

Consider stones on which the value depends on factors not easily determined with standard equipment — the origin and lack of treatment in corundum are obvious situations. Many valuations are stored away only to embarrassingly appear years later with incorrect data. It is important to state when a positive identification has been made and when you have made an educated guess.

*3: **Rubies.** Country of origin, heat treatment, and the extent and composition of residues/fillers all affect the value of ruby, even if not readily visible. Shown here are an unheated Mogok Burmese ruby, heated Mong Hsu Burmese ruby with residues, lead-glass filled hybrid ruby, heated Madagascar ruby with flux residues, and unheated Mozambique ruby.*



*4: **Yellow stones.** Penetrating up to 7mm from any surface, beryllium diffusion can affect the colour of an entire stone or just a shallow surface layer. Colour of beryllium diffused yellow sapphire is often a deep golden or greenish yellow, but every shade of yellow has been seen, including pastels. Shown are various shades of both untreated and treated stones. Learning which is actually which treatment category may be surprising.*

> Labs continue to evolve and serve as a reflection on the market. Effectively used, they can become an important extension of any business's gemmological department.

For the Retailer
More valuable gems sourced from non-traditional sources, such as buying from the public, can pose a challenge. Jewellery manufacturers are not necessarily gemmologists, so it is important to closely examine coloured gemstone jewellery, especially corundum and quartz. While you may trust the reputation of your supplier, trust should not be extended to all of *their* suppliers.

For Volume Sellers
Vulnerable gems with difficult to detect treatments such as beryllium diffused corundum, fancy coloured diamonds, turquoise, jade and amber are worth focusing on. Sourcing large volumes of consistent-quality, natural gems is challenging. Compare batches and look for anomalies or suspicious consistency.

For Dealers
Look out for any corundum or jade represented as untreated. Spot check these items, randomly sample quartzes — even if you cut from rough. Consider spot checking carefully chosen samples rather than testing every item, thereby spreading the cost over more than one item. Many labs will offer batch testing that provides a summary of overall results rather than a report on individual stones.

WHAT NOT TO SEND TO A LAB

- *Light blue aqua, topaz, synthetic spinel, glass:* with refractometer and Chelsea filter combined, these are readily identified.
- *Synthetic color change sapphire (a.k.a. imitation alexandrite):* aunts and grannies bought tons of these on holiday in the 1960s.
- *Peridot:* peridot naturally resists treatment. Only confirm that it is peridot — an accurate RI along with 10X observation should suffice.
- *Spinel vs garnet:* with spinel prices skyrocketing, it makes sense to know how to separate them from other gems. UV, Chelsea filter, magnets, or spectra — this is an easy one to learn.
- *Lead glass filled ruby or sapphire:* the value is typically less than the cost of testing. Look for large air bubbles, blue flash from inclusions in ruby, surface-reaching glass fillings and unusual colour concentrations in sapphires, along with red CCF reaction from the cobalt. Size alone should alert you. Any recently sold ruby over two carats should be accompanied with a lab report stating the type and possibly the extent of treatment.
- *Check for coatings:* either on the pavilion or all over. Also check for seams indicating assembled stones as new and often creative varieties of doublets and triplets evolve.

STONES ON WHICH TO FOCUS

Amethyst
The sheer volume of synthetic quartz produced each year continues to make quartz of all colours require vigilance. While much talked about, synthetics grown from twinned seed crystals remain rare. Twinning and natural inclusions are strong indicators of natural amethyst, while unusually large or clean stones should be carefully looked at and possibly sent for lab testing.

Ruby
To identify how it is treated, the extent of treatment and possibly origin. Significant changes in price are the result of levels of treatment that are not always

*5: **Sapphires.** Detecting heat treatment in corundum is more difficult in practice than in theory, with many stones exhibiting mixed indicators. As the value gap between heated and unheated stones broadens, lab testing makes sense on stones of significant size and quality.*

eye-visible. Age is not a good indicator to rely on. For example, a classic 1960s style fishtail mounting was submitted with a green 'jade' centre and surrounded by 'rubies'. The jade was C-jade – polymer impregnated and dyed – and the rubies were filled with lead glass. Neither treatment was known during the period the ring was originally constructed.

Blue sapphire

There is little merit in advanced testing of dark blue, magmatic sapphires, even though some may be unheated. An experienced eye can learn to recognise heat halos and dissolved silk, confirming common heat treatment. The presence of silk is not proof of lack of heat treatment, which often is done below the melting point for rutile, but it can be a clue that the stone – depending on size and quality – merits lab testing.

Lack of treatment currently adds a significant value premium, depending on size and quality. If evidence of high heat is observed, the stone could be beryllium diffused. In the case of blue sapphire, this treatment will lighten over-saturated stones. Many of these stones remain under the radar in today's marketplace, but future markets may better account for this.

A fine sapphire of over 10 carats was submitted by a jeweller who had sold it five years previously as a natural Ceylon sapphire, based on the dealer's word. The colour was a vivid violetish blue and all indicators pointed to the origin being Sri Lanka, however advanced testing indicated beryllium diffusion, resulting in a dramatic difference in value. The older method of surface diffusion of blue sapphire has made a quiet comeback in recent years. A surprising number of sapphires submitted in contemporary settings have tested as surface diffused, including stones over five carats and even 6x4mm ovals in a bracelet. While many gemologists may forget to routinely check for this, simple detection by immersion on a white background is still effective.

Yellow to orange sapphire

In today's gem market, the beryllium diffusion of yellow to orangey-red sapphire is to be presumed, unless you have reliable documentation that it is untreated or only heated. Unheated, heated, and diffused stones all have a different value structure.

Paraiba and cuprian tourmaline

A surprising number of those presumed to contain copper do not, even when they have the appearance of cuprian coloration, while others will contain copper without appearing in the expected peacock colors. While there is good reason to argue value should be based on colour rather than unseen chemistry, market forces cannot be ignored. Advanced testing can also confirm if a cuprian tourmaline has been heat treated.

Black opaque gems — beyond the limits of the refractometer

These vary widely from black spinel to synthetic moissanite to a variety of synthetic, natural and treated diamonds. There are a discouraging number of synthetic black moissanites seen with lab reports stating they are natural black diamonds. Whether the labs lacked the correct equipment to detect them, were ignorant of their existence, or merely issued reports without testing is left to speculation.

Diamond testers will miss many of these, but moissanite detectors, which work on electrical conductivity rather than thermal inertia, will accurately identify these in most cases. Carbonado diamonds, a natural polycrystalline black diamond, may falsely test as moissanite.

Any important gem with surface reaching inclusions

Once considered a treatment applied only to emerald, oiling has become part of the finishing process for many gems. Clients may be unpleasantly surprised to find that their otherwise-untreated cuprian tourmaline, alexandrite, ruby or sapphire contains resins. Any gemstone with fine, surface-reaching fissures can be treated this way. Once cleaned, such stones can appear of lower clarity. Semi-permanent clarity enhancement is now routinely done to more gems.

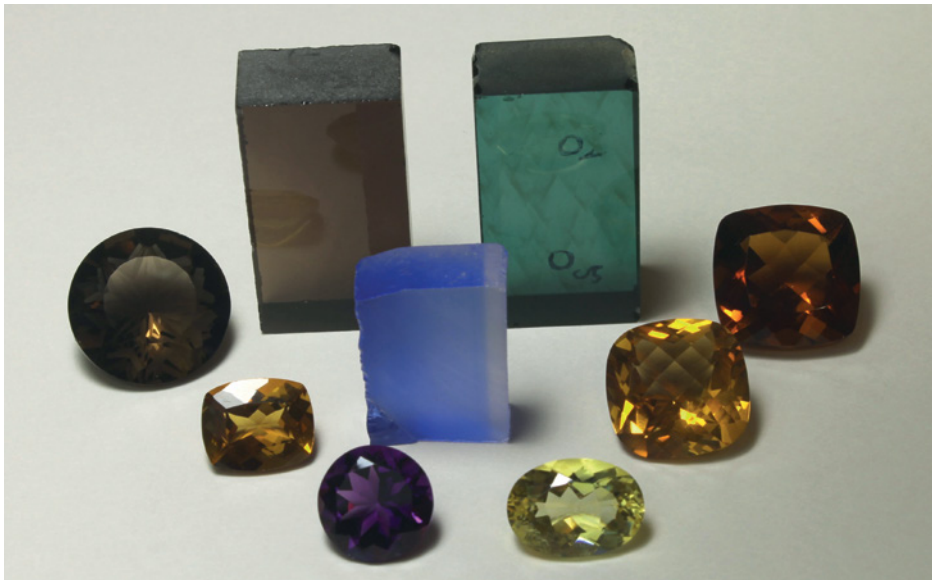
CONCLUSION

Ideally, a lab report should be easily interpreted by the trade and consumers, however if unclear about any wording, ask the lab for clarification. Some lab reports use simple language, while others disclose by omission, requiring professional interpretation.

Labs continue to evolve and serve as a reflection on the market. Effectively used, they can become an important extension of any business's gemmological department. Accurate gemmological information ensures market confidence and protects all players in the market.

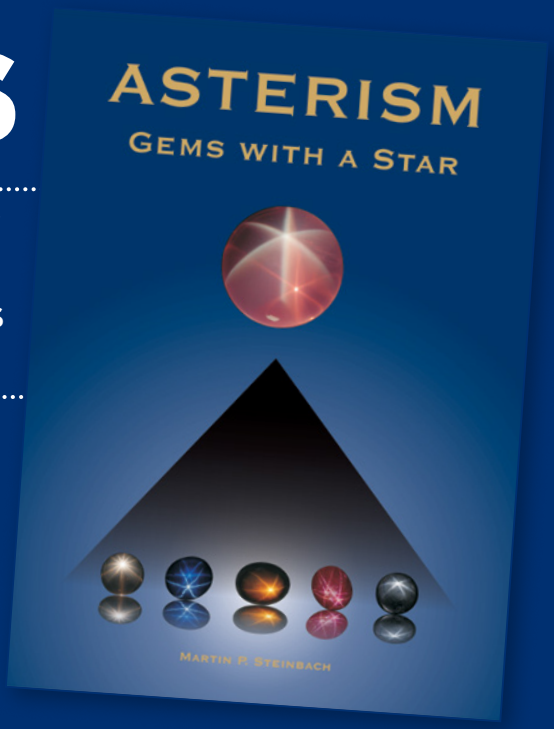
Be prepared for an occasional result of 'undetermined'. Some questions remain unanswerable either due to the limitations of non-destructive testing or because the art of treating stones closely imitates nature in many cases; however the science is always improving. ■

All images by Bear Williams.



*6: **Quartz.** Artificial colours that test as quartz make for an easy ID, but there is no variety nor shade of colour seen in natural quartz that has not been synthesized, including inexpensive smoky quartz and lemon quartz. More batch testing at the dealer and manufacturer level would increase confidence in the market.*

SEEING STARS



Having launched his book *Asterism: Gems with a Star* earlier this year, Martin P. Steinbach FGG AG shares insights from his 900-page tome, including anecdotes as to the origin of his love of stars...

The gleaming firey rays of angel's hair in a star-like shape hovering about the surface of a gem have fascinated people of all cultures and religions for centuries, if not for thousands of years.

In general, relatively little research has been done and published about star gems. Asterism has been described mainly over the last 40 years. Now, I have finally finished and published an ample book with 900 pages on star gems with all the glowing aspects of these awesome gemstones, including hundreds of fascinating photos.

In the beginning, my plan was to write a pure specialist book only about asterism, but it became more; rare gems, many countries, mining areas, exotic temples, street life and art were all integrated.

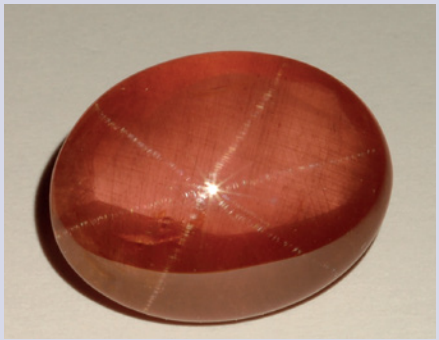
I fell in love with gems in general and star gems in particular back in 1982 when I travelled to Asia, got trapped in Bangkok and took gemmology courses at AIGS (Asian Institute of Gemmological Sciences). After graduation I returned to Idar-Oberstein, Germany, and graduted there as a FGG gemmologist. Over the years, I travelled to more than 40 countries buying, selling and collecting gemstones.

Already by the 1990s, the idea to write a book about the stars of gems was slowly forming in my mind.

WHY STARS?

Many people ask what I find so fascinating about the phenomenon of asterism. Just look at the sky in darkness, the stars always shine bright. If you have a wish, you have to wait for a shooting star. Everybody wants to be a star, or a superstar or a megastar, or needs a guiding star, or is admiring stars. There is so much passion, emotion, mystery and fantasy connected to a star. Being able to hold these attributes in my hand or even wear them as a jewel on my body is an incredible feeling.

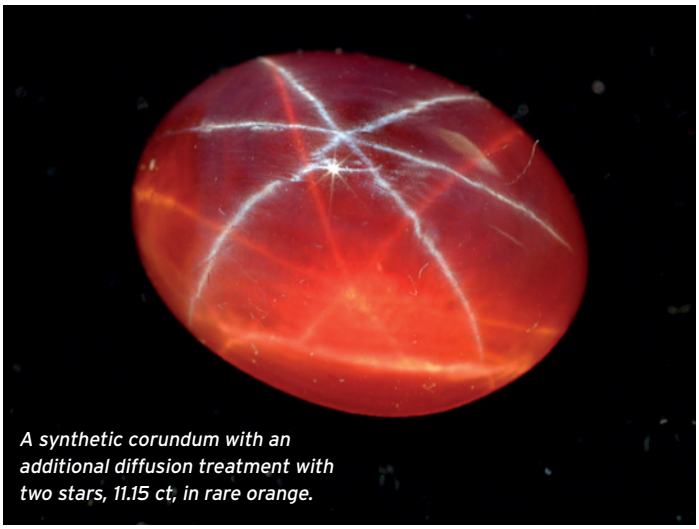
Golden star sapphire, Thailand, 10.02 ct.



Star spessartite, extremely rare, 18.15 ct.

Star rose quartzes in reflection by a mirror-like surface.

I am really proud to have all of these in my book, especially the Star of Ceylon, Star of Asia, Star of Bombay, Rosser Reeves Ruby, DeLong Star Ruby, Star of India, the Midnight Star, Star of Jolie, the Black Star of Queensland...



A synthetic corundum with an additional diffusion treatment with two stars, 11.15 ct, in rare orange.

ASTERISM: GEMS WITH A STAR

The book is divided into nine main chapters and each chapter is accompanied with a comprehensive literature list. In Chapter One, I describe asterism throughout history, referencing the most important historical sources to which the first star gems can be traced, and outlining the names with which they were described – *asteria, asterius, astrion, astrodamas, astriotes* – as well as several other names. Asterism is described and discussed from the ancient world to the mysterious Middle Ages, right up to the present day.

In Chapter Two, attention is turned to famous star stones, including some of the planet's most captivating and spectacular star sapphires and star rubies. I am really proud to have all of these in my book, especially the Star of Ceylon, Star of Asia, Star of Bombay, Rosser Reeves Ruby, DeLong Star Ruby, Star of India, the Midnight Star, Star of Jolie, the Black Star of Queensland and many more. Included in the book are the engravings of huge star sapphires portraying a number of US presidents and celebrities, and the stories behind them.

An ultra-rare star tourmaline, 8.12 cts.

Chapter Three covers the scientific and gemmological aspects of asterism, like the causes of asterism, correct cutting, brief facts about

Continues on next page

What is Epiasterism and Diasterism?

Most commonly, stars are four or six-rayed, but some stones can show up to 24 rays. Epiasterism is an internal reflection effect that is caused by light reflecting off two or more sets of parallel fibrous or channel inclusions. Diasterism is similar to the star-like effect of epiasterism, but is caused by transmitting light through a gem and can be seen in such gemstones as rose quartz.

The Marcial de Gomar Star Emerald. © 2017 by Emeralds International LLC.

The Marcial de Gomar Star Emerald

Carl A. Schütze, research librarian and historical archivist at GIA, discusses the 24.86 carat star emerald, originally purchased in 1997, which today has been examined and recertified as the largest known and possibly first double-sided star emerald specimen.

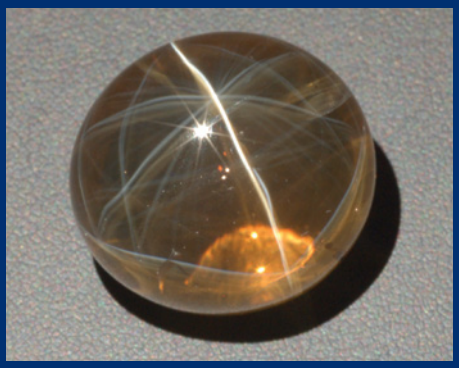
The 25.86ct star emerald was cut from a rough specimen that was part of a small parcel of about 1,000 carats purchased in 1999 from an independent emerald dealer from Africa. About five years later a hand selected specimen was sent in for cutting to Brazilian cutter, Mr. Jone Ribeiro, in Miami, who under instructions cut it into a double sided cabochon. The gem came back and was more than what was expected, with its unusual and mesmerizing play of light. It was not a typical cat's eye and although it was examined many times, was never once thought of being a specimen with asterism, being that it was practically unheard of and even rarer than the cat's eye phenomenon in emerald.

In 2013, independent gemmologist and appraiser, Martin Fuller of Martin Fuller & Associates, came to Key West to inspect a private one of a kind collection that Marcial de Gomar had built up over his 56 year career in the emerald and conch pearl industry, and upon examining this emerald was equally mesmerized with it and urged Marcial to contact Robert Weldon and send the gem into GIA for identification. The gem was identified with asterism and as the largest recorded specimen to date. It was again examined and recertified in 2017 with asterism on both sides and is possibly the first of its kind ending a remarkable journey of 18 years from obscurity to the world stage.

Further information can be found in *Gems & Gemology*, **2015/ Volume 51/ No.3**

The 'Private Dancer' star sapphire, 7.22 ct, Myanmar, with 2 stars.

The only known plastic-covered 'star ruby' called 'Red Devil', 3.38cts.



Star quartz with a network, Brazil, 75.57 cts.

Black star sapphire with two stars, approx 20 cts.

gemstone colour, crystallography, geology, history and occurrences of gemstones. It also defines epiasterism and diasterism and talks about the role of inclusions in various types of gems and how they are formed.

Chapter Four is very valuable for the young gemmologist, including the various treatments found in star gems, the history of treatments and the important concern of diffusion treatment and glass fillings, irradiation, shellac filling, dying and heat treatment. Synthetic star gems are discussed in the following chapter, with various methods used throughout time to produce synthetic gems (Verneuil, Linde, Kyocera etc) described. Later chapters deal with asteriated gems, assembled gems and artificial products, including doublets, triplets and other assembled stones, scratched stars, coatings and how to identify them.

WORLD PREMIERES

Chapter Seven is where we enter the heart of the compendium – 'All Gems with a Star'. It is a huge chapter of 440 pages and covers all gemstones and gemstone groups from A to Z. Some asteriated stones, like apatite, have rarely been written about. For example, asterism in apatite is very rare. I published the four-rayed version in 2009 and in this volume the six-rayed version follows as a world-premiere.

Other world premieres include star amazonite, star prehnite and star spessartite garnet.

Other gem groups, like the corundum group, occupy as many as 123 pages, and in this section, I also dig into the gemmological data, the asterism of star rubies and sapphires, the 17 countries of star rubies and the 24 countries where star sapphires are found, their deposits, different colors, fascinating star formations and variations.

I have always been a corundum man. This is reflected by these corundum chapters, which are much longer than the others. And of course, with its various stars, colors and producing countries, star sapphire is the epitome of all star gems.

The topic of Chapter 8 is 'Dream Stars', with all the fantastic and unbelievable star phenomena you can dream of. Stars with 12 rays, double stars, multiple stars, star networks, stars in transmitted light and all possible varieties of trapiche stars in a large range of gems are revealed.

CREATING A DREAM

Now, in 2017, after more than 30 years of intense research and writing, my dream of a lifetime has finally come true: the realization of the first book worldwide on asterism.

It is my philosophy that my weapon is not the gun, nor the pen, but the penlight. ■

All images © Martin P. Steinbach unless otherwise stated.

Asterism: Gems with a Star
by Martin P. Steinbach FGG AG, RRP £160, available from Gem Instruments.

Star quartz magic — a sphere with two stars.

"More work needs to be done on understanding these resins and their reactions."

Maggie Campbell Pedersen FGA ABIPP shares her insights on treated Baltic amber and the processes of altering the colour of resins.

Some years ago I bought a Baltic amber pendant from a Polish vendor at the fairs in Tucson. I bought it because the amber had been treated in an autoclave in the same way as the younger South American copals, and had been turned green.

When I hunted it out to take along to a recent Gem Central evening on organics, I realised that it was no longer green, but had turned yellow with just a hint of green.

We know that the induced green colour can 'fade' with time. This information was confirmed by the largest producer of 'greened' copal in Hong Kong, though he could not give a time-scale. This, however, is the first time I have seen an example.

Pendant containing Baltic amber which has been treated to turn it green.

The pendant has been stored in a box in a cupboard — in other words, in the dark. My samples of treated Colombian copal, some of which pre-date the pendant, have retained their colour whether they have been kept in the dark or – in the case of a small carving – in the light.

Such findings add to the queries we have about the process of altering the colour of resins by methods other than dyeing or coating. What does it do to the resin, and just how permanent is it?

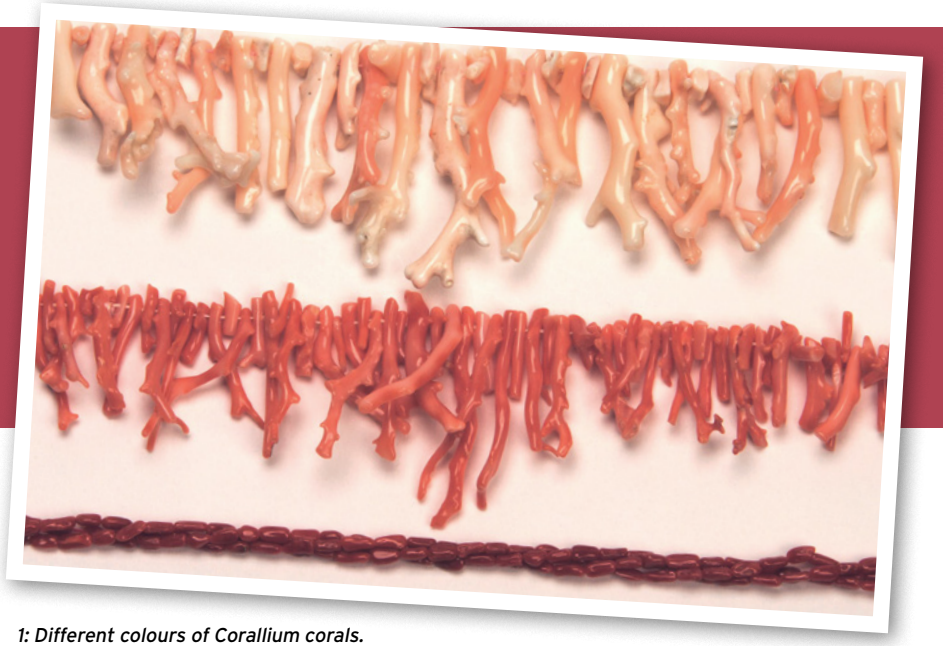
Not all pieces of resin, even if they come from the same source and in the same batch, will turn green during treatment. Some simply darken, whilst others will go green but retain patches of brown in the interior. Evidently, among those that turn green, the colour is not always stable.

The same pendant which has reverted to near its original colour.

More work needs to be done on understanding these resins and their reactions. We should of course already be warning buyers that the 'greened' material's colour is not natural. Should we perhaps also be warning them that it might not be permanent? ■

A Connection to Coral

Coral may not inspire the same emotional outpouring as ivory, but its delicate ecosystem needs to be protected, says Gem-A president Maggie Campbell Pedersen FGA ABIPP.



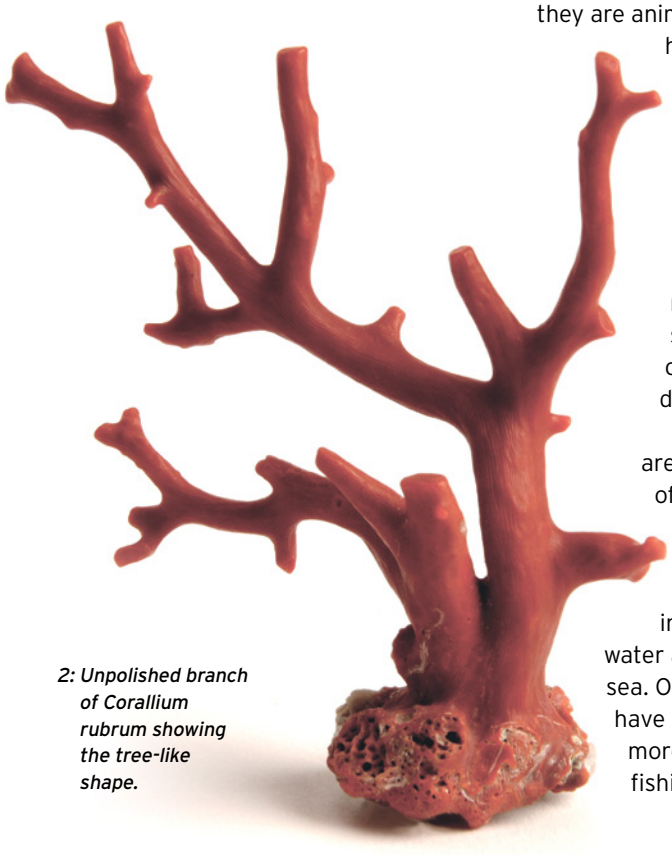
1: Different colours of Corallium corals.

Coral has a long and rich history. Red coral has been found in Neolithic graves and two thousand years ago was much sought-after by the Chinese. The Ancient Greeks preferred black coral, while in some African countries red coral beads signified wealth. Few gem materials have been believed to have such powers as coral, both talismanic and medicinal. For example, it was thought that coral could cure madness, could strengthen babies' teeth, and that it turned pale when worn by someone who was sick. A piece of coral above the door of a house would protect its inhabitants, or its wearer, from being struck by lightning.

Coral use today is more limited and consists of some jewellery and carvings. It does not have the same emotive impact as some other organic gem materials (notably ivory), yet it is understood that corals are vital to marine eco-systems and that they are threatened, and it should perhaps be remembered that they are animals, not plants — albeit tiny, headless ones (called polyps).

The coral used in past times in Europe was predominantly the red *Corallium rubrum* (often termed 'precious coral' by the gem trade), mainly from the Mediterranean. In recent years we have used several different species of coral, originating from many different seas and oceans.

World-wide, coral beds are diminishing. Each species of coral needs different conditions to flourish, but all of them are extremely sensitive to alterations in the temperature of the water and in the acidity of the sea. Our coral fishing methods have been refined and we are far more aware of the risks of over-fishing, but the threats to corals of global warming and pollution remain, and many believe that corals are still being over-fished.



2: Unpolished branch of Corallium rubrum showing the tree-like shape.

Most corals consist of a white core – the 'communal skeleton' – made of calcium carbonate in the form of aragonite or calcite. They are covered by 'flesh' which consists mainly of tiny polyps connected to each other by living tissue. In most corals the tissue also contains algae called zoolxanthellae with which the corals live in a symbiotic relationship. It is the algae that give the living corals their wonderful colours. In only a few of them is the calcium carbonate 'skeleton' coloured (**1**).

Global warming is causing ocean temperatures to rise, which can result in 'coral bleaching' — a phenomenon where large areas of corals reject their vital algae (zooxanthellae) and consequently die off, losing their coloured fleshy covering and leaving just the white skeletons. Corals grow very slowly – some at a rate of a few millimetres per annum – so it takes from 10 to 20 years for a reef to regenerate. As coral bleaching is today happening more often it is becoming less likely that the corals can recover, hence the worry about the Great Barrier Reef off Australia's north-east coast, and also the reefs around Belize.

The phenomenon affects reef corals because they grow in shallow waters,

however, of our gem corals only blue coral is a reef coral, and all other gem corals are either solitary or colonial in habit. They live on the seabed and grow at greater depths where they are less vulnerable to changes in the water temperature. Despite this, they are still sensitive to the raised acidity of the water and rising sea levels caused by global warming, and to all pollutants that find their way into the oceans. A further risk to their survival is physical impact which breaks them, for example caused by fishing nets, or divers. But perhaps their greatest threat has been over-fishing for the gem trade.

Corallium corals grow in colonies, and have a tree-like appearance (**2**). They range from white through shades of pink, salmon, and blood red to deep red. There are several *Corallium* varieties, of which *C. rubrum* is the best known. The Latin names of a number of the others are at present being changed — a frequent occurrence with corals. The colour in *Corallium* corals is in the hard skeleton, as they lack zooxanthellae.

The coral is recognised by the tiny striations along its 'branches', which are still visible after cutting and polishing as they penetrate the entire skeleton. They are about 0.25 - 0.5 mm apart. The material takes a very high, porcelaineous polish (**3**).

3: Detail of Corallium rubrum beads, showing structure and high lustre.

Corallium coral is found in the Mediterranean and around Japan, China, and other areas of the Pacific. Fishing is now being regulated in several of these areas due to extremely depleted coral beds, and the rarity of the material is reflected in its price. It has been suggested that some *Coralliums* should be included in the CITES Appendices (the Convention on International Trade in Endangered Species of Wild Fauna and Flora), but this has not happened as the trade prefers to regulate itself. Methods being used include rotating areas where fishing is permitted, specifying the amount and minimum size of coral taken, the number of licences granted, and the equipment used.

4: Corals for sale at the Tucson fairs in 2008.

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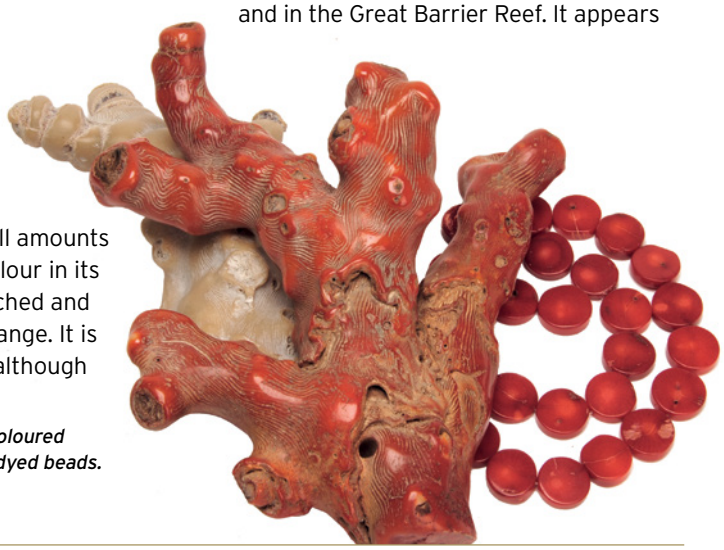
Torre del Greco (on the outskirts of Naples in Italy), has been a famous centre for coral carving for hundreds of years. Today the large companies cannot rely entirely on local coral to meet demand, so make up the shortfall – about 30% – from the Far East. The Mediterranean raw material is generally smaller in size, so larger items are carved from the Far Eastern material.

Several years ago at gem fairs such as those in Tucson, bamboo coral (of the family Isididae), was sold in abundance, but today we see only small amounts for sale (**4**). A beige colour in its natural state, it is bleached and dyed, usually red or orange. It is a heavy material, and although the outer surface displays longitudinal striations similar to *Corallium* corals they are much coarser. Bamboo corals also have a growth habit resembling that of a tree, but they have nodes of organic material called gorgonin between the internodes of calcium carbonate. These characteristics limit the coral's use, and it is most commonly seen sliced into discs and used as beads, or as simple carvings. Occasionally it is seen imitating *Corallium* coral. It has been so popular that the coral beds are now severely depleted (**5**).

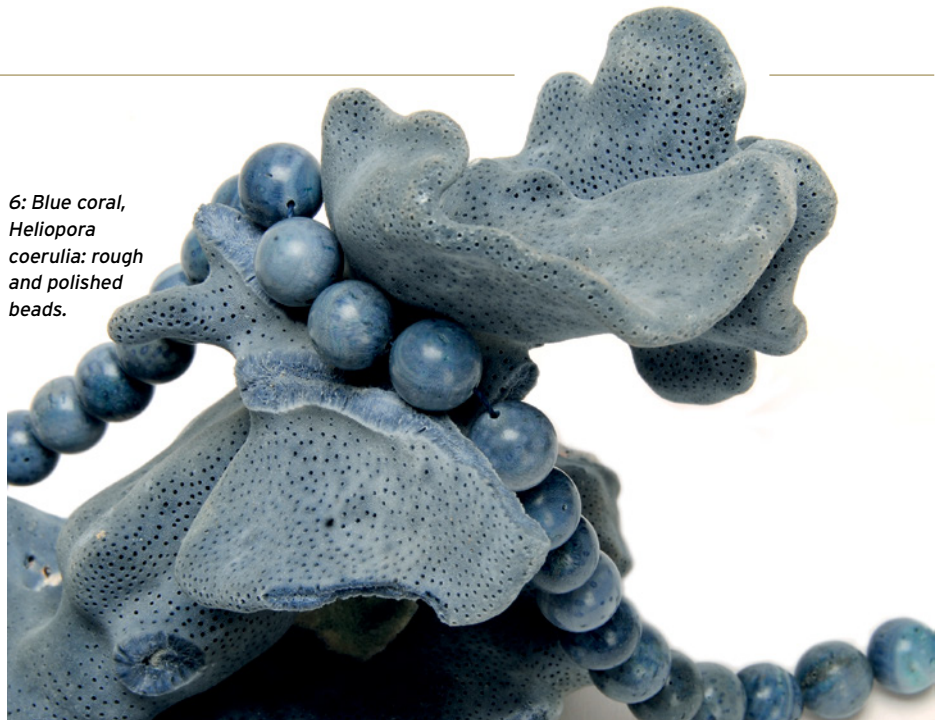
Heliopora coerulia or blue coral is found in many parts of the Indo-Pacific region and in the Great Barrier Reef. It appears



5: Bamboo coral: natural coloured rough, dyed rough, and dyed beads.

on CITES Appendix II, indicating that it is permissible to trade but only under very strict conditions, and licences are required. It is a reef coral with a blue aragonite skeleton – one of only two reef corals with a coloured skeleton – and is massive in form rather than tree-like. It is covered in tiny holes in which the polyps lived (**6**).

Some years back another red coral began to appear on the gem market: *Melithaea ocracea*. It is often called red sponge coral. It belongs to the family of soft corals, which create a less compact skeleton. Though it is still rigid, it is less stable as a gem material and is usually impregnated with a resin to stabilise it



6: Blue coral, Heliopora coerulia: rough and polished beads.

7: Melithaea ocracea: polymer impregnated disc, colour enhanced beads (inner row), and reconstructed (chips in a red polymer, outer row).

and to enable it to be polished to a satin finish. The resin also makes it much more comfortable to wear as it is a very rough material in its untreated state. It is naturally a red colour with veins of red-beige, but a red dye is frequently added to the resin to enhance the colour in the beige veins. It is found in the Indian and Pacific Oceans, and the China Seas (**7**).

Black and golden Antipatharia corals are found around the Philippines and Indonesia. They are also listed on CITES Appendix II. They differ from other corals in that their skeletons are made up of organic matter (closely related to keratin), not of calcium carbonate. Although flexible when growing, the material becomes rigid after fishing (**8**).

Golden corals are rare, but black Antipatharia can be bleached to a golden colour, and is often sold as a natural material. Once popular at gem fairs in the form of loose beads, black or bleached material is still occasionally encountered today, and is generally sold as 'old stock'.

There are other corals not mentioned here that can be used for jewellery or *objets d'art*, and not all are listed by CITES — often because they have not been adequately researched. It is incumbent upon the buyer or seller to check a species' status, which can be problematic as coral is notoriously difficult to identify when it has been cut and polished.

In the EU, licences must be obtained (e.g. from APHA, the Animal and Plant Health Agency in UK), for any corals that are listed by CITES on Appendix II. Each request is considered individually with many criteria taken into account. Other countries have different guidelines, sometimes stricter than ours, for example the beautiful *Kulamanamana haumeaae* golden coral from Hawaii is not listed by CITES, but it protected by US law.

Some coral jewellery is still sold at the high-end of the market, beautiful items are still being produced in coral in the Far East, and there is still a coral industry around the Mediterranean, but generally not nearly as much coral is being worked today as in times past, partly due to fashion, partly to the rarity of the raw material, and partly because there are many people who feel that corals are too endangered and vulnerable and should not be fished.

Attempts have been made at culturing corals, but so far it is a tiny industry, targeted mainly at the aquarist market where small corals are a popular addition to tropical fish tanks. Gem corals grow too slowly to make it a feasible alternative to wild-caught corals.

We do not emotionally equate the use of coral with that of ivory, but corals play a significant role in marine ecosystems and need to be protected, and failure to do so will eventually result in a total ban. Meanwhile the gem trade should ensure that any coral purchased is reliably sourced. ■

All images © Maggie Campbell Pedersen.

8: Black Antipatharian coral, genus Leopathes: rough, and polished beads.

"The magic of the Northern Lights captured in one stone..."

Jenny Söderström FGA, who leads the Gem-A ATC at Kristallen Stenslip in Lannavaara, Sweden, shares her fascination with the Aurora Borealis and its connection to gemstones.

It is dark around me and totally silent. The only sound I can hear is my own footsteps in the cold snow. The sky is full of stars, the air is cold, -32 below zero and crystal clear. Suddenly it is growing, dancing and playing all over the dark sky. The stars do not have a chance against this blue, green and sometimes red light that now covers the sky. I am silently standing still looking at the powerful light show that nature offers us. There is a great magic in the Northern Lights!

The Northern Lights seen in Lannavaara. Photo credit Jan-Åke Fors.

As a teenager, when my family went on summer holiday, my dad always took every opportunity to find stones. I followed, even though I must admit, I was not always enthusiastic at that age. When dad said that we should go to a place where they mined stones, I just thought: 'Okay, we will go to another place similar to all the others we have visited so many times before!' At first glance it was the same, but then I saw a stone that in some spots was sparkling in blue, green and red. I realised that this was amazingly different.

This was the first time I got to know about spectrolite, which actually shows the same colours as the Northern Lights. This particular spectrolite was one I picked up in Ylämaa, Finland. It is an unusual variant of labradorite, belonging to the feldspar family, and shows the effect by reflecting the light from different layers within the stone. I hope that you too will get the chance to experience these incredibly beautiful natural phenomenon; the lights playing off spectrolite and the magical Northern Lights. ■

Spectrolite jewellery designed and produced at Kristallen – Scandinavia's leading educational centre for gemstones, gemmology and jewellery making in Lannavaara. Photo credit Jenny Söderström.

Image by Helen Molesworth.

Ancient sapphires and adventures in Ceylon

Helen Molesworth FGA, managing director of the Gübelin Academy and a professor of the history of jewellery, takes the reader back in time to Seilam, now Sri Lanka.

'From here... we reach the island of Seilam, which is, for its size, one of the finest islands in the world... This island produces many precious gems, amongst which are rubies, sapphires, topazes and amethysts. The King of the island owns a ruby thought to be the most beautiful in the world, as long as the palm of your hand and as thick as three fingers; it shines like the most burning fire and is perfect.'

***Livres des Merveilles du Monde* or *Book of Marvels of the World*, Marco Polo, ca 1300**

At the age of 17, a young merchant from a Venetian family set off with his father and uncle on an unusual expedition: to travel and explore the Far East. Twenty-four years later, in 1295, they returned to Venice, wealthy men, with a valuable hoard of both stones and stories. Immediately caught up in the Italian war to which they had returned, Marco Polo was imprisoned, and before his release, dictated his travels to a fellow inmate for posterity. What is passed down to us is a wonderful medieval European account of parts of Asia and the Middle East, from a unique historical perspective. Although relatively brief, the account of Sri Lanka, here Seilam, is extremely appropriate. It is an excellent early reference not only to the first known source of ruby (and maybe also and/or spinel, which was often confused in early sources) and sapphire at the time, but also to the beauty of the island.

A Roman sapphire cameo, almost certainly from Sri Lanka, depicting Aphrodite feeding an eagle, first century. Image courtesy of the Fitzwilliam Museum, Cambridge.

A Roman gold ring mounted with a sapphire, Sri Lankan, circa third century AD, Babar-Content Collection of Ruby, Sapphire and Spinel. Image courtesy of Medusa-art.com.

Known by the Greeks and Romans as Tabropane, in Persian as Serendib, and to be recognised more recently under British rule as Ceylon, Sri Lanka was often referred to by writers as a utopian land of natural riches and great beauty. The earliest gem reference to the island was, as the origin for the valuable gems given by Middle Eastern King Solomon to the Queen of Sheba in the Old Testament. Centuries later, not far away in ancient Iraq, a wonderful oral tradition of fabulous story-telling developed in the *Thousand and One Nights*, in which we find the fantastic tales of continuous castaway Sinbad the Sailor, whose sixth voyage saw him shipwrecked on the very same island, where rivers flowed with rubies, diamonds, pearls and 'many precious things'. From a western perspective, Sri Lanka's natural resources were already being traded into Europe through India by the time of Alexander the Great in the third century BC, thanks to the development of the Silk Route. By the time of Marco Polo's *Livres des Merveilles du Monde*, this fine island paradise was already clearly recognisable as an 'Island of Gems': the Ratna Dweepa of ancient Sanskrit.

All the more amazing are such early geographically-relevant accounts of sapphire when we realise that many seemingly ancient references to corundum are mistranslations or transliteration errors. Traditionally, European scholars have substituted our word (and European variations of) 'sapphire' for the ancient Latinised Greek or Persian versions of sapphirus, discarding modern day mineralogy in their translation efforts. In the majority of early references, such sapphirus would have been the blue lapis lazuli from the ancient mines of Afghanistan, and at worst case, any blue stone in general. The poor ruby suffers even worse the woes of inaccurate reporting. Often credited by non-historians today with being one of the Old Testament gemstones mounted in the High Priest's breastplate in the book of Exodus

The Imperial Crown of Great Britain, British School, early-mid nineteenth century, showing the Stuart Sapphire below the Black Prince's Ruby before it was removed to the back to make room for the Cullinan II in 1909, and the St Edward's Sapphire, in the cross surmount. Image: Public Domain.

Alluvial gem mining in a river near Ratnapura, Sri Lanka. Image by Helen Molesworth.

The spoils of river mining in Sri Lanka: a collection of water worn sapphire pebbles. Image by Helen Molesworth.

Helen Molesworth trying out traditional faceting and polishing techniques with a bow drill in Sri Lanka. Image by Armil Sammoon

together with other marvelous ancient ruby references, in fact we have little to no archaeological evidence supporting the use of ruby as a gem so far back. Other red gems such as garnet, spinel, maybe; ruby, sadly not.

This highlights the importance of archaeological evidence supporting ancient references, and happily in the case of sapphire, a handful of important sapphires survive from antiquity. Several known Roman jewels exist, perhaps set in a ring with a single 'cabochon' polished pebble, such as the third century example from the Babar-Content Collection; and a few more tend to appear with other multi-coloured gems in later Byzantine jewels. Arguably one of the earliest and most beautiful is the Roman sapphire drilled as a bead and carved in cameo depicting Aphrodite feeding an eagle, a subject of imperial allegory from the first century and now in the Fitzwilliam Museum in Cambridge: an extraordinarily important object, which would have been in the most prestigious of ancient collections.

Traditional heat treatment with blow-pipe and charcoal, Sri Lanka. Image by Helen Molesworth.

By the Middle Ages onwards, naturally more sapphires survive, and unsurprisingly the best are found in royal collections. Two spectacular sapphires sit in the Imperial Crown of Great Britain: the seventeenth century Stuart Sapphire and the eleventh century St Edward's Sapphire, the oldest gem in the Royal Collection. Under Queen Victoria, both astonishing stones took pride of place at the front and atop the Imperial Crown. The huge hundred carat Stuart Sapphire sat central to the circlet, until it was bumped to the back by the Cullinan II in 1909, while the smaller St Edward's sapphire, eponymously and originally belonging to Edward the Confessor, remains in its venerated position, befitting its earliest owner, in the surmounting Maltese Cross. Perhaps the most remarkable early medieval sapphires, however, were those mounted in the early ninth century Carolingian amulet known as the Talisman of Charlemagne. Said to have been sent to the Holy Roman Emperor by the Middle Eastern Abbasid Caliph Haroud Al-Rashid, two sizeable sapphires once sandwiched a hair of the virgin as combined powerful symbols of purity, loyalty, royalty and righteousness. Exemplary too, of our Silk Route road for sapphire travels. These, and all those preceding, were almost undoubtedly examples of Sri Lankan sapphires, as Sri Lanka was, crucially, our only known source of sapphire in the ancient world.

I was fortunate enough to visit this incredible country recently, and to experience production and trade first hand on this 'Island of Gems'. Sapphires are still central, psychologically and financially, with a host of other gems, including garnet, moonstone, quartzes and spinel featuring frequently in local mining and manufacturing. I experienced main mining techniques directly, plus post production, in the regions surrounding Ratnapura, our traditional 'City of Gems', and from a historical perspective, it was remarkable to see hundreds, if not thousands, of years' practices continuing today as if through unbroken tradition. River panning for alluvial deposits continues almost unchanged, a millennial old mining practice which sorts surface-reachable deposits with relative ease. I descended shaft mines, also after secondary placers and another age old mining technique, which would have developed naturally after easier alluvial river beds would have been worked out. Watching the traditional blow-pipe heat-treatment of ruby buried amongst coke and coconut shell in a back yard reminded me of two medieval Arabic accounts — of Middle Eastern polymaths Al-Biruni and Teifashi — of burying Sri Lankan rubies within or under bonfires to improve their colour. Even some of the local cutting and polishing practices, with original hand-held bow drills, followed almost the exact same mechanism as a gem-carving drill depicted on one Mediterranean Roman gem-engraver's tomb from the first century AD.

Yet Sri Lanka has balanced tradition with continual development. While quality of production and some traditional techniques have remained consistent for thousands of years, cutting-edge technologies have been developed and international trade drawn in from all over the world. At the same time as remaining a player on the world stage of gem production, Sri Lanka has successfully held off the loom of large scale mining giants ready to reap the riches of this tiny island below the surface, a forward-thinking decision in favour of local sustainable practices to give the country and its people a long term future. This compact but competent land, long considered a natural utopia to travelers and traders, and once more coming into its own in terms of tourism, has consistently remained a true Island of Gems, a centre for sapphires, and indeed one of the 'finest islands in the world'. ■

Sapphire crystals from Sri Lanka. Image by Helen Molesworth.

Watching the traditional blow-pipe heat-treatment of ruby buried amongst coke and coconut shell in a back yard reminded me of two medieval Arabic accounts... of burying Sri Lankan rubies within or under bonfires to improve their colour.

Traditional techniques in panning, shaft mining, and their discoveries, near Pelmadulla, Sri Lanka. Image by Helen Molesworth.

THINK PINK: EXPLORING THE PINK IN DIAMOND

Diamond diploma graduate Anna Casdagli DGA shares her 2016 project exploring the fascinating world of pink diamonds.

8: The 12.76ct rough Argyle Pink Jubilee, one of the largest ever found in the mine. Image courtesy of Rio Tinto 2017.

It is said that the ideal gem must possess a combination of beauty, durability, rarity, desirability and value. If this is the case, then pink diamond, one of the rarest, most desired and valuable types of diamond must surely be the winner of the title of the perfect gem.

Pink diamonds are rare in terms of availability and, more interestingly, in the manner in which colour is distributed throughout the stone. The characteristic lamellae or graining, not seen to the same extent in other coloured diamonds, poses intriguing questions for research, enhancing its mystery.

Pink diamonds are currently achieving staggering prices at auction and as the world's supply of pinks dwindles, both demand and price will only get higher. This is prompting researchers to look closer at why pink diamonds appear pink. Motivating factors are threefold; first because in the near future, as new pinks are no longer being found it may become too expensive a material to study, secondly because if the cause of the pink colouration is understood, synthetic diamond production stands a better chance of accurately imitating the real thing and thirdly, science hates unanswered questions. Although progress is being made, the exact cause of the pink colouration remains elusive.

This report will look at the current popularity of pink diamonds, the term 'pink' covering natural pink diamonds of all types (Ia, IaA/B and IIa) and of all saturation and tone, e.g. reddish-pink, orangey-pink and includes pinks with modifiers such as brown and purple), their origin and locality and explore current suggestions as to how the pink colour occurs.

CAUSATION

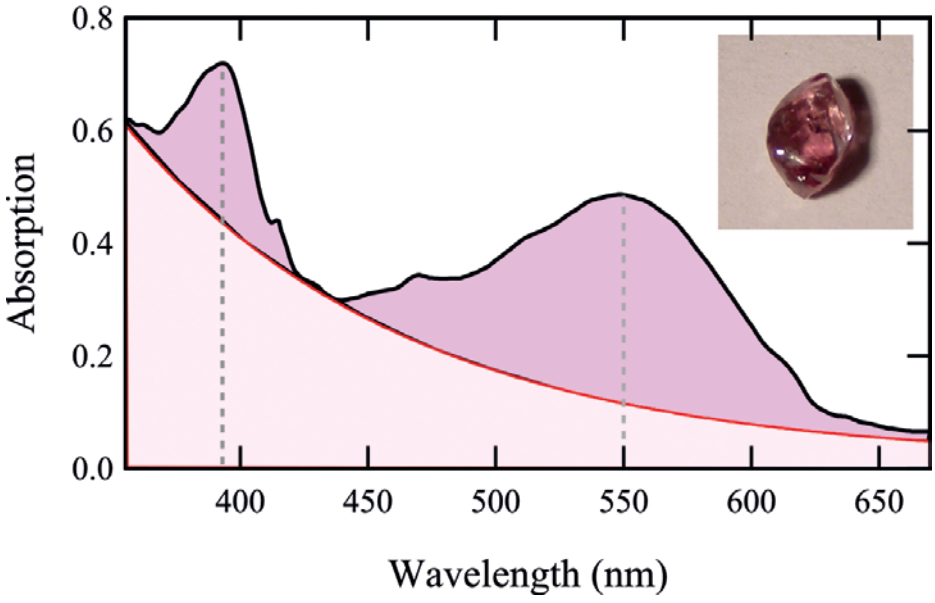
Diamond is essentially pure carbon. Each carbon atom bonds covalently to its four nearest neighbours in tetrahedral formation, resulting in a crystalline lattice that possesses extreme hardness and also unique optical properties.

> ...pink diamond, one of the rarest, most desired and valuable types of diamond must surely be the winner of the title of the perfect gem.

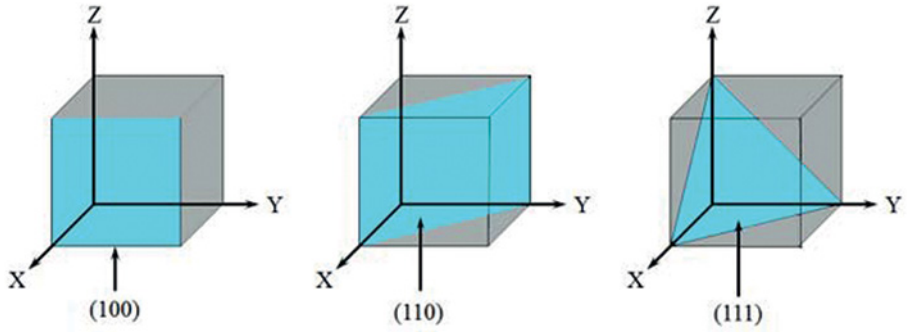
If defects are introduced into the diamond in the form of impurities, structural faults or vacancies (missing carbon atoms), the lattice is disturbed and no longer transmits light in the same way.

With enough of these 'defect centres', the diamond may take on different properties, such as absorbing light to the point of visible colour difference. This is why they are also sometimes called 'colour centres' and different defects produce different colours — enough nitrogen in a diamond will make it appear yellow, enough boron will cause it to appear blue, for example.

It is well known that the majority of pink diamonds absorb certain wavelengths of green and blue light, contributing to our perception of their pink colour. Spectrometer readings show a wide absorption band at 550nm in both Type Ia, IaA/B and type II pink diamonds (Byrne, 2013). The band was first identified in 1958 by Raal, and at the time falsely attributed to manganese impurities, as no chemical impurities have since been conclusively linked to pink diamond. Another strong peak at 390nm is commonly found in pink diamonds, and interestingly the stronger this peak is, the more red a diamond is, suggesting that whatever defect causes the peak is strongly implicated in colour causation (**1**).



1: The 550nm and 390nm optical absorption band in an Argyle pink diamond. Image copyright Keal Byrne. Image courtesy of Rio Tinto.



2: Three lattice planes in a cubic crystal lattice; the {100} plane, {110} plane and the {111} plane. There are 4 possible {111} planes. There are four possible {1,1,1} planes, corresponding to the four octahedral faces on a diamond crystal. Image courtesy of Crystal Scientific UK Ltd.

DEFORMATION

Although the colour centre or centres that cause these pink absorption bands in diamonds haven't been identified yet, the origin or catalyst of at least one is thought to be the significant lattice defects cause by some form of plastic deformation.

Diamond is a face-centred cubic crystal material and has axes running through it, identified as a, b and c. If a plane runs parallel to an axis it is labelled 0, if it intersects an axes it is given a number 1. The octahedral faces of a diamond crystal intersect all three axes and because they intersect rather than lie parallel to the axes, the planes on which they intersect are known as {1,1,1} planes. (**2**).

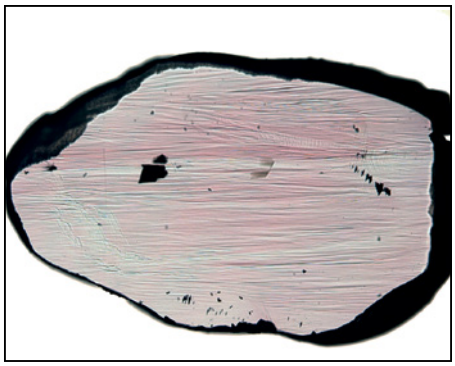
The {1,1,1} planes within a diamond are also the cleavage, 'slip' or 'shear' planes where atomic bonding is weakest. In pink diamond, (and also brown) the lattice defects in the stone are most likely the result of directional pressure upon a crystal, causing the dislocation or shearing of atoms along the weaker bonding of the {1,1,1} planes. The pressure is probably very gradual, meaning the stone is effectively squashed out of shape rather that fractured, cleaved or broken.

Although diamond has four possible directions in which this 'shearing' can occur, it only usually happens in one direction in any one stone. This effect can be seen in natural pink diamond, where the colouration is found concentrated in microscopic coloured bands alternating with uncoloured crystal. These pink stripes, known as grain lines or lamellae, are the result of damage to the lattice structure caused by the squashing effects of plastic deformation and always run parallel to the {1,1,1} plane. The stronger the graining, the more intense the colour of the diamond (King et. al. 2002). Viewing a thin slice of pink diamond under cross-polars shows stress caused by disruption of the lattice within the crystal, represented by anomalous extinction or strain pattern. This follows the main directions of the pink colour, further indicating that the lattice defect and colour are linked (**3**&**4**).

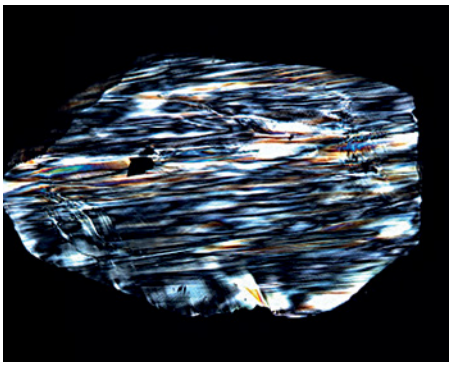
The nature of this unique graining in pink diamond is crucial to the discovery of why these diamonds are pink and how the colour centre formed.

Eloise Gaillou (2010 and 2012), identified two distinct groups of pink diamond based on their graining. While both groups show the Ð550 nm broad absorption band that is responsible for the pink colour and in both the two groups of pink diamond the colour is confined to parallel lamellae that give the diamonds a banded appearance, the two groups differ in lamellae concentration, pattern and distribution within the stone.

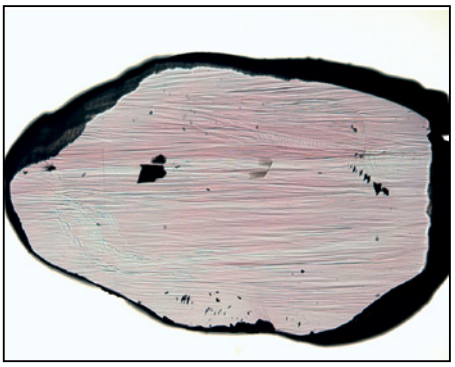
The differences in lamellae concentration and distribution between



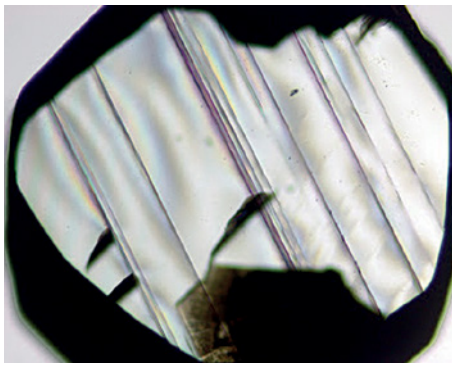
3: A slice of pink diamond polished perpendicular to the pink graining viewed under magnification. Image courtesy of Smithsonian Institution. Photo by E. Gaillou.



4: The same slice of pink diamond viewed through cross-polars, showing the stress pattern following the graining direction. Image courtesy of Smithsonian Institution. Photo by E. Gaillou.



5: A slice of pink diamond from Brazil clearly shows pink lamella but that they are thin and significantly more disparate. Image courtesy of Smithsonian Institution. Photo by E. Gaillou.



6: A slice of diamond from Argyle mines in Australia shows a wavy, more concentrated banding and strong colouration. Image courtesy of Smithsonian Institution. Photo: E. Gaillou.

the groups can be clearly seen when a slice of pink diamond each group is viewed under magnification. Using high spatial resolution spectroscopic methods and transmission electron microscopy Gaillou also identified that a pink lamella consists of a cluster of paired micro-twins created under stress by plastic deformation. This makes sense as the {1,1,1} slip plane is also the twin plane in diamond. To quote Gaillou: "A lamella will form, defined by the initial pair of twin planes, and then expand as more are created on either side of the original twins, as for example the six twin pairs within a given lamellar cluster. If the resistance to additional twinning within a given lamella becomes greater than in another region in the crystal, then the twinning process will jump to this new site, and the cycle will continue. The crystal will, therefore, contain multiple parallel twin zones, i.e. lamellae, like those observed in the pink diamonds." (**5**&**6**)

In 2015 Daniel Howell further expanded on this research by discovering that twinning can only be found in the Group 2 pink diamonds. While this finding could imply that twinning has nothing to do with the pink colouration, Howell suggests that it is possible that micro-twins did once exist in Group 1 diamond and were somehow removed, perhaps in the extreme conditions of mantle or journey out of it; i.e. some form of 'de-twinning' has occurred in Group 1 pink diamonds (Howell, 2015).

Increasingly, it appears that that the different features of the two pink diamond groups might correlate to the particular geological conditions under which the diamonds formed. Gaillou found that the two groups are not only distinguished by graining pattern but also by geographical location — Group 1 stones come from the Argyle mines in Australia, Santa Elena in Venezuela (and possibly a third as yet unknown primary source in Africa). Interestingly, these deposits are located within younger Proterozoic cratons. Most other pink diamonds, forming Group 2, originate from older Archean cratons, (Gaillou, 2012). Geological conditions in the earth where diamond crystallisation takes place, and also how long the diamonds resided in those conditions, might be important in the formation of pink colour centres, rather than just plastic deformation itself.

Plastic deformation is traditionally understood to occur when a diamond is carried out of the mantle in molten kimberlite or lamproite host rock. Current evidence suggests that while this may be the case for brown diamonds, it is not for pinks. Deformation can be generated during a diamond's residence in the Earth's mantle, somewhere between 150km and 800km deep, where crystals are less stable due to extreme high pressure and where temperatures are estimated at 1,150C. Argyle diamonds have been found to be an anomaly; temperatures in the area of the mantle where diamond for have been estimated to be 100C higher than other diamond forming areas, (Gem-A Diamond Diploma course notes, p8-9). This variance could be relevant to the development of more pink colour found in diamonds in that specific location and could show more conclusively that, along with geographical location and related craton age, conditions in the mantle may be more important to the formation of pink colouration, than the ascent out of it.

It was recently realised that high pressure, high temperature (HPHT) treatment can remove the brown colouration, creating a stone of higher worth. This process has inadvertently thrown light on the nature of pink diamonds because removing the brown hue from stones has occasionally revealed a 'hidden pink colour' (Gaillou, 2010). The fact that brown colouration can be removed from a stone during HPHT treatment, suggests that the defect that caused it couldn't have survived in the extreme high temperature, high pressure conditions (mimicked by HPHT) of the Earth's mantle. The pink colour centres however, are stable enough to withstand the harsh conditions of the upper mantle (Gaillou, 2010).

Further evidence that the pink colouration occurs in the earth's crust rather than a stones journey out is that following extraction from the host rock, some pink diamonds still retain their octahedral form and surface characteristics, knows as trigons (triangular etch pits). On these particular pink stones, the trigons have been found to lie along direction of the pink lamellae. This strongly indicates that the pink lamellae and therefore whatever causes the pink colour within them, occurred before they moved up though the earth crust, carried by magma, where dissolution happens, typically removing trigons, among other surface features (Gaillou, 2010).

7: The top stone in this is a replica of the Great Table. It is believed that it measured 56.3 x 29.5 x 12.15mm. Below the Great Table are replicas of the stones that are believed to have been cut from it. On the left is the Noor-ul-Ain (60 carats oval shaped). On the right is the previously mentioned Darya-i Noor (182 carats rectangular shaped/table cut. ©Scott Sucher, museumdiamonds.com

9: A selection of Argyle pink diamonds from the 2007 tender, showing a range of colour depth. ©GIA, Photo by R. Weldon.

The Unique Pink, 15.38 ct, sold at Sotheby's Geneva in May 2016 for $31.56 million (approx. £21.9 m).

Additionally, some stones show both pink and brown colourations at once, indicating that they were subject to two different types of plastic deformation pressures, one inside the mantle and one on the way out, one causing pink and another, brown.

Future research into the specific defect responsible for generating pink in diamonds will clearly need to take geology and geography into account.

SUPPLY

Whatever causes their colour, the world's supply of natural fancy pink diamonds is tiny and nearing exhaustion. Throughout history small numbers of pink diamonds have been found in several localities across the globe. The earliest known source was India. Jean Baptiste Tavernier, famous diamond merchant of the 17th century documents being shown a 200 carat rough 'rose' diamond by the moguls of Golconda in 1642. Named by Tavernier 'The Great Table', this stone is still the largest pink diamond known to date and is believed to have been cleaved to become the famous Darya-i-Noor and sister stone the Noor-ul-Ain, the inspiration behind the 1963 film *The Pink Panther* (**7**).

Late in the 19th century South Africa became an important source of pink diamond, producing both the Mouawad Pink and Lilac and the Steinmetz Pink, among others. The 1940s saw a small number of pinks found in Tanzania, including what is considered to be one of the finest pinks ever know, the Williamson Pink, currently part of the British Crown Jewels.

Occasional pinks have been discovered at other localities including Canada, Brazil, Venezuela, Russia and Siberia but currently the most important source is the Argyle mine, owned by the Rio Tinto group.

Located at the northern most tip of Western Australia, hundreds of kilometres from the nearest town, the Argyle Diamond mine became fully operational in 1985, several years after geologists discovered a diamond bearing primary deposit in the form of an olivine lamproite pipe (Kubel. S). It was the first successful mine not located on a traditional Kimberlite pipe.

During its peak years the Argyle mine produced 34 million carats annually, equal to 40% of world diamond production. This high output has not been sustained, dropping to 10 million in recent years, as supplies dwindle (Howell et al. 2015). In an effort to prolong the life of the mine, it was converted from open pit to underground block caving. The work was officially completed in 2015, but has only extended the life of the mine to 2018, maybe 2020,

Although output is high, the overall quality of diamonds mined from Argyle doesn't match it. A large percentage of typical run of mine is non-gem quality rough. Highly deformed and included brown diamonds account for the majority of the gem quality Argyle diamonds. Argyle stones tend to be small, fewer than 10% weighing more than 0.20ct (King et al, 2002) (**8**) — see main picture on previous spread.

Argyle's output of gem-quality pink diamonds is comparatively minute, equating to only one in every 2000 gem quality stones, less than one-tenth of 1% of Argyle's annual production. So although Argyle boosts the world's annual supply of pinks by 90%, it only equates to 0.0001% (by carat weight) of the annual total global diamond production, which goes to show how very rare they are.

Rare and small as they are, Argyle pink diamonds do show much more vivid array of colouration than pink diamonds from most other mines, to the extent the GIA has been able to develop a much more extensive, 30+ category pink grading process using Argyle pinks, (King et al, 2014) with fancy vivid pink being the most desired and expensive (**9**).

CONCLUSION

In conclusion, pink diamonds are rare and about to get even rarer. They are already one of the most expensive gemstones on the planet and one of the least understood.

While more is known about pink colouration in diamonds than ever before, exactly what causes it is still a mystery. It is hypothesised that the pink colour is caused by plastic deformation, which creates a defect in the crystal lattice, occurring in grain lines or lamellae, along the {1,1,1} plane, also the plane of weakest bonding in the crystal, but why plastic deformation causes a stone to appear pink is an enigma. Furthermore, not all diamonds that have been subject to plastic deformation are pink. Graining can be seen in both colourless and brown diamonds, so the source of the pink colour cannot solely be the graining itself, but the exact nature of it which is as yet, unknown.

Pink colouration can't be readily annealed out of a stone, unlike brown, which suggests that the origins of pink are in the high temperatures and pressures of the upper mantle of the earth. This may go some way towards explaining the rarity of pink diamonds compared to brown — conditions in the mantle necessary to cause pink deformation may be very rare or may occur so deep that most pinks don't make it to the surface. If the conditions needed to generate pink colour existed on the ascent to the surface of the earth, surely we would expect more pinks. ■

An unabridged version of this project, plus additional sources and a full bibliography are available upon request.

Sweet Josephine, sold for $28,523,925 in 2015, bought for and named after a seven year old. ©Christies.

THE GEM-A CONFERENCE 2017: BRINGING TOGETHER THE GREATEST MINDS IN GEMMOLOGY

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SOME OF OUR KEY SPEAKERS:

SATURDAY

ADONIS POUROULIS, Chairman of Petra Diamonds
What makes diamonds so special? This presentation will look at the exploration of diamonds, from their inner beauty to a sustainable future.

JOHN BENJAMIN, Skulls, Steel and Sentiment: A Short Tour of Jewellery Design in the Eighteenth Century
Highlighting many of the notable gems in fashion during this fascinating and fast-changing period of jewellery history.

EVAN CAPLAN, The Magic of Alexandrite
Dive into the magical world of alexandrite a unique, beautiful and extremely rare gemstone. Learn about its history, sources old and new and of course its very famous colour-change effect.

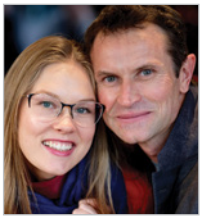
REENA AHLUWALIA, Diamond Storytelling Through Art & Design
Reena Ahluwalia threads stories and weaves them in her body of work. Reena will share her creative journey with examples of her work which is steeped in symbolism, meaning and metaphors.

SUNDAY

PATRICK DREHER, Generations of Mastery
Master carver, Patrick Dreher, known for the Dreher families incredible animal carvings, will take us on a journey into the history of the Dreher family and their connection to Idar-Oberstein.

DR JOHN RAKOVAN, Gem Crystal Formation: An Introduction to Crystal Growth
Dr. John Rakovan will explore the various factors that influence how crystals grow into the beautiful objects that they are.

DR ULRIKA D'HAENENS-JOHANSSON, Developments in Laboratory-Grown Gem Diamonds and their Identification
Senior Research Scientist at the Gemological Institute of America (GIA), Dr. Ulrika D'Haenens-Johansson examines advances in diamond synthesis and the resulting products available in the gem market.



VLADYSLAV AND SAMANTA YAVORSKYY, Looking Beyond Commerce and Science to the Magic of Natural Stones
In a talk seasoned with vivid photography and previously unseen mining videos, Yavorskyy and his wife and fellow explorer, Samanta will take us on an interactive journey revealing the life and passion of a celebrated gemstone lover. ■

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Workshops – Monday
- Richard Drucker, Coloured Stone Grading and Pricing Workshop
- Dominic Mok, Contemporary Jadeite Testing and Grading
- Sarah Steele, Separating Black Stones

Trips – Tuesday
- Natural History Museum
- Crown Jewels, Tower of London

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Portrait of a Diamond

Painter Angie Crabtree has built a reputation as one of the most sought-after diamond artists, literally recreating every sparkling facet in incredible detail. Here, she shares her passion for painting gemstones (and the occasional watch movement) with *Gems&Jewellery*...

With the job title 'Diamond Portrait Artist', Angie Crabtree has turned the facets of diamonds and gemstones into a thriving career. Her up-close-and-personal diamond paintings are flying off their easels, while Angie herself is in hot-demand for in-person event appearances and brand collaborations. Here, *Gems&Jewellery* gets to the bottom of her fascinating career in the world of fine jewellery and precious gems...

What is your background and how did you begin painting diamonds?

My background is in art. I have been painting since I was four years old. I went to an arts high school and graduated from the San Francisco Art Institute in 2009. I also attended the School of the Art Institute of Chicago and the Rietveld Academie in Amsterdam.

I painted my first diamond – at 1.5m tall – in 2013 for a luxury-themed gallery exhibition in San Francisco. Having known very little about diamonds at the time, I began researching and found out that diamonds come in different cuts. This is where my continuous series of diamonds began!

What is it about diamonds that has held your attention for so long?

Painting diamond portraits is meditative. I love learning about each one, and I love the abstract patterns and geometry. It's hypnotising! The symmetry, rainbow accents and reflections are so alluring. Every diamond is unique and presents a new challenge.

> ...it became more about getting lost in the abstract patterns, facets, reflections and colours...

How do people react to your work and how has this led to collaborations and commissions?

When I do live painting at special events, it is a great conversation starter. A handful of companies have commissioned me to paint their special stones, and invited me to paint at their event. Having a stone painted is a great way to show people the details in an up-close and personal way.

Where do you see your paintings progressing — will you be moving into coloured gemstones?

Absolutely yes! I recently started a series of fancy coloured diamonds behind-the-scenes, which I will be releasing sometime in the next year. Eventually, I will work my way to other gemstones and I really can not wait. Recently I started painting close-ups of very detailed and unique timepieces. They are a new challenge, so I am excited to do more.

What can you tell us about the process of painting a diamond? Do you think people presume it is easier than it appears?

There is a lot that goes into the process that people can not see just from looking at my Instagram account. Choosing the diamond, having it photographed, drawing the diamond, building the canvas, prepping the canvas, mixing the paint, base coats, layering, glazing, and weeks of drying time between coats. Even the photography is a big step: capturing the essence of my paintings – the exact colours and details – is no easy task.

The average piece takes over 100 hours — large paintings take hundreds of hours. I imagined I would only get faster at painting diamonds, but they actually take longer than when I first started because the level of detail has gone up tremendously. The more diamonds I see and paint, the more I learn about how to portray the facets with more brilliance.

Why do you think people are so enamoured with your diamond portraits?

I think people are initially interested in my work because diamonds are luxurious, but when they see them as painted works of art they become mesmerised in a new way. At least that is what drew me into the idea of painting them. Originally, I was interested in exploring ideas of luxury through art, but after researching diamonds and gemmology, the whole series went in a new direction: it became more about getting lost in the abstract patterns, facets, reflections and colours — similar to how I feel when I look into a kaleidoscope.

Are there any particular pieces you are most proud of?

My favourite piece is the painting I did of my engagement ring diamond. It is of an elongated emerald-cut that I picked out from my friends at Perpetuum Jewels in San Francisco. When I was searching for the perfect diamond, I knew it would eventually become a painting, so that is why I chose this one: I wanted to have a panoramic piece to hang in our home. It is the only piece I will never sell. I recently began selling phone cases printed with the diamond because, why not?! It is the perfect proportions!

What would be your advice to amateur artists who want to give painting diamonds and gemstones a try?

My advice would be to focus on not just the symmetry of the design, but also balancing of the colours and contrast. Mix all your colours from scratch so that they are in their purest form. Quality materials are important too. ■

All images courtesy of Angie Crabtree.

What's the buzz in America?

With synthetic diamonds featuring in the industry spotlight, the JCK show once again provided the gemmological insights for the upcoming year says Eric Fritz, FGA DGA, manager of North America for Gem-A.

Several members of the Gem-A team attended the JCK show in Las Vegas, Nevada in June. The JCK show is second only to Basel in attendance and exhibitors. 25,000 attendees had the opportunity to visit over 2,500 exhibitors from all over the world. This year was unique as a certain buzz surrounded the show... synthetic diamonds.

I think we are all aware synthetic stones are here to stay and date back at least 100 years with simulants going back centuries. Why would diamonds be any different? Maybe they hit the pocketbook harder for merchants and good information is still lacking, or at least was. Several seminars at JCK focused on synthetic diamonds. GIA always does a good job with what the lab is doing to detect and prevent the misidentification of diamonds in their reports. Did you know they are growing CVD diamonds to help understand how they can be readily detected?

The JCK hosted breakfast keynote was by the Diamond Producers Association, discussing its 'Real is Rare. Real is a Diamond' marketing strategy. So one must ask, is a synthetic diamond real? Can we touch it, see it, and know it exists? Of course we can. But is it rare.... and will it remain rare? The ad campaigns are good and directed, not to those over 40, but to those in their twenties to mid-thirties. It is clear the potential diamond consumer wants an experience that can be woven into a story.

A tour through the show floor kept the theme alive — synthetic diamonds versus natural. Past years have had a few synthetic-only diamond companies spread about, almost as if they snuck into the show. This year, around 30 were all congregated together, heads held high. We enjoyed talking with them and found four of the five USA producers present. Other companies were resellers and not the actual producers. Many coloured, as well as nice, clean D-colour stones in sizes from melee to 10+ carats, were displayed.

Finally a stroll through the Technology Pavilion sealed the deal. Detectors of synthetic diamonds were abundant priced from $400 to the sky is the limit. One booth selling not-so-reliable detectors quit talking to us when we started asking about natural IIa and the overall accuracy. Can anyone afford to misidentify and toss a natural diamond, thinking it was synthetic or vice versa? Other advanced detectors utilised photoluminescence and potentially could do a good job, but only with a careful understanding of the science behind the equipment.

GIA unveiled their new testing device. We attended the presentation and it is impressive, particularly for a retailer. It will test mounted and loose stones. It was developed for diamonds but future software updates are in the works for identification of colored stones. As with many spectrometers, separation of natural and synthetic colored stones may not be possible. The detector basically passes a stone or says to refer to the lab for further testing.

JCK is a phenomenal show, I highly recommend to all readers. I hope to see you there in 2018. ■

A workshop in progress at last year's IRV Loughborough Conference, hosted by Tammy Cohen and Tatiana Conte.

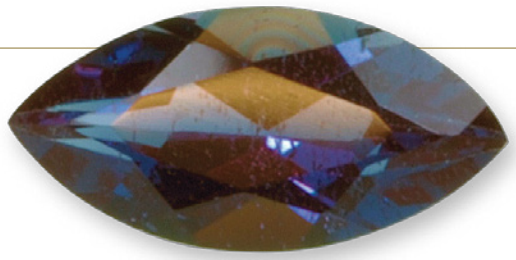
NAJ to celebrate 29th edition of IRV Loughborough Conference 2017

Organised by the Institute of Registered Valuers (IRV), a division of the National Association of Jewellers (NAJ), this fantastic event welcomes all sectors of the trade to experience a plethora of international speakers as well as a choice of 29 workshop sessions.

Due to be held at the University of Technology in Loughborough, this two-and-a-half day conference will offer attendees, ranging from retailers to gemmologists, an opportunity to enrich their knowledge through a sponsored programme of talks, presentations and on-site classes complete with inclusive meals and accommodation.

Gem-A is once again delighted to sponsor this premier event taking place on September 16-18, 2017, where we will be leading an extensive range of practical workshops and will be available to discuss gemmological education. An exhibit of our highly-sought range of instruments as well as our popular publications will also be presented throughout the conference; the perfect introductory guidance for any working professional valuer.

IRV chairman, Frank Wood, comments: "The 'Welcome to Valuing' sessions are a must for those interested in introducing valuation services into their business. The gemstone market will showcase a wide variety of qualities and price points. It's a second to none experience from which you will return to 'normal' life invigorated, full of important knowledge and probably tired as it is an intense learning experience with a social side to match!" ■



Left and below right: chrysoberyl alexandrite synthetic flux
All images by Lily Faber and Gem-A.

THE COLOUR-CHANGE EFFECT IN ALEXANDRITE

Gem-A gemmology tutor Lily Faber FGA delves into the properties of alexandrite and explores the factors that shape its value, rarity and beauty.

There are few optical effects as magical as colour-change, in which a gem appears to be two different colours when the type of lighting changes. This is a rare effect and is not to be confused with pleochroism, in which you can see two to three different colours when viewing a stone in different directions or with a dichroscope.

What is Colour-Change?

Also known as the 'alexandrite effect', colour-change is most closely associated with alexandrite, in the chrysoberyl family. Discovered in the Ural Mountains in Russia in 1830, alexandrite displays one of the most dramatic colour changes. The phrase, 'emerald by day, ruby by night' is apt, with ideal colours being a rich bluish-green and a deep raspberry red.

Why does Colour-Change Occur?

Colour-change can only be seen when using two different light sources: daylight and incandescent light. These types of lighting display varying spreads of wavelengths, or colours, causing your eye to see two different body colours in a gem. Daylight has a more even spread of wavelengths while incandescent light has a higher concentration of wavelengths in the red/orange/yellow end of the spectrum. Alexandrite is coloured by chromium which causes its absorption to be balanced between green and red light. Your eye is more sensitive to green wavelengths, so when you view alexandrite in daylight, you are going to see a green gem. As soon as you use incandescent light, the colour balance flips, more red wavelengths are present, and you see a red gem.

Colour-change exhibited via two different light sources in natural alexandrite.

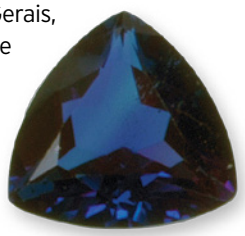
Factors Affecting Price

Aside from the general rarity of natural colour-change gems, which already makes this one of the most expensive gems, one of the most critical factors is the degree of colour-change. The ideal change would be 100% i.e. the stone shows a complete colour-change in every direction viewed through the entire gem. The closer the change is to 100%, the higher the value, however, even the best stones usually do not display more than a 95% change.

The colours, which are also essential, should not be too dark or too light and have an even saturation. Alexandrites found in Sri Lanka are a yellowish-green and brownish-red, which are less desirable.

Natural alexandrites range from transparent to translucent, but it is difficult to find a clean stone above one carat. You will often see some inclusions such as feathers or elongated needle or tube inclusions. Higher clarity equals a higher price, and the same can be applied to size. Larger stones can be worth thousands of pounds per carat.

While Russian alexandrites are more desirable because of their rarity, history and excellent colour-change, it is mostly the quality of the stone that takes priority. Today, the most important source of fine-quality stones is the Lavra de Hematita mine in Minas Gerais, Brazil. Other localities are Sri Lanka, Tanzania, Zimbabwe and Myanmar (Burma).



Synthetics and Simulants

Synthetics and simulants of alexandrite have been on the market for decades, so it is vital to be able to distinguish between a man-made stone and its natural counterpart. As a first clue, look at the colour-change. If it is dramatic (almost too good to be true) and the stone is very clean, investigate further.

Synthetic alexandrite can either be flux-grown or made using the Czochralski crystal-pulling method. Both can be very convincing. To detect whether a stone is flux-grown, look for inclusions such as wispy, twisted veils of flux. Czochralski-grown alexandrite is often inclusion-free, aside from gas bubbles, but they won't always be present. A good test would be UV light — the synthetic will be a bright red under both longwave and shortwave UV light, while natural stones usually show a weak to moderate response in both UV sources.

Synthetic Verneuil Colour-Change sapphire is one of the most prevalent simulants on the market and is often sold as 'alexandrite'. The most important distinguishing feature will be its colours — the synthetic sapphire will be a purple or bluish-grey in daylight and a purplish-red in incandescent light. There also may be thin, curved colour zones (seen with diffused white light) or elongated bubbles. ■

Portuguese Discoveries

Gems&Jewellery contributor and CIBJO delegate, Rui Galopim de Carvalho FGA DGA, describes a recent visit to the Museu Nacional de Arte Antiga, in Lisboa, Portugal, which offered a rare glimpse at biogenic gem materials in wondrous art objects.

The superb exhibition *The Global City: Lisbon in the Renaissance* that took place in 2017 at the Museu Nacional de Arte Antiga, in Lisboa, Portugal, offered a privileged look into the biogenic gem materials that were made available in artistic objects from the 16th-17th centuries (**1**).

The Portuguese discoveries that opened the sea route to India by Vasco da Gama in 1498 initiated what we now call early modern globalisation. This 'India Run' (*Carreira da India* in Portuguese) generated a greater availability of exotic materials for the decorative arts, including jewellery. Diamonds, pearls, sapphires, rubies, spinels (then called 'ballas'), hessonite garnet from various far away regions can be seen in greater numbers after the commencement of this oriental trade route.

Another impact of no lesser importance was the involvement of oriental artisans in the manufacture of commissioned precious objects. Generally included is what is called 'Exotica', using local materials and local techniques to create decorative or functional objects with a European, sometimes, devotional narrative. These objects manufactured, for example, in Sri Lanka, India, China, Japan and the Philippines were presented and traded in Lisbon to Portuguese and European merchants that anxiously awaited the arrival of the oriental ship convoy of the India Run to source exotic goods for their wealthy customers. Lisbon became the first global city with people, animals, plants, materials and objects from all over the known world (**2** & **3**).

1: Casket made in Goa, India in the 17th century. Mother-of-pearl (Turbo marmoratus) and silver. Museu Nacional de Arte Antiga, Lisboa. José Pessoa © DGPC/ADF.

Among these goods, there was a significant variety of biogenic materials*, including pearls, mother-of-pearl, ivory, tortoiseshell, bone, horn, bezoar stone, coco-de-mer and Mediterranean coral. Let's have a look at some of these materials.

2 & 3: Unknown Netherlandish Master. View of the Rua Nova dos Mercadores in Lisboa where most trade in gemstones, jewellery and Exotica took place, 1570-1619. London, Kelmscott Manor Collection, The Society of Antiquaries of London © By kind permission of the Society of Antiquaries of London, Kelmscott Manor

* According to CIBJO, the expression 'biogenic' gem material is more accurate than the widely used 'organic' gem materials due to their nature and composition.

TORTOISESHELL

Tortoiseshell is the general name given to the plaques of the dorsal and ventral carapaces of certain marine turtles, especially the hawksbill turtle, *Eretmochelys imbricata*, and, more rarely, the green turtle, *Chelonia mydas*. The corneous translucent material from the dorsal carapace has a distinctive yellowish-brown colour with brown specks, and the up-to 70 cm long carapace includes 13 plaques that can be as large as 20cm. Its thermoplastic properties allowed it to be worked in a particular fashion that was suitable for embellishing decorative objects and jewellery.

4: Casquet. India, Gujarat (Mid-16th century). Tortoiseshell, silver, wood core. Igreja da Misericórdia de Ourique © Departamento do Património Histórico e Artístico da Diocese de Beja.

One of the uses of tortoiseshell in Portuguese-taste artefacts was decorative caskets and small chests that used either their dorsal plaques or ventral plaques with silver mounts. The ventral plaques are thinner with a light yellow color, being known in the trade as blond tortoise shell. In this illustrated example (**4**), a wood inner structure is covered with dorsal plaques of *E. imbricata* with silver mounts, in a typical case of the so-called Indo-Portuguese artistry manufactured in Gujarat, India.

5: Bini-Portuguese salt-cellar (middle section), Benim, 16th century. Ivory. Private collection © Paulo Alexandrino.

IVORY

Ivory is the material sourced from the teeth of large mammals, e.g. hippopotamus, walrus, orca, narwhal, warthog, sperm whale, but specially elephants, both African and Asian (in the later-case only males). The oriental manufacture of ivory artefacts for European clientele of the time has been extensively reported. However, some extremely rare 16th-century African-manufactured objects are worth a mention. This illustrated example consists of the central section of a salt-cellar made in Benin in equatorial Africa, carved from a tusk of an African elephant (*Lexodonta spp.*) (**5**). In this very interesting piece we can see an armed Portuguese man and a local man wearing a Mahican-style hair-cut, from whose phallus vegetal branches emerge as symbols of fertility.

> The Portuguese discoveries that opened the sea route to India... in 1498 initiated what we now call early modern globalisation.

MOTHER-OF-PEARL

The nacreous interior of certain mollusks, especially the ones that exhibit iridescent effects (namely several pearl oyster species, *Pinctada spp.*, some gastropods, like the great green turban, *Turbo marmoratus*, and abalone, Haliotis spp,) have been extensively used as decorations and in jewellery. Abalone mother-of-pearl is common in 16th-17th century Japanese objects made under Portuguese commission in a style known as *Namban*. In India, pearl oyster and green turban material were used in luxury objects like the chess and backgammon board here illustrated, where the pink to green strong iridescent *Turbo marmoratus* plaques contrast with the more greyish tone of the pearl oyster species' plaques (**6**).

6: Chess and backgammon board, Gujarat, India, 16th-17th centuries. Wood, mother-of-pearl, tortoiseshell. Private collection © Paulo Alexandrino.

BEZOAR STONE AND GOA STONE

Certain ruminants, like goats, can form calcareous concretions in their digestive or urinary systems that are generated by the accumulation of fur, fibres and other substances depending on the animal's diet. These concretions, known in Arabic as *bãnzar* (antidote), were thought to have special powers, namely to inhibit the action of poisons. In fact, these stones can be efficient as antidote of arsenic-based poisons due to their composition rich in brushite and in a protein derived from the degradation of the animal's fur. The Portuguese sourced these bezoars in Ormuz, in the Arabian Gulf, and commissioned special gold containers and gold filigree mountings to hold them in a sumptuous manner. A by-product of

7: Indo-Portuguese silver filigree container and Goa Stone (ø 8 cm). Goa, India. 17th Century. Lisboa, Museu da Farmácia/ANF, Lisboa, inv. 12222 © Emanuel Santos de Almeida.

these stones, the Goa Stone, was manufactured using fragments of the bezoar mixed with other substances, having an almost metallic lustre and usually encased in specially made precious metal containers (**7**).

Many other biogenic materials, some from exotic places, like narwhal incisive teeth (believed to be from the mythical unicorn), bone, natural pearls from Pinctada spp., rhinoceros horn and sea coconuts (*Lodoicea maldivica*), some of European origins, like the red Mediterranean coral (*Corallium rubrum*) were worked by Asian and African artisans using European models, mixing western narratives, sometimes with devotional significance, with local aesthetics and techniques.

Many European collectors sourced these treasures for their 'Exotica' cabinets and these can be seen today in museums and private collections all over the world. The modern conservation issues that created CITES (*Convention on International Trade in Endangered Species of Wild Fauna and Flora*) in Washington D.C. in 1973, now regulate the trade in many of the biogenic gem materials presented in this review and special attention should be given to it in protection of biodiversity. ■

Acknowledgements
The author wishes to thank Maggie Campbell Pedersen and Hugo Miguel Crespo for their contribution and assistance.

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Events Directory

Your essential guide to gemmological events

EVENTS

Midlands Branch – Valuation Practice
29 September 2017, From 18.30
Fellow Auctioneers from Birmingham Geoff Whitefield will discuss valuation practice at the Midlands Branch. For more information please contact the chairman of the Gem-A Midlands Branch, Georgina Southam, at georgekettle@hotmail.com.

Price: £4 for Students; £6 for Gem-A members; £8 for non-members

International Jewellery London (IJL)
3-5 September 2017 (booth J10)
International Jewellery London (IJL) will wow London Olympia once again with its amazing array of all things jewellery, diamonds and gemstones. As a supporter of IJL, Gem-A will continue to bolster emerging designers with the annual Gem Empathy competition, and offer two free workshops for attendees.

For more information visit the IJL website at: **www.jewellerylondon.com**

Denver Gem & Mineral Show
15-17 September 2017, from 09.00 Friday
Visit Gem-A at the Denver Gem and Mineral Show this September where we will have in-booth demonstrations, showing you how to use portable gemmological instruments to quickly identify gemstones.

To learn more visit the Denver website: **www.denvermineralshow.com**

Hong Kong Jewellery and Gem Fair
15-19 September 2017 (booth 3M004)
Hong Kong Jewellery and Gem Fair is the world's number one fine jewellery event. With just under 60,000 visitors in attendance, this is the perfect event for Gem-A to connect with its members and teaching centres in and around Asia.

For more information please visit: **www.exhibitions.jewellerynetasia.com**

IRV Loughborough Conference
16-18 September 2017
The annual IRV Loughborough Conference has become a permanent fixture in the calendars of many current and prospective Registered valuers from the UK and abroad. Gem-A will again be on-hand throughout the conference discussing education and training, as well as exhibiting our range of instruments and publications.

For more information please visit: **www.jewelleryvaluers.org**

World of Gems Conference
23-24 September 2017
Gem-A is delighted to sponsor this premier industry conference boasting an extensive line-up of first-class speakers offering gemmological knowledge on the latest spotlight topics and market trends. Gem-A will lead a range of practical workshops throughout the two-day conference and will be available to discuss gemmological education.

To register your interest please visit: **www.gemguide.com**

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Monthly birthstone guide round-up

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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 basics. Workshops take place at Gem-A Headquarters, 21 Ely Place, London from 10:00–16:30 where all gemmological equipment is provided. Here are our upcoming workshops to get involved with:

Understanding Diamond Grading
22 September 2017

Understanding Diamond Simulants
29 September 2017

Understanding Gemstones
6 October 2017

Understanding Practical Gemmology
13 October 2017

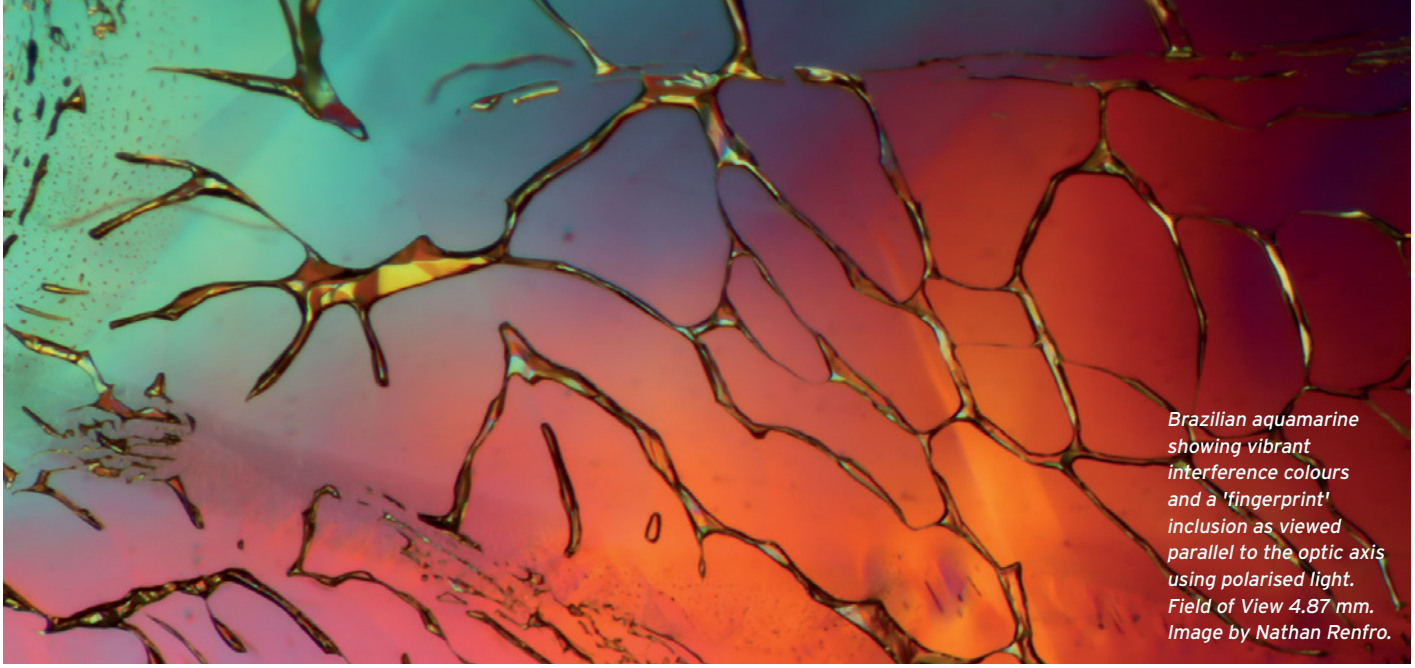
For more information contact the Education Department via education@gem-a.com
Price: £120 for Gem-A members, students and NAJ members; £150 for non-members.

‘Strawberry Starfish’ carving by Patrick Dreher

This incredible carving by Patrick Dreher depicts a starfish sitting on coral and rocks. What makes this piece so remarkable is that it is carved from a single crystal, rather than being constructed from multiple specimens. After carving out cracks and imperfections in the rough material, Dreher was surprised to discover that, between the strawberry quartz and rock crystal, there was another gemstone: an amethyst. When choosing what animal to carve, Dreher needed one with a limited thickness and a sense of flexibility and movement to maximise the red rutile inclusions in the quartz (hence the name strawberry quartz). He opted for a starfish, using its long arms to make the most of the 3cm thick strawberry quartz, as well as the amethyst and rock crystal to depict a bed of coral and the sea floor. The surface of the starfish is textured in a cabochon-style, ensuring the colours create a wonderful contrast. The finished 6,420 carat carving is 136mm high, 113mm wide and 115mm long.

Discover more in *Dreher Carvings: Five Generations of Gemstone Animals from Idar-Oberstein* by Wilhelm Lindemann, Will Larson, Ekkehard Schneider *et al*, and a foreword by Dieter Hahn and Jörg Lindemann. RRP £48, available October 2017, from Gem-A Instruments. Patrick Dreher will also be speaking at the 2017 Gem-A Conference in November.

Picture credit: Robert Weldon. Copyright Bill Larson. This starfish carving is now in the collection of Bill Larson.



Brazilian aquamarine showing vibrant interference colours and a 'fingerprint' inclusion as viewed parallel to the optic axis using polarised light. Field of View 4.87 mm. Image by Nathan Renfro.

GEMSTONE PHOTOGRAPHER OF THE YEAR 2017

Have you got what it takes to be Gem-A's gemstone photographer of the year?

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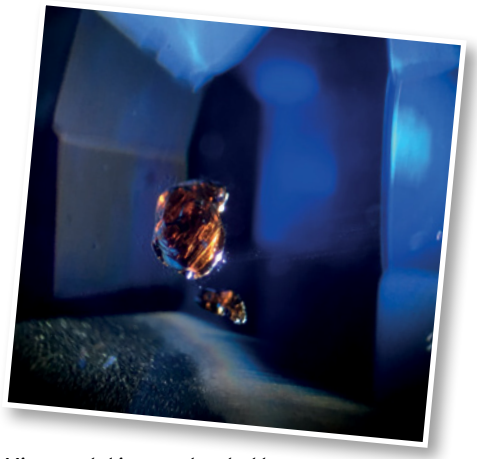
SUBMISSIONS

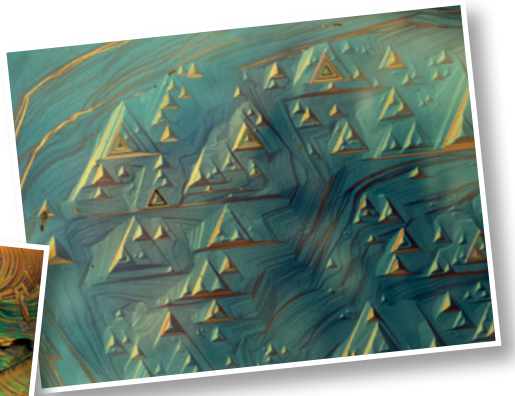
Members and current students of Gem-A only. Please submit all entries to *editor@gem-a.com*, specifying your membership or student number and category of entry. Please send files larger than 10mb via Dropbox or WeTransfer. Closing date for entries is Friday 1 September 2017.

WINNERS

A Member Award and a Student Award will be given. Honourable mentions will also be given for each category. Winners will be announced at the 2017 Gem-A Conference.

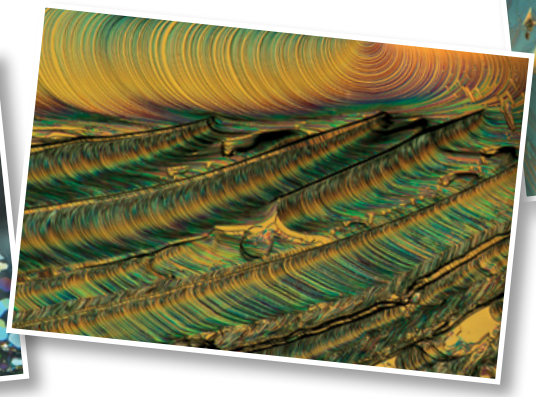


Mica crystal in an untreated burmese sapphire, taken with an iPhone 6s through an Eickhorst microscope with darkfield, magnification approximately 40x. Image by Sebastian Hänsel.



Trigons and growth marks on a diamond macle; field of view 2.81 mm; imaged using episcopic differential interference contrast (DIC). Image by Ziyin Sun.

Reflective thin films and crystal inclusion in Goshenite Beryl. Field of view 7.19 mm. Fiber optic light. Image by Jonathan Muyal FGA.



Surface growth features on pulled synthetic alexandrite. Field of view 2.81 mm. Differential interference contrast. Image by Jonathan Muyal FGA.

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