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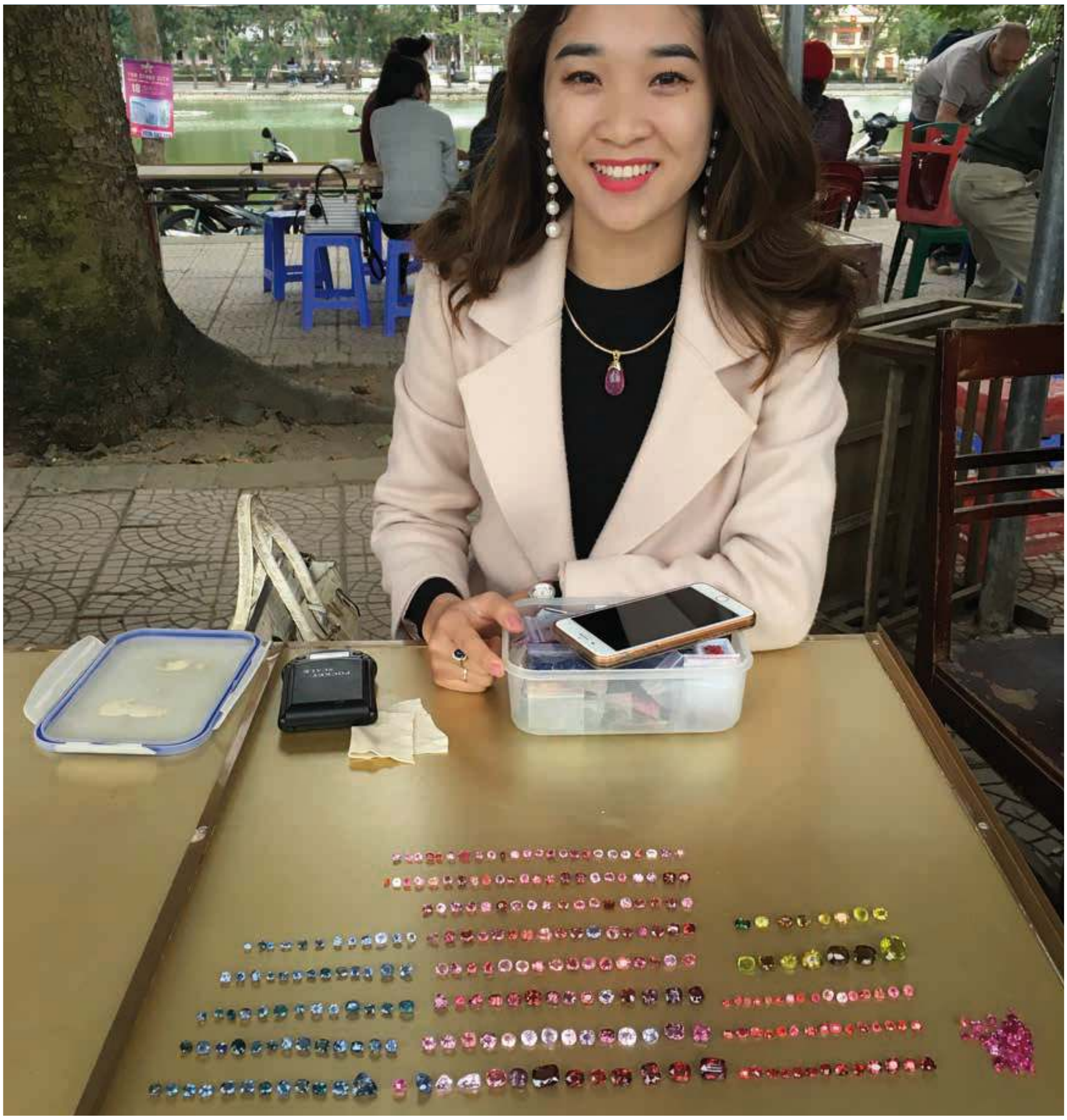

TRACEABILITY & BLOCKCHAIN / MOZAMBIQUE RUBIES / COLOUR CHANGE
DNA FINGERPRINTING / PARAIBA TOURMALINE / SSEF AT AUCTION
SSEF COURSES / SSEF IN USA & ASIA

SSEF
SCHWEIZERISCHES GEMMOLOGISCHES INSTITUT
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Dear Reader

It is my great pleasure to present you the 25th issue of the SSEF Facette, the annual magazine of the Swiss Gemmological Institute. Published now since a quarter of a century, it has definitively grown up to become an important resource of information for both the gemmological community and the trade, and is often referenced in gemmological publications.

As in previous years, this issue will again summarise our current work and research, and I am proud to say that in the past few months we have achieved important breakthroughs, which we will share with you in the following pages.

These breakthroughs are only possible thanks to the work of motivated and dedicated SSEF staff and external research partners. In this respect, collaboration and research networking is more than ever a vital precondition for any progress, both in terms of scientific research and in the daily working routine at the laboratory. Since many years, the SSEF is collaborating with a large number of research institutions, such as the universities of Basel, Bern, and Lausanne, the Federal Institute of Technology Zurich, the Centre for Electronics and Microtechnology, and the Paul-Scherrer Institute, which is the largest research institute for natural and engineering sciences within Switzerland. We are glad to announce that in 2018 we have expanded our collaboration network even further, adding the Institute of Forensic Medicine of the University Zurich as research partner in a project on DNA analysis of pearls and corals. You will find more about this very promising and fascinating topic inside this SSEF Facette.

The traceability of gems and responsible sourcing is another important topic which has emerged in recent years in the trade and gained momentum. In the past few months, the SSEF has participated in conferences and meetings to contribute to this important issue. We also felt that it is necessary to clarify and explain the many terms often used as buzzwords in discussions to avoid any misconceptions. As such, a summary of our publication in the Journal of Gemmology is our headline article in this issue of the SSEF Facette. As a consequence of these discussions with stakeholders and the trade, I am also glad to announce that SSEF is offering a new tracking service starting from 2019, gemmologically documenting the journey a gem from rough to cut and even when mounted in jewellery. For more details I refer the reader to the article about the SSEF GemTrack™ service.

To conclude, I wish you lots of reading pleasure with this issue of the SSEF Facette and a very successful and exciting 2019 in your business and personal life.

Dr. Michael S. Krzemnicki
Director SSEF

COVER PHOTO ▷

Gemstone dealer at gem market in Yen The, Vietnam.

Photo: S. Hänsel, SSEF

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TRACEABILITY AND BLOCKCHAIN FOR GEMSTONES – AN OVERVIEW

Recent developments have brought, due diligence, along with tracking and traceability, to the forefront of discussions and requirements in the diamond, coloured stone and pearl industries. To address this trend, certification mechanisms and technologies (such as blockchain) are being developed to solve inherent traceability challenges. As applied to gems, such standards and associated technology could benefit from the support of existing gemmological approaches (e.g. geographical origin determination) to enhance traceability and transparency measures. This article seeks to provide the reader with an overview of current developments, terms used in this context and the research that SSEF is carrying out in this regard.

Diamond – in the context of conflict diamonds and the Kimberley Process Certification Scheme (KPCS)- is not the only mineral or metal used in jewellery supply chains that has been scrutinised in recent years: for example, there has been a focus on gold (Dirty Gold campaign in 2004 and Conflict Gold in 2012), rubies and jade from Myanmar, lapis lazuli from Afghanistan or precious corals listed under CITES to name a few notable cases. In response to these developments, jewellery industry associations (e.g. CIBJO, WDC, ICA, AGTA) have begun to address these issues and groups have gone on to form a range of initiatives to strengthen responsible practices in the industry, such as CIBJO's responsible sourcing blue book or the Responsible Jewellery Council (RJC).

Why traceability? Why now?

As in other sectors (e.g. food, fashion, shipping), there is now greater demand for specific information on how the raw materials leading to finished pieces of jewellery are extracted and processed. Traceability is one way to provide more transparency and specific information, and it is frequently argued that by increasing transparency, supply chain issues can be better mapped and understood. Blockchain and other traceability tools are being heralded by some as solutions to transform the jewellery industry, others disagree. As the October 2018 Emerald World Symposium and CIBJO Congress in Bogotá (Colombia) showed; 'blockchain', 'due diligence', 'responsible sourcing' and 'traceability' were very widely discussed topics.

At present there are a number of factors shaping the development of responsible practices and the move for increased traceability and transparency in the jewellery industry, and more specifically for diamonds and coloured gemstones:

- Consumers are increasingly interested in knowing where and how the gemstones and jewellery they purchase are mined and manufactured.
- Media and NGOs are placing the gem and jewellery industry under increased scrutiny regarding the origin and sustainability footprint of various gemstones and human rights issues in the artisanal mining sector.
- Some companies want to be proactive so as to mitigate risks and better understand their own supply chains and contribute to positive outcomes.
- Governments want to improve the management and revenue collected from gem resources.
- Global governing bodies have highlighted issues such as smuggling and money laundering.
- Some governments (e.g. USA, EU) have instituted 'conflict mineral' legislation, requiring publicly traded companies to know and trace their supply chains and comply with their laws.

Traceability is often understood to mean an object is fully traceable (i.e. an individual gem is uniquely documented and identifiable at each step of the supply chain from mine to market), but there are other models of product traceability. Traceability information could be used as:

- a tool for supply chain management (managing and locating stock)
- demonstrate compliance (against given standards or legal requirements) and support due diligence
- provide evidence of provenance and/or sustainability claims

△ **Figure 1: Rough emeralds and emerald cutting in Brazil. The cutting, polishing and possible treatment of gems is an under-researched bottleneck for traceability. Photos: Laurent E. Cartier**

As best practices and standards within mining, processing and sale of gemstones are increasingly defined worldwide - the development of techniques to track and trace gemstones may support the accountability of such schemes and may even become necessary for example for publicly listed companies to demonstrate compliance to specific government regulations. Importantly, the Organisation for Economic Cooperation and Development (OECD) developed due diligence guidelines for responsible mineral supply chains for companies seeking to respect human rights and avoid contributing to conflict through their mineral sourcing decisions and practices; these guidelines now apply to all minerals, including diamonds and coloured gemstones.

Translating terms

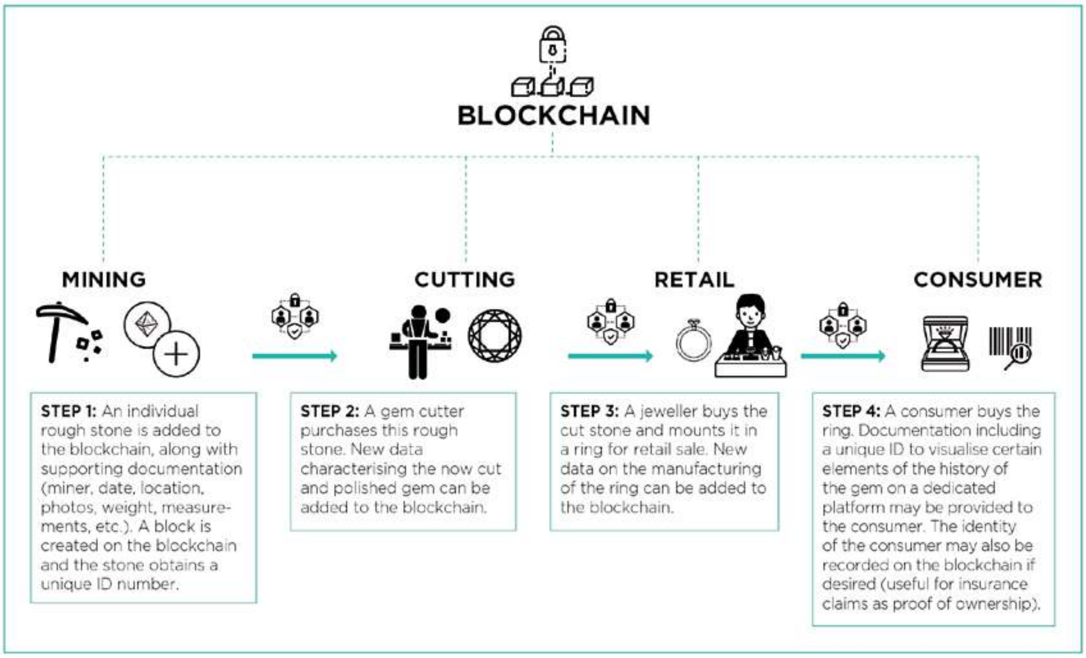
As recent conferences and events suggest, there is some confusion around the terms used surrounding traceability and responsible sourcing. As such in a recent article we sought (Cartier et al., 2018 and references therein) to define and contextualize these terms to provide clarity to members of the trade. These terms include:

Chain of custody: "The document trail recording the sequence of companies and individuals that have custody of minerals as they move through a supply chain."

Due Diligence: "The act of proactively ensuring that the products sourced and traded by companies within a supply chain conform to national and international regulations."

Disclosure: The release of information by companies required by regulators or requested by business partners in the supply chain.
Provenance: A (documented) claim made on the origin (e.g. country or mine), source (e.g. recycled, mined, artisanally mined, natural, synthetic), previous ownership (e.g. a historic gemstone or a piece of jewellery formerly in a royal collection) or extraction and processing practices (e.g. conflict free, untreated, responsibly sourced).
Traceability: "The ability to identify and trace the history, distribution, location, and application of products, parts, and materials" (ISO)
Tracing: The use of traceability records or an object's properties to identify the origin, attributes or history of a product within the supply chain (i.e. from market to mine). This could include origin determination using gemmological science.
Tracking: The use of traceability records to track an item from its origin to the end consumer through the supply chain (i.e. from mine to market). This is often complemented by the use of tracking technology such as radio-frequency identification (or RFID) chips, near-field communication, synthetic DNA implantation, barcodes or other forms of tagging.

Blockchain- a silver bullet for the industry?



△ **Figure 2: This generalised example of a blockchain serves to illustrate how information can be documented on a single gem's journey from mining to cutting and onward to retail and eventually the end consumer. After the stone is mined, the trade and transfer of ownership are validated at each step by both parties involved and recorded immutably to the blockchain. Illustration by L. E. Cartier (Courtesy of Journal of Gemmology).**

There has been considerable hype around blockchain in recent times with radical promises made of how it could disrupt and transform entire industries. Blockchain is a decentralized and immutable ledger, which is the basis for the potentially huge transparency gain that this technology can offer. At each step, data added to the blockchain are verified, ownership is attributed, and the information is time stamped, encrypted, and stored permanently in a distributed and decentralized manner, providing an immutable record that is formed of a single, yet shared, source of information about a gemstone's journey from source to end consumer.

Blockchain can thus provide transparency and verification to the regulators and other users who require it, while still providing the privacy and the specific views into the ledger that are relevant for each different type of user. This is an important factor for the gem and jewellery industry, which demands verified, but often anonymized, chain-of-custody solutions. The prospect of combining blockchain with smart contracts (automatic trades and verification between accounts/users if pre-required conditions are met) can potentially provide a huge gain in efficiency (especially with regards to demonstrating compliance and know-your-customer procedures), and they are one of the main reasons why blockchain is being widely investigated as a game-changing technology.

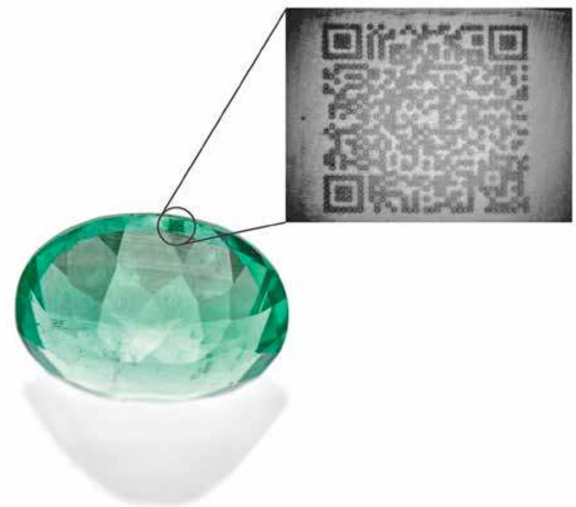
Diamond miner De Beers launched the Tracr blockchain in 2017 to track diamonds through the full value chain. The Trustchain Initiative (piloted by IBM) is an industry collaboration to pilot traceability using blockchain in diamond and gold jewellery from mine to retailer. Finally, Gübelin and Everledger are piloting a blockchain for coloured gemstones that is due to be launched in 2019.

Traceability for gems is nothing new: the role of gemmology

As the science of gemmology emerged in the early 20th century, and synthetics and treatments became critical research issues, interest grew in carrying out structured investigations on gem materials from different origins to better characterise their properties. For example, Chesley in 1942 attempted to correlate spectroscopic features of diamonds to their source localities. Geographical origin determination of coloured stones as we know it today appeared in the 1980s, and at the beginning focused on characterisation of typical microscopic inclusions from a deposit. This was subsequently complemented by chemical and spectroscopic work on gem materials from various localities, such as the early work on Kashmir sapphires by Prof. Henry Hänni of SSEF.

Origin determination of gems today is an expert scientific opinion on the origin (country) of a stone, based on characteristic inclusions and chemical and spectroscopic features. Although it is not possible to trace a coloured stone back to a specific mine, origin determination can help validate claims made by companies regarding country of origin. Importantly, gemmological science can continue to provide much-needed assistance regarding claims of origin (geographical and whether a gem is natural or synthetic) and whether or not a gem has been treated. A gem's inclusions and their location within the stone can be used to help verify its identity, as well as provide gemmological data that can later be compared to existing chain-of-custody information.

Building on our gemmological expertise we are pleased to announce the launch of our new GemTrack service early 2019 (see article Page 44). A GemTrack document links a cut stone to a specific rough stone using gemmological techniques. GemTrack is based on a combination of crystallographic, structural, chemical and microscopic analyses that allow for detailed and potentially unique characterisation and fingerprinting of a rough stone. These same features are later investigated in the cut stone, following the cutting and polishing process, enabling us to confirm and gemmologically track the journey of a stone.



◁ **Figure 3:** A tiny QR code can be inscribed on a gemstone during chemical analysis with GemTOF instrumentation (Wang and Krzemnicki, 2016). The QR code shown here measures 500 × 500 µm and has been inscribed on the girdle of an emerald weighing 2.5 ct. The material ablated during the inscription of the code is used to measure trace-element concentrations that are evaluated for determining country of origin. The code can be read (after magnification) using a QR reader on a smartphone, and gives the user access to various types of information on the stone. Composite photo by H. A. O. Wang and V. Lanzafame, SSEF. (Courtesy of Journal of Gemmology).

Technology and traceability- what's next?

As blockchain is a nascent concept in other sectors too, it is unclear whether industry-wide consensus is possible or necessary at this stage. Fundamentally, for a gem and jewellery industry that consists largely of cottage and family-owned companies, further research is needed to understand how all levels of the supply chain can benefit from traceability opportunities that blockchain technology provides. The current focus on full mine-to-market traceability may not be as realistic as it has been shown for other sectors, nor may the market necessarily want or require it.

The fragmented nature of some parts of the gem industry makes traceability a complex and challenging undertaking. Sorting and aggregation steps in supply chains—in which goods may be sorted in terms of quality rather than origin—may further complicate this endeavour. Regulatory requirements and consumer demands for supply chain integrity and knowledge of provenance will continue to push the industry to find solutions. This may also provide newfound opportunities if, for example, synthetics and treated stones can be separated more clearly from natural/untreated material in the supply chain based on traceability information to verify the ownership and authenticity of gem materials at different stages of the supply chain.

In summary, there is no 'silver bullet' for traceability or improving practices in the diamond and gemstone supply chains. Ultimately, multiple approaches, initiatives and technologies are likely to spur greater transparency and provide more sustainable outcomes in the industry.
✶ **Dr. L.E. Cartier**

FURTHER READING

Cartier L.E., Ali S.H., Krzemnicki M.S., 2018. Blockchain, Chain of Custody and Trace Elements: An Overview of Tracking and Traceability Opportunities in the Gem Industry.
The Journal of Gemmology, 36 (3), 212-227.

DETECTION OF LOW-TEMPERATURE HEATED RUBIES FROM MOZAMBIQUE

Since their discovery in early 2009, the ruby deposits near Montepuez in Mozambique have produced an impressive number of exceptional-quality stones, including iconic unheated gems such as the Rhino Ruby (22.04 ct), the Scarlet Drop (15.95 ct) and the Eyes of the Dragon (a pair of rubies weighing 11.26 ct and 10.70 ct), all of which were analysed by the Swiss Gemmological Institute SSEF. But from the very beginning, there has been evidence in the market of lower-quality rubies from Mozambique that have been heated with or without a flux (borax), resulting in healed fissures with residue, and in some cases heavily-fractured material that has been lead-glass filled.

In more recent years, an increasing number of rubies from Mozambique have come onto the market, after having undergone so-called 'low-temperature heating' (below 1000 °C). Presumably, the aim of this treatment is to enhance the colour slightly, by reducing subtle purplish zones which are sometimes present in rubies from this location (Figure 1).

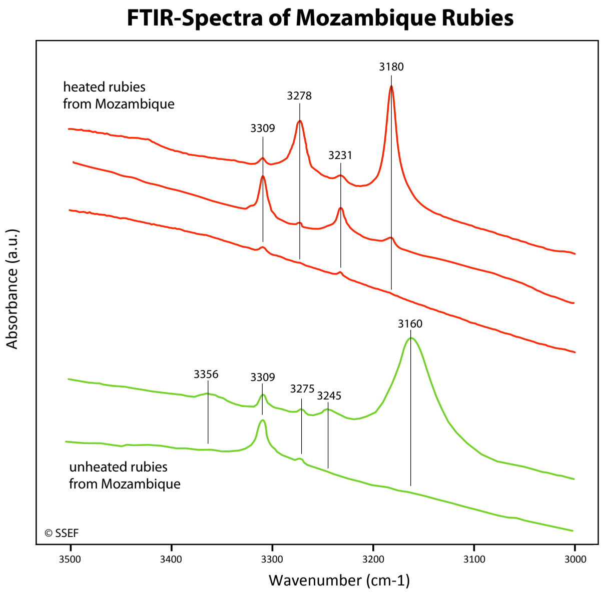
△ **Figure 1:** Slightly purplish zone in a ruby from Mozambique. Photo: M.S. Krzemnicki, SSEF

Only a portion of the rubies that have been subject to this relatively low-temperature heating procedure show the microscopic features that commonly characterise heat treatments (Figures 2a and 2b), which would be easily recognisable by an experienced gemmologist (Gübelin & Koivula 2008, Pardieu 2015, Krzemnicki 2015). Others show no or nearly no heat-related transformations of inclusions (see also Pardieu et al. 2015, Saesseaw et al. 2018). It is a situation that challenges gemmologists and gemmological laboratories, and also, ultimately, the trade.

△ **Left (Figure 2a): A discoid tension crack around an inclusion transformed by heat treatment. Right (Figure 2b): Surface-near healing fissure induced by heating of the ruby. Photos: M.S. Krzemnicki, SSEF**

To meet the challenge, the Swiss Gemmological Institute SSEF has conducted an extensive research project to establish more specific criteria to detect low-temperature heat treatment, studying more than 200 unheated and heated rubies (rough and faceted stones) from Mozambique. In combination with close microscopic examination of the samples, specific infrared spectroscopy (FTIR) peak features were analysed in order to determine additional distinguishing criteria. For decades, FTIR has been considered a useful tool to assist in the detection of heated rubies and sapphires, because of the presence of absorption peaks related to structural hydroxide (OH^-) (Moon & Philips 1991, Smith 1995, Beran & Rossman 2006, Saesseaw et al. 2018).

SSEF's FTIR study showed that, rather than using individual peaks to determine if a ruby has been heat-treated or not, the focus should be on peak patterns (Figure 3). We are confident that this and other research will contribute to consumer confidence in the beautiful ruby material coming from Mozambique. ✶



△ **Figure 3:** **FTIR spectra of unheated rubies from Mozambique (in green, below) and heated rubies (in red, above). The detailed studies clearly show the need for a combined microscopic and FTIR approach, along with analysis of FTIR peak patterns rather than presence or lack of individual peaks.**

CHIPPING OF EMERALDS

△ **Figure 1:** Before and after photos of an emerald with an evident (cleaned) fissure in the upper left corner, which spontaneously chipped at SSEF during normal testing procedures. Photo: V. Lanzafame, SSEF

Emerald fissure filling and issues related to this treatment and its decomposition and cleaning are a constant issue in the lab and in the trade. With the current market-trend to offer emeralds which are either filled only by oil or which show no indications of clarity modification at all, a rather large number of emeralds formerly treated with artificial resin in fissures are cleaned, using strong acidic solutions.

This cleaning process, often supported by mechanical tumbling and ultrasonic cleaning may result in chipping or even cracking of pre-existing fissures within the emerald at any time afterwards (Figure 1).

We have recently come across a few cases, when small chipping actually happened during normal handling procedures in the laboratory. This is very unpleasant for all involved parties, as it requires repolishing at least. We therefore would like to remind the trade that emeralds are rather brittle and fragile especially when exposed to such cleaning processes. This is especially the case for Colombian emeralds, as they often contain small fissures due to specific geological conditions and mining methods (Figure 2). Any cleaning (especially when applied multiple times with strong acids) always bears the risk to cause chipping of the emerald, whether just after cleaning, during lab testing, when mounted in jewellery, or even worse after selling the emerald to a final consumer.

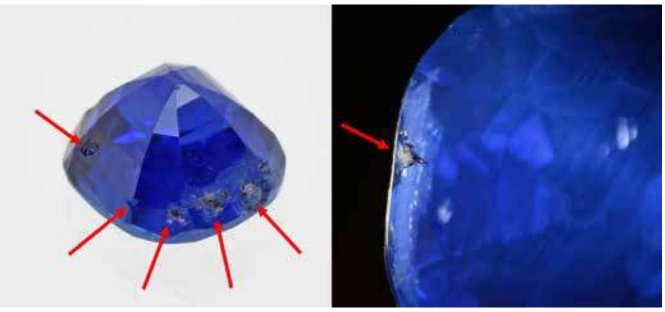
✶ **Dr. M.S. Krzemnicki**

△ **Figure 2:** Journey of a Colombian emerald of 8.1 ct in three stages: Untreated (left) revealing apparent fissures in the stone, with moderate amount of artificial resin in fissures (middle, perfectly hiding most of these fissures, and after partly cleaning but with still with minor artificial resin in fissures (right). Photo: M.S. Krzemnicki, SSEF

BEWARE: LASER DAMAGE IN SAPPHIRES DUE TO JEWELLERY REPAIR

◁ **Figure 1:** Selection of sapphires showing laser damage on the pavilion side. These sapphires range in size from 2.4 ct to 17 ct, all originating from Kashmir except the oval sapphire on the right from Sri Lanka. Photo: M.S. Krzemnicki, SSEF

Having personally tested gemstones for more than 20 years now, the author of this short note was quite shocked in recent months to see distinct laser damage features on quite a number of sapphires (Figure 1) which were submitted to us by different clients. This is even more startling, as we (and other labs) also use lasers for trace element analysis of gemstones but take great care to ablate only the slightest amount of material at the girdle (laser spots of 0.05-0.1 mm diameter) in a very controlled manner. Most of these sapphires with laser damage are actually of high quality, often originating from Kashmir, and were presumably originally set in jewellery years or decades before being submitted as loose stones to SSEF for testing.

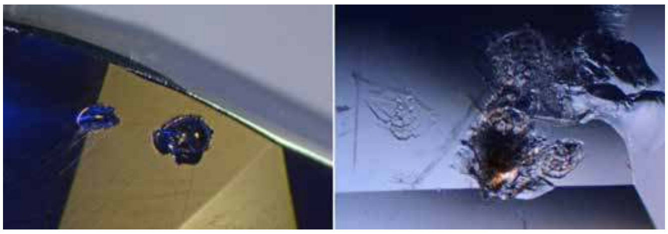


△ **Figure 2:** Evident laser damage on several pavilion facets (indicated with red arrows) of this Kashmir sapphire of very fine quality. The cone-shaped laser drill holes are even visible from the table side (right photo). Photos: V. Lanzafame and M.S. Krzemnicki, SSEF

As a main characteristic, we have observed in all investigated cases more or less deep laser drill holes surrounded by tension cracks and prominent chipping. These laser damage features were always located on the pavilion side and close to the girdle of the stones (Figure 2). This leads us to assume that they were unintentionally created when trying to repair a jewellery item set with one of these sapphires, but using an inappropriate and much too powerful laser (soldering) equipment. So far, we have observed this laser damage only in sapphires, although similar features may occur in principle in any ruby or further colour variety of corundum during repair of a jewellery item.

The conical shape of the laser holes is due to the confocal geometry of the laser beam after it was focused through a lens onto the item. Because of the very high temperatures locally created by the laser at the surface of the stones, we see effects of melting and volume expansion, leading to tension cracks and chipping features. Within the conic laser holes, we observe glassy residues formed as a result of the local melting of the stone by the high laser energy (Figures 3 and 4).

△ **Figure 3:** Close up (in reflected and transmitted light) of laser damage on a sapphire, showing a large chipped area (approx. 3 mm wide) at the surface produced by heat induced tension by the laser. As a further consequence, the central part has melted to finally remain as a greenish and crackled glassy residue in the laser hole. This glassy residue is best seen in the microphoto on the right side. Microphotos: M.S. Krzemnicki, SSEF



△ **Figure 4:** Two other sapphires showing similar molten laser holes with glassy residues (left), and multiple cracking features together with brownish glassy residues (right), all caused by powerful and damaging lasers presumably during jewellery repair. Microphotos: M.S. Krzemnicki, SSEF

Although not a treatment, and certainly unintentionally created, these laser damage features are a rather unpleasant discovery. In many cases it requires considerable recutting and as a consequence results in weight (and value) loss. This could have been easily avoided by using only appropriate laser equipment for jewellery repair. We thus urge the trade to carefully review their laser equipment before using it to repair any jewellery with gemstones or to set and unset a gemstone from an old mounting, in order to avoid damage. ✶ **Dr. M.S. Krzemnicki**

THE RESURRECTION OF SYNTHETIC COLOURED STONES

Occasionally, we encounter synthetic stones at SSEF that are submitted to us by our clients. Usually they are quite surprised by our result, as the issue of synthetic stones – at least in the coloured stone market – has very much vanished in peoples' minds, and is often not anymore considered a real threat when purchasing stones from an unknown supplier or at a local gem market. Furthermore, some rather classic features of synthetic stones are not anymore known to young gemmologists, further adding danger that such stones pass into the market as natural after a first gemmological test (see also SSEF Facette No. 22, 2016, page 14).

In recent months, we have encountered a number of synthetic stones worth describing in a short note, namely synthetic rubies and red spinels, but also a few synthetic corundum samples of blue and padparadscha-like colour.

Synthetic corundum produced by the flame fusion method (Verneuil) are somehow regular guests at SSEF. Nevertheless, it was interesting for us to be recently able to test a brooch of historic design (Figure 1) containing 27 small synthetic rubies. All were characterized by strong curved banding and large air bubbles, thus probably of a quite historic synthetic production.

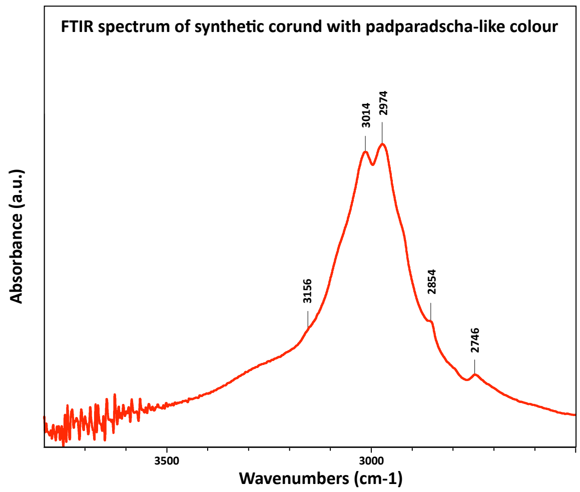
△ **Figure 1:** Brooch with 27 synthetic rubies of presumably historic Verneuil-production. Photo: V. Lanzafame, SSEF

△ **Figure 2:** A 20 ct Verneuil-synthetic sapphire in a ring together with the described Ti-diffusion treated synthetic corundum of 6.74 ct. Photo: V. Lanzafame, SSEF

In addition to this, our client was quite shocked when the 20 ct sapphire set in a ring with real diamonds (of low quality though) turned out to be a classic Verneuil-synthetic product (Figure 2). Even worse was the case of a colourless synthetic corundum which was treated by Ti-diffusion to visually produce a blue colour (Figure 2), but resulting under the microscope in a highly characteristic facet-related colour distribution.

△ **Figure 3:** Synthetic corundum of padparadscha-like colour of 5.1 ct and 2.4 ct. Photo: V. Lanzafame, SSEF

Apart from blue and red, flame-fusion synthetic corundum can be produced in virtually all colours, including emerald-green by doping aluminium oxide with traces of nickel. Using the same trace element, it is also possible to produce yellow to orange and (in the presence of some chromium) pinkish orange corundum, visually beautifully blending with the sought-after natural variety padparadscha (Figure 3). Simple to identify with lab equipment based on their specific trace element composition (Ni traces, but no Ga), these stones may be more challenging when on a buying trip in remote places. Interestingly, however, the displayed two client stones both reveal a 'Punsiri-type' infrared spectrum with a broad (presumably OH^- related) absorption band centered at about 3000 cm^{-1} wavenumbers (Figure 4). This feature is very similar to those described by Fukatsu et al. (2003) in Mg-doped synthetic corundum, or in so-called 'Punsiri heat-treated' blue sapphires and certain untreated yellow basaltic sapphires (Sangsawong et al. 2016; in Gems & Gemology), and even in blue sapphires treated by a pressure-assisted heat treatment (GIT Gemstone Update, 2016).



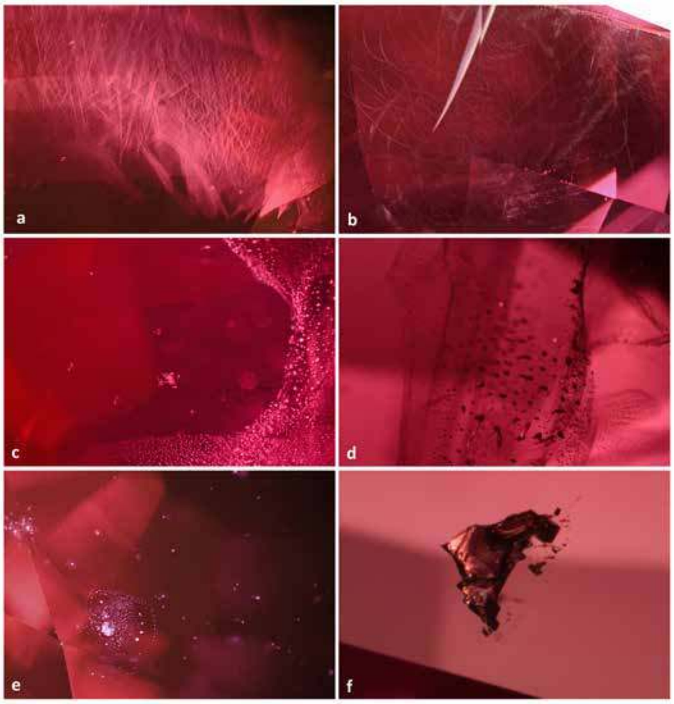
△ **Figure 4:** FTIR spectrum of synthetic corundum with padparadscha-like colour revealing a 'Punsiri-type' pattern with a broad absorption band centered at about 3000 cm^{-1}. Figure: M.S. Krzemnicki, SSEF

△ **Figure 5:** Selection of flux-grown synthetic rubies (weight 5 to 6 ct) which were recently analysed at SSEF. Photo: J. Xaysongkham, SSEF

△ **Figure 6:** Layout of flux-grown synthetic red spinels, ranging in weight from 1.12 to 2.03 ct, adding up to a total weight of 16.6 ct. Photo: M.S. Krzemnicki, SSEF

In contrast to the rather straightforward cases described above, the identification of flux-grown synthetic products is far more challenging and intriguing even at lab level. In the past few months, we were astonished to see again quite an impressive number of such stones in the SSEF, partly accompanied by documents describing them as natural stones.

Whether submitted in larger parcels or as single loose stones, the tested flux-grown synthetic rubies (Figure 5) and synthetic red spinels (Figure 6) all could be identified based on characteristic inclusions and trace elements, with the GemTOF notably revealing 'exotic' elements such as platinum, rhodium, zirconium, tantalium, lanthanum, and bismuth, to name a few. Still, inclusion features in some of these flux-grown synthetic stones may have some resemblance with those in natural rubies and spinels, which makes a very careful microscopic examination and testing protocol mandatory. In this respect, we present here a selection of microphotos (Figure 7a-f) with inclusion features encountered in flux-grown synthetic stones which were analyzed recently at SSEF. For a more detailed description of flux-grown synthetic rubies and spinels, we refer the interested reader to SSEF Facette No. 22 (2016; page 14. Short note about Ramaura synthetic ruby), and the SSEF trade alert (November 2008) about flux-grown synthetic spinel, all documents accessible on our SSEF website. ✶ **Dr. M.S. Krzemnicki**



△ **Figure 7:** Inclusion features in investigated samples of flux-grown synthetic rubies (a-e) and spinel (f). a) Dense pattern of comet-like dust traces in flux-grown synthetic ruby, to some extent resembling features in rubies from Mong Hsu (Myanmar). b) Strange irregularly curved dust traces in flux-grown synthetic ruby, somehow similar to diffusion features in beryllium-treated corundum. c) Small colourless clusters, resembling zircon inclusions in natural rubies. d) healed fissure with brownish flux residues, somehow similar to features in rubies heated with a flux (e.g. borax). e) small whitish inclusion surrounded by a discoid of 'droplets', similar to features in rubies heated at high temperatures. f) irregular platinum flake in flux-grown synthetic spinel, somehow resembling graphite platelets in natural stones. Microphotos: M.S. Krzemnicki, SSEF

DNA FINGERPRINTING OF PEARLS, CORALS AND IVORY: RESEARCH UPDATE

△ **Figure 1:** Biogenic gem materials suitable for DNA testing include items such as these from the SSEF and H. A. Hänni collections: cultured pearls and associated shell material (*P. maxima* and *P. margaritifera*, ~15 cm tall), corals (including *Corallium rubrum* branches up to ~10 cm tall) and ivory (warthog and mammoth). Photo by Vito Lanzafame, SSEF.

SSEF pioneered DNA fingerprinting of pearls in 2013, in collaboration with scientists from ETH Zürich. This was the first published report of oyster DNA extraction from a pearl, allowing us to trace and fingerprint pearls of unknown origin and match them to the specific oyster species in which they formed. This research breakthrough culminated in a publication in the international open-access journal PLoS ONE (Meyer et al., 2013), and was widely reported by media such as the BBC.

We have continued our research in this direction, as it opens up numerous applications in the field of gemmological testing which we hope to provide as a client service in future years. In addition to refining methods for testing and fingerprinting pearls, these methods can be adapted and applied to precious coral and ivory samples too.

In the context of this project we partnered with the Institute of Legal Medicine at the University of Zürich in 2018, one of the leading forensic research facilities in Switzerland. The project is led there by Dr. Bertalan Lendvay and Nadja Morf; and by Dr. Laurent E. Cartier at SSEF. The aim of the project is to develop quasi non-destructive genetic analysis methods with forensic validation that have the potential to accurately and sensitively determine the origin of pearls and precious corals processed for jewellery. Such new methods will considerably enhance our scientific ability to further document the provenance of historic and modern pearls and coral items. Furthermore for corals, given that some species are listed by CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), the developed methodology could contribute toward resource conservation efforts by offering full disclosure of species origin through scientific testing.

What is DNA?

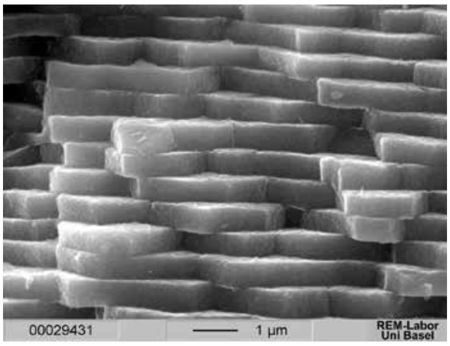
Deoxyribonucleic acid (DNA) contains all the information an organism needs to develop, live and reproduce. It is formed by the four nucleobases (or 'bases') adenine (A), cytosine (C), guanine (G) and thymidine (T). The order of the bases (e.g. ATCGGTT...) codifies the specific instructions for any living organism. As pearls, corals and ivory are formed by living organisms and cells, they are in contact with host cells and thus DNA during their formation. Fortunately, negatively charged DNA molecules are known to have a high affinity for the Ca^{2+} ions of $CaCO_3$, which enhances the conservation potential of DNA in pearls and precious corals as both consist of calcium carbonate. Variations in the genetic code of different pearl and coral producing species can allow us to separate them on the basis of the recovered DNA.

DNA in natural and cultured pearls

Natural pearls form in wild molluscs without any assistance, whereas cultured pearls are the result of human intervention on cultivated pearl-producing molluscs. Pearls and their shells consist of secretions of different polymorphs of calcium carbonate ($CaCO_3$) such as aragonite, calcite and vaterite. The nacreous part of a pearl consists of approximately 92% $CaCO_3$, 4% organic matter, 4% water and minute amounts of residual substances. The organic matter (consisting mostly of conchioline and porphyrines), which is also secreted by the pearl sac, serves as a framework for the $CaCO_3$ matrix (Figure 2) during the biomineralisation process . Organic matter can also be found in concentrated pockets (e.g. cavities). Both are likely sources of minute amounts (nano-grams) of oyster DNA that can be recovered in natural and cultured pearls.

To minimize the potential loss in pearl value that would result from damaging the pearl to obtain sufficient material for a DNA test, we developed a micro-drilling methodology requiring as little as 10 mg of recovered drill powder. This methodology was published in PlosOne in 2013 demonstrating successful identification of cultured pearls from *Pinctada margaritifera, Pinctada maxima and Pinctada radiata* using DNA fingerprinting. The same method works for natural pearls.

Although species identification may be possible for pearls of different colours (that have characteristic pigments that give the pearl its colour) using scientific instruments available at SSEF such as UV-visible photospectrometry and micro-Raman spectroscopy, this may not always be conclusive. Furthermore, it is rarely possible to conclusively determine the species of white to slightly cream-coloured pearls (e.g. Figure 3) using current methods. This explains why it has been SSEF's policy not to state the pearl oyster species on a pearl report, until a sufficiently precise method can be developed to ascertain this information.



◁ **Figure 2:** Scanning electron microscopy reveals the individual aragonite tablets in a cross-section through pearl nacre. DNA is thought to be found in organic matter between the individual tablets. Image by Henry A. Hänni and Marcel Düggelin, Zentrum für Mikroskopie, University of Basel, Switzerland.

◁ **Figure 3:** A natural pearl necklace with pearls likely from *Pinctada radiata* of the Arabian/Persian Gulf. DNA fingerprinting could provide further documentation of the provenance for such exceptional pearls. Photo by Luc Phan, SSEF

Coral species determination

Precious corals used in jewellery and objets d'art represent the coral skeleton (secreted by living polyps), which consists of $CaCO_3$ as well as protein, glycosamino-glycans and proteoglycans. As in pearls, minute amounts of DNA have been found by our research team in precious corals. This DNA can be extracted using methods we have developed and used to determine which species or species group the precious coral is from. At present, there is no other conclusive way of determining the genetic species from which a precious coral piece in jewellery unless there are clear visual characteristics.
The most common types of precious corals used in jewellery include (Figure 4):

- *Corallium rubrum* (Mediterranean/ Sardinian coral)
- *Corallium elatius* (including angel skin coral)
- *Corallium japonicum* (including oxblood coral)
- *Corallium konojoi* (white coral)
- *Corallium secundum* (including Midway coral)

Our ongoing research should allow the separation of different species of precious corals and conclusively identify and distinguish non-CITES-reg-ulated species (e.g. *Corallium rubrum*, or Mediterranean coral) from CITES-regulated species (e.g. *Corallium elatius*, known in the trade as Momo, Cerasuolo or Satsuma coral).

△ **Figure 4:** A selection of precious coral used in jewellery today. The ring in the middle of the photo consists of a dark Aka coral bead, the most expensive variety of precious coral in the world. Samples courtesy of Enzo Liverino. Photo: Laurent E. Cartier

Outlook

The ability to trace pearls, precious corals and ivory back to their species-related and geographic origins can provide greater transparency and help curb trade in illegal materials (and thus restrict poaching and smuggling) and provide further information to document historic items.

Ongoing research and specifically next-generation sequencing (NGS) enables the screening of a large number of DNA sequences from smaller samples at lower costs, subsequently reducing the amount of sample material required. DNA fingerprinting is, therefore, becoming less destructive and more useful for gem materials such as pearls, precious corals and ivory. DNA fingerprinting as a tool in gemmology further illustrates the importance of multidisciplinary research collaborations (in this case, with marine biology and genetics scientists) to develop new gem-testing techniques for the 21st century. ✶ **Dr. L.E. Cartier**

FURTHER READING

Cartier L.E., Krzemnicki M.S., Lendvay B., Meyer J.B., 2018. DNA Fingerprinting of Pearls, Corals and Ivory: A Brief Review of Applications in Gemmology. The Journal of Gemmology, 36 (2), 152-160.

Meyer J.B., Cartier L.E., Pinto-Figueroa E.A., Krzemnicki M.S., Hänni H.A. and McDonald B.A., 2013. DNA fingerprinting of pearls to determine their origins. PLoS ONE, 8(10), article e75606, 11 pp., http://dx.doi.org/10.1371/journal.pone.0075606.

THE USAMBARA EFFECT AND OTHER COLOUR CHANGE EFFECTS IN GEMSTONES

Colour change in gemstones is an interesting phenomenon, which can be due to a number of reasons. One of the causes is the so-called Usambara effect, a type of colour change which is not so well known in the public. In contrast to the alexandrite effect, this phenomenon is not dependent on the type of illumination (different white light sources). It is named after the Usambara mountains in the Umba valley of Tanzania, a region that has been a rich source of colour change gemstones in recent decades.

"Colour change in minerals is complex and its understanding requires a holistic approach." This quotation by Halvorsen (2006) shows that one has to understand all aspects that contribute to an observed colour change, whether it is the classic alexandrite effect or the Usambara effect, which in anisotropic minerals may both be modified by pleochroism, and as such also by the chosen crystallographic orientation for cutting.

Alexandrite effect

Since it was first described in 1831 for alexandrite (the chromium-bearing variety of chrysoberyl) from Russia, colour change, also known as 'alexandrite effect' has been studied extensively by many scientists. When the main hue of a mineral in daylight differs from that seen in incandescent light we traditionally speak of colour change (LMHC 2010, Infosheet No. 9). Figure 1 shows an alexandrite exhibiting this kind of colour change.

△ **Figure 1: Alexandrite with a fine purity and a a remarkable size and weight of 11 ct showing a distinct colour change from bluish green in daylight (left side) to purple in incandescent light (right side). Photo: SSEF**

The three main factors for observation of the 'alexandrite effect' in a gemstone/mineral are : a) two white light sources with distinctly different emission spectra (e.g. daylight vs. incandescent light), b) a material that shows two transmission windows in its absorption spectrum separated by an absorption band at approximately 570 nm (e.g. caused by chromium or vanadium) and c) an observer whose brain interprets the incoming residual light energies into an according colour sensation (White et al. 1967; Nassau, 1983). Minerals showing a colour change like the alexandrite effect are said to have dichromatic transmission spectra. This means that for light sources stronger in red wavelengths (incandescent light), the perceived colour is often shifted to purplish to reddish hues. In contrast, daylight is stronger in the blue to green part of the spectrum for which human eyes are more sensitive. Thus, the perceived colour is often dominated by bluish to green colours. However, other resulting colours may also occur (e.g. heated zircon, see Facette 20, 2013; or Fe-bearing cobalt spinel, Senoble 2010, Hanser 2013).

Apart from the alexandrite effect, there are other effects, which may considerably contribute to the colour perception of a mineral or gemstone, namely pleochroism (Liu et al., 1995) and the Usambara effect (Halvorsen and Jensen, 1997).

Pleochroism

The effect of different colours due to different selective absorption along two (uniaxial) or three (biaxial) vibrational directions within an anisotropic mineral (very distinct in alexandrite) is described as pleochroism. This property may also influence the perceived colours in anisotropic minerals. This happens by reducing the colour change especially in faceted alexandrite due to multiple internal reflections of the different plane polarized pleochroic colours (Liu et al., 1995).

Usambara effect

The Usambara effect describes the property of a material to change colour in relation to the path length that the light travels through the material. At the so-called critical thickness change-over point of the material (the critical path length through the gemstone), the perceived colour of the transmitted light shifts from (dark) green to (dark) red. This effect can be observed when viewing either along the ordinary or the extraordinary ray.

Most studies about this colour change effect were done on crystals and rough fragments, but also on some cut stones of chromium-bearing tourmalines and garnets from the Daluni area in the Umba Valley of northeastern Tanzania. The colour of gem materials exhibiting the Usambara effect can change due to internal reflections (Figure 2 and/or 3) thus 'doubling' the perceived path length within the stone, or when two stones are superimposed (again resulting in a 'doubling' of the path length, Figure 4). Internal reflections are an effective increase in path length and red flashes may appear on some facets only in an otherwise greenish gemstone, for example Cr-bearing tourmaline or garnet. Until today, the Usambara effect was observed in many other gem materials such as corundum, garnet, epidote and kornerupine.
All the above described colour effects may contribute greatly to the beauty of a gemstone and are sought after curiosities of nature and highly appreciated by gem collectors, connaisseurs and gemmologists alike. ✶ **A. W. Klumb**

△ **Figure 2:** Chromium-bearing tourmaline from Tanzania showing the Usambara effect. The colour change from green to red is caused by multiple internal reflections of light. Photo: A. W. Klumb, SSEF

◁ **Figure 3:** Colour change of garnet from daylight (brownish green) to incandescent light (red). The reddish brown facet reflections around the girdle in daylight are the result of the Usambara effect. Photo: SSEF

◁ **Figure 4:** Usambara effect (red trans-mission colour) shown with two superimposed colour changing garnets (=each brownish grey in daylight) of ± 50 ct. Photo: M.S. Krzemnicki, SSEF

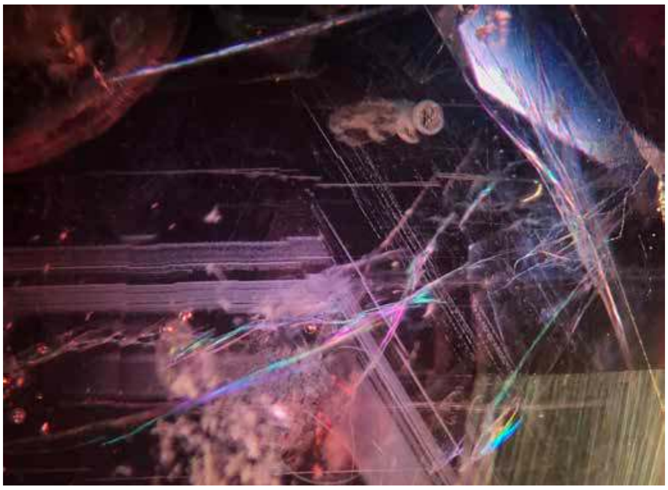
PINK SAPPHIRE WITH LEAD GLASS FILLER

The filling of fissures in corundum with lead glass (or other heavy element such as antimony) to enhance their transparency and colour is well known in the trade since more than 10 years. This treatment is mostly applied on low quality corundum of red colour, this treatment has also much less frequently been used for other varieties of corundum. As such, stones are normally already sorted out before the SSEF is involved in testing. We were thus quite astonished to receive a lead glass treated pink sapphire (Figure 1) from a client.

◁ Figure 1: Pink sapphire heated and with lead glass filled fissures. The yellowish lead glass results in patchy orangey hues in this treated stone. Photo: V. Lanzafame, SSEF

Interestingly, a combination of microscopic observations and analytical data revealed that this pink sapphire was in fact treated with two different processes. The first step involved heating at quite high temperature, and then fissure filling with lead glass, this time assisted by a rather low-temperature heating to melt the lead glass so it was able to enter the fissures.

The first high-temperature heating resulted in numerous 'atoll-structures' of transformed inclusions with discoid tension cracks, a classic feature for corundum heated at higher temperatures. In addition to this, the stone showed pronounced zoning with tiny particles aligned in growth bands which were not much affected by the heating.



△ **Figure 2:** Very prominent fissures with distinct flash effects (purple, blue, yellow) characteristic for this type of fissure filling with lead glass in corundum. In addition there are a few atoll-structures (discoids with white rim) in the background, indicating high temperature heating prior to the fissure filling treatment. Photo: S. Hänsel, SSEF

To fill the few but large remaining fissures in this stone, it was then filled with lead glass. This second treatment is easily recognizable under the microscope by well-trained gemmologists, as it results in intense flash effects (purple, blue and yellow) along the filled fissures when illuminated correctly (Figure 2). In our case, the detection of lead by chemical analyses (EDXRF) further supported the microscopic evidence. Lead glass used for this treatment is often slightly yellowish, which may have in some treated rubies a 'positive' effect on their colour. Due to the fact that the fissures filled with yellowish lead glass were quite prominent in our case, the pink sapphire showed patchy orangey hues (Figure 1), similar to the case of a lead glass filled synthetic pink sapphire described by Hughes (2017). Unfortunately, this effect may look reminiscent of padparadscha and might fool an unwary observer. ✶

A VISIT TO THE GEMSTONE DEPOSITS OF LUC YEN, NORTHERN VIETNAM

Since the late 1980s, the Luc Yen district in northern Vietnam became a reputable source for gemstones such as ruby, spinel and sapphire that mainly occur in white marbles and alluvial deposits. Furthermore, tourmaline, topaz and quartz are also mined in weathered pegmatites of the region.

This area became world famous for well saturated, blue cobalt spinel from the An Phu deposit (Figure 1). Due to its vibrant blue colour, this spinel very quickly became a highly prized gemstone by collectors and the gem trade. Because of its rarity only a very small amount of stones can be found in the local and also international markets and sizes are rarely above 5 carats. SSEF has had the pleasure of testing some exceptional cobalt blue spinels from Vietnam these past few years (e.g. Figure 2). We have also conducted extensive research on this unique gem variety and published research to better understand the colour change phenomenon which can be found in some cobalt spinels from Vietnam (see Facette 2014, p. 14).

△ **Figure 1:** Rough cobalt spinel from An Phu. Photo: S. Hänsel, SSEF

△ **Figure 2:** Cobalt spinel from Vietnam. Photo: SSEF

At the beginning of December 2018 the author made a field trip to the Luc Yen district, with the aim of collecting samples from different ruby and spinel deposits in order to add research samples to the SSEF reference collection. During an 8-day trip around 10 different, mainly secondary deposits, were visited and it was possible to gather scientifically valuable samples directly out of the sieves of the miners. Visits to the gemstone market in Yen The (capital of the Luc Yen District), cutting places and a heating facility for sapphires were also an integral part of this field trip.

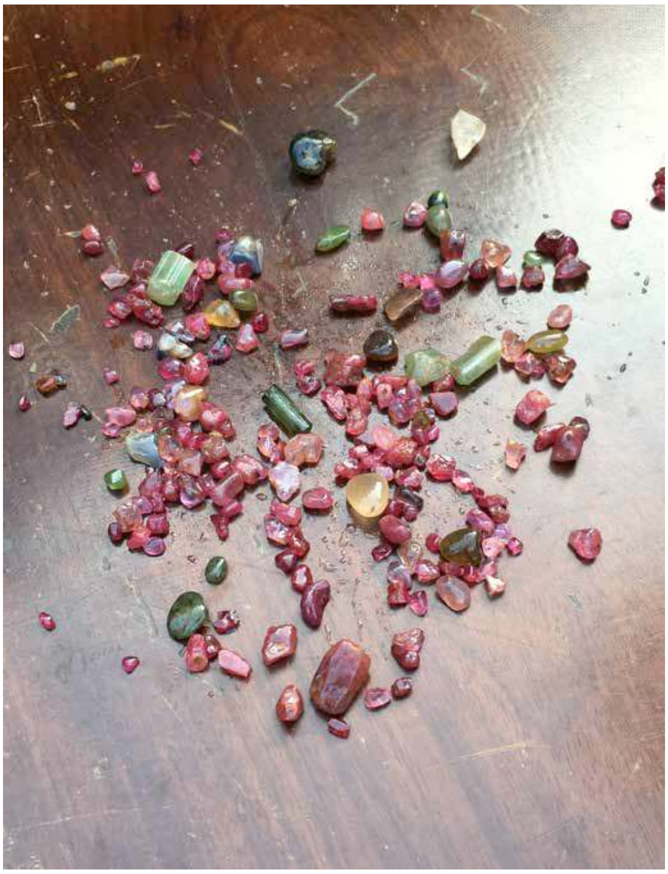
△ **Figure 3:** Yen The, the capital city of Luc Yen District with its impressive marble ridges. Photo: S. Hänsel, SSEF

△ **Figure 4:** Cutter at work, polishing ruby and spinel in Yen The. Photo: S. Hänsel, SSEF

△ **Figure 5:** Gemstone market in Yen The. Photo: S. Hänsel, SSEF

Besides the beautiful landscape the author was highly impressed with the mining community of the Luc Yen district. We were welcomed everywhere and shown around the mining places in a warmhearted fashion. As local mining is in general artisanal or small-scale mining without heavy machinery the author is confident that the area of Luc Yen will be a good source of high quality gemstones for the next decades.

△ **Figure 6:** Small scale mining in the paddy fields between planting seasons. Photo: S. Hänsel, SSEF



△ **Figure 7:** Fresh from the miners' sieve: ruby, sapphire, spinel and tourmaline. Photo: S. Hänsel, SSEF

In summary, it was a very successful field trip with a lot of memorable impressions. Even though Luc Yen is an important gemstone town, there is much more to explore like impressive landscapes, good food, fresh fruits and of course the friendly people of the area.

A very special acknowledgement goes to the wonderful Mai Tran and Geir Atle Gussias (BalderGems) who were perfect guides through all rough roads and of course also lovely hosts. The author is very grateful to them for having made this a memorable and successful field visit.

✶ **S.Hänsel, SSEF**

AGE DATING ON RUBY SET IN ICONIC RUBY NECKLACE BY HARRY WINSTON

△ **Figure 1:** Iconic ruby necklace with ruby ear-pendants by Harry Winston. Photo: V. Lanzafame, SSEF

Harry Winston was certainly one of the most important and influential jewellers of the 20th century. The son of a small jewellery shop owner, Mr. Winston was fascinated by gems and jewels already at a young age. His natural gift for evaluating gemstones and jewellery enabled him to follow his passion and successfully launch his own business in 1920. He was famed for his ability to re-cut and set gemstones of historical provenance into jewellery of a more contemporary design, thus creating a modern way to express luxury and style for his international clientele.

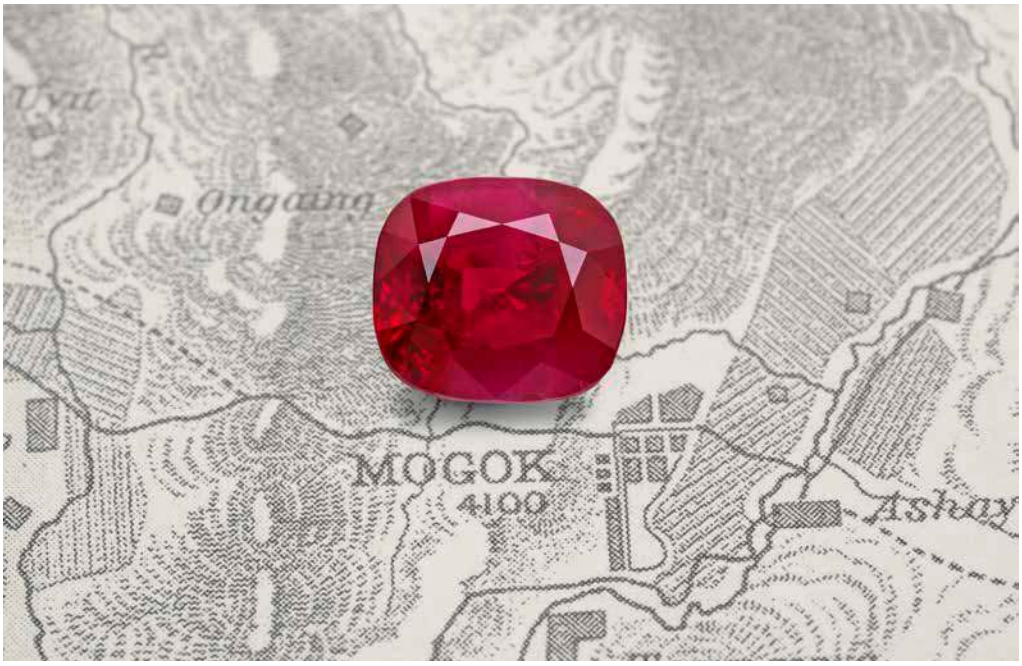
Many of the most important diamonds and coloured gems ever discovered went through his hands, such as the Hope diamond (44.5 ct), the Jonkers No. 1 diamond (126 ct), the sapphire of Catherine the Great (see short note in this SSEF Facette), to name just a few. Quite an important part of his exclusive jewels with coloured stones were actually analysed by SSEF in the past years.

Very recently, the SSEF had the pleasure of analysing a magnificent ruby jewellery set created by Harry Winston in the early 1980s. The set consists of an impressive necklace with 16 rubies and a pair of matching ruby ear-pendants (Figure 1). This jewellery item is pictured and described in the book "Harry Winston: the Ultimate Jeweler" by Laurence Krashes (1984, see pages 162-163)

Each and everyone of these 18 rubies were analysed as loose stones and within the setting. They range in size and weight from 2.06 ct to 17.01 ct for the central ruby of the necklace, leading to an impressive total weight of nearly 116 ct. All rubies were found to be of Burmese origin, showing internal features considered classic for rubies from the famous Mogok valley.

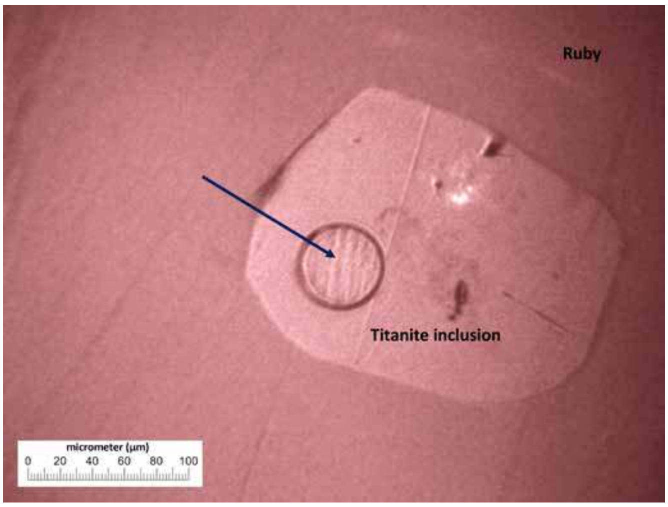
△ **Figure 2:** a) Perfect idiomorphic apatite crystal floating like a space shuttle through the described Burmese ruby. b) Zones of dense rutile needles together with small inclusions of colourless apatite and slightly yellowish titanite in the same ruby. Microphotos: M.S. Krzemnicki

Apart from the normal testing procedures, we were able to identify by Raman microspectroscopy a number of small inclusions within these rubies (Figure 2), namely calcite, apatite, diaspore and titanite (also known as sphene in the trade). Especially interesting to us are those inclusion minerals, which intrinsically incorporate trace to ultra-trace amounts of radioactive isotopes, such as ^{238}uranium (^{238}U). The radioactive isotope ^{238}U is not stable and decays to a stable isotope of lead (^{206}Pb) at a constant rate. Hence, by measuring the ratio of parent (uranium) and daughter (lead) isotopes using a mass spectrometer (e.g. GemTOF at SSEF), it is in principle possible for us to precisely determine the formation age of that mineral. An excellent mineral for age-dating is titanite ($CaTiSiO_5$), which often incorporates distinct concentrations of uranium but only low amounts of lead during its formation.



◁ **Figure 3:** Exceptional Burmese ruby of 12.8 ct from the described Harry Winston necklace. This ruby contains a tiny titanite inclusion at the surface which was used for age dating using the SSEF GemTOF. Photo: M.S. Krzemnicki, SSEF

Interestingly, one of the largest rubies of this necklace (12.8 ct, Figure 3) revealed a tiny titanite inclusion exposed to the surface, hence accessible to our GemTOF laser (Figure 4). By using a laser spot size of 0.05 mm (less than half the thickness of a human hair) we were able to acquire not only radioactive pairs of isotopes, but also major-, minor-, and trace-elements from almost the entire periodic table of elements. This specific feature of our time-of-flight mass spectrometer of the newest generation (GemTOF) enabled us not only to calculate the geological age of this specific titanite inclusion, but also to quantify its full range of trace elements at the same time.



△ **Figure 4:** Tiny titanite inclusion (0.15 mm small) at the surface of a 12 ct Burmese ruby originally set in the Harry Winston necklace. The small circle (blue arrow) indicates the minute amount of material which was ablated by a focused laser beam (ablation diameter 0.05 mm) using our SSEF GemTOF system. It enabled us not only to calculate the age of this titanite inclusion (approx. 40 million years) but also to determine its complete chemical composition. Photo: H.A.O. Wang, SSEF

Based on our analysis, we were able to successfully calculate the formation age of the titanite inclusion to be approximately 40 million years (40 Ma ± 2 Ma). This is in good agreement with the formation age of rubies in the Mogok area (Myanmar), which formed by complex geological processes as a consequence of the collision of the Indian plate with Eurasia during the mid to late Cenozoic period (66 Ma to today). In addition, we were able to simultaneously analyze with GemTOF a large number of trace- and ultra-trace elements in this titanite, such as zirconium, hafnium, tantalum, and rare earth elements, all in accordance with reference samples from the same area analysed previously by SSEF.

To conclude, age dating of inclusions in gemstones is a rather new and highly promising method, adding evidence in certain cases for origin determination. SSEF has dated in the past few months numerous inclusions (mostly zircon, but also further uranium-bearing minerals such as the described titanite). These inclusions were mostly found at the surface of sapphires, rubies and spinel which were either submitted to us by our clients or which are from our SSEF research collection. To be able to carry out such cutting-edge analyses on one of the most important ruby necklaces of historic provenance is a perfect example to demonstrate the scientific progress that has been made in past years in gemstone testing, and we are proud to report with this short note the first ever documented age dating of a titanite inclusion in a gem-quality ruby. ✶ **Dr. M.S. Krzemnicki & Dr. H.A.O. Wang**

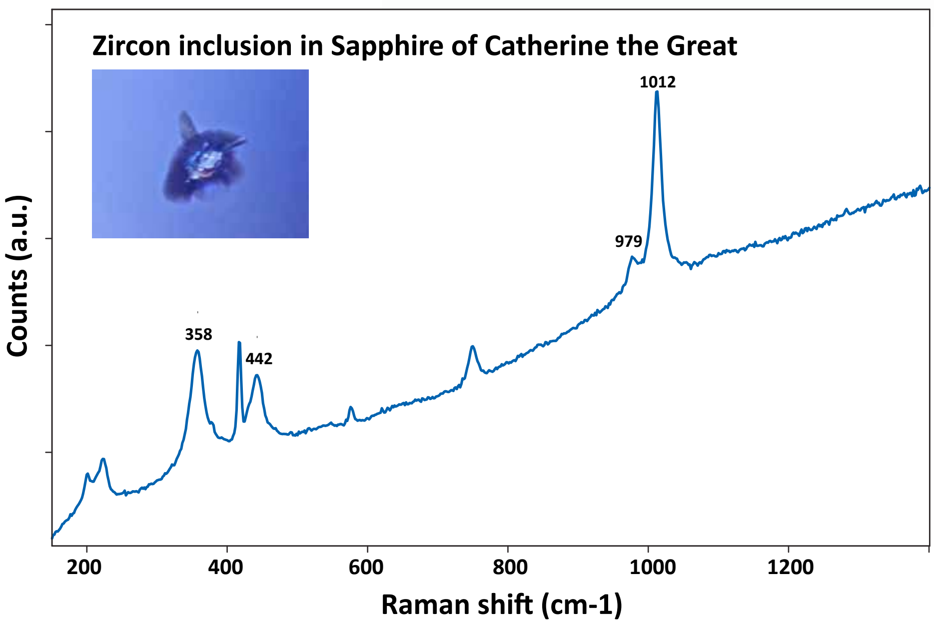
HISTORIC SAPPHIRE OF CATHERINE THE GREAT

At SSEF, an impressive number of sapphires of exceptional size and quality have been tested in the past few decades. In the last few weeks, however, we had the pleasure to add to this eclectic (data) collection the famous sapphire of Catherine the Great, a historic gem from Ceylon (Sri Lanka) of exceptional quality and beauty (Figure 1).

Based on the provided documentation, this sapphire is of historic provenance and once belonged to Catherine the Great (Figure 2), empress of the Russian Empire from 1762 to her death in 1796 (see Les Joyaux des Tsars by M. Greece). This sapphire of 331 ct (originally 337 ct) was closely related to the history and fate of the Russian Empire and was finally sold in 1914 to a private collector. It later became part of the Harry Winston 'Court of Jewels' collection which toured the United States from 1949 to 1953, and is depicted on an iconic photograph, on which Harry Winston is seen holding the 'Sapphire of Catherine the Great' in his hand together with other impressive gems, including the Hope diamond (see Harry Winston, the ultimate Jeweler by Krashes and Winston, 1984, page 27).

Meticulous microscopic examination and detailed analyses confirmed its Sri Lankan origin, highlighted by the presence of tiny metamict zircon inclusions (Figure 3), characteristic for this gem source. Since historic times, Ceylon (Sri Lanka) is known and appreciated as source of exceptional gems, especially blue sapphires. Found in the gravels of the lush green plains and valleys of this tropical island, these gems were already traded throughout ancient cultures in Southeast Asia, Persia, and even to the Roman Empire and medieval Europe along maritime trade routes and the famed Silk Road (see also Marco Polo's 'Livres des Merveilles du Monde'). Up to today, this small island in the Indian Ocean has produced and still is producing some of the largest gem-quality sapphires known in the trade, such as the 'Star of India' (583 ct), 'Giant of the Orient' (486 ct), the 'Logan Blue Sapphire' (423 ct), the 'Blue Belle of Asia' (392 ct), and the described 'Sapphire of Catherine the Great'(331 ct). ✶

◁ **Figure 1:** The historic 'Sapphire of Catherine the Great' of 331 ct. Photo: L. Phan, SSEF



◁ **Figure 3:** Raman spectrum of a metamict zircon inclusion in the sapphire of Catherine the Great recorded at SSEF. Figure: M.S. Krzemnicki, SSEF

△ **Figure 2:** Portrait of Catherine the Great Empress of Russia (1729-1796), after Alexander Roslin and Fedor Rokotov, together with her sapphire. Photos: Christie's and SSEF

MOGOK RESEARCH PROJECT: UPDATE ON SPINEL

Since the end of 2015, Myint Myat Phyo is at the Mineralogical Institute of the University of Basel (Switzerland) researching rubies and spinels from the Mogok Gemstone Tract (Myanmar) and their complex formation conditions. This PhD study under the supervision of PD Dr. Michael S. Krzemnicki and Prof. Dr. Leander Franz has been generously supported by grants from the Canton Basel-Stadt, the Freiwillige Akademische Gesellschaft (FAG) Basel and the Swiss Foundation for the Research of Gemstones (SSEF).

During her PhD, Ms. Phyo has studied a large number of samples, collected directly at several mining sites along the mineralized Mogok zone, using a wide range of analytical methods, including trace element analyses (LAICP-time of flight- and -sector field-mass spectrometry), radiogenic isotopes (U, Pb) for age dating, Raman micro-spectrometry, scanning electron microscopy (SEM) and charge contrast imaging.

A detailed account of part of her research will be published in the next issue of the Journal of Gemmology (Gem-A). This article focusses mainly on solid and fluid inclusions in spinels from the Mogok Gemstone Tract, with a special emphasis on multiphase inclusions and retrograde exsolution of geikelite within spinel.

Interested readers are referred to the article by the upcoming JoG issue, which will be published in Spring 2019. ✶

△ **Figure 1:** Sunset over Mogok town and a pendant with red and greyish blue spinel from Mogok. Photo: M.S. Krzemnicki, SSEF

REFERENCE

Phyo M.M., Bieler E., Franz L., Balmer W., Krzemnicki M.S., 2019. Spinel from Mogok (Myanmar) - a detailed inclusion study by Raman microspectroscopy and scanning electron microscopy. In Press, Journal of Gemmology

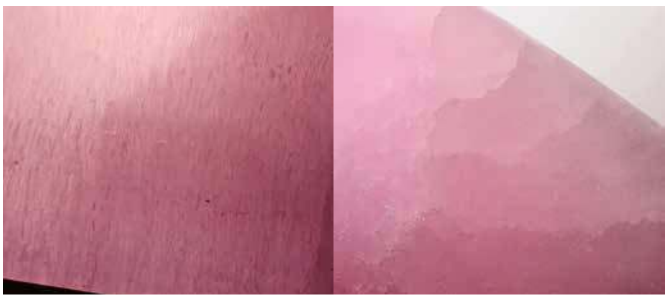
LA ‘ROSE DE MINE’: PINK COBALTOCALCITE FROM SWITZERLAND

△ **Figure 1:** Pink cobaltocalcite from the Valais in Switzerland as stalactites on the graphite-rich host rock and as cut and polished specimens investigated for this study. Photo: V. Lanzafame, SSEF

Switzerland is not known for gem deposits, although we have some small outcrops and findings even of ruby and emerald in metamorphosed rocks in the Swiss Alps. Well-known however are Alpine-type hydrothermal mineral formations, e.g. the ‘classic’ rock crystals with pink fluorite and many other and partly very rare and unique minerals for mineral collectors. All of these minerals formed during the main geological activity of the Alpine orogeny in the late Tertiary about 35-10 million years ago as a result of the collision of the African plate with the Eurasian continent.

Interestingly and very much in contrast to the above, we were able to study in the past few months an ornamental mineral (Figure 1) from Switzerland of an attractive pink colour and translucency, which formed only very recently (in the last 100 years) and at ambient conditions. This mineral crystallized as stalactites in shafts in a now depleted coal mine near Isérables in the Valais, and as such its formation and presence is linked to human mining activity and metal-enriched residual mining waters circulating through these old shafts.

Chemical and structural (Raman spectroscopy) analyses immediately revealed that this material is cobaltocalcite $(Ca,Co)CO_3$, a pink to purple variety of calcite, well-known and appreciated by mineral and gem collectors due to its attractive colour. Cobaltocalcite - mostly found as polycrystalline aggregates – is especially known as a by-product from several ore mines in Africa (e.g. Democratic Republic of Congo) and further mines in Spain, Italy (Elba), and Germany, to name a few.

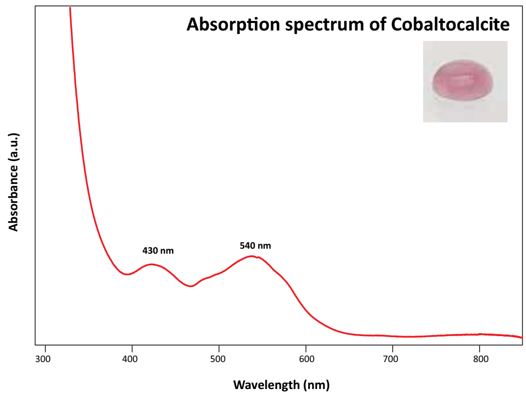


△ **Figures 2 (left) and 3 (right)** revealing the dense fibrous to mosaic texture of the investigated cobaltocalcite. Photos: M.S. Krzemnicki, SSEF

Under the microscope, the polycrystalline nature of the material was evident, with numerous tiny fibrous crystallites forming botryoidal to stalactitic structures, partly also forming a mosaic-like pattern (Figures 2 and 3).

The chemical analyses (ED-XRF) on two items from this source revealed calcium carbonate as mainly dominating constituent, with minor amounts of Mg and Sr, commonly encountered in carbonates where they replace Ca by a simple substitution process. The cobalt concentration was in both samples very similar (0.167 and 0.159 wt% CoO) with additional traces of zinc (about 2500 ppm), nickel (about 500 ppm), but only very low concentrations of iron (about 100-200 ppm). In contrast to cobaltocalcite described by Siritheerakul and Sangsawong (G&G 2015), the investigated specimens showed no manganese (below detection limit of 100 ppm).

The absorption spectrum on the studied cobaltocalcite samples revealed a characteristic absorption band at about 540 nm with a smaller band at about 430 nm (Figure 4), both attributed to Co^{2+} in octahedral position within the cobaltoalcite structure.



△ **Figure 4:** Absorption spectrum of one of the studied cobaltocalcite samples from Valais, Switzerland with two absorption bands related to cobalt. Figure: M.S. Krzemnicki, SSEF

The occurence of cobaltocalcite in a depleted former coal mine in the Valais (Switzerland) is linked to a series of local Co-Ni-As-Bi mineralisations within the Siviez-Mischabel fold-nappe (Penninic unit) in the Valais, possibly representing primary native metal precipitations reworked by younger Alpine geologic events (Kneissl et al. 2016). The formation of this material as stalactites at ambient conditions is caused by a combination of natural and anthropogenic factors, i.e. carbonate precipitation from Co-enriched meteoric waters and mining activity, similar to by-products found in tailings of other Co-mining districts (Gonzalez-Lopez et al. 2014). Apart from its beauty, this ornamental material thus represents a perfect new addition to the Swiss gem trade (Figure 1), as it is rare, of local occurrence, and has an intriguing history of formation and discovery. It is thus also poetically referred to by the fancy name ‘Rose de mine’ (English: The Rose of the mine).

Finally, we would like to thank Grégoire Maret (Pierre d’Alexis SA, Geneva) for the supply and donation of this material to the SSEF.

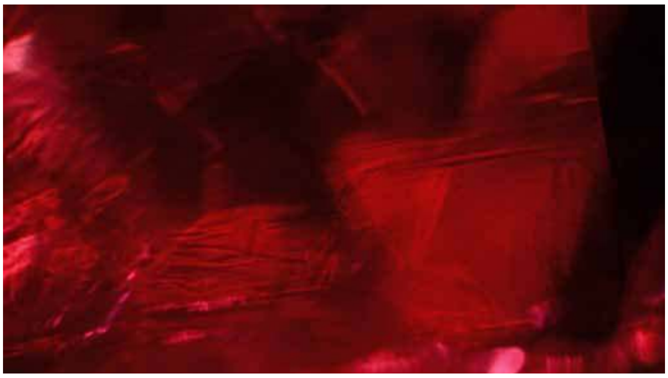
✶ **Dr. M.S. Krzemnicki**

VANADIUM-RICH RUBY FROM MOGOK, MYANMAR

Mogok-type rubies are known to contain small but distinct amounts of vanadium (often in the range of 0.015 – 0.025 wt% V_2O_3), but are commonly highly dominated by chromium (approximately by a factor of 20-100 x) responsible for their often attractive and saturated red colour and strong fluorescence. In some cases, vanadium enriched rubies and purple sapphires from Mogok have been reported (Zaw et al., 2014 and Sutherland et al. 2015), especially from the western part of the Mogok Stone Tract that extends into a zone from Pingu Taung (Kyatpyin), Yadanar Kaday-kadar, to Singh-wa.

◁ **Figure 1:** Vanadium-rich ruby from Mogok, 4 ct. Photo: J. Xayasingkham, SSEF

Recently, the SSEF received an unheated Burmese ruby (Figure 1) which showed a very uncommon and high vanadium concentration (up to 0.51 wt% V_2O_3) compared to rather low chromium (0.05 wt% Cr_2O_3) and very low Fe (0.005 wt% Fe_2O_3). This trace element composition (analysed by ED-XRF) results in a V/Cr-ratio of 11.4, which is distinctly higher than those commonly encountered in Burmese rubies (V/Cr-ratio about 0.1), but similar to reported V-concentrations and V/Cr-ratios reported by Zaw et al. 2014. The ruby showed a slightly purplish colour of strong saturation (Figure 1), especially visible in daylight equivalent light (6500 K). Using a warmer white light (about 4000 K), the colour was distinctly less purplish and much more a dark saturated red. The inclusions were very characteristic and classic for Burmese rubies from marbles, showing distinct swirl-structures (Figure 2), colourless carbonate-inclusions, and zones with dense and fine rutile needles.

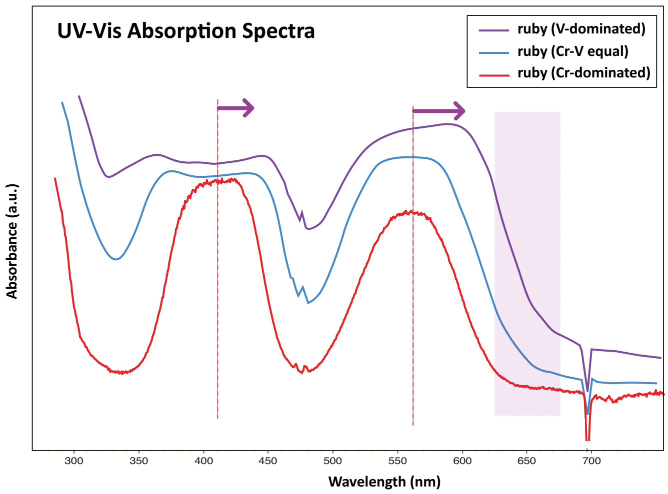


△ **Figure 2:** Vanadium-rich ruby from Mogok, 4 ct. Photo: J. Xayasingkham, SSEF

Minerals (e.g. corundum, spinel, chrysoberyl, beryl) coloured by vanadium (V^{3+}) or chromium (Cr^{3+}) often show a very similar absorption spectrum, dominated by two absorption bands in the visible to ultraviolet range, with the chromium absorption bands located at slightly lower wavelengths than those caused by vanadium. This slight shift may however have quite an effect on the apparent colour of such materials (e.g. shift from colour-changing alexandrite to green vanadium chrysoberyl).

Vanadium in (synthetic) corundum is known to produce a greyish–purplish colour change (somehow imitating alexandrite), whereas chromium in rubies results in a pure red colour. In the case of small traces of vanadium besides the main colouring elements (e.g. Cr, Fe and Ti), the effect on the colour in rubies and sapphires can be neglected. However, higher amounts of vanadium in sapphires shifts their blue colour slightly to purplish blue hues, in some cases even resulting in a slight to moderate colour change.

The described V-rich ruby is a perfect sample to study the effect of high vanadium (and low Cr) on the colour of rubies. It shows a saturated purplish red hue which can be definitively attributed to the high vanadium concentration. In addition, this ruby shows only a very dull red fluorescence reaction in longwave ultraviolet, thus indicating that the high vanadium concentration effectively reduces the Cr-fluorescence even in the near absence of any iron in the crystal structure.



△ **Figure 3:** Absorption spectra of V-rich ruby compared with Cr dominated ruby and intermediate ruby (equal Cr and V concentration), all from Mogok; Myanmar. The purple arrows qualitatively indicate the vanadium-related shift of the absorption bands. Figure: M.S. Krzemnicki, SSEF

A comparison of the absorption spectra (Figure 3) of this V-rich sample with a normal Cr-dominated (and Fe poor) ruby from Mogok illustrates the above described shift of the two main absorption bands (purple arrows) towards longer wavelengths due to the high vanadium concentration (combined with a distinct reduction of transmission in the UV range). As a result, the transmission in the red spectral range is reduced in this vanadium rich ruby (light purple zone in Figure 3), which explains its colour shift towards purplish red as the transmission window in the blue gets more important. However, due to the stronger crystal field effect of Cr^{3+} compared to V^{3+}, even small chromium concentrations contribute more to the colour (red) than vanadium (purple-grey addition) (Zaw et al. 2014). Consequently the identification of the described specimen as ruby is evident as its colour is still distinctly chromium-related, although chemically dominated by vanadium as a trace element.

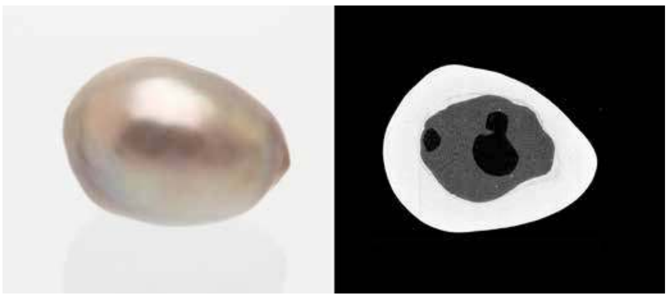
The high vanadium concentration of this and other related rubies clearly indicates that vanadium is a major characteristic of Burmese rubies, notably from Mogok and related marble deposits (Zaw 2014, Sutherland et al. 2016), which sets them apart from other marble deposits along the Himalayan mountain range (e.g. Tajikistan, Afghanistan, Vietnam) or in East-Africa (e.g. Tanzania, Kenya), to name a few. ✶ **Dr. M.S. Krzemnicki**

CULTURED PEARL FILLED WITH ORGANIC MATTER

In 2013, we described a new method to produce large baroque-shaped Tahiti cultured pearls with exceptional pearl lustre and orient, using shell pieces as beads (Cartier & Krzemnicki 2013, and Facette No. 21, 2014). These cultured pearls are produced in a two-step process. In a first step, a kind of a 'hollow' cultured pearl is created in a few months, using an organic bead material. This bead is initially small and compact when introduced into the shell, but becomes soft and gelatinous by absorbing the surrounding liquid, and as a consequence grows in size. This expands the pearl sac, so that after the harvest of this first cultured product, a much bigger shell piece can be introduced into the pearl sac in order to grow the above-mentioned exceptional baroque cultured pearls.

This first product, however, is often very fragile and light, as it is mainly 'hollow', i.e. only filled with organic gelatinous matter, and often characterised by a very thin layer of nacre at the surface. As such, this product should not be used in jewellery, as it is prone to cracking and chipping at any time.

In the past year, we found a cultured pearl filled with organic matter (Figure 1) in a parcel of pearls. It was sent to us because our client became suspicious of the rather low weight of this specific pearl (3.9 ct) compared to its dimensions (maximum diameter 10.6 mm). The cultured pearl (presumably from *Pteria Penguin* species) shows a brownish grey colour in combination with beautiful rosé, green, to blue overtones. The X-ray microtomography best reveals its large internal cavity, which is filled with an organic material (granular dark grey) with a few empty 'bubbles' (black in the tomography). Due to its organic 'bead', we consider this cultured pearl a rather fragile product, especially if drilled and soaked with water during the drilling. ✶



▷ **Figure 1:** Cultured pearl using an organic gelatinous bead material together with section of X-ray microtomography (right). Figure: M.S. Krzemnicki, SSEF

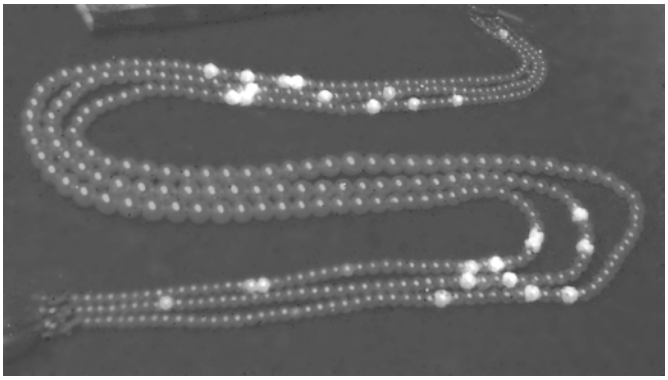
FAKE HISTORIC PROVENANCE: 'AGED' CULTURED PEARLS

Historical age and provenance can have an important impact on the price of pearls. This is best illustrated with the pearl pendant of Marie Antoinette (see short note in this Facette), which sold in November 2018 for the fabulous price of 36 million Swiss Francs at Sotheby's Geneva.

It is therefore not astonishing, that some innovative treaters are 'ageing' pearls with the intent to fool the trade and buyers about its real and recent formation. For paintings and especially for fake antiques, similar 'ageing' treatments are well-known in the art trade (see e.g. F. Arnau 1964: Kunst der Fälscher. Fälscher der Kunst. Dreitausend Jahre Betrug mit Antiquitäten. Econ Publisher, Germany).

△ **Figure 1:** Natural pearl necklace containing 28 freshwater cultured pearls with 'aged' surface treatment. Photo: V. Lanzafame, SSEF

At SSEF, we have encountered few cases of pearls which had been treated to make them look old and historic. Most recently, we received a pearl necklace with 410 pearls strung on three regularly graduated strands (Figure 1). The pearls were characterized by a beautifully matching colour and a fine pearl lustre, reminiscent of 'classic' natural pearls from the Arabian Gulf. However, a closer look using X-ray luminescence (SSEF PearlView) revealed that 28 pearls of the necklace showed a distinct reaction typical for freshwater pearls (Figure 2). A more detailed investigation with radiography further unveiled that they in fact represented beadless freshwater cultured pearls, similar to those produced in Chinese pearl farms in huge quantities. They were mixed (intentionally) into this necklace of saltwater natural pearls.



△ **Figure 2:** X-ray luminescence image (SSEF Pearl View) reveals 28 freshwater cultured pearls with distinct luminescent reaction. To better visualize the position of these cultured pearls within the pearl strands, the X-ray luminescence image was overlaid by a photo taken in exactly the same position. This overlay explains the small bright lamp reflections on each pearl. Figure: M.S. Krzemnicki, SSEF

Under the microscope, these freshwater cultured pearls all showed a slightly corroded surface (Figure 3), as if they had been exposed to an acidic solution to create an 'ageing' effect with a cream colour. Trace element analyses (EDXRF) showed not only manganese (993 ppm), strontium (1780 ppm), barium (60 ppm) at levels typical for freshwater pearls, but in addition iron (418 ppm), titanium and copper (both not quantified), which is presumably related to the treatment of these cultured pearls.

◁ **Figure 3:** Detail of this pearl necklace showing one 'aged' freshwater cultured pearl with corroded surface, interlayered between natural saltwater pearls from *Pinctada radiata*. Photo: M.S. Krzemnicki, SSEF

In summary, this pearl necklace contained a majority of untreated natural saltwater pearls of cream colour which had been intentionally mixed with a number of freshwater cultured pearls. We assume that these cultured pearls were treated ('aged') with the aim to create a uniform necklace of historic look. ✶ **Dr. M.S. Krzemnicki**

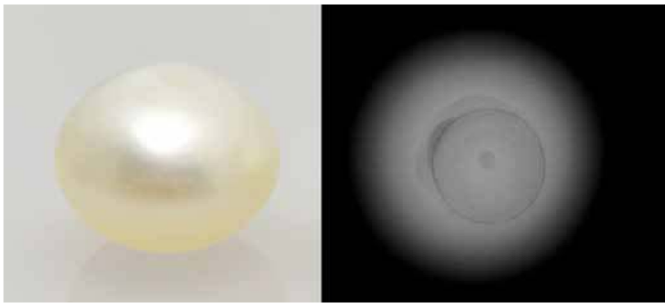
CHASING CULTURED PEARLS AT SSEF: CULTURED PEARLS USING A NATURAL PEARL AS A BEAD

As a leading pearl testing laboratory worldwide, the SSEF has analysed in the past few months a large number of pearls for our clients. Besides natural pearls of impressive size or historic provenance (e.g. the pearl pendant of Marie Antoinette and the so-called Dodge pearls), we regularly identify and sort out cultured pearls which were mixed intentionally or non-intentionally into pearl parcels.

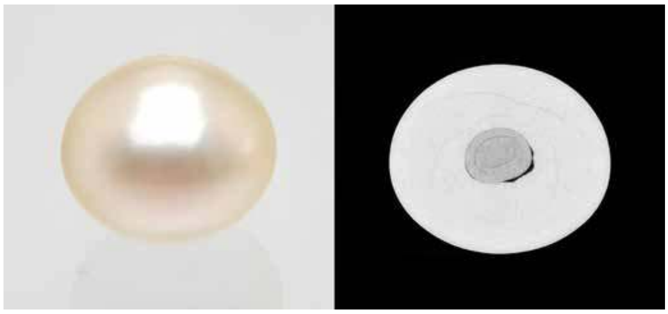
△ **Figure 1:** Too perfect to be true. A parcel of 19 cultured pearls with mixed structures, from 'classic' beaded to beadless, and even using a natural pearl as a bead, see following short note. Photo: V. Lanzafame, SSEF

Apart from the usual suspects, i.e. beaded and beadless cultured pearls with characteristic structures, we occasionally also encountered cultured pearls with uncommon features and structures (Figure 1), such as cultured pearls using a natural pearl as a bead, worth mentioning in a short note to remind the trade about this cultured product.

Reported already years ago (Krzemnicki 2010, Hainschwang 2010), natural pearls of low quality can be used as a bead to produce a cultured pearl of larger size and better quality. So far, we have seen these cultured products mainly produced within *Pinctada maxima* and *Pinctada margaritifera* shells. In the past year, we have again seen a few such samples, ranging in size from 8 – 12 mm, mostly mixed in parcels of undrilled or drilled pearls



△ **Figure 2:** Radiography showing a cultured pearl with a natural pearl as bead. The natural pearl is darker grey as it contains more organic matter interlayered within the tiny radially arranged calcite columns. The surrounding nacre overgrowth (bright grey) of this cultured pearl shows nearly no internal features apart from a cavity structure along the nacre/bead intersection. Radiography: J. Braun, SSEF



△ **Figure 3:** Cultured pearl with natural pearl as bead of 5.8 ct (9.5 mm diameter) and X-ray microtomography cross-section image showing the natural pearl bead (dark grey) surrounded by cultured nacre overgrowth (bright) and with an irregular empty cavity (black) adjacent to the bead. Tomography: J. Braun, SSEF

Although it is possible to already spot this through meticulous X-ray radiography analysis (Figure 2), these cultured pearls are best identified using X-ray microtomography (Figure 3), which provides a three-dimensional analysis of the internal pearl structures at high resolution. The characteristic features are a clear demarcation line between the natural pearl bead and the cultured nacre overgrowth, often with a more or less conical to irregular cavity structure adjacent to the bead structure, very similar to those observed in many traditional beaded cultured pearls. Another striking feature in many of these cultured pearl products is the obvious different texture of these two parts, with the natural pearl bead mainly or completely formed by columnar calcite with many drying fissures and a nearly perfect and uniform nacre overgrowth with nearly no drying fissures. ✶ **Dr. M.S. Krzemnicki**

PARAIBA RESEARCH UPDATE: AN ELEMENTAL ANALYSIS OF PARAIBA TOURMALINES FROM BRAZIL

◁ **Figure 1:** Paraiba tourmaline from Brazil of 4 ct recently tested at the SSEF. Photo: V. Lanzafame, SSEF

In the Paraiba state of Brazil, a Cu-Mn bearing tourmaline was first discovered by Heitor Dimas Barbosa in 1980s, and named after the state as Paraiba tourmaline (Figure 1). After its first discovery, this 'neon-blue' colored gemstone was also found in the nearby Rio Grande do Norte state in Alto do Quintos mine and Mulungu mine (currently in operation by MTB). Besides Brazil, Cu-Mn bearing material has been found in Nigeria and Mozambique. Although not from Paraiba state, this material may also be called 'Paraiba Tourmaline' in the trade. In recent years, Paraiba tourmalines of various colours (such as blue, green and purple) have gained popularity in the trade and have become some of the most coveted gemstones in market. Due to the market price difference of Brazilian and African material, origin determination of the Cu-Mn bearing tourmaline is often a request to gem testing laboratories.

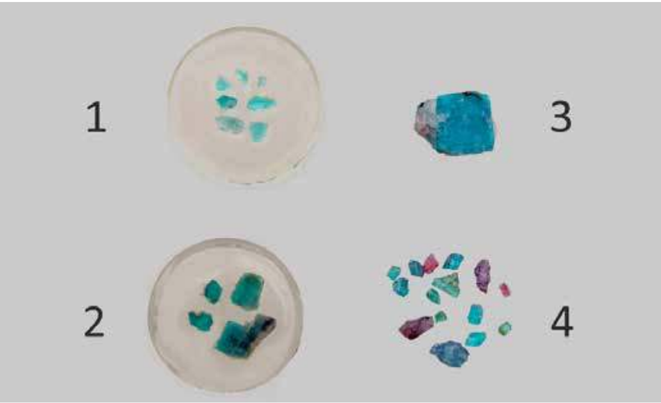
At the SSEF, origin determination of Paraiba tourmalines is based on years of experience researching collection samples from SSEF and Prof. Hänni collections, donated and loaned samples from clients, as well as knowledge from scientific literature. However, the mining area and depth of the material have been increasing ever since. Considering geological variation, it is probably not valid to assume that properties of material mined today shall resemble that of those mined years ago. Therefore, along mining progress throughout the period, the SSEF has tried its best to collect samples from various reliable sources to improve it collection and database. In October 2017, a team of gemmologists from SSEF conducted a field trip in the mining area of Paraiba state and Rio Grande do Norte state in Brazil, during a beautiful autumn season (Figure 2). The team had a defined goal of collecting first-hand samples and record gemmological and geochemical data back in the lab, and it turned out to be very successful. We would like to thank the generous supports from local hosts, especially Mr Carlo Somma, Mr Sebastian Ferreira and Mr Nelson Oliveira. A short report of this trip was presented in last issue of Facette (2018).

△ **Figure 2:** Beautiful sunset view in the direction of Parelhas, the closest town to the Mulungu mine (in operation by MTB), Rio Grande do Norte state, Brazil. Photo: H.A.O. Wang, SSEF.

△ **Figure 3:** Paraiba tourmaline with pegmatite host rock sampled inside the Mulungu mine, (Mineral Terra Branca, MTB). Photo: H.A.O. Wang, SSEF

A large number of samples were collected during the field trip, including for example rough material sampled within the pegmatite host rock inside the mine (Figure 3), small pieces sampled on the sorting table (Figure 4), and pieces donated by local hosts. As partially shown in Figure 5, dozens of Paraiba tourmalines were picked out and prepared. Major, minor and trace elements were quantified by our in-house GemTOF instrument (a LA-ICP-Time-Of-Flight-MS system, www.gemtof.ch). As routine analysis, a tiny laser spot was used to extract the material from the sample. Three positions were shot on each one to reproduce sample heterogeneities. Additionally, from SSEF's chemical database, we extracted highly confident data of 56 Paraiba tourmalines from Brazil and 43 samples from Mozambique of various colours, all of which were previous analyzed by GemTOF. The instrument was tuned to deliver consistent performance, which is critical for fusing long-term data into comparisons. Although traces of geochemical differences can be observed among different mines within Brazil, it is not SSEF's policy to distinguish materials from different regions of Brazil for client reports.

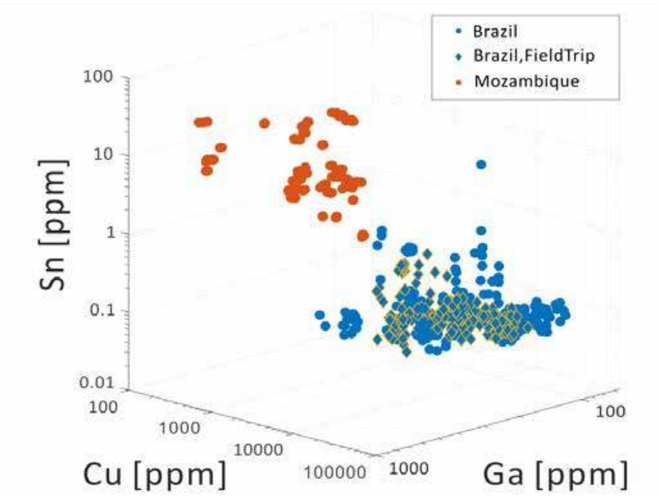
△ **Figure 4:** Sorting table at MTB where Paraiba tourmaline small pieces are sampled. Photo: A. Klumb, SSEF



△ **Figure 5:** Prepared Paraiba tourmaline samples for GemTOF analysis. (1-2) small samples embedded in epoxy-resin; (3) polished rough sample with host pegmatite; (4) polished small sample fragments of various colours. Photo: V. Lanzafame, SSEF

Using the benefit of full mass spectrum acquisition and low limits of detection, the GemTOF simultaneously detects almost all elements in the periodic table with superior detection limits. Such a figure of merit is required for a comprehensive quantification of the almost entire elemental composition in Paraiba tourmalines. Given its reputation of forming in the last 'drop' of melt (Pezzotta 2018), tourmaline contains multi-elements ranging from major to ultra-trace concentration. In our study, more than 35 elements were found in more than 50% of the analyses (total number of analyses/spots >600). Most of these frequently occurring elements show medium to strong overlapping patterns between Brazil and Mozambique samples. However, current data suggests that three elements indicate the most variation among samples of the two origins: copper (Cu), gallium (Ga) and tin (Sn). Higher concentration of Cu is frequently observed in Brazilian Paraiba tourmalines than the Mozambique ones. On the other hand, Mozambique samples normally contain higher concentrations of Ga and Sn than Brazilian counterparts.

Additionally, three dimensional scatter plots (Figure 6) using concentrations of Cu-Ga-Sn are useful to display these variations. It is apparent that Brazil and Mozambique samples are distinguished in general. The separation provides gemmologists complementary evidence to assist them in the origin determination of Paraiba tourmalines. Furthermore, elemental concentrations of Brazilian Paraiba tourmalines sampled from the current field trip have been found to overlap with those of previously tested Brazilian samples at SSEF



△ **Figure 6:** Scatter plot of Cu-Ga-Sn concentrations in Cu-Mn bearing tourmalines from Brazil and Mozambique. Blue and red dots are extracted from SSEF's database for Paraiba tourmalines from Brazil and Mozambique. The blue diamonds with yellow outline indicate samples originating from the field trip to Paraiba, Brazil.

As a conclusion, analyses of samples from this field trip have added confidence to the validity of SSEF's current database used for the origin determination of Paraiba tourmalines. Although 3D element plot is one of the most straightforward ways for visualization, overlap may happen and outliers are occasionally present, probably due to the small number of elements plotted used to represent the multi-element complexity of tourmalines. In order to better visualize between-group sample variation and within-group sample similarity, advanced data analysis is becoming more and more inevitable. Current research is focusing on a deeper look into the same dataset using principle component analysis, or even deeper investigation applying machine learning algorithms. As SSEF recently received generous support through submission of high confidence Cu-Mn bearing tourmalines from Mozambique and Nigeria, a comprehensive study is in the pipeline. ✶ **Dr. H.A.O. Wang**

THE DETECTION OF HPHT-TREATMENT OF DIAMONDS AT SSEF: 20 YEARS LATER

HPHT treated diamonds first appeared on the market more than two decades ago. At this time, the treatment was not specifically disclosed nor could it be identified by gemmological institutes.

At this stage, SSEF thus immediately initiated a research project to develop a method to identify these newly treated diamonds which presented a challenge to the trade. Finally in 2000, SSEF announced that it was able to identify the HPHT treatment of type II diamonds. About 20 years later, this article summarizes how we were able to achieve this breakthrough and which people from the trade and other research institutions were involved in this important step.

The term 'High Pressure High Temperature' (HPHT) refers to a diamond treatment that first appeared in industrial patents in the late 1970s (Schmetzer, 2010). It's about twenty years later that the term HPHT was first mentioned at a gemmological conference (Van Bockstael, 1997). Probably by lack of available information at this time, the treatment was not described in detail. Specifically, the author described this treatment as being applied to fancy colour diamonds of type Ia and a possible Russian source was also mentioned.

Thus, in March 1999, when Rapaport quoted a press release from Lazare Kaplan (LKI) & General Electric (GE), announcing an "irreversible permanent process [that] can significantly enhance the color and brilliance of select types of rough and polished diamonds", the gemmological community was far away of thinking that this treatment was involving high pressure and temperature (HPHT). Intriguingly, the press release also mentioned that the "… treatment is undetectable and will remain undetectable…".

Soon after, a meticulous survey of these said treated diamonds revealed that they were in fact exclusively colourless and of type IIa (Moses et al., 1999). This announcement was even more diverging from what we had learnt before from Mark Van Bockstael (1997).

In 1999, as part of our research project about this topic, SSEF ran a systematic study on the photoluminescence of colourless type IIa diamonds, inspired by the pioneering work of Dr. Joe C.C. Yuan (China) and the support of Prof. E. Fritsch (University of Nantes). Getting diamond samples for such a research project is always a real issue for gemmologists, and here we needed a selection of colourless diamonds and brown diamonds of natural colour together with colourless HPHT-treated diamonds, all of them being of type IIa - this rare type of diamond represents only about 3% of natural diamonds.

One colourless treated diamond was offered to SSEF by Ronny Totah (Horovitz & Totah SA, Geneva) another one was loaned by Mr. R. Biehler (Ernst Färber, Münich) and, encouraged by first promising results of our study, more than ten gemmological laboratories loaned to SSEF their own samples to complete our study. Numerous additional colourless and brown type IIa diamonds of natural colour were kindly loaned to SSEF by Mr. D. Gol (Gidish SA, Geneva). Using the first prototype of the SSEF Spotter, the type of these diamonds was separated and selected by SSEF in one day out of an impressive series of diamonds.

In April 2000, SSEF announced in a Rapaport press release its ability to detect the HPHT-treatment of type II diamonds. One month later and arguing that SSEF was not the first laboratory claiming to do so, DTC-Research (De Beers group) sent to SSEF three series of type II treated and untreated colourless diamonds for a blind test. Fifteen days later SSEF sent its testing results and, according to DTC-Research, SSEF was up to that day the first laboratory to pass this test! So, our ability to detect the HPHT-treatment of colourless type IIa diamonds was independently confirmed. We were thus proud to receive during the following Basel Show the congratulations of Mr. Nicky Oppenheimer (DeBeers) and Dr. James Shigley, director of research at GIA at that time.

Concerned by a possible secondary treatment applicable to HPHT-treated diamonds of type II, DTC-Research continued its research in this matter which led two years later to two informative meetings (2003 and 2004), both held at the SSEF to present their new findings to the exclusive attention of the most exposed international gemmological laboratories, including the GIA, IGI, HRD, and GGL.

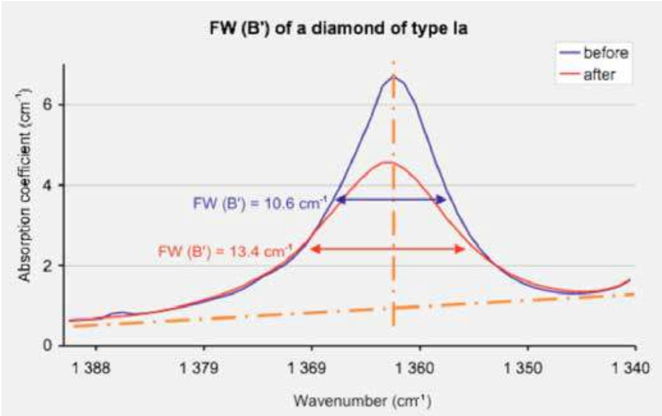
What about the HPHT-treatment of type I diamonds?

Similar to diamonds of type II, the HPHT-treatment removes the brown colour which may be present in diamonds of type I. But while type II diamonds are (quasi) nitrogen-free, type I diamonds contain nitrogen impurities, which are affected by the HPHT-treatment. The temperature involved in this treatment is high enough to break some of the commonly aggregated nitrogen atoms in the diamond structure, releasing them as single nitrogen atoms. As such, they subsequently induce a strong yellow hue - that of the famous 'canary diamonds' to the HPHT treated diamonds of type I. In addition, an optical centre also present in type Ia diamond may also be modified by the treatment to induce a (vibrant) green to greenish yellow hue (Collins, 2000).

Interestingly, we were able to study shortly after a historical greenish yellow diamond of natural colour, loaned to us by the Natural History Museum of Vienna (Chalain et al., 2004) that showed very similar spectral features, indicating the complexity of diamond coloration and treatment detection up to today.

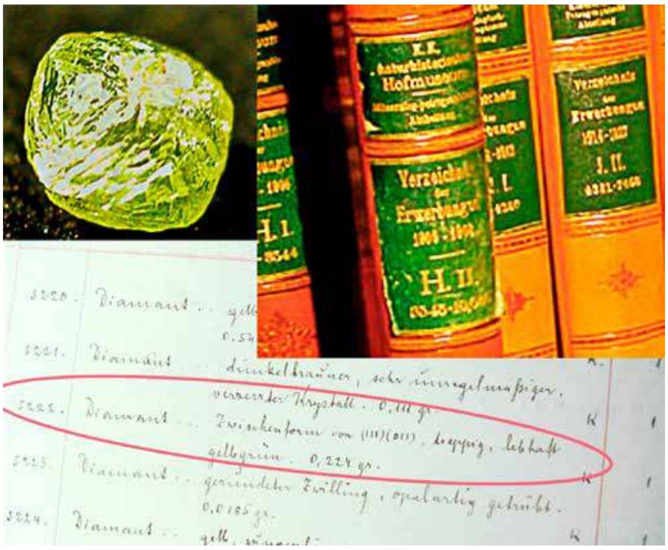
This study started whilst visiting the collection of mineralogy of the Natural History Museum of Vienna, where we discovered a rough diamond in their collection with exactly the same greenish yellow colour than that commonly described for HPHT-treated diamonds of type Ia.

The curator of the museum, Dr. Vera Hammer kindly loaned this rough greenish yellow diamond of historic provenance to SSEF to further study its colour. Originally offered to the Vienna museum in 1907 by the Emperor Franz Joseph I, we were able to carry out advanced spectral analyses on this specimen. We found that most of the features we encountered in HPHT-treated type Ia diamonds studied by SSEF in 2001 (Figure 1) were also present in this historic greenish yellow diamond of natural colour, except only one feature showing a distinct difference: the width (FWHM) of the platelets peak (B') was much broader in HPHT treated diamonds than that of the investigated untreated diamond of historical provenance. Due to the lack of further samples of natural greenish yellow colour at that time, we could not further confirm this separating key feature by additional measurements.



△ **Figure 1:** In 2001, SSEF conducted a research project on the HPHT-treatment of type Ia diamonds. 30 brown rough diamonds from Argyle were spectroscopically documented before and after treatment and polishing. The study showed that after HPHT-treatment, the platelets peak (B') intensity is reduced and its full width at half maximum (FW) broadens. Figure: SSEF

Only in 2009, still focusing our research on these greenish diamonds of natural colour, we were able to confirm the postulated criterion by adding data of ten more samples of natural colour. In a collaborative effort, we shared our findings with DTC-Research and together we were able to plot a graph (FWHM B' vs. position of the platelets peak) using all data from samples separately studied by SSEF and DTC. The graph revealed that the width vs. the position of the platelets peak is a key feature for separating greenish yellow to yellowish green type Ia diamonds of natural colour from those (type Ia diamonds) which are treated by HPHT.



△ **Figure 2:** In 2004, for comparing the detectability tests of HPHT-treated diamonds of type Ia with those of natural untreated diamonds of the same colour and of the same type, SSEF fully studied this yellowish green rough diamond (ref. H5222) loaned by the Natural History Museum of Vienna. This diamond (1.12 ct) is archived under the reference H 5222 and was offered to the Museum in 1907 by his Majesty, the Emperor Franz Joseph the First.

This sums up the contribution of SSEF in the detection of the HPHT treatment, which today is still detectable using the then established criteria. Clearly, these breakthroughs would not have been possible without the collaboration of the following institutions: University of Nantes, DTC-Research (today De Beers Technology) and the Natural History Museum of Vienna.

But our short note would not be complete if we would not reveal what we interpret as the most probable motivation of Lazar Kaplan and GE for announcing in 1999 – as mentioned above - that its undisclosed treatment (which turned out to be the HPHT treatment of type II diamonds) would remain undetectable. They knew how to do it, but had a patent on the detection method, thereby attempting to shield their treatment from being detectable by others. This fact was brought to our attention by Dr. Karl Schmetzer , who documented that GE was granted in 2002 a United States Patent (Patent No. US 6,377,340,B1) describing "a method for detecting whether a natural diamond has been processed at High Pressure and High Temperature (HPHT)" using photoluminescence. In light of this, SSEF took all the necessary legal steps to be able to reject the possible application of this patent in case we would have faced a patent infringement action, based on the argument that this patent is against public interest in Switzerland. ✶ **J.-P. Chalain**

SSEF
The Science of Gemstone Testing™

SOME OF THE HIGHLIGHTS OF THE SEASON WITH SSEF REPORTS

Necklace with 21 Kashmir sapphires (total 109.08 ct), sold for 15 mio US$ at Christie's Hong Kong, November 2018.

Royal blue Kashmir sapphire (16.47 ct) set in a ring, sold for 1.82 mio US$ at Sotheby's New York December 2018. Photo: Sotheby's.

Sapphire from Madagascar (46.81 ct) set in a ring, sold for 516'000 US$ at Christie's Geneva, May 2018.

Kashmir Sapphire (10.18 ct) set in a ring by Cartier, sold for 1.27 mio US$ at Sotheby's Hong Kong, April 2018. Photo: Sotheby's.

Royal blue Kashmir sapphire (14.01 ct) set in a ring (1930s), sold for 1.82 mio US$ at Sotheby's Geneva, May 2018. Photo: Sotheby's.

Brooch (late 19th century) set with three cabochon Kashmir sapphires (46.86, 10.09 and 9.93 ct), sold for 3.32 mio US$ at Sotheby's Geneva, November 2018. Photo: Sotheby's.

Royal blue Burmese sapphire (69.99 ct) set in a ring sold for 3.86 mio US$ at Sotheby's Geneva, November 2018.

18 Ceylon sapphires, set in a necklace (approximately 80 ct) and a bracelet (28 ct) by Cartier, sold for 696'000 US$ at Christie's Geneva, November 2018. Photo: Christie's.

Burmese sapphire (23.49 ct) set in a ring, sold for 980'000 US$ at Poly auction Hong Kong, October 2018

Ceylon sapphire (8.90 ct) set in a neck badge of the Order of the Golden Fleece (circa 1820). Sold for 1.70 mio US$ at Sotheby's Geneva, November 2018. Photo: Sotheby's.

Kashmir sapphire (19.28 ct) set in a ring by Chopard, sold for 1.73 mio US$ at Christie's Hong Kong May 2018.

Sugarloaf cabochon royal blue Kashmir sapphire (15.08 ct) in a ring, sold for 2.05 mio US$ at Christie's Geneva, May 2018. Photo: Christie's.

Necklace with 58 Burmese rubies (total 69.45 ct) sold for 2.16 mio US$ at Christie's Hong Kong, May 2018.

Burmese rubies (2.62 and 2.42 ct) set in ear pendants, sold for 1.50 mio US$ at Christie's Hong Kong, May 2018.

Burmese pigeon blood ruby (10.04 ct) set in a ring, sold for 7.20 mio US$ at Christie's Hong Kong, November 2018.

Burmese ruby (7.34 ct) set in a brooch by Cartier, circa 1940. Sold for 1.06 mio US$ at Sotheby's Geneva, November 2018. Photo: Sotheby's.

Burmese ruby (5.43 ct) set in a ring, sold for 870'000 US$ at Poly auction Hong Kong, April 2018.

Burmese ruby (3.92 ct) set in a pendant, sold for 60,000 US$ at Sotheby's Geneva, November 2018. Photo: Sotheby's.

Burmese rubies set in a bracelet by Faidee, sold for 1.08 mio US$ at Christie's Hong Kong, May 2018. Photo: Christie's.

A Burmese (36.68 ct) elongated pear-shaped spinel set in a necklace, sold for 472'000 US$ at Bonhams Hong Kong, May 2018.

Unheated Burmese ruby pair (10.12 and 10.07 ct) set in ear pendants, one ruby with minor oil. Sold for 766'000 US$ at Sotheby's Hong Kong, April 2018.

Burmese rubies (150.58 ct) set in a Harry Winston necklace. Sold for 3.52 mio US$ at Tiancheng, June 2018.

Burmese rubies (4.01 and 3.21 ct), sold for 276'000 US$ at Tiancheng Spring 2018, June 2018. Photo: Tiancheng.

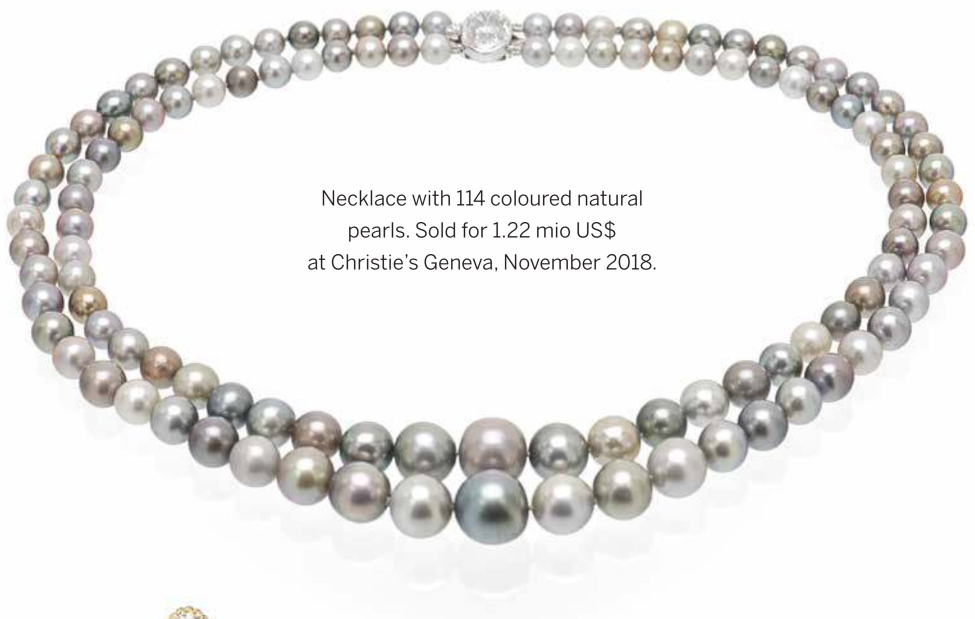
Burmese ruby pair (5.06 and 5.03 ct) set in ear pendants, sold for 1.85 mio US$ at Christie's Hong Kong, May 2018.

Unheated Paraiba tourmaline from Brazil (approx. 1.35 ct) in ring. Sold at Christie's Hong Kong in May 2018 for 87'000 US$. Photo: Christie's.

Purple sapphire (15.97 ct) set in a ring, sold for 190'000 US$ at Christie's Hong Kong, November 2018. Photo: Christie's.

Ceylon sapphire (4.89 ct) and a Burmese ruby set in a ring with a diamond, sold for 287'000 US$ at Sotheby's Hong Kong April 2018.

Padparadscha sapphire (16.66 ct) from Ceylon set in a ring, sold for 900'000 US$ at Sotheby's Hong Kong, October 2018. Photo: Sotheby's.



Necklace with 114 coloured natural pearls. Sold for 1.22 mio US$ at Christie's Geneva, November 2018.

Natural abalone pearl (approx. 45 ct), set in a ring, sold for 87'000 US$ at Christie's Geneva, May 2018. Photo: Christie's.

Pink sapphire from Madagascar (6.09 ct) set in a ring, sold for 190'000 US$ at Christie's Hong Kong, November 2018.

Pink sapphire (95.45 ct) from Ceylon set in a pendant, sold for 2.30 mio US$ at Sotheby's Geneva, May 2018. Photo: Sotheby's.

Pair of heated Paraiba tourmalines from Brazil (7.46 and 6.81 ct) set in ear pendants, sold for 2.77 mio US$ at Christie's Hong Kong, May 2018. Photo: Christie's.

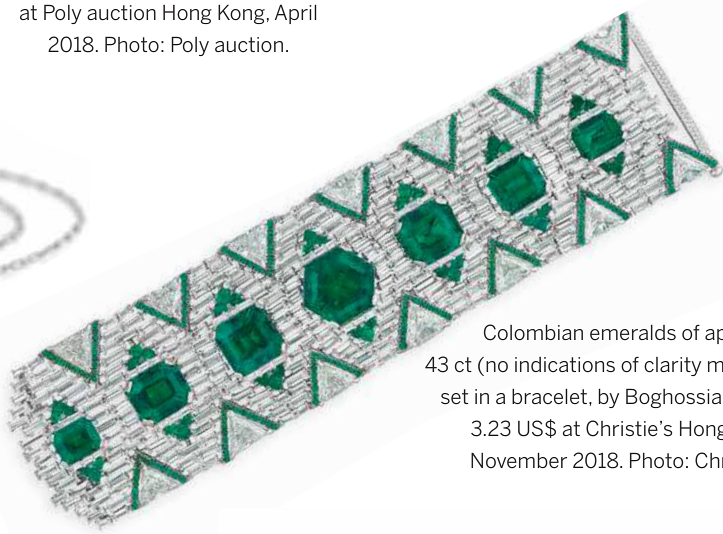
Padparadscha (11.54 ct) from Ceylon set in a ring, sold for 90'000 US$ at Poly auction Hong Kong, October 2018. Photo: Poly.

Brooch (first half of the 19th century) set with a Colombian emerald of approx. 21 ct (moderate oil), sold for 225'000 US$ at Sotheby's Geneva, November 2018.

Pair of Colombian emeralds of 20.15 and 21.79 ct (no indications of clarity modification) set in ear pendants, by Graff. Sold for 2.86 mio US$ at Poly auction Hong Kong, April 2018. Photo: Poly auction.

17th century Mughal carved Colombian emerald (minor oil) of 49.08 ct, sold for 552'000 US$ at Sotheby's Hong Kong, April 2018.

Colombian emerald of 10.00 ct (no indications of clarity modification) and diamond pendant, sold for 222'000 US$ at Bonhams Hong Kong, May 2018.



Colombian emeralds of approx. 43 ct (no indications of clarity modification) set in a bracelet, by Boghossian. Sold for 3.23 US$ at Christie's Hong Kong, November 2018. Photo: Christie's.

30.98 ct Colombian emerald (minor oil) set in necklace by Harry Winston, sold for 1.64 mio US$ at Tiancheng, June 2018.

Necklace with 77 jadeite jade (A-type) beads, by Boucheron. Sold for 263'000 US$ at Christie's Hong Kong, May 2018.

Colombian emeralds (approx. 315, 55, 21 and 20 ct, minor to moderate oil; 1 with moderate oil and artificial resin) set in a necklace, bracelet and earrings. Sold for 1.21 mio US$ at Christie's Geneva, November 2018.

Colombian emerald of 14.72 ct (no indications of clarity modification) set in a ring. Sold for 1.00 mio US$ at Christie's Hong Kong, November 2018.

Pair of Colombian emeralds 42.25 and 40.41 ct (minor oil) set in earrings, sold for 1.30 mio US$ at Christie's Geneva, May 2018. Photo: Christie's.

Extraordinary jadeite jade bead, ruby and diamond necklace.
Composed of twenty-nine graduated jadeite jade beads,
measuring approximately 14.7 to 15.9 mm, sold for 12.16 mio US$
by Christie's Hong Kong in November 2017.

Necklace with 28 natural pearls and seed pearls, sold for 1.15 mio US$ at Christie's Geneva, November 2018.

Pair of natural pearl earrings (second half of the 19th century), sold for 675,000 US$ at Sotheby's Geneva, May 2018.

Detachable natural pearl pendant on necklace, sold for 663'000 US$ at Sotheby's Geneva, May 2018.

Earrings with natural and cultured pearls, by Etcetera for Paspaley. Sold for 1.09 mio US$ at Christie's Hong Kong, November 2018.

Necklace with 63 natural pearls, sold for 2.00 mio US$ at Christie's Hong Kong, May 2018.

A pair of natural pearl earrings, by Harry Winston. Sold for 275'000 US$ at Bonhams New York, April 2018.

Necklace with 119 natural pearls formerly belonging to Queen Marie Antoinette. Sold for 2.30 mio US$ at Sotheby's Geneva, May 2018.

Brooch with 2 natural pearls (23 and 21 ct), by Cartier. Sold for 325'000 US$ at Christie's Geneva, November 2018.

RECORD-BREAKING: MARIE-ANTOINETTE'S PEARL PENDANT

In November 2018, the historic pearl pendant of Queen Marie Antoinette (1755-1793) sold for a whopping 36 million Swiss Francs at Sotheby's Geneva as part of the sale of the Bourbon Parma family jewel collection. This saltwater natural pearl of perfect drop-shape measures approximately 26 mm in length, and is set in the original bow-like pendant together with old-cut diamonds.

Originally in the possession of Queen Marie Antoinette, known for her extravagance and splendor, this pearl was part of her jewellery collection which 'survived' the French revolution in 1792, much in contrast to her, who suffered a tragic end in 1793 when she was executed by guillotine.

Having tested already many pearl jewels of historic provenance, such as the Peregrina pearl, the Dodge Pearls and the Cowdray Pearl necklace, to name a few, it was an exciting experience for us to meticulously analyse this pearl of cultural and historic significance at SSEF using X-ray fluorescence, X-ray luminescence and digital X-ray radiography and to document it as a natural saltwater pearl. ✶

SSEF COURSES
in 2019

2018 was again a busy year for the SSEF Education Department. Our courses have a strong international reputation and we see more and more gemmologists, jewellers and gemstone and pearl professionals from very different countries attending our courses. It's interesting to have participants from so many different gemmological and international backgrounds. In 2019, we will again be offering a wide range of courses. The SSEF Basic Gemmology Course (15 – 26 July and 11 - 22 November 2019) and the SSEF Basic Diamond Course (07 - 11 October 2019) offer good introductions, and participants can graduate with a certificate after taking theoretical and practical examinations. For more in-depth courses we offer Advanced Training Courses on coloured gemstones, pearls and small diamonds. Finally, the Scientific Gemmology Course (SGC) is an ideal course for those interested in learning about the advanced instruments used in laboratory gemmology today and should be available again in 2020.

ADVANCED PEARL COURSE

This two-day pearl course takes place twice a year (09-10 December 2019). It is ideally suited for participants who want to know more about how pearls are formed, about possible treatments, and how natural and cultured pearls can be identified and separated. SSEF's important collection of shells and pearls offers a good opportunity for practicing and expanding your skills and knowledge of pearls. The course also offers an introduction into the use of UV-visible spectrometry, EDXRF, X-ray radiography and luminescence for pearl testing in a scientific laboratory.

ADVANCED COLOURED GEMSTONES COURSE

The advanced coloured gemstone training course is an intense gemmological programme that offers a detailed hands-on approach to identifying treatment and origin of ruby, sapphire and emerald. Please note that this course is always in high-demand and already fully booked for the April and July 2019 sessions. The last remaining spots are available for the course 21 – 25 October 2019. In this course we demonstrate the possibilities and limitations of treatment detection and origin determination of corundum and emerald. Participants will have the opportunity of analysing and testing numerous samples from our collection.

SMALL DIAMOND COURSE

The SSEF small diamond course (29 October - 31 October 2019), which focuses on diamonds of a diameter between 0.7 and 3.8 mm, mainly used in the watch industry, enables participants to themselves perform the quality control of such small diamonds. These courses are aimed at people working in the jewellery and watch industry, and can be tailored to your company's specific needs. Previous gemmological experience is welcome but not a requirement.

SCIENTIFIC GEMMOLOGY COURSE

In 2019, the one-week Scientific Gemmologicy course will not be taking place. We are currently revamping this course that has been very successful in recent years by focusing on the scientific aspects of gemmology. This includes learning about techniques and applications of instruments like X-Ray fluorescence spectrometry, UV-Visible-NIR spectroscopy, GemTOF, Raman and FTIR spectrometry in the field of gemmology, as performed at the Swiss Gemmological Institute SSEF.

SSEF COMPANY COURSES

The SSEF Swiss Gemmological Institute can personalise a course based on your or your company's specific requirements. This course format is especially suited for companies that need specific gemmological training for their employees. In 2018, a number of companies have benefited from such courses that were tailored to specific topics including small diamond quality control, diamond treatments or learning to identify coloured gemstones from different origins. If you or your company are interested, please contact us to discuss how a gemmological course can be tailored to your needs. ✶

△ ATC Coloured Gemstone Course participants in October 2018 in Basel. Photo: SSEF

CONGRATULATIONS:

The Swiss Gemmological Institute SSEF wants to express its congratulations to the following persons for graduating from the following courses in 2018:

Basic Gemmology Course

- Laurent Rumann
- Saiwasan Hostettler
- Maria Susana Castro Neininger
- Simon Lienhard
- Manuela Müller
- Ursula Neuwald
- Lorena Dumitru
- Tatiana Meyer
- Thomas Gohl

Basic Diamond Course

- Ronald Schneller
- Tania Iellamo
- Anastasiia Batulina
- Agathe C. Mora
- Khakimoghaddam Amirali
- Felix Bots
- Laurent Rumann
- Victoria de la Soujeole

Advanced Pearl Course

- Tomás Basilio Larralde
- David Lam
- Dr. Hubert Bari
- Federico Baldan
- Michael Gardner
- Nayan Bhagat
- Joanna Hardy
- Mallika Kaul Gomes
- Anastasiia Batulina

Advanced Coloured Stones Course

- Kiefer Tang
- Mohammed Hassen Milfer Caffoor
- Joeri Van Den Plas
- Dries Van Den Plas
- Joshua Nassi
- Thomas Schröck
- Serena Menzi
- Stefania Suter
- Nicky Pinkas
- Amanda Bilberry
- Brigitte Scattarreggia
- Juliette Cros
- Polina Korabelnik
- Chantelle Lobo
- Aakash Sancheti
- Farah Alsuhaily
- Tomás Basilio Larralde
- Anup Jogani
- Justine Vahdat
- Mathilde Austruy
- Ajmal Sahibunissa
- Jen-Wei Hsu
- Jordan Abram
- Prashant Kothari
- Benjamin Guttery
- Ruman Ahmed
- Nathalie Bouet
- Céline Mortessagne
- Marie Schoor
- Susanne Büche
- Alizée Vesin
- Julien Xaysongkham

Advanced Small Diamond Course

- Katarzyna Binkowska
- Claire Aharfi
- Anastasiia Batulina
- Elena Staub

△ ATC pearl course in December 2018 at SSEF. Participants included Dr. Hubert Bari and David Lam authors of the impressive book 'Pearls' and Joanna Hardy who has written books on ruby and emerald. Photo: SSEF.

SSEF LAUNCHES NEW GEMTRACK™ SERVICE

There is growing demand for traceability and transparency—including tracking (from mine to market) and tracing (from market to mine)—of gemstones in the jewellery industry. The Swiss Gemmological Institute SSEF has decades of experience in providing scientific opinions regarding claims of origin (geographical and whether a gem is natural or synthetic) and whether or not a gem has been treated.

Gemmological approaches will continue to be important in supporting supply chain integrity and maintain consumer confidence in rare natural gemstones. In addition to existing services, new and combined gemmological techniques (based on unique features within a stone) are being developed to enhance documentation of stones as they journey from mine to market. As such, the Swiss Gemmological Institute has decided to launch GemTrack™ in January 2019 as a new service to the trade.

What is GemTrack™?

A GemTrack™ document links a cut stone to a specific rough stone using gemmological techniques. GemTrack™ is based on a combination of crystallographic, structural, chemical and microscopic analyses that allow for detailed and potentially unique characterisation and fingerprinting of a rough stone. These same features are later investigated in the cut stone, following the cutting and polishing process. Currently, SSEF offers GemTrack™ services only if a specific rough stone is made into one cut stone. A GemTrack™ document can only be issued if sufficient crystallographic and microscopic characteristics are present in a stone. SSEF reserves the right not to issue a GemTrack™ document if characterising evidence is insufficient.

What claims does a GemTrack™ document make?

GemTrack™ provides expert scientific opinion linking a rough stone to a cut stone, thereby gemmologically documenting part of a stone's journey from mine to market. It does not make any specific claims of mine of origin. When credible documentation is provided (e.g. transparent sales receipts from a rough auction), a GemTrack™ document may state that based on provided documentation a gemstone was sourced from a specific company or auction. GemTrack™ does not make any claims about how and when a gemstone was mined, as this cannot be ascertained using gemmological methods. GemTrack™ is a SSEF document, which presents data of a specific stone in its rough and cut state, and is only issued in addition to a SSEF Report for the cut stone. A GemTrack™ document may also be issued if a gem is later mounted in jewellery, in order to document the stone from rough to jewellery.

What are the requirements to issue a GemTrack™ document?

To be able to offer the GemTrack™ service for a specific gemstone, SSEF has to analyse a stone twice. First, the gem is submitted to the Swiss Gemmological Institute as a rough stone for detailed analysis along with available documentation. Important: The rough gem needs to have a polished window on one side. The rough stone is characterised in detail by SSEF, given a unique identifying number, and sent back to the client for cutting and polishing. No document is issued at this time by SSEF. Subsequently, the client resubmits the cut stone with the unique identifying number. The cut stone is then meticulously analysed by SSEF a second time in order to confirm that it was cut from the rough stone that was previously submitted to SSEF. In the case where this data comparison is positive, SSEF will issue a GemTrack™ document in addition to the SSEF Report for the same cut gemstone. A GemTrack™ document may be updated at a later point in time, for example if the gem is recut again or even after having been mounted in jewellery, thus representing a unique and independent tracking record documenting the journey of a gemstone from rough to jewellery.

Please visit www.ssef.ch/gemtrack or contact us for more information. ✶

SCHWEIZERISCHES GEMMOLOGISCHES INSTITUT
SWISS GEMMOLOGICAL INSTITUTE
INSTITUT SUISSE DE GEMMOLOGIE

SSEF GEMTRACK™ DOCUMENT

ROUGH RUBY
Testing by SSEF

Date of Testing:	5 July 2018
Weight:	3.169 ct
Measurements:	10.20 x 7.60 x 6.10 mm

CUT RUBY
Testing by SSEF (Report No. XXXXX)

Date of Testing:	28 August 2018
Weight:	1.525 ct
Measurements:	6.46 x 6.29 x 4.27 mm

TRACKING RECORD

1 Based on the provided documentation, the rough ruby (3.169 ct) described above was mined and recovered in Mozambique and sold at Gemfields auction in Singapore on the 9th of June 2018.

2 After the auction, the rough ruby was submitted to SSEF and meticulously analysed and characterised on the 5th of July 2018. The stone was then sent for cutting.

3 After cutting, the ruby (1.525 ct) was resubmitted to SSEF and extensively analysed on the 28th of August 2018.

Based on the consistency of the analysed properties and internal features of the described rough and cut ruby, it is the opinion of the SSEF that the ruby of 1.525 ct described in SSEF Gemstone Report No. XXXXX was cut from the 3.169 ct rough ruby, tested by SSEF before cutting.

Disclaimer: SSEF makes no warranty for the provided documentation and issues this GemTrack™ document based on provided information and within the limits of gemmological characterization of gemstones. Measurements and photos are approximate.

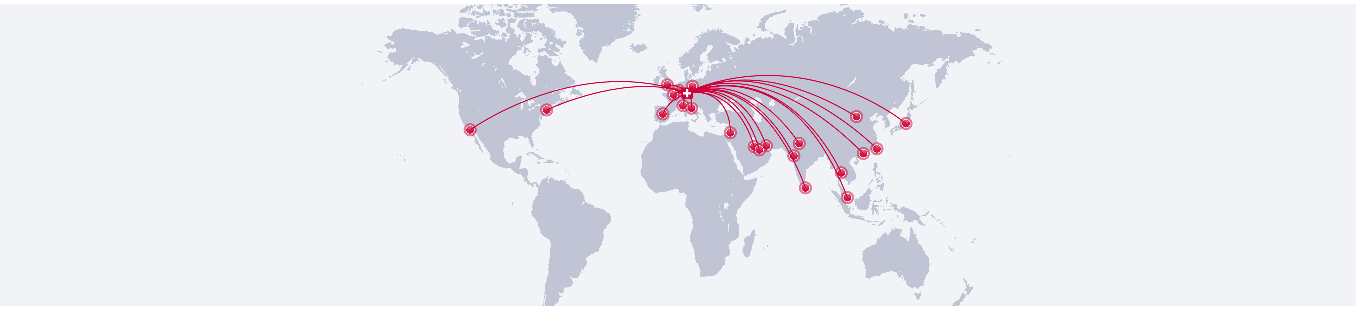
Mandatory document verification: www.myssef.ch

SSEF www.myssef.ch

Aeschengraben 26 CH-4051 Basel Switzerland - Tel : +41 61 262 06 40 - Fax : +41 61 262 06 41 - admin@ssef.ch - www.ssef.ch

△ **Specimen of GemTrack™ document issued by SSEF to document gemmologically the history of a gemstone.**

SSEF-FERRARI SHUTTLE SERVICE



DAILY SHUTTLE BETWEEN GENEVA - SSEF

call Ferrari **Geneva** office **+41 22 798 82 60**

Costs: 100.- Swiss Francs per round trip.
For values > 500'000 Swiss Francs, an additional liability fee of 0.035% is charged for the amount exceeding this limit, based on the declared value.
Example 1: declared 100'000 SFr > shipping costs: 100 SFr
Example 2: declared 1'000'000 SFr > shipping costs: 255 SFr

WEEKLY SHUTTLE BETWEEN LONDON, PARIS, MONACO - SSEF

call Ferrari **London** office **+44 1753 28 78 00**
call Ferrari **Paris** office **+33 1 49 96 60 60**
call Ferrari **Monaco** office **+377 97 70 34 92**

Costs: 160.- Swiss Francs per round trip and an additional liability fee of 0.035%
Example 1: declared 100'000 SFr > shipping costs: 195 SFr
Example 2: declared 1'000'000 SFr > shipping costs: 510 SFr

ON REQUEST SHUTTLE BETWEEN DUBAI (UAE), SINGAPORE, BANGKOK, MUMBAI, JAIPUR, TAIPEI - SSEF

call Ferrari **Dubai** office **+971 4295 1089**
call Ferrari **Singapore** office **+65 6547 5560**
call Ferrari **Bangkok** office **+6622674755 to 8**
call Ferrari **Mumbai** office **(Tel: +91 22 3392 34 59; +91 22 3392 19 63)**
call Ferrari **Jaipur** office **+91 9782526618**
call Ferrari **Taipei** office **+886 2 25078511**

Costs: 240.- Swiss Francs per round trip and an additional liability fee of 0.035%
Example 1: declared 100'000 SFr > shipping costs: 275 SFr
Example 2: declared 1'000'000 SFr > shipping costs: 590 SFr

ON REQUEST SHUTTLE BETWEEN SPAIN - SSEF

call Ferrari **Spain** office **+34 915 572 648**

Costs: on request

WEEKLY SHUTTLE BETWEEN NEW YORK, HONG KONG, LA - SSEF

call Ferrari **New York / LA** office **+1 212 764 06 76**
call Ferrari **Hong Kong** office **+852 2 264 20 01**

Costs: 160.- Swiss Francs per round trip and an additional liability fee of 0.035%
Example 1: declared 100'000 SFr > shipping costs: 195 SFr
Example 2: declared 1'000'000 SFr > shipping costs: 510 SFr

ON REQUEST SHUTTLE BETWEEN ITALY, ANTWERP - SSEF

call Ferrari **Italy** office **+39 0131 208520**
call Ferrari **Antwerp** office **+32 3 4752723**

Costs: 160.- Swiss Francs per round trip and an additional liability fee of 0.035%
Example 1: declared 100'000 SFr > shipping costs: 195 SFr
Example 2: declared 1'000'000 SFr > shipping costs: 510 SFr

ON REQUEST SHUTTLE BETWEEN TEL AVIV, COLOMBO (SRI LANKA) - SSEF

call Ferrari contractor office in **Tel Aviv**
(D2D Val express Israel) **+972 3 575 4901**
call Ferrari contractor in **Colombo**
(Dart global logistics Ltd.) **+94 11 460 09 600**

Costs: 240.- Swiss Francs per round trip and an additional liability fee of 0.035%
Example 1: declared 100'000 SFr > shipping costs: 275 SFr
Example 2: declared 1'000'000 SFr > shipping costs: 590 SFr

ON REQUEST SHUTTLE GERMANY - SSEF

call Ferrari contractor office **Germany**
(Gerhard Enz GmbH) **+49 711 4598 420**

Costs: 240.- Swiss Francs per round trip and an additional liability fee of 0.035%
Example 1: declared 100'000 SFr > shipping costs: 275 SFr
Example 2: declared 1'000'000 SFr > shipping costs: 590 SFr

For all other destinations, please contact us

MANDATORY VERIFICATION OF SSEF REPORTS ONLINE: WWW.MYSSEF.CH

Preserving the security of issued reports is a priority for SSEF. Since 2009, all reports issued by the Swiss Gemmological Institute SSEF carry a Prooftag™ label of authentication. This label contains a fraud resistant bubble tag that can only be used once and is impossible to reproduce. The owner of a SSEF report with such a label can check its authenticity online on www.myssef.ch. This website allows owners to verify the authenticity of reports and also download PDF scans of these reports. Reports issued after July 11th 2016 are available on this platform for download. Older reports can continue to be verified on www.myssef.ch but are not available for download.

With the MySSEF platform, owners can compare the original report with the archived SSEF scan copy of the report. This adds another layer to the security already provided using signature, embossment, lamination and the label affixed to the laminated report.

Verifying the validity of an SSEF report on MySSEF step report is considered a mandatory step. SSEF's terms and conditions state that "Once verified on www.myssef.ch, only the report with the valid original signatures, embossed stamps and Proof Tag™ label affixed on to the surface of the laminated report is a valid document."

Furthermore, online report verification is especially important as it is SSEF's policy for there to only be one report in circulation for a given item or gemstone. When items are submitted for Recheck, old SSEF reports are cancelled by SSEF on the MySSEF platform. Verifying your report on MySSEF thus enables you to know if this is the most recent up-to-date version of the report available.

Step 1: Go to www.myssef.ch

Step 2: Click on 'verify and download your SSEF report'

Step 3: Enter SSEF Report Number and unique Prooftag Reference Number

Step 4: Complete robot check and click 'Verify'

Step 5: Compare Bubble Tag on top right of window with that on your Report

Step 6: Click 'View PDF of report'

Step 7: Click 'Download' (top-right of browser) to download PDF copy of report

Step 8: If you have further reports to verify and download click ' Verify Further Report'

Should you have any queries regarding the authenticity of a report please do not hesitate to contact us. ✶

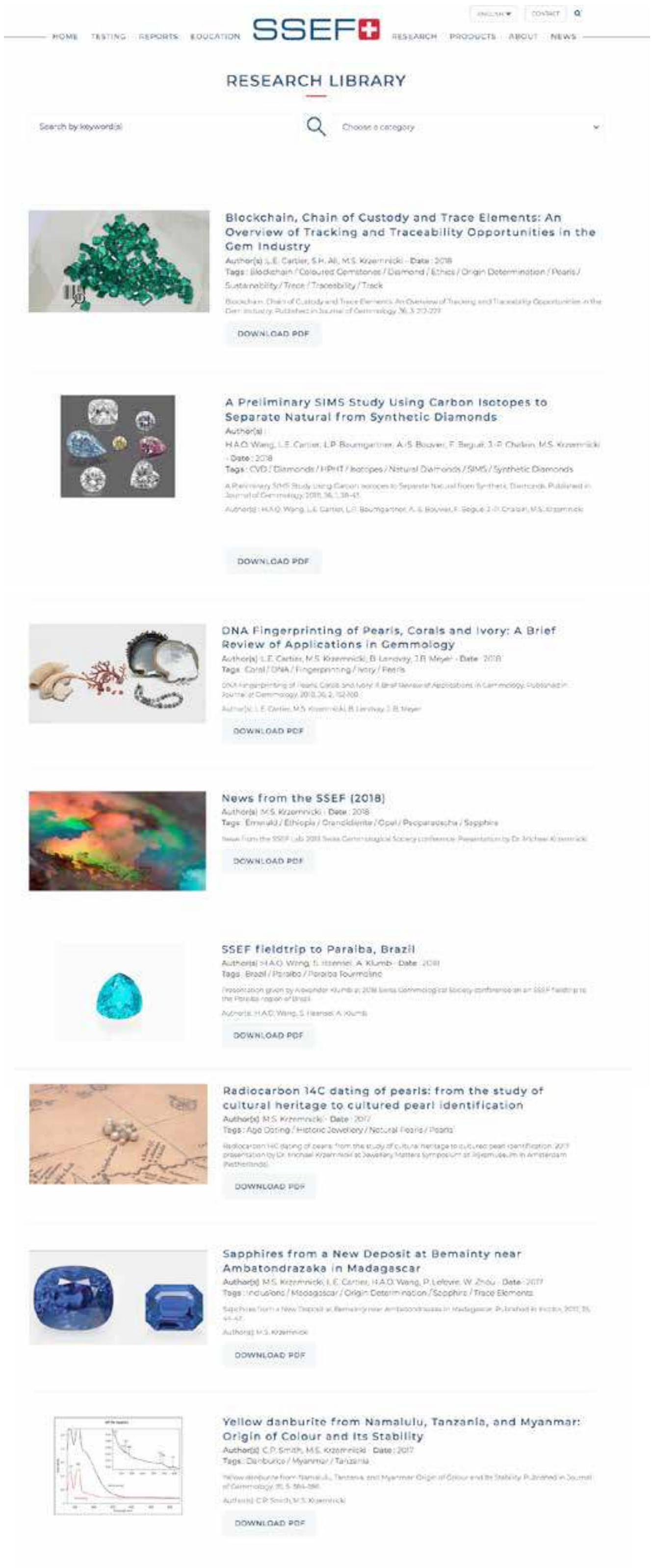
LIBRARY OF SSEF PUBLICATIONS

In our mission to share gemmological research and provide educational resources to the gem and jewellery industry we continue to upload research articles authored or co-authored by SSEF researchers to our website, that now reaches over 400 articles. This Library of Publications also includes a wide range of presentations that we have given over the years at different conferences and venues. All files are available as PDF copies. This library contains most of our research that has been published since 1974 and will be continuously updated.

SSEF has been central to a number of important discoveries and developments in gemmological research in the past four decades. A selection of related important publications now available online. For example:

- Analysis of the Dresden Green diamond (1989)
- Contribution to Kashmir sapphire identification (1990)
- Identification of Douros synthetic rubies (1994)
- Identification of artificial resin in emeralds (1999)
- Detection of HPHT treatments in diamonds (2001)
- Identification of Be-treatment in sapphires (2004)
- Micro X-ray computerized tomography of pearls (2009)
- Age dating of pearls (2012)
- DNA fingerprinting of pearls (2013)
- Simultaneous High Sensitivity Trace-Element and Isotopic Analysis of Gemstones Using Laser Ablation Inductively Coupled Plasma Time-of-Flight Mass Spectrometry (2016)
- Neutron imaging for pearl and emerald testing (2017)
- SIMS isotope analysis of natural and synthetic diamonds (2018)
- Blockchain and traceability of gems (2018)

This vast openly accessible resource should be useful for gemmologists and other members of the trade, providing information on a diverse range of topics in coloured gemstones, diamond and pearl issues. ✶



NEW CHINESE VERSIONS OF SSEF WEBSITE

In our endeavour to make the SSEF website more accessible to the target communities we serve, and in particular in response to strong demand for SSEF's gem testing services, both in Hong Kong and greater China, we have introduced a Chinese-language version of our website. The site is available both in traditional and simplified Chinese. It offers an overview of history, the services we offer, and latest news in the world of gemmology. ✶

PROJECT ASSURE

When in 2013 SSEF launched the very first machine to automatically control the authenticity of colourless diamond melees batches (see Facette 21, 2014), we did not expect that five years later more than twenty different machines would exist on the market that claim to serve a similar purpose.

The different machines today proposed to the trade may address different shapes, sizes and/or colours of diamonds, and they may be automatic or not. They may check one stone after another or large batches. Some may refer diamonds, others may not. Some of them are portable and prices may also vary widely from one machine to another.

In order to clarify this offer to the diamond trade, the Diamond Producers Association - DPA launched the 'Project Assure' program and SSEF, as member of this program's technical committee, contributed to developing its testing standard named 'Diamond Verification Instrument Standard'.

More information on the DPA-Project Assure program is available at: https://diamondproducers.com/diamond-industry/assure/ ✶

LMHC MEETING IN LUCERNE

In November 2018, the Laboratory Manual Harmonization Committee LMHC held their 29th meeting to discuss current issues of gem testing and nomenclature, this time hosted by the Gübelin Gem Lab in Lucerne, Switzerland. Any agreements between these laboratories are openly accessible and presented in LMHC infosheets to the gemmological community and the trade.

LMHC currently comprises of representatives from the Central Gem Laboratory (CGL), CISGEM Laboratory, DSEF German Gem Lab, Gübelin Gemlab, GIA Gem Laboratory, the Gem and Jewelry Institute of Thailand (GIT) and the Swiss Gemmological Institute SSEF. This meeting brought significant achievements in the harmonization of wording on laboratory reports and the reporting of new treatments.

Notably, LMHC now specifies that the term padparadscha is not applicable if the colour of the stone is unstable and shifts to pink when exposed to a colour stability test (Figure 1, see also LMHC infosheet IS 4). Additionally, a new infosheet about organic fissure filling in any gemstone (IS 12) and an infosheet about hydrophane opal (IS 13) were unanimously approved by the laboratory representatives.

The LMHC also discussed issues raised by new treatments. These include the low-temperature heating of corundum and a new sapphire heat treatment, which has been incorrectly named High Pressure-High Temperature (HPHT) heating in the trade. Current scientific knowledge and available data from the LMHC laboratories indicates that the latter treatment is essentially a form of heating, and as such is similar to most known heating techniques.

A more detailed press release about this meeting and all LMHC infosheets (including the two new releases) are accessible on the new LMHC website (www.LMHC-gemmology.org). ✶

△ **Figure 1:** A corundum with such an unstable colour is not qualified to be called padparadscha (LMHC infosheet IS 4, 2018). Photo: Luc Phan, SSEF

SSEF AT SGS CONFERENCE 2018

In 2018, the annual conference of the Swiss Gemmological Society (SGS) was held in Lugano in southern Switzerland. Organized by the local SGS committee, this event was again a great success, not only with numerous talks on a wide range of gem-related topics, but also in terms of networking opportunities and socializing, especially during the conference dinner on top of Monte Generoso (1704 m) famous for its cretaceous fossils.

The main theme of the conference was diamonds from southern Africa, with invited speakers Mike Brook (Debswana, Gaborone, Botswana) who talked about prospecting and mining of Botswana's diamonds, Dr. Jurgen Jacob (Namdeb Diamond Corporation Pty Ltd, Oranjemund, Namibia) who reviewed the characteristics of Namibia's diamond megaplacer, and Brendan Laurs (Gem-A, editor of the Journal of Gemmology) who reported about the recent mining of some alluvial diamond deposits in South Africa.

The Swiss Gemmological Institute SSEF was present with talks by Dr. Michael Krzemnicki about news and exceptional cases recently analysed at SSEF. Alexander Klumb summarized a recent SSEF field trip to Paraíba tourmaline mines in Brazil, and Judy Tu reviewed gem materials of Taiwan, namely nephrite, chrysocolla chalcedony, and precious coral. Additional presentations came from our SSEF research associates Prof. Dr. Henry A. Hänni (GemExpert, Basel) about a recently discovered ornamental stone from Pakistan and Dr. Walter A. Balmer about a field trip to Sri Lanka organized for SGS members.

The Swiss Gemmological Society SGS is a very active association and provides many options to access relevant and up-to-date gemmological knowledge and networking opportunities for jewellers and gemmologists in Switzerland and beyond.

For more information, please check the SGS website https://gemmologie.ch/en/ ✶

SGG SSG
Schweizerische Gemmologische Gesellschaft
Société Suisse de Gemmologie
Società Svizzera di Gemmologia
Swiss Gemmological Society

△ Lugano by night. Photo © Swiss-Image.ch/Remy Steinegger/Ticino Turismo

CIBJO CONGRESS 2018 HELD IN BOGOTÁ

The 2018 CIBJO congress took place in the nice city of Bogotá, Colombia. While the official congress was held from the 15th to 17th October, the pre-congress, where CIBJO steering committees meet, began on 13th of October. Jean-Pierre Chalain, director of SSEF's diamond department was present as technical advisor to the Swiss delegation to CIBJO. Mr. Chalain is a vice-president of the diamond commission and member of the coral, gemstone, laboratory and pearl commissions. Dr. Laurent E. Cartier of SSEF was invited by CIBJO to be a panellist for the special CSR panel discussion that focused on issues facing companies in the supply chain.

In parallel to the pre-congress, the World Emerald Symposium was held at the same place and gave rise to a unique gathering of information, speakers and discussions. The opening ceremony of the Congress was highlighted by the presence of the Vice-President of the Republic of Colombia. CIBJO's blue books were updated according to the reviewed recommendations received since the last congress and they are downloadable from the CIBJO website (www.cibjo.org, tab 'blue book').

This year's congress was characterized by the launch of a new blue book named 'The Responsible Sourcing Book' and was released on 14/01/2019. It is downloadable free of charge on the CIBJO website.

More information on the 2018 CIBJO congress can be found at: http://www.cibjo.org ✶

△ CIBJO Diamond Commission Vice President Jean-Pierre Chalain (right), together with Stephane Fischler, President of the World Diamond Council. Photo: CIBJO

WORLD EMERALD SYMPOSIUM IN BOGOTÁ (COLOMBIA)

The second edition of the World Emerald Symposium (WES) took place in Bogotá, Colombia, 12-14 October 2018. Colombia's thriving emerald industry organised this event to coincide with the CIBJO congress that also took place in Bogotá. This major conference covered a wide range of topics and sessions related to emeralds, and featured a great mix of international speakers. This was a unique opportunity to discuss the challenges and opportunities facing the sector, including responsible mining and sourcing, traceability technology and gemmological research on both treatment detection and origin determination. SSEF was represented by Dr. Laurent E. Cartier who gave a presentation providing an overview of sustainability and traceability concepts and trends as applicable to gemstones. Themes surrounding due diligence, responsible sourcing, blockchain and traceability were widely discussed both at WES and the CIBJO congress. Dr. Cartier was also a panellist on a WES panel moderated by Ron Ringsrud, which discussed treatment disclosure and nomenclature for emeralds.

In addition to these topics of central interest to SSEF, it was especially interesting to attend other sessions that provided other perspectives on the mining situation in Colombia, the emerald trade and design of emerald jewellery. ✶

VISIT TO THE SMITHSONIAN

Dr. Laurent E. Cartier was invited to teach a gemmology Masterclass at the University of Delaware in late September 2018. This 2-day course at the Geological Department of the University of Delaware – providing an introduction to major aspects of gemmology- also included a visit of the Smithsonian Institution in Washington D.C. Students there got a special 'Behind the Scenes' tour of the National Gem and Mineral collection and this was unique opportunity to see some of the world's most exceptional gems. Many thanks go to Dr. Post and Russell Feather for making this very special and informative tour possible. Thank you to Prof. Neil Sturchio, Prof. Saleem Ali and Dr. Sharon Fitzgerald at the University of Delaware for their kind help in organising the course and we look forward to future collaboration with them on a range of gemmological research projects. ✶

△ Dr. Laurent E. Cartier and Masterclass students with Dr. Jeffrey Post, Curator of the National Gem and Mineral Collection, and Russell Feather, Gem Collection Manager.

SSEF AT THE EUROPEAN GEMMOLOGICAL SYMPOSIUM 2019

The 7th European Gemmological Symposium will be held 24-26th May 2019 in Idar-Oberstein by the German Foundation for Gemstone Research (DSEF) to celebrate their 50th anniversary. Organized biannually since 2007 by one of the participating European gemmological associations, past symposia were so far held in Idar-Oberstein, Paris, London, Bern, Leiden (Netherlands), and Zermatt (Switzerland).

Dr. Michael S. Krzemnicki is one of the invited speakers at this prestigious event and will give a presentation about colour varieties of gems, and the complex issue to define comprehensible boundaries between such varities.

Detailed information about the programme and registration of this upcoming symposium can be found on the website of the German Gemmological Association.
https://www.dgemg.com/egs-2019-en.php ✶

GAHK TALK IN SEPTEMBER 2018

In September 2018, Dr. Michael S. Krzemnicki was invited to speak at the Academic Conference on Coloured Gemstones of the Gemmological Association of Gemmology GAHK during the Hong Kong Jewellery Show. In his talk "On the Trail of New Gem Deposits", he shared research data from newly discovered gem deposits to the audience, and discussed the impact and excitement in the trade triggered by the supply of new exceptional gems, but also the challenges laboratories face when analyzing such newly found gems.

Interested readers find this presentation on the SSEF website at
https://www.ssef.ch/presentations/ ✶

△ Harbour at West-Kowloon, Hong Kong. Photo: M.S. Krzemnicki

GEMTOF AT SCIENTIFIC CONFERENCES

Two years after the SSEF's elemental analysis platform - GemTOF – started being in operation; a large amount of data on various gemstones has been carefully collected and analyzed. Not only does the new data shine light on the previously studied topics, such as origin determination of blue sapphires and emeralds, but also novel methods of data analytics have been applied to elemental data and helped to discover new insights in gemmology.

The year 2018 has seen more presentations about GemTOF than the year before. Starting from January, Dr. Hao A.O. Wang presented a poster at the Winter Conference on Plasma Spectrochemistry in Amelia Island, Florida, USA. The poster discussed analytical technique development and validation of this novel method.

In April, in a more application-oriented conference - European Geosciences Union General Assembly - in Vienna, Austria, Hao introduced GemTOF – a novel technique for elemental analysis in a poster, and emphasized origin determination of blue sapphires from Kashmir and Madagascar using this method. The presentation included a recent case study of blue sapphires found in newly-discovered deposits near Ambatondrazaka, Madagascar, from which these blue sapphires resemble microscopic features of that from Kashmir. It has been shown that combined elemental data and advanced statistical methods are useful to distinguish samples from these two origins.

Every two years, Europe holds one of the most important conferences on a specific topic of LA-ICP-MS. In June 2018, the European Workshop on Laser Ablation was held in Pau, a historic town in southern France. Two talks were given by SSEF staff. Doctoral student Myint Myat Phyo gave the audience a tour through inclusion analysis of rubies and spinels found in Mogok, Myanmar. She determined the age of zircon inclusions embedded in these gemstones using GemTOF, and postulated the formation age of these gemstones in the Mogok area. During the same conference, Hao presented a refined version of the elemental analysis procedure using GemTOF, which received positive feedback from peer fellows.

Although the weather was chilly in autumnal Melbourne (Australia), the passion of worldwide mineralogists was just at its peak, when the 22nd Meeting of International Mineralogical Association took place in August 2018. Two sessions dedicated to gemmological research attracted many participants, and these were probably two of the most attended sessions. The SSEF's contribution in the form of a talk was a presentation about the application of multi-element analysis in origin determination of gemstones. The presentation given by Hao was among many other interesting talks, from professors, researchers, experts and students at universities and gemological laboratories. It was a nice opportunity to interact with and learn from other gemmologists and scientists in a nice atmosphere. We appreciated the fruitful discussions and feedback from gemmological colleagues as well as analytical chemistry colleagues. ✶

△ **Figure 1:** Sunset at the conference venue of the Winter Conference on Spectrochemistry, January 2018, Amelia Island, Florida, USA. Photo: H.A.O. Wang.

△ **Figure 2:** Conference venue of European Geoscience Union General Assembly, April 2018, Vienna, Austria. Photo: H.A.O. Wang.

△ **Figure 3:** Ms. Myint Myat Phyo presented her research on age dating of inclusions in ruby and spinel from Mogok, Myanmar at the European Workshop on Laser Ablation, June 2018, Pau, France. Photo: H.A.O. Wang.

△ **Figure 4:** View from conference venue of the meeting of The International Mineralogical Association after a day-long discussion on gemstone research, Aug 2018, Melbourne, Australia. Photo: H.A.O. Wang.

2018 SWISS GEOSCIENCE MEETING IN BERN

The 2018 edition of the Swiss Geoscience Meeting took place in Switzerland's capital Bern November 30th and December 1st. Dr. Laurent E. Cartier and Dr. Michael S. Krzemnicki again convened a gemmology session at this annual conference that brings together hundreds of Swiss-based researchers working in different geoscience and earth science disciplines. The gemmology session included 4 oral presentations and was chaired by Prof. Leander Franz (University of Basel). This included Myint Myat Phyo, a PhD at the University of Basel (in collaboration with SSEF) shared findings of her study 'A new suite of inclusions in spinel from Mogok (Myanmar) – a study using Raman microspectroscopy and scanning electron microscopy'.Dr. Hao Wang and Dr. Michael S. Krzmemnicki of SSEF discussed 'Colour instability of Padparadscha-like Sapphires' in their talk. Dr. Walter A. Balmer (SSEF research associate) and colleagues presented research on 'Marble-hosted ruby deposits of the Morogoro Region, Tanzania'. Finally, Dr. Wenxing Xu and colleagues from the Gübelin Gem Lab who gave a talk entitled 'Age determination of zircon inclusions in sapphire from Kashmir and characterization with Raman spectroscopy'.

The abstracts of these talks can be found on: http://geoscience-meeting.ch/sgm2018/wp-content/uploads/SGM_2018_Symposium_04.pdf ✶

16th SWISS GEOSCIENCE MEETING 2018 BERN

GEMSTONE AND SUSTAINABLE DEVELOPMENT KNOWLEDGE HUB

As mentioned in last year's Facette, a Gemstone and Sustainable Development Knowledge Hub was created with the aim to facilitate learning across the full supply chain of coloured gemstones from mines to markets, and improve the sector's contributions to sustainable development. The hub is a collaboration between the University of Delaware (USA), the University of Queensland (Australia), and the University of Lausanne (Switzerland), supported by the Tiffany & Co. Foundation. The Knowledge Hub is also working with museums, gem miners, gemmologists, dealers, jewelry manufacturers, grassroots organizations and development agencies in this endeavor. SSEF's Dr. Laurent E. Cartier is involved as a senior research partner and Dr. Michael S. Krzemnicki as an advisory board member.

The hub features two signature projects that focus on different parts of the supply chain. The first covers specific health and safety issues in the gemstone-cutting sector in Jaipur (India), and how such issues could be addressed and mitigated. The research study is being carried out with Workplace Health Without Borders (WHWB), the University of Queensland and the American Gem Trade Association (AGTA). The project seeks to improve the understanding of health issues in gemstone manufacturing and identify suitable solutions in a number of different cutting facilities. The research focus has been on sampling and monitoring of dust and silica in selected factories, and evaluating and implementing control measures to improve conditions. Based on that research, educational material on the prevention of silica exposure and other relevant occupational health information in gemstone cutting and polishing has been developed. The results of this study will be presented in Tucson in February 2019.

The second signature project focuses on the education of women miners in Madagascar. Lynda Lawson—part of the Hub's core research team—has for the past three years been documenting and analyzing the lives of women involved in the sapphire value chain in Madagascar.It became clear that artisanal women miners and traders in South Madagascar could benefit from gem identification and processing skills in the form of workshops and the use of basic gem identification kits. A year after the first training, it was found that the kits had been carefully maintained and the knowledge applied. Participants were also taught basic lapidary skills, and a number of the women have shown great talent and interest in learning more about gem cutting and gemology. Partnerships with donors and local partners are being set up so that this work can continue long term. In addition to these signature projects, the Hub has also supported separate smaller projects in Colombia, Pakistan and Tanzania. ✶

△ **Amethyst-cutting workshop in Jaipur, India. Photo: Laurent E. Cartier**

CLOSE UP: DAVID HORSTMANN

Whenever you hold an SSEF report in your hands, it is likely that David Horstmann, our Head of Production, together with his team has printed, laminated, and tagged the report with the Prooftag™ label. Even more workmanship is required from him for our prestigious SSEF Premium Appendices and Provenance Books, all carefully crafted in handmade leather folders.

David joined the SSEF team in summer 2013, and has become in the past few years a very important member of the administration and production team. He is frequently present on our on-site locations, organizing there our back-office workflow, and also taking care of customers at the reception desk.

David is a real team player at SSEF, not astonishing given that he is a staunch supporter of the local football club FC Basel, and has travelled with the football team to many Champions League matches abroad, notably celebrating their winning games against Chelsea, Manchester City, and many more. Apart from this, he has plenty of musical talent and an interest in the harder edge of rock, and has played the drums – again as a team player but setting the rhythm – in several local rock bands in Basel.

But his interests do not stop there. Coming to SSEF as a team member means to dive deep into the fascinating world of gems and pearls, and he took this literally, by joining the Kamoka pearl farm on the Ahe atoll in French Polynesia for a summer internship and by successfully passing the FGA Diploma in 2018. Congratulations! ✶

CHANGES AT THE SSEF FOUNDATION BOARD

As a fully independent non-profit organisation (Swiss Foundation of the Research of Gemstones), the SSEF is supervised by a foundation board of currently of 8 members. The board meets regularly to discuss the general policy and strategic matters of the foundation and the laboratory.

New board member: Martin Häuselmann

In June 2018, Martin Häuselmann, attorney from Bern and Head of Tax and Legal at BDO Bern (Switzerland) joined the SSEF Foundation Board. He has already participated at SSEF foundation board meetings for one year, with the aim of enabling a smooth and continuous handover in the coming few years of the presidency of the foundation board, held currently by attorney Marc A. Christen. We would like to thank him for his commitment and the support he has already given to SSEF and look very much forward to working with him in the future.

Departing board member: Nik Bieri

End of 2018, Nik Bieri, former President and CEO of the Swiss manufacturer Furrer-Jacot will depart from the SSEF Foundation Board after a 10-year tenure. With his personal management background, he has contributed much to the development and success of SSEF in the past few years. The SSEF team and foundation board would like to thank him very much for his advice and support over all these years and we wish him and his family all the best for his future plans. ✶

◁ Martin Häuselmann

SSEF TEAM EVENT IN DECEMBER 2018

After an exciting year full of hard work at SSEF, time had come to reward the team with an inspiring and fun day out. Beautiful gemstones and magnificent jewellery did not get, for once, all our devoted attention. Instead, we visited Basel's cartoon museum and had the pleasure to be guided through the exhibition Le Monde de Tardi, one of the world's most prominent comic artists. Born in 1946 in France, Jacques Tardi primarily works with historical topics, such as the two World Wars for example, to which he devotes himself with remarquable meticulousness. More than 200 original drawings were exhibited by the museum, each reflecting his clear and extremely confident line which has inspired generations of artists in the comics scene. This visit was paired with a workshop themed 'Black is beautiful' in the musuem's atelier during which we discovered how to approach black ink and play with its various shades of coulour, as do comic artists. It was an enjoyment to see that some of us have true talent!

After a cultural morning and a pleasant lunch all together we headed to an afternoon of adventures in one of Basel's escape rooms. The principle is simple, you get trapped in a room and have one hour to escape, or be trapped forever. Whether the mission is to break into Casino Royale, escape from Bâlecatraz or find the well-kept Middle Age recipe for gold, only outstanding team work and quick riddle solving helped us escape.

The day was wrapped up with a well-deserved dinner where delicious and hearty burgers, local beer and Chardonnay were a fitting finale to our challenging team event. ✶

SSEF IN THE UNITED STATES: NEW YORK, LAS VEGAS, LOS ANGELES

In 2019, SSEF will be in New York in January 2019 offering express on-site testing services for coloured gemstones only in Midtown NYC. This service is on an appointment basis only.

We are also pleased to inform you that SSEF will be exhibiting at the Las Vegas Antiques Jewelry & Watch Show from 30 May - 03 June 2019 at the Las Vegas Convetion Centre. Please stay tuned to our website and newsletter for more information regarding our booth number and contact information.

We would like to inform our USA based customers, that shipping can be arranged daily from New York or Los Angeles using the efficient SSEF-Ferrari shuttle system (for prices see website). For shipping from all other locations in the USA please contact us so that we can advise you on the best shipping options. ✶

SSEF ON-SITE IN 2019

In 2019 we will be exhibiting and/or offering our on-site testing services as follows :

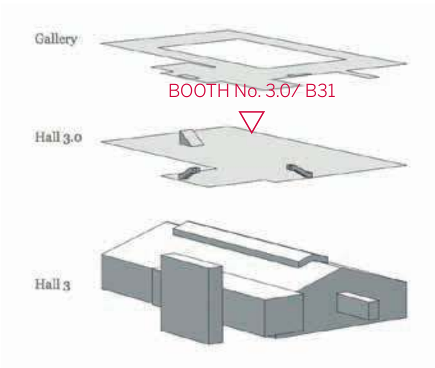
Hong Kong	21 February - 04 March
BaselWorld	21 - 26 March
GemGenève	09 - 12 May
Bangkok	20 - 24 May
Las Vegas	30 May - 03 June
Hong Kong	17 - 23 June
Bangkok	19 - 23 August
Hong Kong	11 - 22 September
Paris	on request
Other locations	on request

Further on-site services will be communicated through our website and in newsletters. Please subscribe to our newsletter on our website www.ssef.ch to be updated regularly about our on-site schedules, other services and news. ✶

BASELWORLD 2019

During BaselWorld 2019 (21 - 26 March), the SSEF will be once again offering its convenient gemstone and pearl testing services.

You can find us on the ground floor of Hall 3 at **booth No. 3.0/ B31, at a different location than last year.** The phone number at our booth (+41 61 699 51 29) remains the same, as does our high-quality express service, which may even include a nice cup of coffee and some Swiss chocolate. We are looking forward to meeting you at our booth and to testing your gemstones and pearls during the Basel Show. If you would like to have a number of items analysed, we suggest you call us in advance at the SSEF office (tel. +41 61 262 06 40) to fix an appointment. This is also strongly suggested if you would like to have your items tested shortly before the show. ✶



△ Photo courtesy of Baselworld.

SSEF AT GEMGENÈVE SHOW: 9 - 12 MAY IN GENEVA

GemGenève, a new gem and jewellery show that was successfully launched in May 2018 at the congress and exhibition centre Palexpo in Geneva will again take place in May 2019 (9 – 12 May 2019). Initiated and organised by a small group of traders, this international show unites some of the most prestigious and reputed international gem companies. The show has been ideally scheduled just ahead of the viewing days of the Geneva spring auctions of Christie's and Sotheby's. For more information about this show, please check their website www.gemgeneve.com

The SSEF will be present with a booth at GemGenève, where we will offer our testing services for coloured gemstones. Clients who wish to submit us their gems at this new show are kindly requested to fix an appointment beforehand (admin@ssef.ch). ✶

DONATIONS

As in previous years, we are grateful for numerous donations we received in 2018 from many pearl and gemstone dealers around the world. These donations not only support our research but also add to our collection of specimens to be used in our courses, with the aim to educate the participants and to give them the opportunity to learn gemstone & pearl testing on a wide variety of untreated and treated materials.

We would like to especially thank the following persons and companies:

FOR PEARL DONATIONS:

Atlas Pearls (Indonesia), Justin Hunter (J. Hunter Pearls, Fiji), Hussain Alfardan (Qatar), Andy Müller (Hinata Trading, Japan), Laurent Cartier (Basel), Al Majed Jewellery (Qatar), Alexandra Leitão-Ben Hamadou (Qatar University), Douglas McLaurin (Cortez Pearls, Mexico), René Lauper (Frieden AG, Switzerland), Paspaley Pearling Company (Australia).

FOR GEMSTONE DONATIONS:

Groh & Ripp (Germany), Charles Abouchar (Abouchar S.A., Geneva), Nino Autore (Australian South Sea Pearl, Dubai), Henry A. Hänni (GemExpert, Basel), Michael S. Krzemnicki (Basel), Yianni Melas (Cyprus), Sebastian Hänsel (Basel), Koh Choo & Miemie Thin Thut (Bangkok), Kyaw Swar Htun (AGGL Gem Lab, Yangoon), Pierre-Yves Chatagnier (France), Jörg Domeisen (Switzerland), Sebastian Ferreira (MTB Brazil), Marcel Guillong (ETHZ), Horst Munch (Brazil), Carlo Somma (Brazil), WB Stern (University of Basel), Enzo Liverino (Torre del Greco, Italy), Ekaterina Kolye (Switzerland), Amit Jain (Napra Gems Ltd.), Joseph Belmont (KV Gems, Bangkok), Martin Julier (Bucherer AG), Alexander Leuenberger (Aline GmbH), Ueli Sandmeier (Switzerland), Gebrüder Henn KG (Germany).

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