Facette

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LOW TEMPERATURE TREATMENTS

PARAIBA TOURMALINE / SPINEL

SCIENTIFIC DIAMOND COURSE / AUCTIONS

SSEF
SCHWEIZERISCHES GEMMOLOGISCHES INSTITUT
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Dear Reader

It's springtime once again, a season of flourishing and blossoming. As in previous years, I am delighted to witness the growth of the SSEF Facette—now in its 29th issue—as it has developed over the past few weeks from an initial shortlist of topics into a vibrant magazine filled with the latest scientific news and information about our activities and services. Over the decades, the SSEF Facette has expanded significantly from a humble leaflet into a colourful volume. This evolution of the SSEF Facette mirrors the growth of the SSEF team, which now comprises over 40 dedicated staff members, all committed to providing you with the highest level of service.

This SSEF Facette brings you firsthand information about key achievements from the past year, covering internal developments, new services, course options, and, most notably, new research findings. These findings include insights into the detection of low-temperature heating of corundum, an update on the irradiation of corundum, new gems from Afghanistan, antique jewellery, and short notes about a wide range of intriguing, beautiful, and exceptional coloured stones, diamonds, and pearls.

A significant milestone for our growth and future development is the completion of the reconstruction work at SSEF in Basel. With a total of nearly 1300 square meters on two floors, we now have much larger laboratory premises. More importantly, we offer a very inviting and spacious environment for SSEF education. This includes not only course and meeting rooms but also a cozy cafeteria with a library and an exhibition space for inspiring and informative gemmological displays. We invite you to visit our new facilities to gain inspiration during a course or a meeting in our new premises.

Another important achievement is the launch of our new online shop (www.ssef-instruments.ch), aimed at offering you a range of excellent products, from advanced scientific equipment to small gemmological tools or even books, at your fingertips.

Currently, the two best-selling products developed by SSEF, in collaboration with the Physics Department of the University of Basel and our industrial partners, are the ASDI-500—an automated solution for the industry to separate natural from synthetic diamonds down to half-a-millimetre size—and two versions of a light box, a perfect solution for standardized colour grading of diamonds, coloured stones, and pearls.

I would also like to thank Jean-Pierre Chalain who has retired as Head of SSEF's Diamond Department for his great work and dedication to SSEF, gemmology and diamond research over the past three decades. It's been a great pleasure to have worked with him since the 1990s and we look forward to collaborating further with him in his new capacity as R&D consultant for SSEF Instruments.

These, along with much more, are highlighted in the following pages. We hope you find the selection of topics and articles in this SSEF Facette not only interesting and informative, but also inspiring and helpful in your daily business in the gem trade and industry. Lastly, any feedback, questions, or suggestions from your side are always welcome.

Yours sincerely,

Dr. Michael S. Krzemnicki
Director SSEF

COVER PHOTO ▷

Pearl farmer in Ago Bay, Japan.

Photo: L.E. Cartier, SSEF

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LOW-TEMPERATURE HEATING OF CORUNDUM: POSSIBILITIES AND CHALLENGES FOR DETECTION

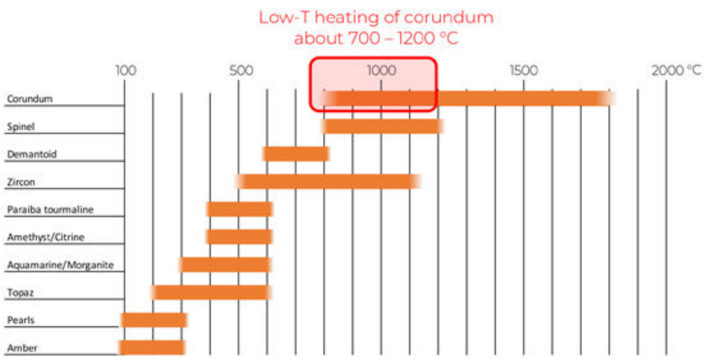
△ **Figure 1**: Unheated (left) and heated (right) gemstone pairs indicating the colour change intended by a heat treatment. Starting material in the upper row is greenish blue aquamarine (left), amethyst (middle) and purple Cu-bearing tourmaline. Starting material in the lower row is greyish 'geuda' sapphire, purple sapphire and purplish ruby. The collage of these gemstones has been digitally arranged. Photo: M.S. Krzemnicki, SSEF.

Heat treatment is generally applied to gemstones to change and enhance their colour. Over the past few decades, it has become a very common practice for certain gem species, such as aquamarine, amethyst (resulting in citrine), copper-bearing tourmalines (Paraiba), tanzanite, and notably for any colour variety of corundum. (Figure 1). But it is important to know that heat treatment of gems has been known since historic times and was described and practiced many centuries ago (see Hughes et al. 2017, and Notari et al. 2019, and references therein). A historic account describing the effect of heating rubies is found in the Book on *Mineralogy* (trans. Said, 1989) by Al-Biruni (AD 973–1048):

"The practice is therefore, to roast the reddish [stones] so that the mixed colours are made to disappear...A ruby stone having been roasted is re-examined, and, in case it does not gain clarity, it is re-heated. ...."

This early account explains perfectly the effect of heating on rubies with a purple/blue zone (see Figure 3), and also how even today, a heat treatment can be repeated if the first attempt was unsuccessful.

The effect of heat treatment on a gemstone depends on several different factors. These include external parameters, such as the duration of treatment, gradient of heating and/or cooling, atmosphere (e.g. oxidizing or reducing), and most importantly the peak temperature reached during such a treatment. Intrinsic properties of the gemstone such as the presence and distribution of colouring elements and their valency-state and aggregation and the presence of lattice defects acting as colour centres define how the gemstone responds to a heating process.



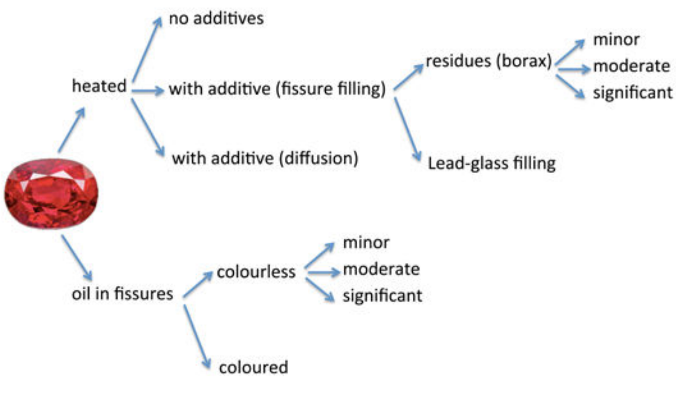
△ **Figure 2**: Approximate temperature ranges for the heat treatment of selected gemstones (based on gemmological literature). Figure: M.S. Krzemnicki, SSEF.

When a gemstone is heated, the result may range from no visual change to a distinct change/enhancement of colour, but also to cracking, and in the worst case (overheating) to partial degradation, a complete structural phase transformation, or even melting. Over the last centuries, more specific heat treatment processes have been developed, based mostly on the same principle (heating in air) but using different temperatures adapted to each gem species (Figure 2). Most gem materials are heated at temperatures well below 1000 °C, whereas heating of corundum that has a visible effect on colour has generally been documented only at rather high temperatures.

△ **Figure 3**: Unheated Mozambique ruby of very fine quality showing a diffuse bluish zone in a corner. It may be possible to remove such a bluish zone by a low-temperature heat treatment. However, the trade nowadays prefers to keep these rubies unheated, if such a bluish zone is not affecting the beauty of the stone. The reason is that the price of unheated stones is much higher than of that of heated stones. Photo: L. Phan, SSEF.

Heat treatment detection of corundum

For corundum -Al_2O_3 (ruby and sapphire and other colour varieties)- various heat treatment processes with or without additives have been developed, specifically in the last few decades (Figure 4). They are widely applied in the gem trade (e.g. in cutting/manufacturing and trading hubs in Sri Lanka, Thailand, India) to enhance the colour and additionally improve -in some cases- the transparency and stability of certain types of corundum. With such heat treatments, it is possible to modify rubies (and other varieties of corundum) of lower quality into visually more beautiful stones, and consequently guarantee a steady supply of gems to the international market.



△ **Figure 4**: Selected treatment options for corundum. For heat treatment, a range of options are possible, either without or with additives. Figure: M.S. Krzemnicki, SSEF.

Heat treatment of ruby and other corundum varieties is usually carried out at temperatures ranging from 700 to 1800 °C. Historically, this has been done using a simple and artisanal blow-pipe (e.g. in Sri Lanka) reaching temperatures of about 1200 °C. Heating has evolved into a multitude of treatment options, today often carried out under controlled conditions (atmosphere and pressure) in electric muffle furnaces (Nassau 1981; Themelis 1992; GIT 2019). Heating of corundum at higher temperatures (> 1200 °C) may have a considerable impact on its internal features and colour, notably local discoid expansion cracks may develop around solid and fluid inclusions and tiny rutile (TiO_2) needles commonly present in corundum as so-called 'silk' may (partially) dissolve. In contrast to this, a heat treatment process in the range of about 700 - 1000 °C, known in the trade as 'low-temperature' heating, usually results only in a slight (but desirable) shift of colour and may leave inclusions basically unaltered.

Traditionally, the detection of heat treatment in corundum is mainly based on meticulous microscopic observation. Because of the heating process, internal features may be affected and altered as mentioned above and thus provide a clear indications of heat treatment. However, in corundum which is heated at so-called low temperatures (about 700 °C to 1200 °C) only very minute or even no alterations of inclusions may be observed under the microscope (Figure 5).

△ **Figure 5**: The lower the heating temperature, the less evident are microscopic features indicating such a heat treatment. From distinct discoid expansion features (left), through tiny and very tiny discoid features and spotty appearance of platelets in rubies heated at so-called low temperature. Microphotos: M.S. Krzemnicki, SSEF.

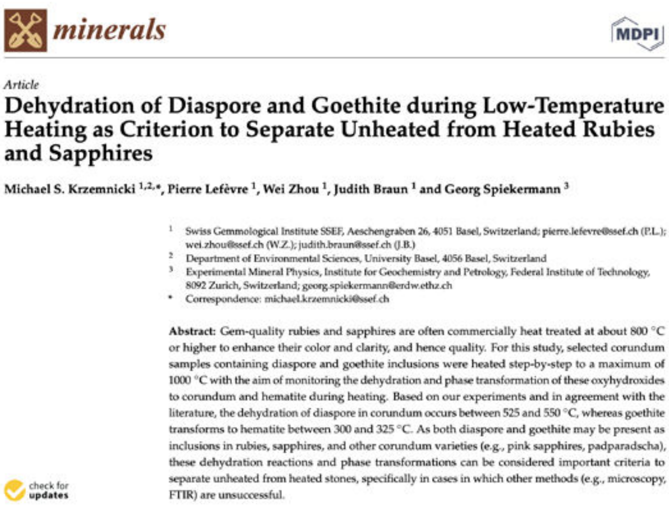
Therefore, the detection of heat treatment in corundum today mostly relies on a combination of infrared spectroscopy (FTIR) and Raman micro-spectroscopy, in addition to 'classic' microscopic observations.

In FTIR analyses of corundum, the focus lies very much on the presence and intensity of OH^- related absorption peaks. Namely the 3309, 3232 and 3185 cm^{-1} series in metamorphic corundum is considered a strong indication for artificial heat treatment (Smith 1995; Beran & Rossman 2006; Balmer et al. 2006; Pardieu et al. 2015; Krzemnicki 2019; Saeseaw et al. 2020). The presence or absence of a Mg-O related band at 3160 cm^{-1} or broad boehmite and diaspore bands in the 3500-2500 cm^{-1} range are other important criteria, as these bands are reduced or completely disappearing during heating (Smith & van der Bogert 2006). Another approach is to determine the peak width (FWHM) of the main Raman peak of zircon inclusions. This approach has been explored more recently (Wang et al. 2006; Krzemnicki et al. 2021; Karampelas et al. 2023), notably in pink sapphires from Ilakaka (Madagascar), as a way to detect heat treatment.

However, both FTIR and Raman have certain limitations, i.e. hydroxide-related bands in infrared spectra are not always present in heated rubies and sapphires (Saeseaw et al. 2018, Pardieu et al. 2015) and the FWHM of the main Raman peak of zircon inclusions in unheated and heated corundum may show considerable overlap (Krzemnicki et al. 2021, Karampelas et al. 2023). Additionally, this Raman bandwidth in zircon inclusions is strongly dependent on the concentration of radioactive trace elements, crystallinity (metamictisation), and finally geological and geographic origin where the corundum has formed (Nasdala et al. 1995 and 2001; Xu & Krzemnicki 2021).

Recently, we published a new scientific Raman study using the presence of the oxyhydroxides diaspore and goethite as inclusions in corundum to separate unheated corundum (and other gems) from heated stones (Figure 6). The study, entitled ***Dehydration of Diaspore and Goethite during Low-Temperature Heating as Criterion to Separate Unheated from Heated Rubies and Sapphires,*** is freely accessible on the internet (https://doi.org/10.3390/min13121557) or from the research library on our SSEF website. For this study, we carried out heating experiments on selected corundum samples containing epigenetic diaspore α -AlO(OH) and goethite α-FeO(OH) inclusions, to document the phase transformation and dehydration of these hydroxides into the anhydrous oxides corundum α-Al_2O_3 and hematite α-Fe_2O_3 upon heating. Both phase transformation systems have already been studied extensively in the past decades (Ervin 1952; Lima-de-Faria 1963; Frost et al. 1999; Majzlan et al. 2003; Gialanella et al. 2010; Koivula 2013; Sripoonjan et al. 2016). Both hydroxides, diaspore and goethite are known to be thermally stable only up to about 350 °C (goethite) and 500 °C (diaspore) and to transform to their respective Al- and Fe-oxide phases when further heated.

During our heating experiments, selected diaspore and goethite inclusions in corundum samples were monitored using a Raman microprobe and their phase transformation and dehydration to corundum and hematite could be clearly documented in all samples (Figure 7).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Article

Dehydration of Diaspore and Goethite during Low-Temperature Heating as Criterion to Separate Unheated from Heated Rubies and Sapphires

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Abstract: Gem-quality rubies and sapphires are often commercially heat treated at about 800 °C or higher to enhance their color and clarity, and hence quality. For this study, selected corundum samples containing diaspore and goethite inclusions were heated step-by-step to a maximum of 1000 °C with the aim of monitoring the dehydration and phase transformation of these oxyhydroxides to corundum and hematite during heating. Based on our experiments and in agreement with the literature, the dehydration of diaspore in corundum occurs between 525 and 550 °C, whereas goethite transforms to hematite between 300 and 325 °C. As both diaspore and goethite may be present as inclusions in rubies, sapphires, and other corundum varieties (e.g., pink sapphires, padparadscha), these dehydration reactions and phase transformations can be considered important criteria to separate unheated from heated stones, specifically in cases in which other methods (e.g., microscopy, FTIR) are unsuccessful.

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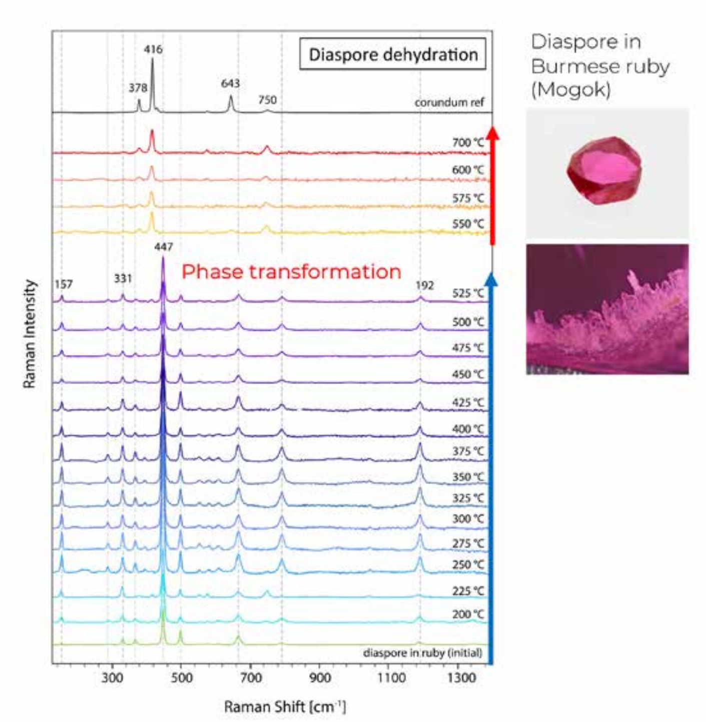
△ **Figure 6**: Title page of our most recent scientific publication about heat treatment detection of corundum. Source: Minerals, MDPI.



△ **Figure 7**: Raman spectra of the same diaspore inclusion taken after stepwise heating from room temperature to 700 °C. In a narrow temperature range between 525 and 550 °C, the diaspore dehydrates and transforms to corundum. Figure: M.S. Krzemnicki, SSEF.

Interestingly, this dehydration occurred for both inclusion minerals quite abruptly in a narrow temperature range (525 to 550 °C for diaspore to corundum; 300 to 325 °C for goethite to hematite). These ranges are far below heating temperatures commonly applied on corundum, but specifically for goethite even lower than those applied on many other gemstones (e.g. Paraiba tourmaline). Therefore, it is valid to say that Raman spectroscopy has proven to be a very useful analytical method to document these phase transformations and can thus be considered a very promising tool to separate unheated from heated gem-quality ruby and other corundum varieties and even other gemstones.

In the past few months, we have applied these phase transformation markers successfully on numerous client stones. By adopting this approach, we were able to conclude a treatment status even in cases in which microscopic features or FTIR analyses were non-conclusive.

✶ **Dr. Michael S. Krzemnicki, SSEF**

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UNRAVELLING THE SECRETS OF ANTIQUE JEWELLERY

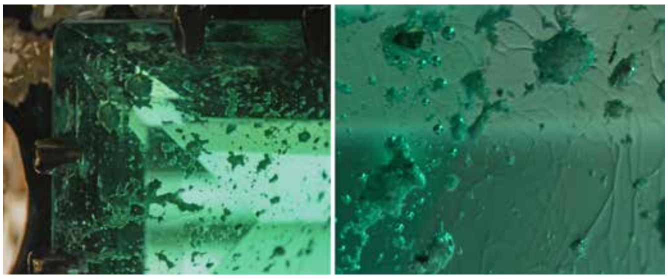
△ **Figure 1:** Antique brooch with a green stone and diamonds recently tested at SSEF. Photo: L. Phan, SSEF.

Testing of antique jewellery at SSEF may provide insights which go far beyond simple gem testing. They add valuable information to the jewel, starting from its design and craftsmanship in the making, the choice of colours and qualities of gemstones, or the facet arrangement and proportions of old cutting styles. Additionally, it is possible to recognize in certain cases the re-use of historic gems, later additions, repairs and even forgeries. Although such insights are often assumptions based on meticulous (microscopic) observations and study, they still may shed light on how jewellery was created and used in past times and until today.

In the following, we would like to present a few interesting cases which we came across in past few months at SSEF:

Early replacement:

Recently, the SSEF received a brooch of late 19th century design set with old-cut diamonds and a rectangular emerald green stone in the centre (Figure 1). Upon closer inspection, however, some doubts arose as distinct wear marks, smoothed-out facet edges, numerous scratches were seen under the microscope, pointing towards an emerald imitation made of glass (paste). Chemical analyses quickly confirmed the glassy nature of this green stone, consisting mainly of lead, potassium, and silicon and coloured by traces of chromium. Such glass is historically known as flint glass and characterized by a higher refractive index, lustre (brilliance) and density compared to normal (soda) glass. Interestingly, this green glass not only contained numerous tiny air bubbles, but also rather prominent inclusions of spiky irregular shape – by the naked eye quite convincingly imitating the jagged fluid inclusions well-known from Colombian emeralds (Figure 2).



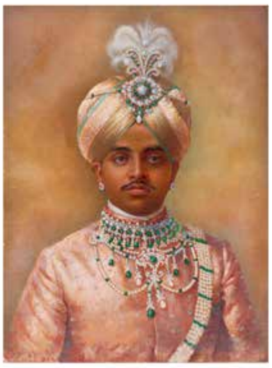
△ **Figure 2:** Microphotos exhibiting the numerous irregular (spiky) inclusions (left) and round air bubbles (right) in the green glass stone at the centre of the antique brooch. Microphotos: M.S. Krzemnicki, SSEF.

The remaining question is: at what stage was the green glass stone set into this 19th century brooch? Based on the fine quality of the setting and diamonds, we assume that the brooch originally contained a real gemstone, most probably a Colombian emerald, which may have been heavily damaged and needed to be replaced by a green look-a-like. Given the included (old) nature of this lead glass and its wear marks, we assume that this replacement is not recent but already happened during the late 19th or early 20th century.

Re-use of gemstones in antique jewellery

It is quite common that old and out-of-fashion jewellery is drastically redesigned so as to be again attractive for a new and younger generation. This is very much in difference to visual arts such as paintings and sculptures, for which such a change and re-use would be considered quite a sacrilege.

When old jewellery is re-designed and adapted to a new style and use, it often also means that the original gemstones are re-shaped and re-cut to fit in the new design and setting.
Historically, we know that such re-cutting was a very common practice as access and availability of gemstones of high quality was far more limited than today. But evidently, this practice continues up to the present day. Although in certain cases this leads to a loss of original appeal and historic reminiscence, such re-cutting may also offer interesting insights, specifically when it manifests itself in the gems re-used in a new setting.



△ **Figure 3:** **Antique Indian turban ornament containing drilled Colombian emeralds and a painting of the Maharaja of Mysore waering a similar ornament. Photo: A. Chalain, SSEF, and portrait by K. Keshavayya (1906). Source: V&A Museum, London.**

Historic jewels, especially those from the Middle East, Central Asia, Southeast Asia to the Far East are often dominated by large and colourful gems, which are quite often rather baroque in shape, polished (engraved) and drilled or half-drilled, to string or fix them in their antique setting (see Figure 3). This indicates that in some cultures the sparkling brilliance of facets may not have been a primary factor in determining the quality of a gem. They were more a means for rulers and nobility at court to show-off their wealth and power to the public through large and colourful brooches, pendants and dress decorations which are even impressive when seen from far away (see also focus article in Facette 2023, pages 6-9).

△ **Figure 4:** **Historic multi-gem necklace containing a mix of coloured stones, all drilled and suspended on pearl strands. Photo: A. Chalain, SSEF.**

Recently, we received two interesting cases of antique jewellery in which such drilled gems were used or even re-used.

The first case was an antique multi-gem necklace with polished to faceted coloured stones, all drilled to be suspended on three pearl rows (Figure 4). Interestingly, the necklace not only contained amethyst, citrine, red coral, red to brown garnet, and pink tourmalines of presumably Indian and/or Sri Lankan origin, but also a mix of light blue sapphires from Sri Lanka (metamorphic sapphires) alternating with dark blue basaltic sapphires probably from a historically known alkali-basalt occurrence in Southeast Asia, and bright green emeralds from Colombia.
All these gems were drilled, often with rather large drill holes as is characteristic for old historic drilling techniques. They were drilled from two sides towards each other (V-shaped half-drills) to enable to suspend them on metal threads attached to the pearl strands. As these metal threads were quite old and delicate, a small number of coloured stones had chipped and broken off the pearl strands when we received the item for testing.

△ **Figure 5:** Shallow V-shaped drill holes at the tip of a Sri Lankan sapphire of the described multi-gem necklace. We assume that this sapphire was re-cut and faceted in historic times from an initially rather baroque stone with originally much deeper drill holes. Figure: M.S. Krzemnicki, SSEF.

A close look at one of the faceted Sri Lankan sapphires (which fell off the necklace) shows that the V-shaped half-drills at the tip of the stone are only shallow and thus create a very fragile suspension situation (Figure 5). In contrast to this, such drill holes in ancient gems were commonly very deep (often even penetrating throughout the gem) to allow for a stable fixation of the gem on the jewel and dress decoration. We thus assume that the present shape and faceting is actually the result of a re-cutting process. Presumably, the initial sapphire was a rather baroque-shaped and polished bead with deep V-shaped drill holes and was mounted on an even more historic jewellery piece. It thus was recut and faceted into its present shape now exhibiting very shallow drill holes. The cutting style (large culet facet), the strong wear marks at the facet edges, and the chatter marks on the pavilion of this sapphire and all other faceted gems on this necklace indicate that this postulated re-cutting may have been carried out in historic times, most probably already in the 17th – 18th century.

△ **Figure 6:** Sri Lankan sapphire which was originally set in an antique brooch. The large, polished bulge on the backside is presumably the remains of a former drill hole of the initially larger sapphire of historic provenance. The bulge is even visible from the front side in the upper part of the sapphire on the left. Photos: J. Xaysongkham, SSEF.

The final case in this survey on antique jewellery is about a sapphire which was originally mounted as a centre stone in an antique diamond brooch reportedly from circa 1880.
Gemmological testing clearly revealed it to be a sapphire of Sri Lankan origin. The stone had been recently repolished to remove small blemishes and knock marks. However and interestingly, this sapphire exhibits on the backside a long linear bulge, visible even from the front side (Figure 6). Based on the antique setting, the cutting proportions and style (slightly convex table facet), we assume that this polished linear bulge on the pavilion side of this sapphire is a remaining feature of an originally present large drill hole in an even more historic and larger sapphire. As the stone is nearly free of any inclusions, we consider it rather unlikely that this polished bulge was made to remove a large straight inclusion feature in this sapphire.

To conclude, as mentioned at the beginning, the testing of antique jewellery and their gems may provide insights that stretch far beyond routine gemmological testing. The re-cutting of gems over centuries is well-known and relies mainly on the fact that gems are not perishable consumables. Gems are actually here to stay and serve to embellish and fascinate not only people from the past and present, but also those coming in the future, be it in their original historic state or as a newly redesigned and re-cut gem and jewel.

For those who would like to learn more about these and further fascinating findings related to antique gems and jewellery, we suggest you enrol in our Advanced Course in Jewellery History, that will next take place July 15-19 2024 and in January 2025 (www.ssef.ch/courses).
✶ **Dr. Michael S. Krzemnicki, SSEF**

VANADIUM CHRYSOBERYL

△ **Figure 1:** A Selection of V-chrysoberyls revealing the range of possible colours from bright 'mint' green to saturated buish green. Photo: SSEF.

Vanadium as a colouring element is quite often underestimated, mostly as it is often associated and acting together with chromium, a chemical element with a similar geochemical behavior and paragenetic occurrence but which is historically better known in the trade and easier to detect with simple tools (spectroscope) by gemmologists.

Apart from tanzanite (V-bearing zoisite) and tsavorite (V-bearing grossular garnet), vanadium is actually also found as an important chemical constituent for example in chrome-tourmaline - which is in fact mostly dominated by vanadium despite its trade name - and Colombian emeralds. In all these cases, vanadium is the main cause of or at least contributing to the colour of these gems.

Vanadium-chrysoberyl (or V-chrysoberyl) is an interesting and very attractive addition to these vanadium-coloured gems. Its colour ranges from bright 'mint' green to saturated bluish green (Figure 1). It has been found in Tunduru (Tanzania), Ilakaka (Madagascar), Sri Lanka and Myanmar (Krzemnicki & Kiefert, G&G 1996, Schmetzer et al. JoG 2013, see also SSEF Facette 2014, page 20). Being rather rare but often nearly free of inclusions, these gems are sought after by gemstone collectors and jewellery designers.

At SSEF, the classification as vanadium chrysoberyl is based on a combination of visual appearance (colour), absorption spectroscopy and chemical trace element analysis, very similar to other colour variety calls, such as cobalt-spinel, emerald, Paraiba tourmaline, to name a few.

△ **Figure 2:** Chemical comparison (Fe/V) of two V-chrysoberyls and a normal chrysoberyl mainly coloured by iron (containing traces of vanadium). Figure: M.S. Krzemnicki, SSEF.

It is important to understand that yellowish green chrysoberyl mainly coloured by iron with traces of vanadium is not fitting to be classified as V-chrysoberyl. As there is a gradual range between vanadium chrysoberyl and iron-dominated chrysoberyl, a separation into these two varieties is not always straightforward and requires a standardized analytical protocol and light (see also the light box article, page 44). The complexity is further increased as there are two different lattice sites in the chrysoberyl structure on which vanadium, but also Cr and Fe may substitute for aluminium, resulting in slightly different impact on absorption and finally colour. Ultimately, the visual colour, i.e. the predominance of a 'mint' green to bluish green colour is key to recognize and appreciate this attractive colour variety of chrysoberyl.

THE COLOUR RANGE OF PARAIBA TOURMALINES

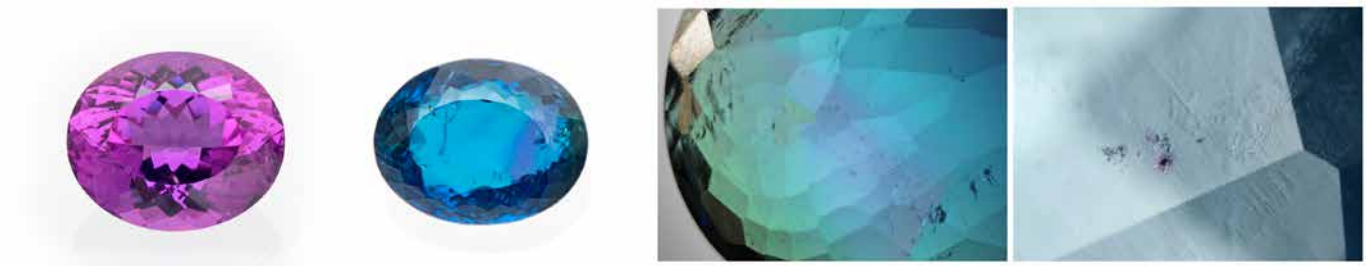
△ **Figure 1:** Colours of copper-bearing tourmalines and the restricted range qualifying for Paraiba tourmalines at SSEF. Photo: SSEF

Paraiba tourmalines owe their attractive colour to the presence of copper. In the best case, this gives rise to a vivid blue colour, also known in the trade as 'neon' blue or 'electric' blue and not known from any other gemstone in nature.

In the last SSEF Facette, we discussed the criterion of colour saturation towards classifying a copper-bearing tourmaline as Paraiba tourmaline (see SSEF Facette 2023, page 35). As was shown, tourmalines of very low blue saturation do not qualify to be called Paraiba tourmaline, even if their light blue colour is caused by traces of copper.

This time, we would like to clarify about the colour range of Paraiba tourmaline. It is well-known that copper-bearing tourmalines from Paraiba in Brazil, but also from Nigeria and Mozambique come in a rather large colour range (Figure 1). Copper-bearing tourmaline may be found in purple, deep blue, greenish blue, bluish green, vivid green to greenish yellow colours. Sometimes a mix of these colours are even found in a single zoned tourmaline crystal. The reason for this colour range is the contribution of other chromophores such as manganese and iron in the absorption spectra of these copper-bearing tourmalines.

At SSEF, the term Paraiba tourmaline is mentioned on a report only if the colour of the copper-bearing tourmaline ranges from deep blue to vivid green. Purple or greenish yellow to yellowish green stones containing distinct amounts of copper, however, are only described as copper-bearing tourmalines on SSEF reports.



△ **Figure 2:** The purple colour of the copper-bearing tourmaline on the left is proof that this stone is unheated. The same conclusion applies to the Paraiba tourmaline with a diffuse purple zone and with only a tiny purple halo around a hollow channel. Figure: M.S. Krzemnicki, SSEF.

It is important to know that most copper-bearing tourmalines are heat treated to enhance their colour. This is especially the case with originally purple (or greyish purple) Cu-bearing tourmalines. They are heated at about 550 °C with the aim of shifting their colour to an attractive Paraiba-blue colour. In other words, the purple colour of a copper-bearing tourmaline is proof that this stone had not been heated. This is also valid for stones containing purple zones or a tiny purple halo around a hollow channel as seen on the right in Figure 2.

*** Dr. Michael S. Krzemnicki, SSEF**

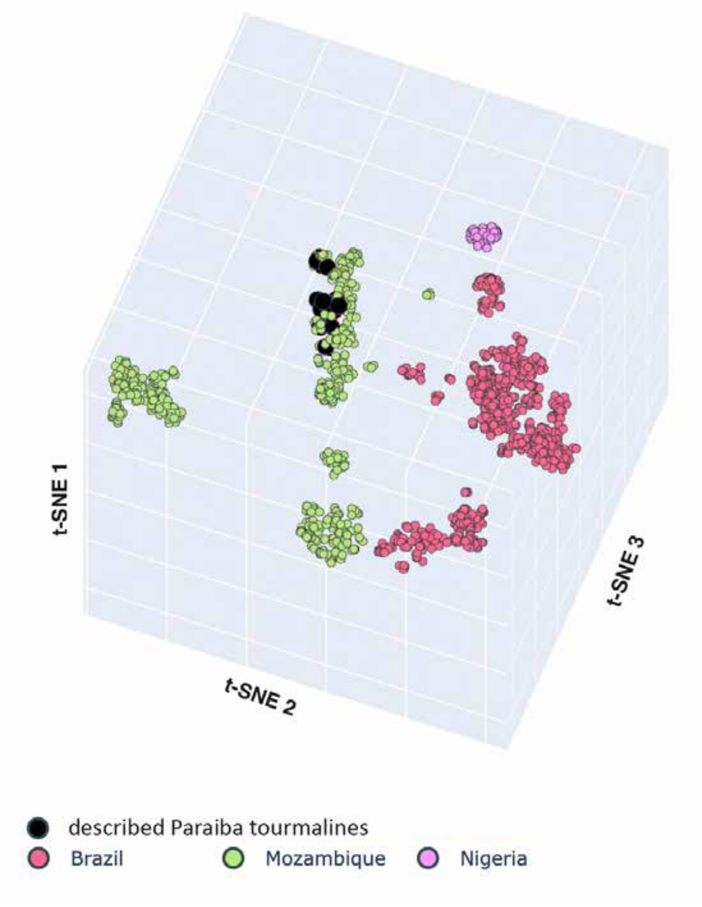
EXCEPTIONAL SET OF TOURMALINES

△ **Figure 1:** A layout of six Paraiba tourmalines of exceptional quality and size (from 4.75 to 32.62 ct) were recently submitted to SSEF for testing. Photo: L. Phan, SSEF.

Paraiba tourmaline is among the most highly prized of gems today and they are sought after for their vivid colour ranging from blue to green. Although Mozambique is known to have produced occasionally copper-bearing tourmalines in large size and exceptional colour and clarity, we were quite stunned when a client submitted a set of six Paraiba tourmalines of matching vivid ('neon' or 'electric') blue colour and excellent quality. Trace element analyses quickly revealed copper as a main colouring element in all these tourmalines, and further confirmed their reported origin from the alluvial gem deposit near Mavuco in the Alto Ligonha pegmatite district in northern Mozambique. This could be best deciphered by visualising the chemical data in a three-dimensional t-SNE scatter plot (using GemTOF trace element data) in which data clusters of Paraiba tourmalines from Brazil, Mozambique and Nigeria can be distinguished (Figure 2). Such visualization of high-dimensional chemical data is based on machine learning algorithms which are applied by SSEF since several years as a supporting tool for the origin determination of gemstones.

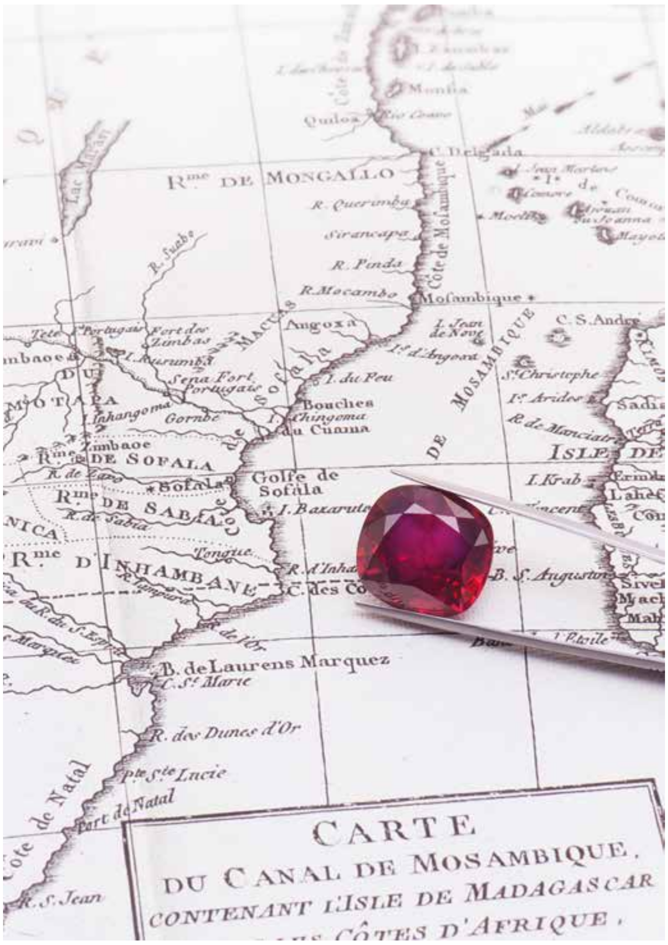
We were pleased to see that the suite of the four smaller Paraiba tourmalines (in total 31.01 ct) - assembled by Joseph Ambalu of Amba Gem Corp.- shortly afterwards won the prestigious Cutting Edge Award by the American Gem Trade Association and were on display during the AGTA Show in Tucson early February 2024.

*** Dr. Michael S. Krzemnicki, SSEF**



△ **Figure 2:** Three-dimensional t-SNE scatter plot revealing that the above described copper-bearing tourmalines originate from Mozambique. Figure: M.S. Krzemnicki, SSEF.

ESTRELA DE FURA: AN EXCEPTIONAL RUBY OF 55 CT

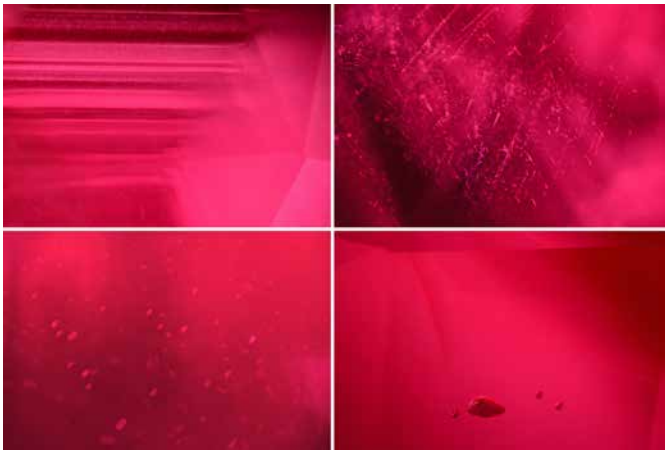


△ **Figure 1: The Estrela de Fura ruby at SSEF in February 2023. Photo: J. Xaysonghkam, SSEF.**

On the 8th of June 2023, the Estrela de Fura ruby was sold at Sotheby's in New York for a world record price of US$ 34.8 million. This ruby of 55.22 ct was cut from a 101 ct piece of rough, discovered in July 2022 near Montepuez in Mozambique, in a mine operated by the Fura Gems company.

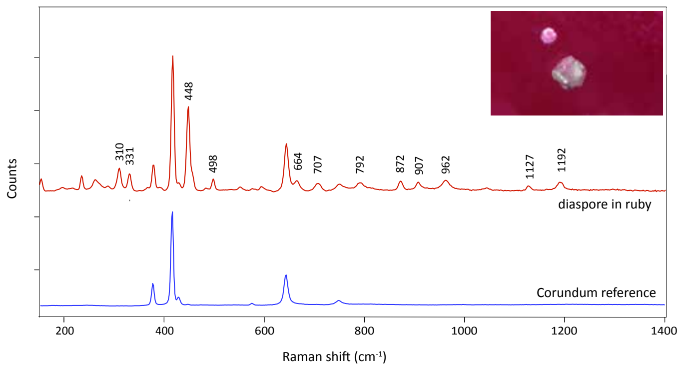
The SSEF analysed the 55.22 ct ruby before the auction and issued one of its prestigious Provenance Books™, a document only reserved for rare and exceptional gems and jewellery tested at SSEF.

Microscopic observations revealed inclusions well-known from the mines near Montepuez in Mozambique, such as fine rutile needles arranged in zones, platelets, roundish amphibole inclusions, and regularly dispersed tiny whitish patches (Figure 2). Its colour can best be described as a beautifully saturated and evenly distributed red (red of medium strong saturation by SSEF standards).



△ **Figure 2: Microphotos of inclusions found in the Estrela de Fura ruby, with fine rutile inclusions, particles and wedge-shaped platelets, tiny whitish patches, and greenish amphibole. Magnification 50x, except upper left image at 25x. Microphotos: M.S. Krzemnicki, SSEF.**

Interestingly, we were able to further analyse an idiomorphic fluid inclusion ('negative' crystal) containing a whitish mineral phase. The Raman micro-spectroscopy analyses clearly identified this mineral as diaspore (Figure 3), an epigenetic phase formed during geological times when the ruby was slowly cooling down in the host-rock. As the analysed fluid inclusion is very tiny, the Raman spectrum of the diaspore is also showing corundum peaks from the surrounding ruby matrix. That is the reason why the corundum reference spectrum was added in the figure to visualize this overlap of peaks.



△ **Figure 3: Raman spectrum of diaspore (whitish phase) detected in a fluid inclusion in the Estrela de Fura ruby. Only the diaspore peaks are labelled. Figure: M.S. Krzemnicki, SSEF.**

In addition to other observations (microscope and FTIR), the presence of diaspore in corundum was a further proof that this ruby had not been heat treated at any time (see also focus article in this Facette, pages 6-9).

*** Dr. Michael S. Krzemnicki, SSEF**

PIGEON BLOOD RED RUBY FROM VIETNAM

△ **Figure 1:** 2.10 ct ruby from Vietnam (left), colour grading of rubies at SSEF (right). Photos: SSEF.

Recently, a beautiful Vietnamese ruby of 2.10 ct and vivid red colour was submitted to SSEF for testing. Microscopic observations and chemical trace element analysis confirmed its Vietnamese origin and our colour grading protocol revealed that this stone was well fitting to be called 'pigeon blood red' based on SSEF standards.

Although most rubies which have been classified by SSEF as 'pigeon blood red' are of Burmese origin (Mogok or Mong Hsu), we have seen in the past also rubies from other gem deposits such as Vietnam - as the above-described gem -, Tajikistan, and even East Africa which were fitting to be called 'pigeon blood red'.

The SSEF applies strict criteria to classify a ruby as 'pigeon blood red'. Apart from the saturated and vivid red colour which is compared with a set of ruby master stones, the ruby must be untreated (e.g. no indications of heating and/or clarity modification) and show a strong red fluorescence under UV light. It is important to know that the geographic origin is not a criterion at SSEF and therefore the term 'pigeon blood red' is applied and mentioned on our report if the listed criteria are met.

A detailed description of the criteria for 'pigeon blood red' rubies (and 'royal blue' sapphires) is found on our SSEF website (https://www.ssef.ch/pigeon-blood-red-royal-blue/) and in SSEF Facette 2016 (pages 8-9).
✶ **Dr. Michael S. Krzemnicki, SSEF**

VISIT TO JAPAN'S PEARL FARMS

Having attended the IGC conference in Tokyo in October 2023, Dr. Michael S. Krzemnicki and Dr. Laurent E. Cartier took some time to travel south to visit the cultured pearl trading hub of Kobe and pearl farmers in Mie prefecture. This region is the birthplace of Akoya pearl cultivation and where one can still visit the Mikimoto pearl island today.

Our visit was aimed at understanding current pearl cultivation practices in Japanese Akoya production. The farms in this area are still renowned for producing high-quality Akoya cultured pearls today.

During our visit, we closely observed farming techniques for pearl oyster growth and operation procedures for oysters. We examined each stage of pearl development, from oyster selection to pearl harvesting. Engaging with experts, we learned about selective breeding and environmental optimization techniques to enhance Akoya cultured pearl quality and yield.

Our findings and samples collected will contribute to the scientific understanding of Akoya pearl cultivation, and ongoing research projects on pearl formation and DNA fingerprinting. We greatly appreciate the hospitality of Andy Müller and Akira Horiguchi in Kyoto, George Kakuda (Kakuda Pearl Co. Ltd.) and the local pearl farming families that generously shared their time and expertise.

*** Dr. Laurent E. Cartier & Dr. Michael S. Krzemnicki**

△ The Akoya pearl oyster has been producing beautiful, cultured pearls for over a century, thanks to the beautiful iridescence effect it can produce (see the colours on the shell). Photo: L.E. Cartier, SSEF.

△ Three generations of pearl operating technicians on the same farm. Photos: L.E. Cartier, SSEF.

△ Pearl farming activities in the Ago Bay of Mie Preferecture (Japan). Photo: L.E. Cartier, SSEF.

△ Pearl farming is still very labour-intensive today as the oysters need to be sorted and regularly cleaned from biofouling (e.g. algae). Photo: L.E. Cartier, SSEF.

△ Juvenile oysters are placed in lantern nets as they grow to maturity before they can be operated. Photo: L.E. Cartier, SSEF.

△ The fundamentals of the pearl oyster operating process have not changed greatly in over a century. Visible here are nucleus beads that will be inserted together with a mantle tissue piece ('saibo' being cut on the wooden board), into a host oyster. Photo: L.E. Cartier, SSEF.

△ Interestingly, in the production of 'baby Akoya' cultured pearls it is possible to insert two nuclei with two pieces of mantle tissue into an Akoya oyster. Photo: L.E. Cartier, SSEF.

△ Great thanks go to George Kakuda and the pearl farmers we could visit in Ago Bay. Photo: SSEF.

△ Pearl farming in Ago Bay takes place in a beautiful environment, so much that certain pearl farmers are providing tours and expanding into ecotourism. Photo: L.E. Cartier, SSEF.

△ Visting Andy Müller and Akira Horiguchi in Kobe. Andy has been a decades-long supporter of SSEF's pearl research by generously providing us with numerous samples. Photo: Hinata Trading.

EXCEPTIONAL NON-NACREOUS PEARLS AND PEARL JEWELLERY

Over the past few months, we have again analysed a number of outstanding, historic, or gemmologically interesting pearls. These include natural pearls from gastropods and non-nacreous shells (Figure 1). These pearls often consist of interwoven bundles of aragonite fibres, which result in patchy to spiky patterns poetically known in the trade as flame structures. The selection of recently tested non-nacreous pearls presented in Figure 1 includes a perfectly roundish purple pearl from the Lion Paw scallop (*Nodipecten nodosus*), an important pink Conch pearl (*Aliger gigas*, previously known as *Strombus gigas*), two brownish Horse Conch pearls (*Triplofusus Giganteus*), two large round Melo pearls (*Melo melo*) each of about 130 ct, and a pair of ear-pendants designed by Anna Hu with an orange and white non-nacreous pearl of excellent quality and matching drop-shape.

△ **Figure 1: A horse conch shell together with a parcel of small horse conch pearls, digitally reunited with a selection of non-nacreous natural pearls tested recently at SSEF. Photo: M.S. Krzemnicki, SSEF.**

SSEF GEMTRACK™: EXCEPTIONAL CASES FROM THE LAST FEW MONTHS

Since January 2019, SSEF offers the gem trade a tracking service and document, known as SSEF GemTrack™. It not only allows the client to track a gemstone in time, but is also an attractive option for our clients to tell the story of the provenance of a specific and exceptional gemstone to their customers.

The SSEF GemTrack™ is a versatile document that can be used as a solution for different needs as it may document the journey of a gemstone from:

- a rough pebble/crystal to the cut gemstone
- a loose stone to the gemstone set in jewellery
- an old weight to a new weight after recutting and repolishing
- an old stone, thus not being a new find from a source under boycott today

To be able to issue such a SSEF GemTrack™ document, the SSEF has to see the stone twice, for example as a rough stone and then again after cutting. It is important to know that SSEF can issue a GemTrack™ document for any gemstone which is resubmitted for a recheck and for which a previous SSEF report already exists.

In the past few months, our clients have again supplied exceptional gems for the SSEF GemTrack™ service. A selection of these gems is shown in the photo above, presented in their initial stage and after cutting/recutting. This selection includes a tsavorite garnet of more than 200 ct (rough), a Colombian emerald of more than 40 ct, a Burmese sapphire and a Sri Lankan sapphire, each initially about 60 ct, a pink sapphire from Myanmar of more than 25 ct (rough), and several rubies from Mogok and Namya in Myanmar and from Mozambique.

For any further information about our SSEF GemTrack™ service, please check our website https://www.ssef.ch/gemtrack/ or contact us directly at SSEF (phone: +41 61 262 06 40, email admin@ssef.ch).

EFFECTS OF GAMMA IRRADIATION ON RUBY AND PINK SAPPHIRE: AN UPDATE

△ **Figure 1: Purple to pink sapphires before and after the so-called ‚hospital' irradiation treatment. As evident from the photo, the colour shift induced by the irradiation treatment varies from stone to stone from nearly no change to a rather distinct change. Photo: SSEF.**

Gamma irradiation is a treatment method that may enhance the colour and visual appearance of gemstones, such as diamond, topaz, quartz, and corundum, to name a few. This treatment method uses strong gamma rays, either from radioactive isotopes like cobalt-60 (^{60}Co) or from a linear accelerator (LINAC), to induce point defects in the crystal structure of gemstones. These defects, caused by the displacement or ionization of atoms, can lead to the creation and activation of so-called colour centres. This process can alter the gemstone's colour in ways that range from subtle to dramatic, with the extent of the change depending on intrinsic properties of a gemstone (e.g. chemical composition and site occupancy) and the specifics of the irradiation process.

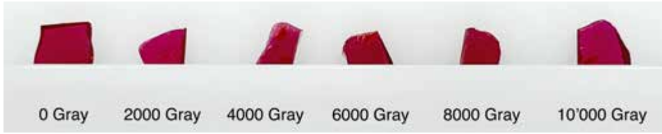
The exploration of gamma irradiation as a technique to enhance the colour of corundum dates back several decades. The advent of ruby lasers (synthetic, mostly of light colour and with pinkish hue) in the 1960s sparked extensive investigations in optical and material sciences into how gamma radiation affects these ruby lasers, especially its impact on their performance. In the 1980s, a keen interest appeared in the gem trade to experiment with gamma irradiation. The aim was to intensify the colour of yellow or pale gem-quality corundum and to bring these now more attractive irradiated stones to the market. It is thus safe to say that the irradiation of corundum is not a new treatment, but somehow remained mostly below the 'radar' of the gemmological community and the trade in the past decades, probably as the quantity of irradiated corundum was rather limited and mainly restricted to yellow sapphires.

The new so-called 'hospital' treatment

This has changed in the past few years, as we have multiple trustworthy sources which indicate that quite a number of rubies and fancy sapphires ranging in colour from pink to purple, light yellow and even blue may undergo an undisclosed gamma irradiation treatment before entering the marketplace (Figure 1). As this is a new challenge to the trade and labs alike, it initiated immediate research activities and discussions among gem labs with the aim to develop criteria to detect this irradiation treatment (Pardieu et al. 2022, Scarratt – pers. comm. 2022, Leelawatanasuk – pers. comm. 2022, Krzemnicki 2022, Krzemnicki 2023). Based on our information, this gamma irradiation treatment was originally carried out (secretly?) in medical facilities, utilizing cancer radiotherapy equipment, hence its name 'hospital' treatment. Based on more recent information, the treatment now is also carried out at non-medical irradiation facilities, mainly in countries known as cutting and trading hubs of corundum.

As mentioned above, the aim of this irradiation is to change and shift the initial colour to a more vivid and marketable one. Specifically, to remove the bluish hue in purple sapphires and rubies to end up with a vivid ('hot') pink or pure red colour, or to introduce an orange hue in pink sapphires, resulting in the best case in a pinkish orange colour as known for Padparadscha sapphire.

△ **Figure 2: LINAC gamma irradiation source, a gyroscopic radiosurgery platform, installed at SNRC, Zurich, Switzerland.**



△ **Figure 3:** Visual inspection of ruby (six dark red slices, cut from a single stone) initially and after gamma radiation treatment with incremental change in radiation dose. No colour shift is observed. Photo: SSEF.

Irradiation experiments carried out by SSEF

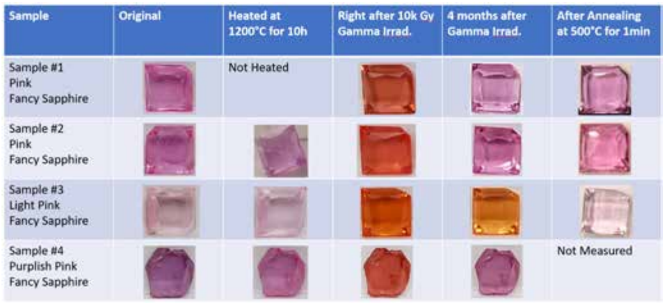
Since 2022, the Swiss Gemmological Institute SSEF has been collaborating with the Swiss Neuro Radiosurgery Centre SNRC (Zurich) to better understand the effects of gamma irradiation on chromium-bearing corundum (rubies and pink sapphires) and to develop a testing method for detecting such irradiation treatment. In a series of experiments, corundum samples ranging from light pink (from Madagascar) to dark red colour (from Mozambique) were treated by gamma radiation using a LINAC instrument (ZAP-X, gyroscopic radiosurgery platform, USA) (Figure 2). This device features a well-defined 3D radiation profile and offers accurate radiation dose control. The samples were exposed to a total radiation dose of 10,000 Gray in increments of 2,000 Gray. Some of the samples were heated (1200°C for 10h) before gamma irradiation to eliminate any potential residual effects from previous treatments on the host gemstone and structurally 'reset' (anneal) any present zircon inclusion. The reason for this pre-treatment heating was to make the possible colour shift by gamma irradiation more pronounced and discernible. Following the irradiation experiments, immediate visual inspection was conducted. Various analytical methods, such as UV-VIS absorption spectroscopy of the corundum and Raman analysis of the zircon inclusions in pink sapphires were conducted to compare the results before and after gamma irradiation. To determine the colour stability of the irradiated gemstones, a standard stability test as well as a final annealing step (500°C) were applied.

In a second experiment run-up, we recently submitted a number of purplish sapphires from Madagascar anonymously to a facility for a so-called 'hospital' irradiation treatment (see Figure 1). These samples were kindly donated to SSEF by a supportive member of the trade. Again, all these samples were meticulously analysed at SSEF before and after irradiation. They are currently being inspected using further advanced analytical methods in collaboration with Swiss academic research institutions to fully document any changes which occurred by this treatment. This 2nd experiment is still an ongoing research study, which means that more detailed results of this experiment will only be presented in the near future.

Effect of irradiation on corundum: results of our experiments

Our experiments using the LINAC instrument reveals that gamma irradiation (at least with our chosen dose and experimental conditions) has no discernible effect on the colour of ruby of strong red saturation (from Mozambique). This is in line with results by other international research groups and labs. It may have, however, a certain influence on rubies of purplish hue and lower colour saturation as described by Suwanmanee et al. (2023), shifting their colour to a more attractive red hue.

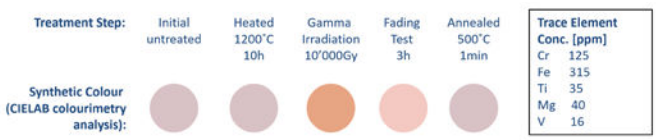
In contrast to this, our experiments revealed a significant impact of gamma irradiation on the colour of pink and purple sapphires. All these samples exhibited a pronounced transition from pink or purple to orange (see Figure 4) after irradiation. This induced colour shift, however, is commonly not permanent. The majority of the treated pink to purple sapphires shifted back to their original colour within a few months or after passing a colour stability test.



Sample	Original	Heated at 1200°C for 10h	Right after 10k Gy Gamma Irrad.	4 months after Gamma Irrad.	After Annealing at 500°C for 1min
Sample #1 Pink Fancy Sapphire		Not Heated			
Sample #2 Pink Fancy Sapphire					
Sample #3 Light Pink Fancy Sapphire					
Sample #4 Purplish Pink Fancy Sapphire					Not Measured

△ **Figure 4:** Visual changes of pink to purple sapphires after heat treatment, after gamma radiation treatment and after final annealing treatment. Figure: H.A.O. Wang, SSEF.

Among our specimens, sample #3, a light pink sapphire, is the only one which exhibits a (quasi) stable colour shift to orange after gamma irradiation, with only a slight decrease in orange saturation after four months— thus remarkably not reverting to its initial light pink colour. This stability persisted to some extent even after a colour stability test with the sample retaining a weaker but still orange hue until it was subjected to an annealing step, which finally restored its original light pink colour (Figure 5). This exceptional case suggests the presence of at least two distinct types of orange colour centres within these samples: one unstable and one stable. The unstable colour centre likely contributes to the colour reversion observed in the other samples, while the stable one accounts for the prolonged retention of the orange hue post-gamma irradiation. Sample #3's behaviour provides valuable insights into the mechanisms of colour shift in pink sapphires, indicating a complex interplay between different colour centres and the potential for targeted colour modifications through this specific treatment.



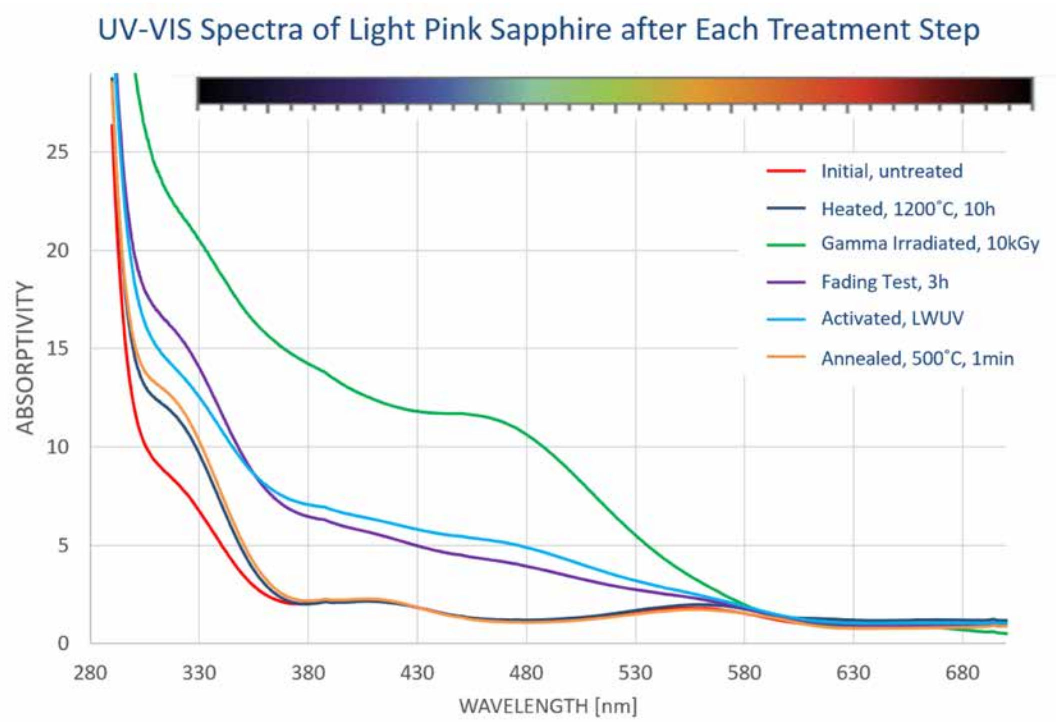
△ **Figure 5:** Colour shift of Sample #3, a light pink sapphire, after each treatment step. From left to right, different treatments show the colour of the stone shifting from light pink to intense orange and reduce to light orange, and finally back to the original light pink colour. The colour was analysed by Gem Colour Analyzer at SSEF after each experiment step. Trace element concentrations of the stone are provided to the right. Figure: H.A.O. Wang, SSEF.

In summary, these findings suggest a differential response to gamma irradiation across corundum varieties, potentially influenced by their chromium (Cr) content (Powell 1966). The varying effects of gamma irradiation might be attributed to the difference in Cr concentration, with high-Cr corundum (ruby of saturated red colour) exhibiting resilience to colour modification compared to low-Cr corundum (pink sapphire). This distinction raises intriguing questions about the structural and compositional factors contributing to the observed behaviours, pointing towards the need for further research to understand the mechanisms underpinning the differential sensitivity to gamma irradiation within corundum varieties.

In search of a detection method for this treatment

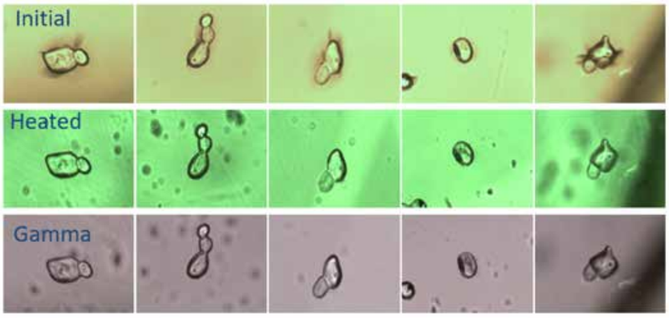
UV-VIS spectroscopy is a powerful technique that can capture the detailed absorption behaviour of colour centres in a gemstone. Our analysis of Sample #3, depicted in Figure 6, showcases the spectral changes following each experimental step. Notably, there is an observed enhancement in absorption at approximately 320nm and 475nm post-gamma irradiation (green trace in the spectrum). Unlike the effects of heat treatment at 1200°C which did not alter theabsorption at 475nm, gamma irradiation distinctly increased absorption at this wavelength. This phenomenon is likely attributable to the formation of trapped holes (O^{-1}) adjacent to Fe^{3+} or Cr^{3+}, substituting for Al^{3+} in the crystal structure of corundum, thereby generating two types of colour centres responsible for the shift of the initially light pink gemstone to an intense orange colour. This mechanism, facilitating the creation of trapped holes and consequent colour alterations in Cr- and Fe-containing corundum, aligns with previous observations on natural untreated corundum of orange colour (Dubinsky et al., 2020). Moreover, our analyses reveal that a subsequent colour stability test (using a strong daylight source) does not necessarily revert the spectrum to its original state, leaving in our sample #3 a persistent light orange hue.

Besides investigating the before/after irradiation properties of our corundum samples (aka host gems), we also looked whether inclusion features in a corundum may reveal evidence of a gamma irradiation treatment. We specifically focused our analyses on the lattice disorder of zircon inclusions within one of the pink sapphires from Ilakaka, Madagascar (light pink Sample #3) before/after irradiation. This investigation was inspired by literature indicating that Raman peak broadening, a proxy for increased lattice disorder (Nasdala et al., 1995), could result from gamma radiation (Zhu et al., 2015). We focused on the behaviour of two characteristic Raman peaks at 974 cm^{-1} and 1008 cm^{-1}. Our experimental results, derived from five zircon inclusions, reveal no statistically significant broadening of the Raman peaks following gamma irradiation (Figure 7). To kind of 'reset' the structural disorder of these zircons, the sample was heated prior to the irradiation treatment. As detailed in Figure 7, the full width half maximum (FWHM) values for both peaks remained consistent with those observed in the 'reset state' after heat treatment, indicating no notable increase in lattice disorder by the irradiation experiment. This observation was further supported by the analysis of the mean FWHM values across the inclusions and the variability of these values, as measured by standard deviation (STD) and relative standard deviation (RSD).



◁ **Figure 6:** UV-VIS spectra comparison of Sample #3, a light pink sapphire, going through a series of treatments. Note the visible colour range bar on the top, which indicates that only spectral changes between 380nm and 700nm may be noticed by our eyes.
Figure: H.A.O. Wang, SSEF.

Interestingly, while gamma irradiation altered the colour of the light pink sapphire significantly, it did not affect the structural integrity of the zircon inclusions to a measurable extent. In contrast to this, the heat treatment applied prior to gamma irradiation markedly decreased the FWHMs and RSDs of the zircon Raman peaks, suggesting a reduction in lattice disorder. These findings suggest that the dose of gamma radiation used in our study was insufficient to induce detectable changes in the zircon inclusions, contrary to expectations based on previous literature. Consequently, analysing zircon crystal disorder post-gamma irradiation may not currently serve as an effective method for detecting this irradiation treatment.



	974 cm^{-1} v1(SiO4) Peak			1008 cm^{-1} v3(SiO4) Peak		
Unit [cm^{-1}]	*Initial*	*Heated*	*Gamma*	*Initial*	*Heated*	*Gamma*
FWHM Mean	16.19	10.75	10.92	14.77	11.03	11.27
FWHM STD	4.26	0.44	0.64	1.80	0.36	0.43
RSD	26.34%	4.09%	5.85%	12.22%	3.25%	3.84%

△ **Figure 7:** Raman analysis of zircon inclusions in Sample #3 (light pink sapphire), which retains a light orange colour after gamma irradiation and a colour stability test. Top: morphology of zircon inclusions at their initial state, after 1200°C heat treatment, and after gamma irradiation. Bottom: Statistical summary of Raman spectroscopy peaks (at 974 cm^{-1} and 1008 cm^{-1}) including full width half maximum (FWHM), standard deviation (STD), and relative standard deviation (RSD) for each peak. FWHM serves as a measure of crystal disorder, with higher values indicating increased disorder. RSD values assess the variability of FWHM across the inclusions, with higher RSDs suggesting greater differences in crystal disorder levels among the inclusions.

Outlook: what is to come?

Based on our current research results and after discussion with other gem labs, it has to be said that to this day, there is no criterion known which allows an unambiguous detection of gamma irradiation treated corundum.

Ongoing research at SSEF is focused among other things on exploring the relationship between the Cr-related photoluminescence (R-line intensity) and Cr-concentration, all with the aim to find a possible detection method for gamma-irradiated ruby and pink sapphires. It is essential to note that the detection of this irradiation treatment will likely require not only one criterion and detection method, but a combination of tests and methods, following the complexity of the effects of this treatment on corundum of different trace element composition and from different geological and geographical settings. This is even more true, as natural untreated corundum may have experienced natural irradiation if exposed to fluids containing radioactive elements or by natural irradiation in the host rock (Nassau and Valente 1987).

It currently is only possible to detect the treatment when the stone has also been analysed in its pre-treatment state and is compared and again analysed after irradiation. We know that this is a challenging situation for the trade and labs alike and would like to emphasize that we do the utmost in research trying to find solutions for the trade against this challenge and will update the trade regularly about any new findings in this matter.

*** Dr. Hao Wang, SSEF**

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ORANGE SODALITE FROM AFGHANISTAN

△ **Figure 1: Orange sodalite found near the famous lapis lazuli mines in Badakhshan in Afghanistan. These stones show an attractive and vivid orange colour and range in weight from 9.4 ct to 28.7 ct. Photo: A. Chalain, SSEF.**

Sodalite, a complex tectosilicate with the ideal formula $Na_8Al_6Si_6O_{24}Cl_2$ is known in the trade mostly as dark blue ornamental material, often as translucent to nearly opaque beads and cabochons, but in rare cases also as transparent faceted stones. Even better known is hackmanite, a tenebrescent variety of sodalite which is characterized by an intriguing but unstable colour shift from greyish to saturated purple when exposed to ultraviolet radiation, but usually fading quickly back to its initial greyish colour (see also Blumentritt & Fritsch 2021).

We thus were quite astonished when a series of faceted sodalites of a very attractive and vivid orange colour and quite important size (up to 28 ct) was submitted to the Swiss Gemmological Institute SSEF for testing. Reportedly, these orange sodalites were recently mined in the Kokcha valley near Sar-e-Sang (Badakkhshan Province) in Afghanistan (Figure 2), famous since ancient times for its lapis lazuli mines (Wyatt et al. 1981; Moore & Woodside 2014).

The identity of these orange sodalites was confirmed by structural (Raman), chemical (EDXRF), and classic gemmological analyses. As is well-known from sodalite (and hackmanite), our samples showed a strong orange fluorescence under longwave ultraviolet and a distinct bluish white fluorescence under shortwave ultraviolet.

Interestingly, some of this material was reportedly more reddish orange when mined, but turned to vivid orange during cutting, thus indicating a slight reversible photochromism (tenebrescence). A colour stability test at SSEF confirmed the photochromic behaviour of part of these orange stones shifting from orange (stable colour) to reddish orange (after activation, unstable colour) and back again to their initial colour after a fading test. Interestingly, this colour shift mainly affected stones of orange colour, whereas sodalites from the same mining site of yellowish to light yellow colour showed nearly no such photochromic shift.

Although sodalite is a rather soft and fragile mineral (Moh's hardness 5½ to 6), we believe that this new orange sodalite from Afghanistan may become a welcome addition to the gem trade due to its size, quality, and vivid colours.

The interested reader is referred to the coming issue of the Journal of Gemmology (2024, Vol. 39, No. 1) in which a more detailed gemmological short note about this material will be published.

✶ **Dr. Michael S. Krzemnicki, SSEF**

△ **Figure 2: Sar-e Sang, famous mining area for lapislazuli and sodalite (and other gems) in the northeastern Province Badakhshan in Afghanistan. (map slightly adapted from https://www.freeworldmaps.net/asia/afghanistan/map.html)**

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AFGHANITE FROM BADAKHSHAN IN AFGHANISTAN

◁ **Figure 1:** Rough and faceted afghanite samples recently submitted to SSEF. The faceted afghanite samples range in weight from 0.2 ct to 4.2 ct, all are characterized by an attractive colour and exceptional clarity. Photo: J. Xaysongkham, SSEF.

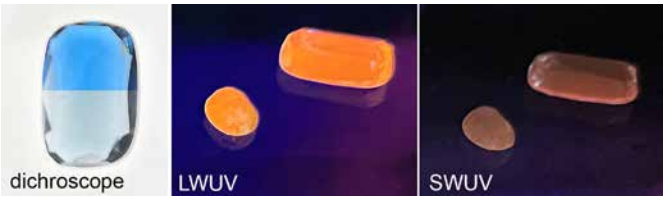
Afghanistan is known since ancient times as source of exceptional gems, namely lapis lazuli, tourmalines, beryls, rubies and spinel (Bowersox & Chamberlin 1995). Apart from these rather classic gemstones, Afghanistan is also source for numerous rare collector minerals, such as väyrynenite, triplite, bastnäsite, purple diaspore, sodalite and its tenebrescent variety hackmanite, to name a few (see for example SSEF Facette 2023, page 38).

One of these rare collector stones is afghanite, a complex hydrated silicate, first discovered and described in 1968 from the famous lapis lazuli occurrence of Sar-e-Sang in the Badakshan Province in northeastern Afghanistan (Bariand et al. 1968). Forming whitish to dark blue trigonal crystals, only a small amount of this material is of gem quality and as a consequence faceted afghanite has only been reported in small quantity and sizes over the years.

Recently, the Swiss Gemmological Institute SSEF received an outstanding series of faceted afghanites from Sar-e-Sang together with a larger parcel of rough stones (see Figure 1). These stones were characterized by an attractive colour and exceptional clarity and remarkable size (up to 4.2 ct), thus more than double the size of the largest faceted afghanite of 1.91 ct described so far in literature (McBride, 2018).

Classic and advanced testing of this material revealed its uniaxial positive optical character, a RI of 1.520 to 1.530, with a birefringence of +0.006, and a distinct pleochroism from nearly colourless to blue, all findings well in line with reported afghanite data from literature. Under a longwave ultraviolet lamp (LWUV) all our samples showed a characteristic strong orange fluorescence reaction whereas the reaction in shortwave ultraviolet (SWUV) was weaker and more reddish orange (Figure 2). No tenebrescence (reversible colour shift) was observed in all our samples. Chemical analyses (EDXRF), FTIR, Raman, and UV-Vis absorption spectroscopy further confirmed the identity of our samples as afghanite of exceptional colour and transparency.

A gemmological short note about this material is published in the coming issue of the Journal of Gemmology (Vol. 39, No. 1).



△ **Figure 2:** Afghanite with distinct dichroism and typical reactions under longwave and shortwave ultraviolet light. Figure: M.S. Krzemnicki, SSEF.

✶ **Dr. Michael S. Krzemnicki, SSEF**

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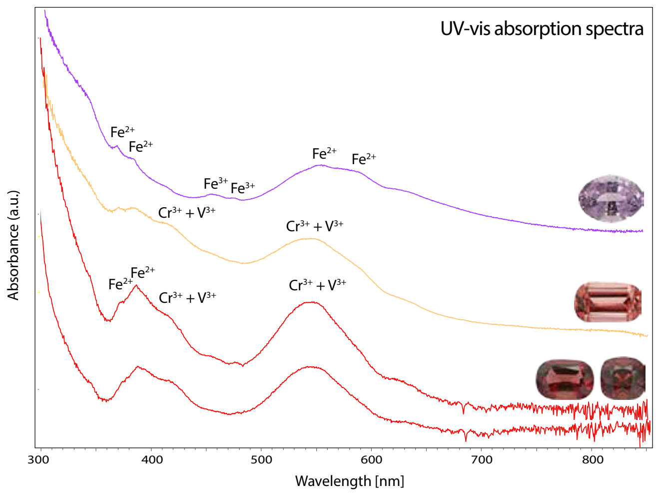
SPINEL FROM AFGHANISTAN

△ **Figure 1:** Spinel from Badakhshan Province in Afghanistan. Photo: J. Xaysongkham, SSEF.

Since ancient times, the Badakhshan Province in northeastern Afghanistan has been known for its gem deposits, most prominently the lapis lazuli mines near Sar-e Sang in the Kokcha valley.

Badakhshan was historically a much larger region extending largely into present-day Tajikistan. The region was famous for spinels known for centuries as Balas rubies, their name derived from the ancient Persian word badaxš for the region during the Sasanian Empire in late antiquity. Most of these spinels were mined at Kuh-i-lal (today in Tajikistan and close to the border to Afghanistan), and still today are among the most important pinkish red to red gems in history. These famed spinels – that had historically often been miscalled ruby – include amongst others the Black Prince Ruby (ca. 140 ct), set in the front of the Imperial State Crown of Great Britain, the Timur ruby (361 ct), today also part of the Crown Jewels of Britain, the Hope spinel (50.13 ct) which sold for $1.47 million at a Bonhams auction in 2015 and finally an Imperial Mughal spinel necklace which sold for CHF 4.5 million at Christie's in 2011.

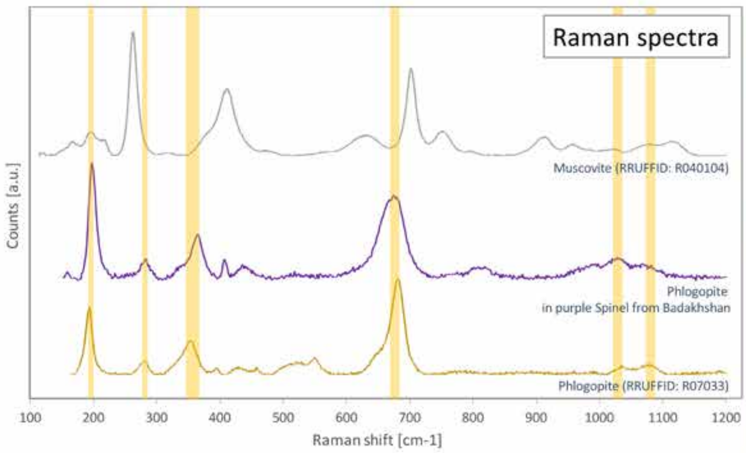


△ **Figure 2:** Absorption spectra in the ultraviolet and visible range of the analysed spinels from the Badakhshan Province in Afghanistan. Figure: M.S. Krzemnicki, SSEF.

In recent years, new spinels ranging in colour from purple to pink and red were found and described from mining sites in the Kokcha valley at or near Pitawak and close to the lapis lazuli mines near Sar-e Sang in the Badakhshan Province of Afghanistan (Boehm 2017, Hänsel et al. 2021, Belley & Palke 2021, Lhuaamporn et al. 2022, Pardieu 2022). Recently, we were able to analyse a series of spinels reportedly originating from this same area (Figure 1). The spinels range in colour from red to pink and orangy pink, and purple to violet.

The absorption spectra reflect the concentration variation of the colouring elements present in these spinels (Figure 2). The purple to violet stones are dominated in the spectrum by iron (Fe^{2+} and Fe^{3+} bands), whereas the pink to orangey pink and red stones show in addition distinct broad bands related to chromium and vanadium. This is also reflected in their UV reaction, being greenish for the purple to violet stones (related to traces of manganese) and reddish in the others due to their chromium content.

Chemical analyses of the spinel samples from Badakhshan reveal for the red and orangey pink stones a Cr/V-ratio of about 1:1 to 2:1 and a Fe/Cr-ratio of about 10, whereas they are about 25:1 to 40:1 (Cr/V) and 1300:1 to 4000:1 (Fe/Cr) for the purple to violet samples. This marked difference is also found in the inclusions. In the purple to violet spinel, we found numerous colourless to slightly brownish phlogopite inclusions (Figure 3) as described in literature (Boehm 2017, Hänsel et al. 2021, Belley and Palke 2021), whereas the red to pink stones analysed by SSEF were often nearly free of solid inclusions, containing only few tiny (hexagonal) graphite flakes and colourless magnesite (Mg-carbonate). All stones contained varying amounts of fluid inclusions mostly as so-called octahedral 'negative' inclusions.



△ **Figure 3: The colourless to** slightly brownish mica are phlogopite as revealed by Raman micro-spectroscopy. Figure: M.S. Krzemnicki, SSEF.

The stones which were analysed for this short note ranged in weight from 0.4 ct to 2.5 ct. Apart from them, larger parcels of faceted Badakhshan spinels of attractive colour and clarity up to 15 ct. were shown to us.

✶ **Dr. Michael S. Krzemnicki, SSEF**

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LITTLE BLUE SURPRISE

After the Covid-19 pandemic, SSEF has been back to carrying out regular on-site services in Bangkok, Hong Kong and the USA. For us gemmologists, the overseas work can sometimes give us more surprises than what we see in Basel. During on-site testing in Bangkok last year, we came across a 'special' vivid cobalt blue spinel. The client who submitted the sample wanted us to give an opinion on the origin of the stone, but the gemmologists were quite surprised when they saw the data. The strong fluorescence effect under short-wave UV light, the high refractive index of 1.723, an 'unusual' chemistry without zinc (Zn) was detected, the FTIR result and the photoluminescence spectra, all confirmed the gemmologists' conclusion: this 1.03 ct blue stone, with a fair cut, is a synthetic cobalt spinel made by the flame fusion method.

In the gemstone market, where people often mostly rely on a loupe and the naked eye, it can be quite a challenge to identify this kind of blue stone. Knowing that it is a synthetic cobalt spinel, the client who is also an experienced gemstone dealer was quite surprised. But this example also shows the importance of classical gemmological testing (UV lamp, SG, RI etc.) for gem identification and that there is not always the need for rocket-science methods.

*** Dr. Wei Zhou, SSEF**

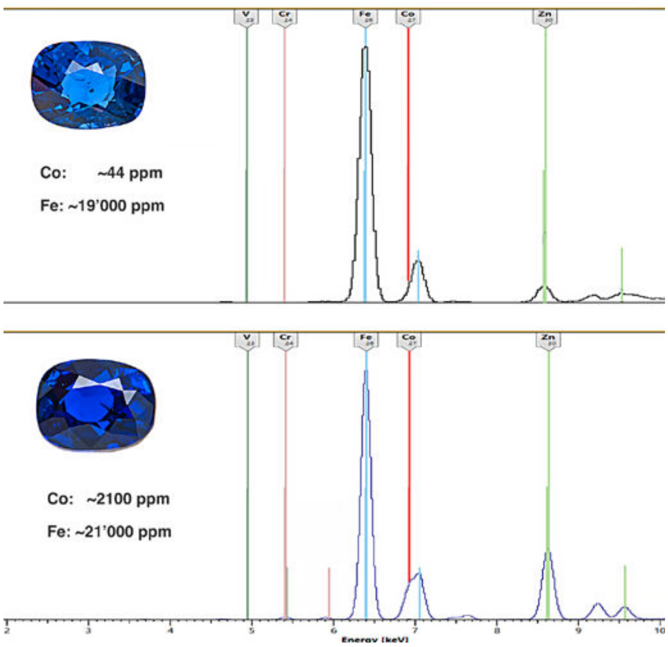
SPINEL WITH EXCEPTIONALLY HIGH COBALT CONCENTRATION

◁ **Figure 1:** Cobalt spinel of dark blue colour containing more than 2000 ppm cobalt. Photo: A. Chalain, SSEF.

Cobalt (Co) spinel is among the most sought-after gems in the trade, owing its attractive colour mainly to cobalt, with or without further contributions by iron. Interestingly, cobalt is a highly effective colouring element, with a few 10 to 100 ppm (parts per million) already resulting in a distinct blue colour. In contrast to absorption spectroscopy, in which cobalt as a main chromophore is generally easy to detect, it is very difficult to detect cobalt at this trace level by classic chemical analysis using X-ray fluorescence spectroscopy (EDXRF). This is partly due to its low concentration in most cobalt spinels, but also due to the interference of the main Co-emission peak (Kα) with the Kβ peak of iron, which is the dominant transition metal found in all natural cobalt spinels.

We were thus quite astonished to receive a cobalt-spinel of 1.0 ct of deep blue colour which contained more than 2000 ppm of cobalt (measured via GemTOF analysis), for which cobalt was even detectable in the EDXRF spectrum (Figure 2). The high cobalt concentration in this spinel resulted in a Co-emission (Kα) visible as a shoulder besides the Fe Kβ peak in the EDXRF spectrum, whereas normally no such feature would be seen in cobalt spinels with lower Co-concentration.

*** Dr. Michael S. Krzemnicki, SSEF**

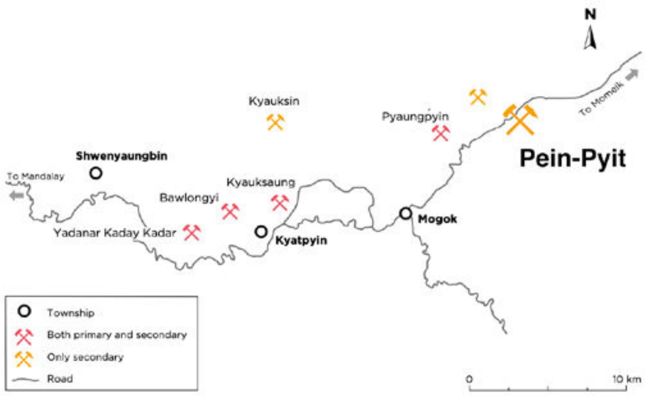


△ **Figure 2:** Comparison of the described cobalt-rich spinel (below) with a cobalt-spinel from Vietnam. The high cobalt concentration of more than 2000 ppm results in a shoulder left of the Fe Kβ peak which is not present in the Vietnamese cobalt spinel with lower cobalt concentration. Figure: SSEF.

SAPPHIRES OF 'TEAL' COLOUR FROM PEIN-PYIT, EAST-MOGOK

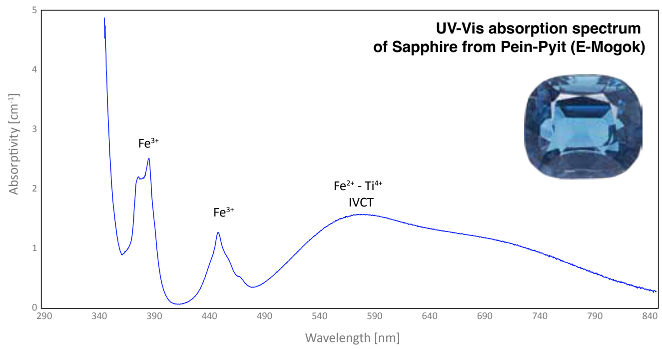
△ **Figure 1:** Paddy fields near the mining sites at Pein-Pyit in 2014, and three typical sapphires of slight to distinct greenish blue colour from that area about 10 km northeast of Mogok. Photo: M.S. Krzemnicki, SSEF.

The Mogok area in northern Myanmar has been known as a major source of rubies and other gems since historic times. Often referred to as the 'Mogok Stone Tract', this gem-rich area is located within the central part of the Mogok Metamorphic Belt which forms part of a larger metamorphic belt structure, extending for more than 2000 km from the Himalayan mountain range in the North to the Andaman Sea in the South. The Mogok area stretches about 25 km from East to West and about 10 km from North to South with the main townships Kyatpyin and Mogok located in the centre of the area. Gems are found at numerous localities and mining sites within this larger area mainly composed of upper amphibolite to granulite facies marbles, schists and gneisses which were intruded by various felsic to mafic igneous rocks (Phyo et al. 2023, see also article in this Facette on page 34).



△ **Figure 2:** Map of the Mogok Stone Tract indicating the location of the gem deposit at Pein-Pyit. Map slightly adapted from Phyo et al. 2019.

At Pein-Pyit, a village about 10km northeast of Mogok (Figures 1 & 2), mining of alluvial gem deposits on small stream banks and in paddy fields has been ongoing for many years, producing rubies, spinel, but mainly also sapphires of yellowish-green to greenish blue and greyish blue colour. The greenish blue colour of these sapphires is the result of a rather high iron concentration, predominantly present as ferric iron (Fe^{3+}) and thus resulting in strong Fe^{3+} peaks in the absorption spectrum (Figure 3). Especially the high and broad Fe^{3+} peak at 450 nm has a major effect on the colour of sapphire, as it shifts the transmission window towards the green (local absorption minimum at about 480 nm). In some cases, the broad absorption band at about 560 nm (related to the Fe^{2+}-Ti^{4+} intervalence charge transfer IVCT) is further reduced or nearly missing, resulting in green to yellowish green fancy sapphires from this same mining area near the village Pein-Pyit.



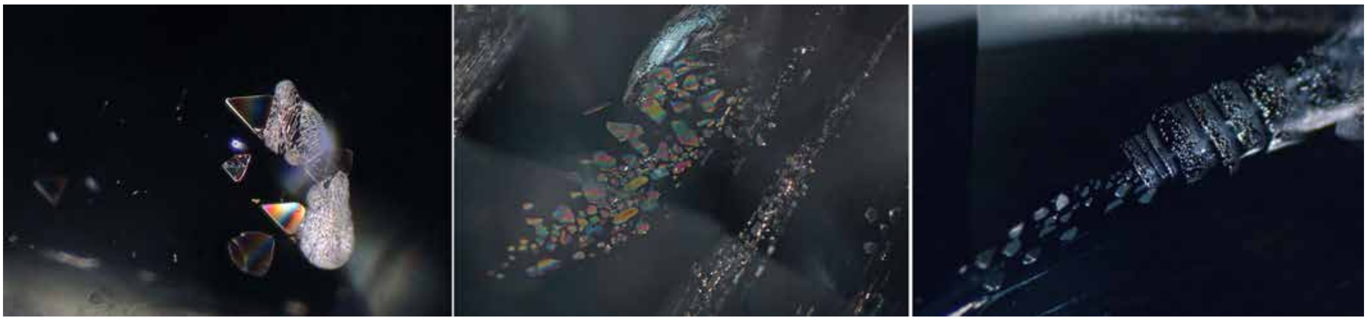
△ **Figure 3:** Absorption spectrum of a sapphire of slightly greenish blue colour from Pein-Pyit, Mogok area. Figure: M.S. Krzemnicki, SSEF.

Interestingly, these 'teal' coloured sapphires are occasionally quite large (50 ct and more) and of excellent clarity. They usually contain only few inclusions (Figure 4) such as tiny rutile needles, but geometric (fluid) platelets, step-like healing fissures, and diaspore exsolutions ('ice flowers') in fissures, features which are in many aspects similar to inclusions known from 'classic' Burmese sapphires (Gübelin & Koivula 2008; Kan-Nyunt et al. 2017; Soonthorntantikul et al. 2021).

For quite some time, sapphires from Pein-Pyit were not much sought after, as they obviously fall outside the 'royal blue' colour range for which classic Burmese sapphires have been cherished in the past. However, this has changed in recent years, as new collectors with broader colour preferences have entered the market. Consequently, the sapphires from the Pein-Pyit area have gained much interest in the trade in recent years (Figure 5), mostly due to their Burmese origin combined with an attractive 'teal' colour, exceptional quality, and size.

✶ **Dr. Michael S. Krzemnicki, SSEF**

△ **Figure 5:** Flat polished sapphire of 36 ct from Pein-Pyit before and after cutting into a beautiful hexagonal gem sapphire of 19 ct. The journey of this sapphire from pre-shaped to cut was documented by request of the client with a SSEF GemTrack™ report. Photo: J. Xaysongkham, SSEF.



△ **Figure 4:** Inclusions in these sapphires from Pein-Pyit. Magnification 50x. Microphotos: M.S. Krzemnicki, SSEF.

PUBLICATION ABOUT THE GEOLOGY OF MOGOK

△ **Figure 1: Near Yadanar kaday kadar in the Mogok area, one of the sampling locations investigated for this scientific publication. Photo: M.S. Krzemnicki, SSEF.**

Each day, the SSEF receives gemstones for testing originating from the famous Mogok area, also known as the Mogok stone tract. This area in Northern Myanmar is known since historic times as a major source of finest quality ruby, spinel and other gemstones.

A very in-depth scientific study about the geology of the Mogok area and the conditions of gemstone formation was published in the Journal of Asian Earth Sciences by Dr. Myint Myat Phyo (SSEF) in collaboration with her co-authors. The paper entitled "Petrology, geothermobarometry and geochemistry of granulite facies wall rocks and hosting gneiss of gemstone deposits from the Mogok area (Myanmar)" summarises the research and findings of our Burmese SSEF team member and former PhD student at the University of Basel (Switzerland). The focus of her study was to derive consistent PT-conditions of metamorphism and fluid conditions during the metamorphic events in Oligocene to Early Miocene time which led to the formation of gemstones in the Mogok area.

Her studies included geothermobarometry and equilibrium phase diagram calculations and revealed granulite facies metamorphic conditions for the investigated Mogok area with peak metamorphic PT- conditions ranging from 756 to 792 °C at 7.3–7.6 kbar, which is in agreement with earlier investigations in the same area. These granulite facies conditions also triggered the formation of spinel and ruby in the Mogok area. Garnier et al. (2008) showed that ruby and spinel in high-grade rocks did generally not form during peak metamorphic conditions but were generated on the retrograde PT-path under amphibolite facies conditions of 620–670 °C at 2.2–3.3 kbar. In the case of the marble-hosted gem deposits of the Mogok belt, the presence of paragenetic high-grade metamorphic inclusions in spinel (Phyo et al. 2019), however, provides strong evidence for their granulite facies formation.

Interested readers may read this open access scientific publication using the following link: https://doi.org/10.1016/j.jaesx.2022.100132

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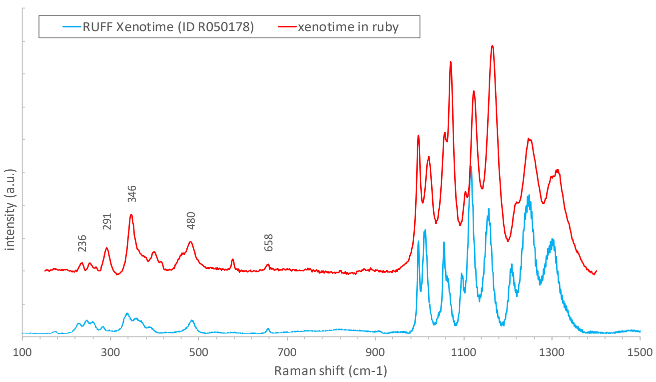
RUBY WITH XENOTIME INCLUSION: AGE DATING PROVIDES EVIDENCE OF EAST AFRICAN ORIGIN

△ **Figure 1:** Ruby of 15 ct that contained a tiny xenotime inclusion that was used for age dating. Photo: L. Phan, SSEF.

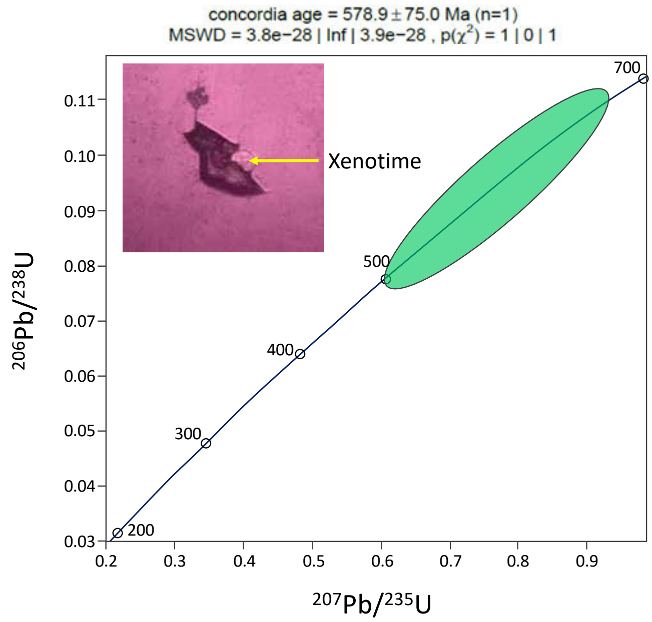
Rubies from marble deposits are chemically rather similar, regardless of whether they originate from marbles in Myanmar, Vietnam, Tajikistan, or even from Tanzania or other countries in East Africa.

Recently, we analysed a ruby of 15 ct of vivid and saturated colour (Figure 1). Based on the trace element composition a Burmese origin could be rather excluded, as nearly no vanadium traces were present in the stone. Still, the question remained if this ruby was from a source along the Himalayan mountain range or from a marble deposit in East Africa.



△ **Figure 2:** Raman spectrum of the xenotime inclusion in the ruby compared to a reference spectrum (RRUFF). Apart from vibrational peaks in the lower range, the spectra are characterized by strong photoluminescence peaks (REE) in the higher range above 1000 cm-1 Raman shift. Figure: M.S. Krzemnicki, SSEF.

We were lucky enough to find a tiny xenotime inclusion at the surface of this ruby, on which we were able to carry out radiometric age dating. Xenotime is an yttrium phosphate (YPO_4), with trace amounts of uranium and thorium, and is known as a rare inclusion in corundum (Figure 2). The analyses of the xenotime inclusion within this ruby revealed a radiometric age of 578.9 ± 75 million years. The data plots well on the Concordia curve, but with a rather large range due to the very small size of the inclusion which strongly limited the number of possible measurements (Figure 3).



△ **Figure 3:** Concordia diagram of the xenotime inclusion found at the surface of the 15 ct ruby. Figure: SSEF.

Based on these age calculations, a formation of this ruby within marbles along the Himalayan mountain range could be definitively excluded, as all ruby deposits located in the Himalaya are geologically much younger (generally only about 15-25 million old). However, the calculated age is in good agreement with the age of ruby formation in metamorphic rocks in East Africa, for example in Tanzania and Kenya (at that time part of the supercontinent Gondwana) and as such this age presents strong supporting evidence of an East African origin for this exceptional ruby of 15 ct.

Interested readers who would like to know more about radiometric age dating and its use in gemstone testing are referred to SSEF Facette 2020, page 10 – 11, in which a general overview about this advanced analytical method is provided.

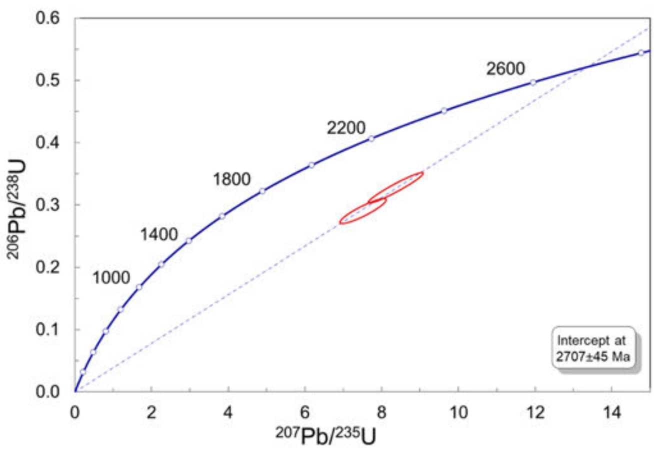
✶ **Dr. Michael S. Krzemnicki, SSEF**

SUCCESSFUL DATING OF ZIRCON INCLUSION IN RUBY DESPITE INTENSE HEAT-TREATMENT

△ **Figure 1:** Three Greenland rubies of 2.39, 3.04 and 1.22 ct. Age dating was successful on a tiny zircon inclusion on the ruby of 1.22 ct (right). Photo: A. Chalain, SSEF

Age dating of zircon inclusions in rubies and sapphires can provide useful information for origin determination. Zircon is a mineral which usually incorporates uranium when it is formed, and this uranium is decaying to lead over time enabling age dating by measuring their ratio. Zircon is loved by geochronologists due its mechanical and temperature resistance, its relative high uranium concentration, and the absence of common lead, i.e. lead that has been incorporated during crystal formation and doesn't come from the radiative decay of uranium. Uranium provides two independent chronometers from its two isotopes ^{238}U and ^{235}U which decay into ^{206}Pb and ^{207}Pb, respectively. Those ratios are plotted against each other and undisturbed accurate ages will fall on the Concordia line, see blue line in figure 2. Crystals which has been disturbed since their formation will fall outside this line, indicating that the ages derived from the Pb/U ratios directly cannot be trusted.

Recently, we analysed three rubies originating from Greenland at SSEF (Figure 1). All showed evident signs of heat treatment and additionally glassy residues in healed fissures and cavities. On the smallest of these rubies, we found two inclusions exposed to the surface which looked like zircons. Whereas the bigger inclusion turned out to be a former inclusion molten and converted to a silica glass, the smaller one was a tiny zircon, circa 15 µm by 60 µm in size. We analyzed this zircon with a small laser beam diameter using our GemTOF instrument, with the hope of calculating a reasonable age for the zircon, despite the fact that the ruby had been heated at high temperatures, and we were fortunately able to get two data points out of it.



△ **Figure 2:** Concordia line (solid blue) and Pb/U ratios from the zircon inclusion (red circles). The sizes of the circles represent the uncertainty of the measurements. The blue dotted line extrapolates the lead loss back to the Concordia, giving an age of 2.7 billion years. Figure: M. Wälle, SSEF.

Unfortunately, the data points were nowhere near the Concordia line, showing that this zircon inclusion in the Greenland ruby has not conserved its age. This was not unexpected as zircon is known to lose lead gradually when it is heated above 900 to 1000°C. In this case, the heat treatment of the ruby had also affected this zircon inclusion and it had lost some of its lead in the heating process. However, we can still get an age by back calculating the effect of this lead loss. Since both lead isotopes are lost with equal proportions and the loss was very recent (at least in geological time scales) during the heat treatment process, we can draw a straight line from the origin through our data points. The age of the zircons is represented by the intercept of this line (blue dotted line in figure 2) with the Concordia line, giving an age of 2.7 billion years. This is well in accordance with other age data from rubies from Greenland, described in literature as the oldest rubies known on Earth.

*** Dr. Markus Wälle, SSEF**

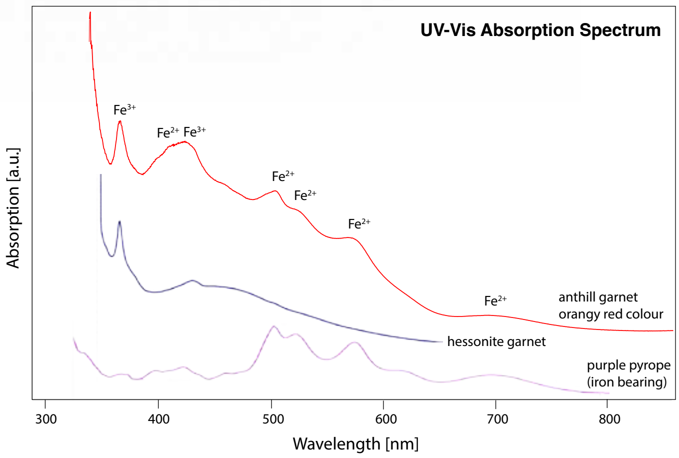
ANTHILL GARNETS FROM ARIZONA

Any gem hunter will tell you that collecting minerals from the soil is a hard job, especially if done in a remote place with rather dry and hot climate conditions and hard rocky soil. So, why not have small and hard-working animals such as ants do the work for you?

What seems to be a dream, has come true with the Anthill garnets, found in the Four Corners region of Arizona, USA. These orangey red to dark red pyrope garnets are commonly rather small (only few carats as rough) and have been collected by native people such as the Navajo for centuries. They discovered these red garnets while traveling along established western trails before the arrival of the Spanish in the New World. What makes these garnets so interesting is that they are not mined by humans, but by ants, specifically the Southwestern Harvester Ant, *Pogonomyrex barbatus*. These ants bring the rough garnets to the surface as they dig and repair their underground homes. The ant hills are usually small, only a few centimetres high, but can spread out to as deep as 2 metres underground. The garnets can be manually 'harvested' from the ground (Figure 1).

△ **Figure 1:** A Navajo man raking anthill garnets from the soil. Photo courtesy of Colombia Gem House.

In 2023, we added to our SSEF research collection two faceted anthill garnets of about 0.5 ct each, which were bought at the Tucson Gem Show (Figure 1). Apart from their intriguing provenance, we were also interested to carry out some gemmological testing on these stones of orangey red and dark red colour.



△ **Figure 2:** UV-Vis absorption spectrum of the orangey red anthill pyrope, compared to reference spectra of hessonite and purple iron-bearing pyrope. Figure: M.S. Krzemnicki, SSEF.

Chemical analyses and absorption spectra quickly confirmed their identity as iron-bearing pyrope garnets with distinct amounts of chromium (0.2 wt% Cr_2O_3 in the orangey red stone and 2.5 wt% in the dark red stone) and calcium (about 10 wt% CaO; grossular component). The high chromium in the dark red garnet is resulting in two broad Cr-related absorption bands strongly overprinting the iron Fe^{2+} related absorption features commonly observed in reddish pyrope. Its dark red colour is therefore mainly caused by chromium. Interestingly, the absorption spectrum of the orangey red pyrope is a combination of Fe^{2+} related bands (almandine component) with Fe^{3+} absorption features as observed in hessonite, the orange brown iron-variety of grossular (Figure 2). In this sample, the chromium (0.2 wt% Cr_2O_3) is only marginally contributing to colour. Much more important for its colour is the presence of both divalent and trivalent iron in its crystal structure.

Anthill garnets are usually small and after cutting rarely exceed 1 ct in size. However, given their saturated red colour, any larger stone would become very dark red, thus far less attractive than these small treasures which were originally 'mined' by the activity of tiny ants.

*** Dr. Michael S. Krzemnicki & Dr. Laurent E. Cartier, SSEF**

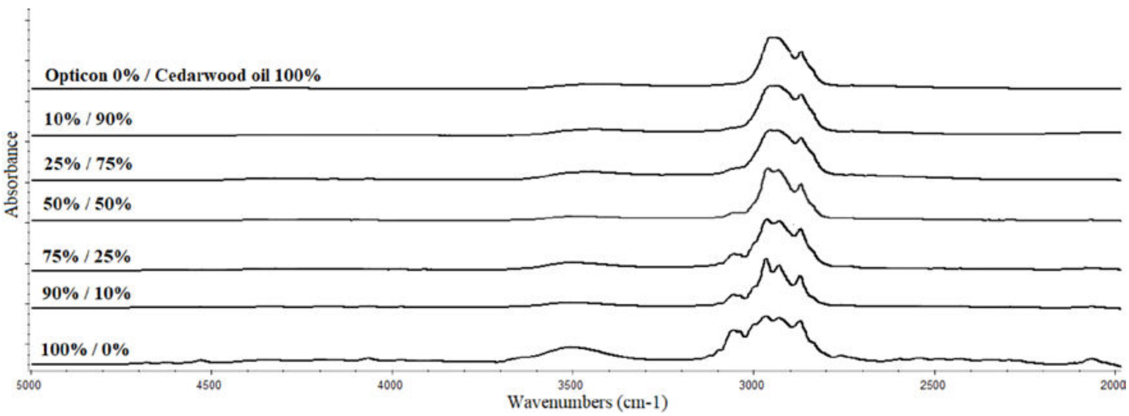
BACHELOR THESIS ON FISSURE FILLING SUBSTANCES IN EMERALDS

◁ **Figure 1:** Altered fissure filling substance (artificial resin) in an emerald fissure. Magnification 50x. Photo: M.S. Krzemnicki, SSEF.

Fissures in emeralds are commonly filled with colourless substances such as oil, wax, or artificial resin to modify and enhance their clarity. This treatment is not new and has been known for many centuries, specifically with oil. All of these filling substances are prone to dehydration and alteration over time, with the consequence that the previously hidden fissures become again visible, possibly with more prominence, as the remaining residues of the filler substances can become opaque whitish to brown over time (Figure 1).

To better understand this ageing behaviour and the alteration of filling substances, we started a bachelor research project in collaboration with Micha Baur, student at the University Basel. Using a wide range of filler substances (different oils, resins, and paraffin wax), he analysed and monitored the changes in FTIR spectra and Raman spectra of these initially fresh substances over time. To mimic ageing behaviour, the filler samples were heated over several different periods of time, and after each step fully analysed by FTIR and Raman spectroscopy. A second focus of this project was to study the effect of polymerization and mixing of filler substances on FTIR and Raman spectra (Figure 2).

We would like to congratulate Micha Baur for his excellent bachelor thesis. The results of this study are not only very useful for our laboratory but will also be published in a gemmological journal in the near future.
*** Dr. Michael S. Krzemnicki, SSEF**

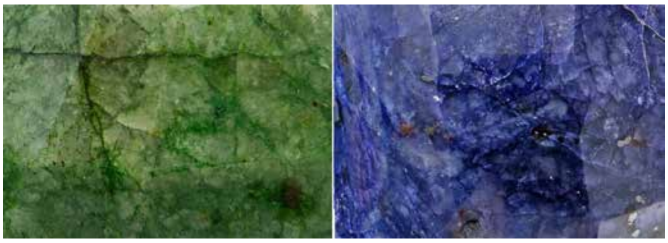


◁ **Figure 2:** FTIR spectra showing the effect of mixing cedarwood oil with artificial resin (opticon). Figure: M. Baur, slightly adapted from Bachelor thesis.

TO GOOD TO BE TRUE: SSEF MEASURES AGAINST FRAUDULENT GEM SCAMS

△ **Figure 1:** Two heavily fractured and treated (coloured) stones recently submitted to SSEF for testing. Photo: L. Phan, SSEF.

From time to time, the SSEF receives so-called 'gems' of very low quality for testing with the request for a SSEF Gemstone Report. Many of these materials are heavily fractured minerals or even rocks, which on top are treated or worked to give them a 'gemmy' appearance, at least to the credulous and naïve treasure hunter. Examples of such material are so-called 'gigantic pearls', which in fact regularly turn out to be shell pieces from the giant Tridacna clam, cut and polished to resemble a natural pearl (see Facette 2017, page 21), reconstructed artefacts made of lead glass fused with corundum fragments, or heavily fractured stones impregnated with a colour dye pretending to be a colourful stone.



△ **Figure 2:** Microphotos of the two stones seen in Figure 1, revealing the green (left) and blue (right) colour dye which was used to impregnate and fill the fissures of these initially greyish stones. Photos: M.S. Krzemnicki, SSEF

We were thus quite prepared for the worst, when a new client called us to announce that they would like to have a pair of gemstones examined and tested at SSEF, each of them above 700 ct (Figure 1). After submission, a quick visual check clearly established that these two stones were in fact heavily treated with all fissures filled with either a green or blue dye, trying to mimic emerald and sapphire (Figure 2). As is obvious from the microphotos, both stones were initially rather greyish opaque and not at all of gem-quality. Raman spectroscopy revealed their true mineralogical composition, being an aggregate of predominantly beryl for the green stone and predominantly cordierite for the blue stone.

As is well-known from numerous cases over the past few decades, such material is commonly used as part of financial fraud schemes. As such, the Swiss Gemmological Institute SSEF decided already about two decades ago that no written report is made for any stone/material that does not fit our internal criteria for gem quality material. This also includes all rough stones. This is a protective measure against scams as the mere existence of a lab report from a reputed laboratory such as SSEF may be misused to fraudulently inflate the 'value' of such 'world-record' stones to grotesque levels. Recent examples can be easily found in newspapers and the media.

To summarize, the above pair of treated stones were returned to the client with a verbal explanation of their treatment status and consequently low quality, but no written document was issued by SSEF. The only exception for which SSEF would issue a written test report is if such an item is part of a court case and requires proper gemmological characterization.

'THIRSTY' OPAL

△ **Figure 1: Opal mounted in a ring. Photo: SSEF.**

△ **Figure 2: . Based on the statement of the client, the thin light yellowish orange layer close to the setting, was the original colour and appearance of this opal. Photo: SSEF.**

We recently received a ring for testing at the SSEF gem lab containing an opal (Figure 1). The client told us that the body colour of this opal had changed after a while. Reportedly, it originally had a quite transparent light-orangey yellow body colour with a vivid play-of-colour but over 2-3 years its body colour became dull whitish which also had a negative impact on the play-of-colour. When checking this opal at SSEF, it immediately became evident, that only close to the girdle a thin layer of the supposedly 'original' appearance was left. The rest of the cabochon dome however had obviously become whitish and dull (Figure 2).

Opal can be a very attractive and colourful gemstone. However, some opals, and especially certain samples from Ethiopia (but also from other sources) may show hydrophilic properties, thus absorb and release liquids (mostly water or even humidity in the air) to some extent. This may cause stress (cracking), colour shifts (more brownish or in this case milky whitish), and dullening and reduction of the play-of-colour effect (see also SSEF Facette 2014, page 15). Our testing confirmed that this opal in the ring had hydrophilic properties.

There is a simple test to find out if an opal has such hydrophilic properties and as a consequence may change in appearance (and weight). For this, first the weight of the opal is measured with a high-precision carat balance, then the stone is immersed for about 5 minutes in water before measuring again its weight with the balance. Hydrophilic opals will have after this test a higher weight, as part of the water has been absorbed by the opal during the immersion. Over time, the opal will slowly dry out and the weight will again go down. Interestingly, such hydrophilic opals even change their weight (slightly) just by changing air humidity conditions (precise balance required!). So, if you weigh your opal over several days and always have a slightly different weight, it could be a strong indication of a hydrophilic behaviour of your stone.

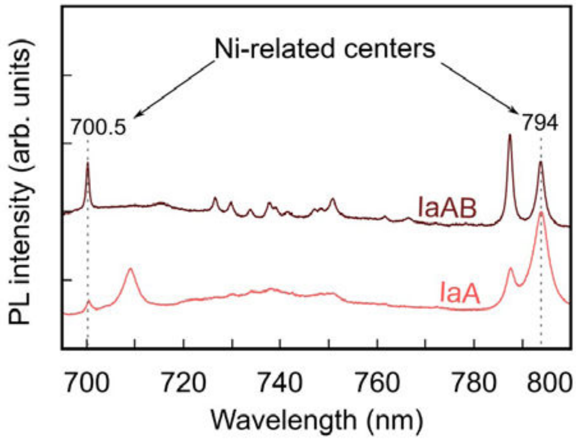
On a SSEF report, such hydrophilic behaviour is mentioned. In case a strong change of weight occurred, the stone is identified as hydrophane opal. If only a slight change of weight was detected, then the hydrophilic behaviour of the opal is only mentioned in the comments section of the report.

*** Dr. Wei Zhou, SSEF**

NICKEL-BEARING TYPE IA NATURAL COLOURLESS DIAMOND

In gemmology, nickel is generally associated with synthetic HPHT diamonds through the presence of the well-known nickel-related (Ni-related) centre at 883/885 nm, which is rarely present in natural diamonds. However, many studies reported the presence of other Ni-related centres in yellow, grey, and pink diamonds, suggesting that nickel in natural diamonds could be more frequent than previously thought (e.g. Chalain 2003; Gaillou et al., 2010: Breeding et al., 2020).

△ **Figure 1:** Fluorescence of the studied natural colourless diamonds observed under UV excitation (365 nm). Note that this fluorescence is typical of natural colourless diamonds. Figure: SSEF.



△ **Figure 2:** Representative spectra of natural colourless diamonds were collected at liquid nitrogen temperature with a 633 nm laser. The spectra are vertically shifted for clarity. Figure: SSEF.

In this study, we investigated the presence of nickel-related centres in natural colourless diamonds (Figure 1). We first analysed 8000 natural diamonds with photoluminescence (PL) at room temperature, followed by PL at liquid nitrogen temperature (-196°C) on 50 representative diamonds. Our preliminary results with room temperature PL show that Ni-related centres between 700 -800 nm are present in ca. 40% of the analysed diamonds, as confirmed by low-temperature PL (Figure 2). Infrared spectroscopy revealed that all those diamonds are type Ia.

The 883/885 nm centre is related to a nickel-vacancy defect, commonly detected in HPHT synthetic type Ib, IIa, and IIb diamonds and some natural type IIa diamonds. Conversely, the nickel-related centres detected in our natural colourless type Ia diamonds are thought to be linked with the aggregation of nickel and nitrogen defects, which takes place over geological timescales.

To summarize, our study confirms that nickel is a common impurity of natural colourless diamonds. Moreover, nickel in diamonds is present in many different forms and as shown its presence does not necessarily identify such a stone as a synthetic HPHT diamond.
*** Dr. Michael Mintrone, SSEF**

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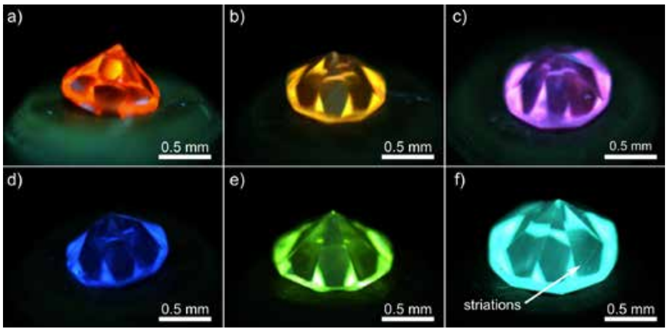
A DESCRIPTIVE STUDY ON AS-GROWN AND HPHT-TREATED CVD SYNTHETIC DIAMONDS

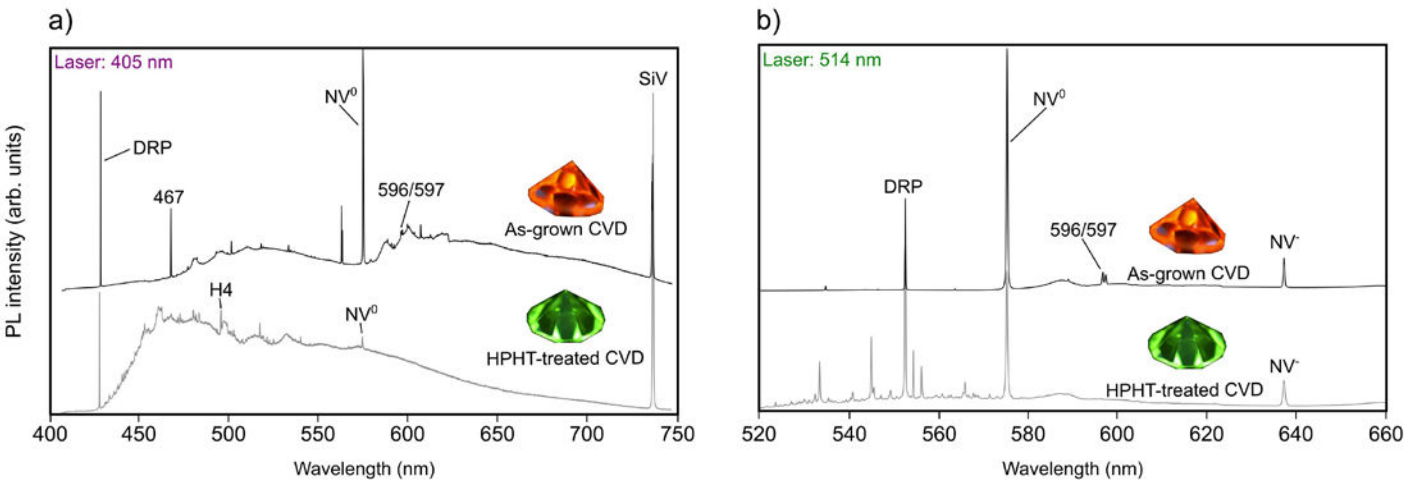
The Swiss Gemmological Institute is testing more than one million colourless melee diamonds for the Swiss watch and jewellery industry on an annual basis to guarantee that no synthetic diamonds are mixed within natural melee diamond batches. Therefore, it remains crucial for our institute to be at the vanguard of the knowledge concerning recent CVD and HPHT synthetic production and to invest resources and time in diamond research.



△ **Figure 1:** Fluorescence colours observed in CVD diamonds with the DiamondView™. (a) and (b) reddish-orange and yellow fluorescence respectively, probably related to NV centres. (c) and (d) purplish-pink and blue fluorescence respectively, generally attributed to dislocations. (e) and (f) green and greenish-blue fluorescence respectively, generally typical of HPHT treated CVD, the green fluorescence is attributed to a H3 centre. Image: SSEF.

In a recent research project with Armin Spelina, a student of the University Basel, we investigated 20 synthetic diamonds (CVD) from a private donation with diameters between 0.9 and 1.2 mm. FTIR analyses showed that all the tested CVD samples are type IIa (i.e. no detectable nitrogen), which - to our knowledge and based on literature – is always the case for colourless CVD synthetic diamonds (Eaton-Magana et al., 2020). Under UV-lamp excitation, 19 of these CVDs display fluorescence colours that are rarely observed in natural diamonds (Fig. 1a, b, c, e, and f). The most observed fluorescence colours were green and greenish-blue. However, one CVD (Fig. 1d) exhibits a blue fluorescence, similar to the reaction commonly observed in natural diamonds. Due to the small size of the samples, typical CVD growth structures like striations were only visible in a few samples (Fig. 1f).

Photoluminescence (PL) analyses at low temperature (-196°C) showed that 8 of these synthetic CVDs were as-grown and 12 HPHT treated. The SiV defect (737 nm) was detected in all the investigated samples, which is a typical feature of CVD synthetic diamonds (Fig. 2a). As-grown synthetic CVD always displayed the 467 nm defect, and most showed the 596/597 nm centre, which is only present in CVD (Fig. 2a and b). As-grown synthetic CVD corresponds to the samples with red, reddish-orange, yellow, purplish-pink, and blue fluorescence colours.



△ **Figure 2:** PL spectra collected at liquid nitrogen temperature (-196°C) for an as-grown synthetic CVD and an HPHT-treated CVD synthetic diamond. The spectra are shifted vertically for clarity. DRP corresponds to the Diamond Raman Peak. Figure: M. Mintrone, SSEF.

In contrast, the 12 CVD samples displaying a green or greenish-blue fluorescence showed indications of HPHT treatment. HPHT treatments on CVD synthetic diamonds are generally performed to reduce their initial brownish coloration (Eaton-Magana et al., 2016). This is supported by the absence of the 467 nm centre (correlated with the brownish coloration, Zaitsez et al., 2021). Moreover, the absence of the 596/597 nm centre and the presence of aggregated nitrogen such as N3, H3, and H4 centres are strong evidence of HPHT treatment. Those CVD synthetic diamonds are also characterized by the presence of numerous peaks between 430-500 nm (Fig. 2a) and 520-580 nm (Fig. 2b) which is common in this type of CVD (Wang et al., 2012).

To summarize:

• Colourless CVDs described here are type IIa synthetic diamonds.

• Unusual colours of fluorescence such as red, orange, yellow, green, and greenish-blue could be used as a strong indicator. Nevertheless, note that some natural diamonds can exhibit such colours too. Moreover, blue fluorescence present in some CVD synthetic diamonds may lead to being misinterpretated as a natural diamond.

• Photoluminescence (PL) with different laser wavelengths remains the most sensitive tool to determine whether a diamond is natural or synthetic.

To conclude, the combination of all these analytical techniques is key to determine if diamond is natural, synthetic, or treated. However, PL and FTIR are not simple and cheap instruments easily accessible to customers who would like to check their diamonds themselves. Furthermore, testing small diamonds of melée size is challenging as their quantity and size can limit the analytical possibilities and greatly affects the duration of such testing. This is why SSEF developed the ASDI-500 (i.e. PL analysis) with our partners in Switzerland as a unique solution to screen diamonds as small as 0.5 mm.

For more information about the ASDI-500 instrument, please see: https://www.ssef.ch/instruments/

*** Dr. Michael Mintrone, SSEF**

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STANDARDIZED LIGHTING FOR COLOURED STONES AND DIAMONDS

In last year's Facette we presented the new standardized light boxes that we sell. These have been ordered by a number of diamond and gem dealers. The feedback we have received has been very positive, and this shows that there is clearly a need for standardized lighting conditions in our industry. This system is applicable to coloured gemstones, diamonds, and pearls.

SSEF now offers two cabinets of different sizes for sale. Each cabinet is equipped with a specific light source allowing the user to easily switch between three different colour temperatures (6000K, 4500K, 3000K). The 6000K illumination is provided with a normalized light intensity of 2'200 lux at 20 cm from the source (following the ISO standard 24016 for diamond grading). The other colour temperatures are useful for gemmologists for coloured stone grading and seeking to evaluate colour shifts or colour change (e.g. alexandrite-effect) of a gemstone.

Standardized lighting ensures that the colour of a diamond or coloured gemstone can be viewed consistently across different environments and conditions. This consistency is essential for an accurate and reliable colour assessments. A standardized lightbox allows gemmologists (and traders) to compare gemstones against each other under identical lighting conditions.

Small light box		
Inner dimensions (lxpxh in cm)	Outer dimensions (lxpxh in cm)	Weight (Kg)
63.5 x 36.0 x 34.0	70.0 x 42.0 x 51.0	10.5
Large light box		
Inner dimensions (lxpxh in cm)	Outer dimensions (lxpxh in cm)	Weight (Kg)
95.0 x 65.0 x 72.5	108.0 x 82.0 x 87.5	27

The advantages include:
- New generation of high-quality LED (manufacturer life-time: 10'000 hours)
- No flickering
- 3 colour temperatures (6000K, 4500K, 3000K)
- Electronic touch screen for the selection of the colour temperature
- Highly effective glass diffusor specifically designed for diamond and gemstone observations
- Colour Rendering Index (CRI) of 98.4%
- Even distribution of the light intensity
- Inner part of the cabinet in normalized neutral Munsel gray

Price: Small model (CHF 8900 excl. VAT and shipping), large model (CHF 10900 excl. VAT and shipping).

The two different light boxes will be on display on our booth during GemGenève 9-12 May 2024. If you'd like to make an appointment to test the system during GemGenève or during one of our upcoming on-sites in Bangkok or Hong Kong, please feel free to contact us (contact@ssef-instruments.ch).

△ **The large light box operating with one of three available temperatures (here shown is 6000K). Photo: SSEF.**

◁ **The small light box operating with one of three available temperatures (here shown is 4500K). Photo: SSEF.**

SSEF JEWELLERY COLLECTION: A BROOCH BY RENÉ BOIVIN (1944)

△ **Front- and backside images of the 1944 Boivin cross. Photos: A. Sato, SSEF.**

A Croix de Lorraine Clip-brooch, by René Boivin, 1944

In 2022 the SSEF began its project of establishing a jewellery collection illustrating the history of jewellery to accompany the Advanced History of Jewellery Course held at SSEF (next taking place July 15-19 2024 in Basel). I was thrilled by this visionary approach – and grateful for this unique opportunity to source such a variety of jewellery through the ages.

Soon I found the Croix de Lorraine clip-brooch by René Boivin. To have a piece by René Boivin in the Collection was of course a dream, not to mention starting it with a Boivin piece… I fired off a few arguments why the SSEF should really buy this brooch. It just ticked all the boxes:

The House of René Boivin

The House of René Boivin (or Jeanne Boivin, really…) is an icon in the history of 20th century jewellery design. In early 2006 I was cataloguing the Christie's Geneva sale. My learning curve was vertical if not looping backwards. I still remember when one day nine extraordinary jewels landed on my desk: amongst them a starfish encrusted with amethysts and cabochon rubies, an orchid with yellow and white diamonds and a pair of sapphire and diamond bindweed flowers. Never had I seen such sculptural, naturalistic jewels; they were almost alive and not afraid of their weight. The colour combinations of some of the pieces in that collection were extraordinary. Talking to Françoise Cailles on the phone, I remember her as a very kind lady who was much bemused by my French (and even more so by my last name). Of course the novelty at the time was overwhelming but these jewels "stuck" with me and although at the time I did not fully grasp the genius of Boivin, they gave me a good taste of it.

In 1893, two years after setting up his workshop, the jeweller René Boivin married Jeanne Poiret, sister of the fashion designer Paul Poiret. She started helping him with the administration of his workshop. Through Jeanne's brother they moved in circles with progressive tastes in art and fashion and soon René started to make jewels for these fashionable intellectuals and artists who wore his brother-in-law's clothes. The seed of Boivin jewellery being different was planted.

A Woman Taking the Lead

However, in 1917 René and in 1918 their son Pierre died in battle during World War I, mort pour la France. Uncharacteristic for a woman at the time, Jeanne decided to take over the running of the company and to keep fulfilling the orders they had already committed to. She had very clear ideas about how a jewel was to look and feel like, and her vision was unfettered by any formal education as designer or jeweller. Her jewels were a collaboration of her ideas and the workshops' skills. In 1919 she hired the 19-year-old Suzanne Belperron as designer who would, in 1932, leave to set up her own company. Soon the two women gave up "standard designs" for good: a complete departure from prevalent contemporary design (geometric, flat, mostly monochrome and using platinum) her jewellery, often mounted in gold, was flamboyant and different with its curves, colours, unusual materials and techniques. Her jewels had volume and were highly tactile, they were jewels designed by women for women. Jeanne Boivin not only continued the legacy of René but she distilled it, reinforced it, went even further and came out with a flourish of new designs, ideas and techniques to almost single-handedly change the history of Western jewellery design. René, however, was always to remain part of the company's name. The jewels were rarely ever signed – too different were they from the rest of the pack so she did not think signing them was necessary: you could see from afar that the gold-studded wooden ring or ivory cuff with gold polka dots were her creations. This makes identifying them sometimes a little tricky. However, awareness has increased since the sale of the jewels of the Duchess of Windsor in 1987 where many (of course unsigned) Boivin pieces were only later identified. Luckily the entire René Boivin archives have miraculously survived, and we are all on our toes awaiting the definite book by Juliet de La Rochefoucauld on René Boivin to come out in 2025. A reliable identification service backed up by the extensive archives is offered by their curator Thomas Torroni-Levene.

The Jewel's Tattoos

As every step of the making of the jewels was closely watched over by Jeanne, Boivin's jewels have a special sensuality to it and the quality is impeccable. Although she had a main atelier Boivin also worked together with a few others. Our Croix de Lorraine clip-brooch is typically unsigned but carries a beautiful maker's mark of CHP flanking a mistletoe for Charles Profilet, one of Boivin's favourite workshops. It also came with an older certificate of authenticity – just to put everyone at ease. We find the eagle's head for 18K gold in all the right places – on the pins and on the cross itself as stipulated by the French assay office. The pins are typically made of pink gold as its higher copper content makes them springier (but also more difficult to work with). The back is engraved "AOUT 1944" (see below).

The Cross of Lorraine and its History

Those well versed in French history will have spotted straight away that the mere shape of the double cross, the Croix de Lorraine, was used by the French Resistance against the Nazi occupation during World War II. The double cross has its origin in Byzantium and came to the Duchy of Lorraine in eastern France probably via Hungary in the late 12th Century, where it was used as a symbol of royal power. In 1477 René II, Duke of Lorraine carried the double cross on his flag into the Battle of Nancy where he then defeated the occupying Charles the Bold, Duke of Burgundy. When Lorraine was annexed by neighbouring Germany between 1871 and 1918, the French used the double cross to rally for a recovery of their lost territory. When France was occupied by Nazi Germany between 1940 and 1944 the Croix de Lorraine was again an obvious choice, thanks to its long history of resistance against invaders, for the Free French Forces led by Charles de Gaulle to symbolise the French Resistance. The engraving "AOUT 1944" gives us a further clue to its historical context: Paris was liberated in a battle between 19 and 25 August 1944 when the Nazi occupants finally surrendered and de Gaulle declared that France freed itself, relegating the Allied Forces to a mere mention in the middle of his victory speech… Our clip is a jewel celebrating the Resistance against and victory over Nazi occupation – it is an object deeply meaningful to its original wearer and contemporaries and heavily charged with emotions: in all probability with relief and joy – but perhaps also with grief for lost ones.

The Rubies

The carved rubies are typically of very low gem quality. They are a vestige of pre-war Art Deco jewellery in the so-called "Tutti Frutti" style (a term invented in the 1970s) made famous by Cartier: Jacques Cartier had set out to India in 1911 to encounter the colourful world of India and her maharajas bejewelled from head to toe in magnificent pearls, multicoloured gemstones and large quantities of diamonds. It was a landmark journey and apart from making important client connections and purchases he also brought bags of little ruby, sapphire and emerald pebbles carved into fruit and leaves. Inspired from his travels Cartier would set them in colourful "exotic" compositions such as bracelets, necklaces and "fruit bowl" brooches but, unlike their Indian counterparts, mounted in platinum and not gold, thereby fusing Indian influences with Western taste. Although Cartier were not the only ones, Cartier was particularly famous for it and their rare Tutti Frutti jewellery still reaches record prices. During World War II precious stones and metals were of course rationed: platinum was used in the production of arms, and it is almost completely absent from jewellery made during or immediately after the war. Gold, on the other hand, has been used since antiquity to finance war efforts. War-time jewellery was therefore made from jewellery brought in by the client and which was to be recycled. Perhaps those rubies were previously set in a platinum Art Deco "Tutti Frutti" jewel?…

△ **René Boivin, with permission of the René Boivin Archives.**

The Beginning of the SSEF Jewellery Collection

Finally, the historic context makes the clip a great study or museum piece. However, the meaning of the Croix de Lorraine and its relevance is mostly lost on us today, so it is not a very wearable piece of jewellery. And that's the last box our clip is ticking off: not very wearable is polite speak for "the price is right". It just took about 10 minutes and a couple of exchanges to get the final OK for the inaugural piece of the SSEF Jewellery Collection. No red tape. Of course, I was on a high for a few weeks. Who would have thought the SSEF could be such an endorphin booster?

I wish to thank Juliet de La Rochefoucauld for pointing out a wrong date and for her opinion on the stylistic development. Any errors that remain are of course my own. Thomas Torroni-Levine graciously helped at the last minute.

*** Kathia Pinckernelle, M.Phil. FGA. Jewellery Historian and Curator of SSEF's Jewellery Collection**

△ Cross of Lorraine and Free France flag at the place where General De Gaulle landed in France on 14 June 1944, Courseulles-sur-Mer - Graye, Calvados, Normandy, France. Source: Wikipedia

△ Charles de Gaulle arriving in Alger with the plane emblazoned with the Croix de Lorraine, May 1944 Source: Fondation Charles de Gaulle.

△ "La Lorraine est française!" Propaganda image advocating the return of Alsace–Lorraine to France, 1914. Source: Wikipedia.

SEASON HIGHLIGHTS SOLD WITH SSEF REPORTS

16.45 ct unheated Kashmir sapphire in a ring sold for ca. US$ 2.6 million at Christie's in Hong Kong in November 2023. Photo: Christie's.

Bulgari sapphire and diamond necklace containing 9 sapphires all unheated and of Madagascar origin. Sold for ca. US$ 1.03 million at Christie's in Geneva in May 2023.

23.00 ct unheated Kashmir sapphire mounted in a ring by Cartier, sold for US$ 3,014,500 at Christie's New York in December 2023. Photo: Christie's.

132.83 ct unheated sapphire from Sri Lanka in a pendant sold at Sotheby's in Geneva in May 2023 for ca. US$ 4.5 million. Photo: Sotheby's.

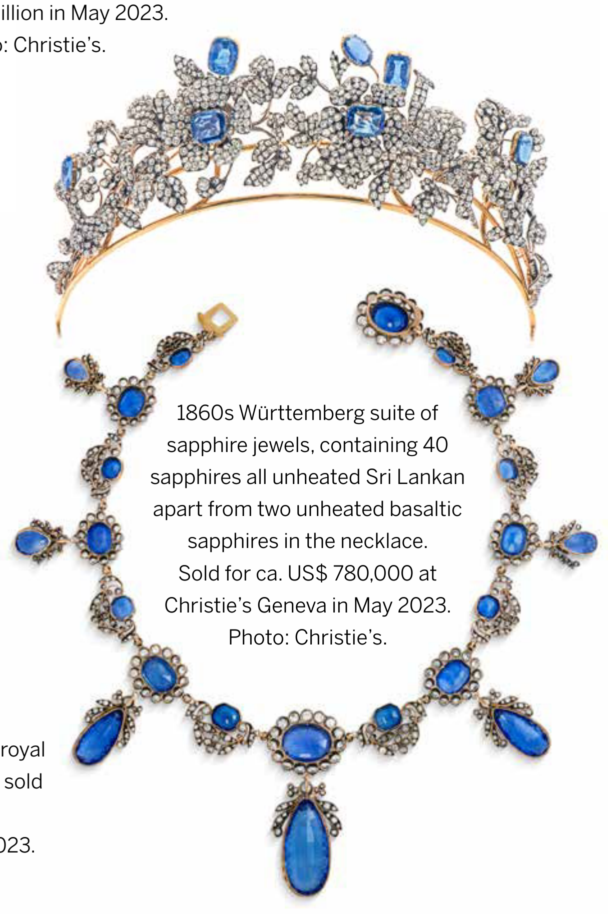
Harry Winston earrings with a pair of unheated Sri Lankan sapphires (52.08 ct and 51.26 ct). Sold at Christie's Geneva in May 2023 for ca. US$ 2.8 million. Photo: Christie's.

36.45 ct unheated sapphire from Burma (Myanmar) in a Graff ring, sold for ca. US$ 1.6 million at Christie's Geneva in November 2023.

21.83 ct unheated sapphire from Kashmir of 'royal blue' colour mounted in ring sold at Christie's in Hong Kong for ca. US$ 4.5 million in May 2023. Photo: Christie's.

118.35ct unheated Sri Lankan sapphire mounted in a Bulgari necklace, sold for ca. US$ 3.4 million at Phillips Hong Kong in May 2023. Photo: Phillips.

Unheated Sri Lanka sapphire of 51.76 ct, sold at Sotheby's Geneva for ca. US$ 1.1 million in November 2023. Photo: Sotheby's.



1860s Württemberg suite of sapphire jewels, containing 40 sapphires all unheated Sri Lankan apart from two unheated basaltic sapphires in the necklace. Sold for ca. US$ 780,000 at Christie's Geneva in May 2023. Photo: Christie's.

8.91 ct unheated Kashmir sapphire of 'royal blue' colour mounted in a Tiffany's ring, sold for US$ 1,925,500 at Christie's New York in December 2023 Photo: Christie's.

28.55 ct unheated Kashmir of 'royal blue' colour mounted in a ring, sold for ca. US$ 3.7 million at Christie's Geneva in May 2023. Photo: Christie's.

5.05 ct unheated ruby from Burma (Myanmar) of 'pigeon blood red' colour mounted in a ring, sold for ca. US$ 2.9 million at Sotheby's Hong Kong in April 2023. Photo: Sotheby's.

The Sunrise Ruby, a 25.59 ct unheated Burmese 'pigeon blood red' ruby mounted in a Cartier ring, sold at Christie's Geneva in May 2023 for ca. US$ 14.9 million.

A ruby and diamond tiara by Köchert (ca. 1896) with all rubies being Burmese and unheated, sold at Sotheby's Geneva in November 2023 for ca. US$ 880,000.

A pair of ruby and diamond pendent earrings with tops by Harry Winston. Each set with an unheated Burmese ruby weighing 20.19 ct and 18.68 ct, sold for ca. US$ 1.9 million at Sotheby's Hong Kong in April 2023. Photo: Sotheby's.

7.31 ct unheated Burma (Myanmar) ruby mounted in a ring, sold for US$ 1,134,000 at Christie's New York in December 2023.

8.05 ct unheated ruby from Burma (Myanmar) of 'pigeon blood red' colour, sold for ca. US$ 1.9 million at Sotheby's Hong Kong in April 2023. Photo: Sotheby's.

5.03 ct unheated Burmese 'pigeon blood red' ruby in a ring, sold at Christie's Hong Kong in November 2023 for ca. US$ 1.5 million. Photo: Christie's.

7.58 ct unheated Burmese ruby mounted in a Graff ring, sold for ca. US$ 1.8 million at Sotheby's Geneva in November 2023. Photo: Sotheby's

Ruby (Burmese, unheated) and diamond brooch by Köchert, sold at Sotheby's Geneva in November 2023 for ca. US$ 410,000.

55.22 ct 'Estrela de Fura' ruby from Mozambique (unheated) mounted in a ring sold at Sotheby's New York in June 2023 for US$ 34,804,500. Photo: Sotheby's.

13.07 ct unheated Burmese ruby in a Chaumet ring. Sold for ca. US$ 5.4 million at Christie's Geneva in May 2023.

24.30 ct (Burma, unheated) ruby and diamond pendant sold at Christie's Geneva in May 2023 for ca. US$ 1.4 million.

Ruby and diamond bracelet by Boucheron. The 39 rubies were unheated and Burmese, part of them were considered to be 'pigeon blood red' in colour.
Sold in May 2023 at Sotheby's Geneva for ca. US$ 410,000.

Diamond necklace containing a 68.13 ct emerald from Colombia with minor amounts of oil in fissures. Sold for ca. US$ 1.8 million at Christie's Geneva in May 2023.

A pair of Forms diamond and emerald (5.57 ct and 4.98 ct) earrings, with Colombian stones without any indication of clarity modification. Fetched ca. US$ 450,000 at Christie's Hong Kong May 2023 sale. Photo: Christie's.

19.34 ct Colombian emerald with a moderate amount of oil sold for ca. US$ 390,000 at Sotheby's Geneva in November 2023. Photo: Sotheby's.

Emerald bracelet with 13 emeralds weighing a total of 25.80 ct, all of Colombian origin, with no indications of clarity modification. Fetched ca. US$ 1.4 million at Sotheby's Hong Kong sale in October 2023.

Bulgari necklace containing 41 Colombian emeralds containing minor to moderate amount of oil and artificial resin in fissures, sold for ca. US$ 990,000 at Christie's Geneva in May 2023. Photo: Christie's.

7.21 ct Colombian emerald with no indications of clarity modification mounted in a ring. Sold for ca. US$ 580,000 at Christie's Hong Kong in May 2023. Photo: Christie's.

33.23 ct Colombian emerald with a moderate amount of artificial resin, sold for ca. US$ 410,000 at Sotheby's Geneva November 2023 sale. Photo: Sotheby's.

Ring with 17.05 ct Colombian emerald with no indications of clarity modification, sold for ca. US$ 2.5 million at Christie's Hong Kong in November 2023.

26.50ct Colombian emerald with a minor amount of oil in fissures mounted in a ring, sold for ca. US$ 1.2 million at Christie's Geneva in May 2023.

Emerald suite with Colombian emeralds, indications of clarity modification, (larger emeralds) minor to moderate amount of resin; (smaller emeralds) minor to insignificant amount of resin. Sold at Christie's Hong Kong in May 2023 for ca. US$ 480,000.

Bulgari emerald bead necklace with 24 emeralds (total weight 1'178.00 carats) from Colombia, containing minor to moderate amount of oil in fissures, sold for ca. US$ 2 million at Christie's Geneva in May 2023. Photo: Christie's.

Pair of emerald and diamond pendent earrings with a pair of Colombian emeralds (8.89 ct each), sold for ca. US$ 1.3 million at Sotheby's Hong Kong in April 2023. Photo: Sotheby's.

Natural pearl and diamond tiara, sold at Sotheby's Geneva in November 2023 for ca. US$ 930,000.

Harry Winston necklace containing 175 saltwater natural pearls and 1 cultured pearl. Sold at Christie's in Geneva in May 2023 for ca. US$ 7.3 million. Photo: Christie's.

Van Cleef & Arpels natural pearl and diamond earrings sold for ca. US$ 130,000 at Christie's Hong Kong in May 2023. Photo: Christie's.

Light greyish brown drop-shaped natural pearl pendant, sold for ca. US$ 770,000 at Christie's Geneva in November 2023. Photo: Christie's.

Natural pearl and diamond brooch, circa 1865. Sold in Geneva at Sotheby's in November 2023 for ca. US$ 990,000. Photo: Sotheby's.

Natural pearl and diamond brooch, attributed to Moritz Hübner, late 19th century. Sold at Sotheby's Geneva in November 2023 for ca. US$ 160,000. Photo: Sotheby's.

Cartier art deco natural pearl, coral and diamond necklace sold at Christie's in Geneva in May 2023 for ca. US$ 300,000. Photo: Christie's.

Natural pearl and diamond devant-de-corsage, circa 1865. Sold for ca. US$ 1.2 million at Sotheby's Geneva in November 2023.

Two-row saltwater natural pearl necklace (5.85 to 11.85mm), sold for ca. US$ 1.1 million at Sotheby's Geneva in May 2023. Photo: Sotheby's.

Late 19th century natural pearl and diamond tiara, sold for ca. US$ 1.1 million by Sotheby's Hong Kong in July 2023. Photo: Sotheby's.

Cartier belle epoque natural pearl and diamond écharpe sold at Christie's Geneva in May 2023 for ca. US$ 750,000.

Two strands of untreated natural pearls sold for ca. US$ 2.8 million at Christie's Geneva in May 2023.

Bulgari jadeite jade and diamond necklace sold for ca. US$ 5.5 million at Christie's Hong Kong in May 2023. Photo: Christie's.

12.02 ct Paraiba tourmaline from Brazil (heated and with minor a amount of filler) sold for ca. US$ 430,000 at Sotheby's Geneva in November 2023. Photo: Sotheby's.

Harry Winston necklace with an unheated padparadscha sapphire from Madagascar (37.92 ct) sold for ca. US$ 1.1 million at Sotheby's Geneva in May 2023. Photo: Sotheby's.

12.43 ct unheated padparadscha sapphire in a ring by Harry Winston, fetched ca. US$ 580,000 at the Sotheby's Geneva May 2023 sale. Photo: Sotheby's.

36.20 ct unheated spinel from Tanzania mounted in a ring, sold for ca. US$ 580,000 at Sotheby's Geneva in May 2023. Photo: Sotheby's.

Untreated zircon, sapphire and diamond neck badge of the Order of the Golden Fleece, early 20th century. Sold for ca. US$ 80,000 at Sotheby's Geneva in November 2023.

A suite of fifteen untreated jadeite-jade cabochons (total weight 180.20 ct) from Burma (Myanmar) mounted in jewellery, sold for ca. US$ 2.6 million by Sotheby's Hong Kong in October 2023. Photo: Sotheby's.

9.27 ct heated tourmaline from Mozambique also called 'Paraiba tourmaline' in the trade. Fetched ca. US$ 400,000 at Christie's May 2023 sale in Geneva.

Bulgari sapphire, coloured sapphire, emerald and diamond necklace sold at Christie's Geneva in May 2023 for ca. US$ 2.9 million. The necklace contained an unheated blue sapphire from Madagascar (37.84 ct), an unheated padparadscha sapphire from Sri Lanka (33.59 ct) and an emerald from Colombia (33.20 ct) with a minor amount of resin.

20.83 ct unheated spinel from Tanzania mounted in a ring, sold for ca. US$ 980,000 at Christie's in Geneva in May 2023. Photo: Christie's.

8.24 ct unheated padparadscha sapphire from Sri Lanka, sold for US$ 88,900 at Sotheby's New York in September 2023. Photo: Sotheby's.

5.31 ct untreated Burmese spinel sold for ca. US$ 100,000 at Sotheby's Geneva in November 2023.

Spring feelings
This exceptional pearl brooch was recently analysed at SSEF.
The two non-nacreous natural pearls of impressive size and weight (in total 150 ct) form the peduncle and blossom of a white lily in a very artistic and filigree design created by Anna Hu.

COURSES IN 2024 AT SSEF

In 2024, we will again be offering a wide range of courses. The SSEF Basic Gemmology Course (14 – 25 October 2024) and the SSEF Basic Diamond Course (25 – 29 November 2024) offer good introductions, and participants can pass the courses after taking theoretical and practical examinations. For more in-depth courses we offer Advanced Training Courses on coloured gemstones, pearls, small diamonds, and launching this year a course on the history of gems and jewellery. Finally, the Scientific Gemmology Course and the Scientific Diamonds Course are ideal courses for those interested in learning about the advanced instruments used in laboratory gemmology today.

ADVANCED PEARL COURSE

This two-day pearl course (04 - 05 November 2024) is ideally suited for participants who want to know more about how pearls are formed, possible treatments, and how natural and cultured pearls can be identified and separated. SSEF's important collection of shells and pearls offers an ideal 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. The last remaining spots are available for the course 17 – 21 June 2024 and 28 October – 01 November 2024. 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.

ADVANCED HISTORY OF JEWELLERY COURSE

This advanced course "Jewellery: History, Identification and Important Trends" is unique in that it combines the history and significance of gems in historic and modern jewellery. You will learn about all the different uses of gems, and how these link with different periods of jewellery. Through this approach you will learn about criteria to identify jewellery with gems, and gain insight into possible criteria for valuation. This course is taught in small groups, and will include workshops and practical work on a wide range of jewellery pieces. It is taught in collaboration with jewellery historian Kathia Pinckernelle. Learn more about antique jewellery and the use of gemstones through the ages by signing up for the course in 15 – 19 July 2024.

ADVANCED SMALL DIAMOND COURSE

The SSEF small diamond course (24 – 26 September 2024), which focuses on diamonds of a diameter between 0.5 and 3.8 mm, mainly used in the watch industry, enables participants to themselves perform the quality control of such small diamonds. This course is 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.

△ Learn to identify gemstones and their characteristic features in our Basic and Advanced courses. Photo: SSEF.

SCIENTIFIC GEMMOLOGY COURSE

The one-week Scientific Gemmology course focuses on scientific aspects of gemmology, but with the use of portable instruments. This includes learning about techniques and applications of instruments like X-Ray fluorescence spectrometry, UV-Visible-NIR spectroscopy, GemTOF (not portable), Raman and FTIR spectrometry in the field of gemmology, as performed at SSEF with testing setups that we use when we travel abroad for on-site testing. 2024 dates include 01 – 05 July 2024 and 11 – 15 November 2024.

SCIENTIFIC DIAMONDS COURSE

The one-week Scientific Diamonds course is dedicated to scientific testing procedures for diamonds with the use of analytical instruments. Instruments and techniques covered in this course include: FTIR spectrometry, NIR-spectrometry, UV-VIS spectrometry, Photoluminescence spectrometry, UV- fluorescence of diamonds (DiamondView™). Upcoming dates: 18 – 22 November 2024.

TAILORED 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 2023, a number of companies benefited from such courses that were tailored to specific topics including small diamond quality control, diamond treatments, overview of gemstone treatments and origins, 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.

To be informed of 2024 and 2025 course dates: check our website, follow us on social media (Instagram, LinkedIn, and Twitter) or subscribe to our newsletter (https://www.ssef.ch/newsletter/)

Advanced History of Jewellery Course	8 – 12 April 2024
Advanced Coloured Stones Course	22 – 26 April 2024
Advanced Coloured Stones Course	17 – 21 June 2024
Scientific Gemmology Course	01 – 05 July 2024
Advanced History of Jewellery Course	15 – 19 July 2024
Advanced Small Diamonds Course	24 – 26 September 2024
Basic Gemmology Course	14 – 25 October 2024
Advanced Coloured Stones Course	28 October – 01 November 2024
Advanced Pearls Course	04 – 05 November 2024
Scientific Gemmology Course	11 – 15 November 2024
Scientific Diamonds Course 1	18 – 22 November 2024
Basic Diamond Course	25 – 29 November 2024

CONGRATULATIONS!

The Swiss Gemmological Institute SSEF would like to extend their congratulations to the individuals who successfully completed the courses offered in 2023:

Basic Gemmology Course

- Madhav Agarwal
- Filippo Quarto
- Pauline Hepner
- Beatrix Motsch
- Elena Vaskevich
- Anna Hasse
- Gideon Dike
- Muhammadu Shahid Abdul Waridu
- Maged Mohsen Abdelmessih Fahmy
- Ernesto Juan Carp
- Harald Gockenbach
- Margaux Bise
- Ulrike Martina Gruben
- Sarah Raemy

Basic Diamond Course

- Filippo Quarto
- Bruno Mojonnier
- Cihat Joshua Lochbrunner
- Elidon Shehaj

Advanced Gemstone Course

- Sullivan Taylor
- Tomás Basilio Larralde
- Ishtiyaaq Ahamed
- Tommaso Peron
- Rajiv Shah
- Fabio Spagnolo
- Luca Pellegrini
- Florine Guichard
- Michella de Carvalho Cruz
- Laura Cuccaro
- Beatrix Motsch
- Markus Wälle
- Ying Chen
- Laura-Elena Enache
- Bijun Zheng
- Annalisa Tabbah
- Tamara Moussaieff
- Maged Mohsen Abdelmessih Fahmy
- Giovanni Taggiasco
- Ralph Boghossian

Advanced Small Diamonds Course

- Myriam Brigitte Christiane Lalain
- Daphné Jacqueline Geoffroy
- Julie Gaillard
- Victor Enzo Schneider

Advanced History of Jewellery Course

- Juliette Bogaers
- Mathilde Gadeau
- Justine Vahdat
- Judith Braun
- Victoria de La Soujeole
- Anaïs Cartier
- Isabelle Drouin
- Chiara Parenzan
- Yuliya Bengui
- Rishab Chhajer

Scientific Gemmology Course

- Yuanchan Chaiyawat
- Seyedeh Fariba Sajadi Alehashem
- Ana-Camelia Perciun
- Amir Emamjomeh
- Ruweesha Jayawardena Suriyaarachchillage
- Sandrina Ramanantsoa
- John Kiran Anthony
- Gourang Sunderji

Christie's Special Course

- Lukas Biehler
- Vittoria Lanza
- Mélanie Christine Matthes
- Wing Kei
- Belinda Yuen

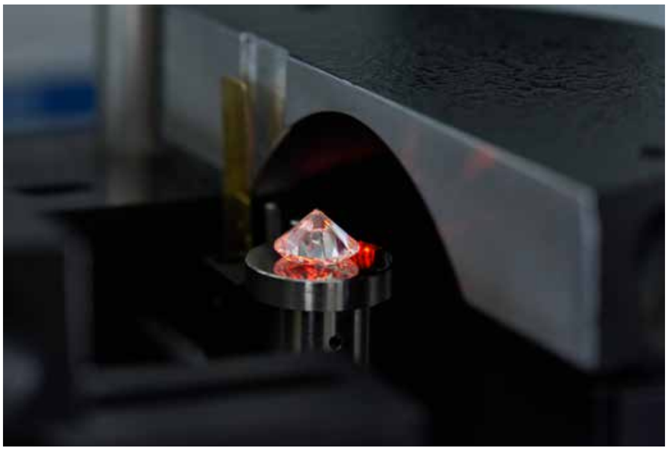
△ Scientific Gemmology Course participants in July 2023 in Basel. Photo : SSEF.

NEW SCIENTIFIC DIAMOND COURSE

In 2024, SSEF has decided to relaunch its Scientific Diamond Course (18-22 November 2024). The aim of this 5-day course is to provide up-to-date information on current possibilities for authentication, treatment detection and colour authenticity of diamonds. Students will work hands-on with scientific spectroscopic methods and get theoretical insights into analytical testing methods such as: FTIR spectrometry, UV-VIS spectrometry, Raman microspectrometry, fluorescence imaging and other approaches used to scientifically test diamonds. Students who take this course will learn to:

• identify different types of natural and synthetic diamonds using advanced laboratory instrumentation
• learn about spectroscopic characteristics of commonly encountered synthetic diamonds (CVD and HPHT)
• identify distinctive spectroscopic traits associated with common treatments applied to diamonds
• cultivate critical thinking skills to evaluate and interpret your analytical findings

For more information and to sign up visit: www.ssef.ch/courses



△ FTIR analysis of a diamond. Photo: SSEF.

△ Low-temperature (-196°C) testing of diamonds in photoluminescence mode. Photo: SSEF.

△ Learn to use a wide array of advanced analytical instrumentation on diamonds. Photo: SSEF.

△ Colour authenticity of fancy-coloured diamonds. Photo: SSEF.

NEW FREE ONLINE COURSES: HISTORY OF JEWELLERY, JADE, SUSTAINABILITY

Three years after having launched a number of free online courses (www.ssef.ch/masterclass) we have decided to further expand our offering. With over 25'000 sign-ups since April 2021, we are pleased to introduce three new topics to our selection of free online courses.

The first one focuses on the history of jewellery, providing a brief introduction to the different periods in jewellery. Whether you're a history enthusiast, a jewellery aficionado, or simply intrigued by the allure of the past, this free online course promises a fascinating exploration of one of humanity's oldest and most enduring art forms.

We are privileged to see very high-quality jadeite jade and nephrite jade at SSEF and felt that an introductory course about jade would be of interest to many of our existing students and clients. Delve into the rich history, cultural significance, geological origin, nomenclature issues and scientific testing of this revered gem with this course.

Lastly, the topic of sustainability and traceability has become very important over the past decade in the gem and jewellery industry. Whether you're a jewellery designer, gemstone enthusiast, or concerned consumer, this course offers a compelling overview of the different issues involved and details industry initiatives working on the subject.

To sign up to these free courses visit: www.ssef.ch/masterclass

△ Learn more about jadeite jade, nephrite jade and other varieties of jade. Photo: M.S. Krzemnicki, SSEF.

△ Explore more than 5000 years of jewellery history: From ancient Mesopotamian amulets to contemporary JAR earrings. Photos: SSEF.

△ Artisanal diamond mining in Sierra Leone contributes extensively to local livelihoods but as with any activity also has sustainability implications. Photo: L.E. Cartier, SSEF.

DR. MICHAEL MINTRONE, NEW HEAD OF SSEF'S DIAMOND DEPARTMENT

Dr. Michael Mintrone joined SSEF in July 2022. He obtained his M.Sc. in Earth Sciences from University Jean Monnet of Saint-Etienne and the University of Clermont-Ferrand 2 (France). He holds a Ph.D. from ETH Zürich that focused on the Petrology, Geochemistry, and Rheology of partially molten rocks during orogenic processes. Michael principally used trace element composition and U-Pb dating on zircons to constrain geological processes in his PhD research. Since joining SSEF in 2022 he was a research scientist in SSEF's Diamond Department but also very involved in daily grading work, quality control of small diamonds and the development of new instruments for diamond testing (such as the ASDI-500). He took over the diamond department in April 2024 following Jean-Pierre Chalain's retirement. Michael looks forward to continuing the strong emphasis on diamond research that has been a central focus of SSEF for many decades now.

△ Dr. Michael Mintrone (right)- new Head of SSEF's Diamond Department- and Ly Phan (left) -Head of Small Diamond Services- in March 2024 presenting the ASDI-500 instrument at the Antwerp Diamond Bourse. Photo: A. Castillon, SSEF.

FREE SSEF-FERRARI SHUTTLE SERVICES FOR CLIENTS

We are pleased to announce that we will continue to offer special conditions on most regular SSEF-Ferrari shuttles until December 31st 2024.

Until December 31st, 2024, the Ferrari shuttle to SSEF from the following locations will be free of charge up to a declared value of goods of 1 million Swiss Francs. Transport insurance is not part of this offer and may be charged extra by Ferrari if a client does not have one.

Europe: Geneva, Paris, London, Italy (only valid for Alessandria, Milan, Rome, Valenza), Monaco, Antwerp

Asia: Bangkok (if not normal entry then extra charges apply), Colombo, Hong Kong, Mumbai, New Delhi, Singapore

Americas: New York

For contact information of the local Ferrari offices please see: https://www.ssef.ch/how-to-submit

IMPORTANT NOTE

For goods with a declared value of more than 1 million Swiss Francs, an additional shipping fee of 0.035% is charged for the amount exceeding this limit, based on the declared value. We remind clients of the need to send an order form with shipments.

RENOVATIONS AND EXPANSION WORK AT SSEF

Over the past year, SSEF has been undergoing extensive renovation and expansion work. We have added a second floor to our main office at Aeschengraben 26 in Basel so that our facilities now total 1300m² for lab work, research facilities, collections and courses. The aim of this renovation and expansion work was to better accommodate the needs of our clients, students, and staff members as SSEF continues to grow. Among the notable changes, we've introduced a spacious exhibition area to showcase our collection and hold temporary exhibitions, alongside a comfortable lounge space for informal gatherings. Additionally, we've added a new classroom, providing ideal conditions for students to learn about different aspects of gemmology in the courses that we offer. With these enhancements now in place, we're excited to seeing them contribute to greater interaction with clients in Basel and an even better learning experience for students.

△ **A lounge area with a library for clients and students. Photo: Donald van der Putten.**

△ **Entering the new 2nd floor at SSEF in Basel. Photo: Donald van der Putten.**

△ **A newly revamped course room that offers ideal learning conditions for students. Photo: Donald van der Putten.**

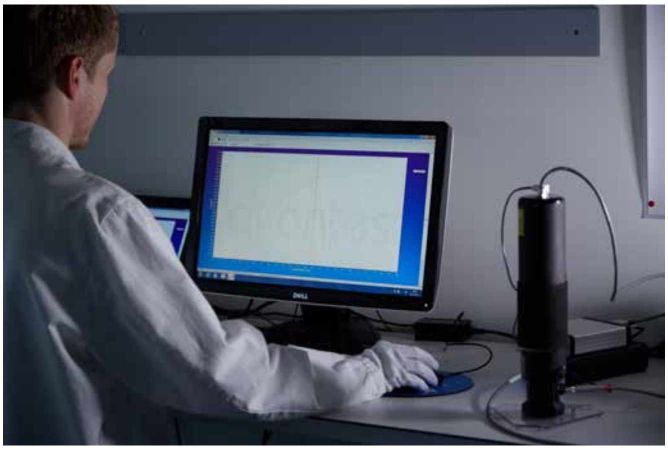
SSEF INSTRUMENTS LTD. REPLACES SATT GEMS AG

SATT Gems was launched as a subsidiary of SSEF in 2014, when we first brought the ASDI instrument to market. A decade later, we have decided to rebrand SATT Gems as SSEF Instruments in order to make the link between SSEF and its subsidiary more clearly visible.

SSEF Instruments will continue to sell pioneering analytical instruments that we develop in-house (such as the ASDI and portable UV-Vis). Furthermore, the new SSEF Instruments website (**www.ssef-instruments.ch**) now has an online shop so that you can buy interesting books about gems and jewellery, and also purchase small gemmological instruments that you may need for testing (e.g. refractometer, polariscope, spotter, loupe, tweezer).

We have some new instruments currently under developments, so stay tuned for some exciting updates!

△ Order a selection of interesting books on gemstones and pearls from SSEF Instruments. Photo: SSEF.



△ The portable UV-Vis instrument was developed in-house, has been sold to a number of dealers and labs, and is very useful for gem identification and origin determination questions. Photo: SSEF.

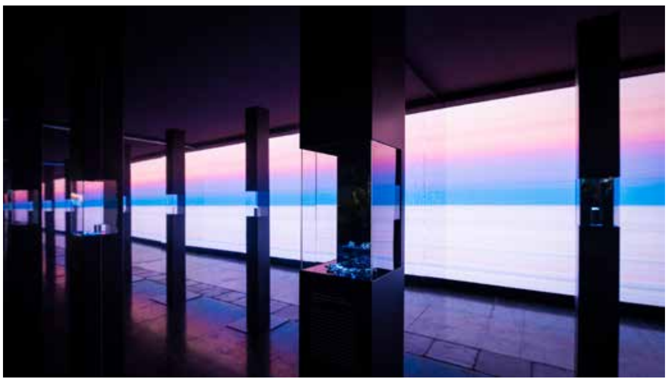
△ On the SSEF Instruments website you'll find a wide range of small gemmological instruments such as the SSEF Diamond Spotter which enables quick and easy identification of type IIa diamonds. Photo: SSEF.

INFINITE REFLECTIONS: EXHIBITION OF SSEF JEWELLERY COLLECTION IN MUNICH

To accompany the 50th anniversary of Inhorgenta Munich in February 2024, an exhibition to celebrate 5000 years of jewellery was organised. This special exhibition was entitled 'Infinite Reflections – A 5000-Year Journey of Jewellery and Humanity'. Many of the jewels that were on exhibit are part of SSEF's Jewellery Collection used for courses and research.

Kathia Pinckernelle who is curator of SSEF's Jewellery Collection also attended the show and was invited to give a talk entited 'A history of metals in jewellery since antiquity'. Dr. Laurent E. Cartier was invited to moderate a host of talks and panel discussions around the history of jewellery, gemmology and industry developments.

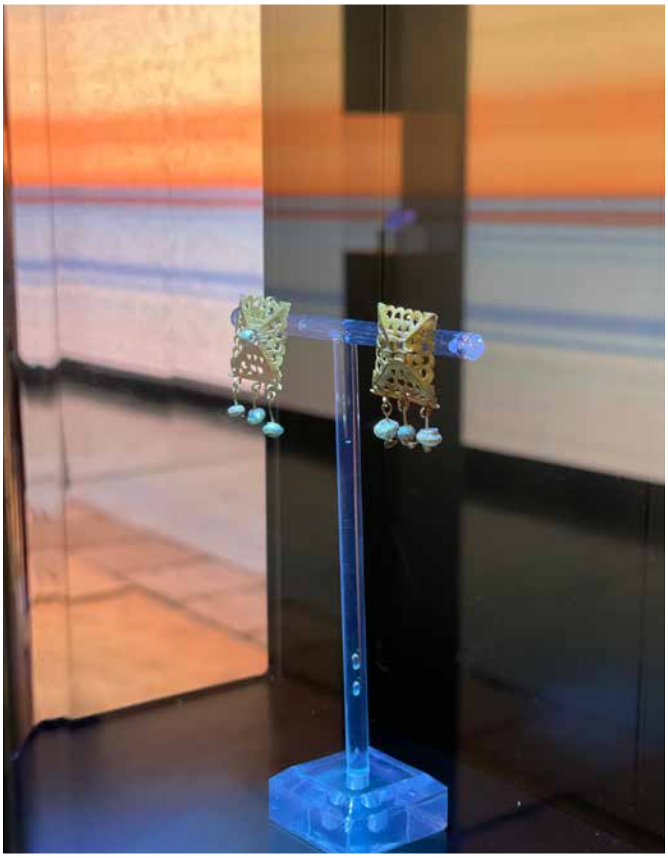
△ This special exhibition combined iconic jewellery pieces from different periods together with AI generated video content (visible in the background) about the different epochs. Photo: Wolfgang Stahl.



△ 5000 years of jewellery history. Photo: Wolfgang Stahl.

△ Walking through the 'Infinite Reflections' exhibition in Münich in February 2024. Photo: Wolfgang Stahl.

△ Celtic Bronze Double Spiral Brooch, circa 900 BC (from the SSEF Jewellery Collection). Photo: Yves Peitzner.



△ Late Roman/early Byzantine "opus interrasile" earrings, circa 2nd-3rd century AD (from the SSEF Jewellery Collection). Photo: Yves Peitzner.

△ "Splash" Bracelet and Earrings, by Henning Koppel for Georg Jensen, circa 1947 (from the SSEF Jewellery Collection). Photo: Yves Peitzner.

GEMGENÈVE: EXHIBITION AND PANELS

SSEF has been partner of the successful GemGenève show since its first edition in 2018. November 2023 saw the seventh edition of this beautiful trade show take place.

During this November show, GemGenève put together a magnificent exhibition entitled 'The Pearl Odyssey', enlisting contributions from SSEF as one of the world's leading institutes on pearls. The exhibition provided an entrancing voyage into the captivating realm of pearls. The exhibition unveiled the diverse dimensions of these treasures, from their enigmatic beginnings including an immersive film on natural pearls in Qatar and about the Alfardan family. Magnificent natural pearl jewellery was showcased that spanned the centuries, and Chaumet was heavily featured with outstanding natural pearl objects from the house's heritage collection. The 'Pearl Odyssey' also sought to take visitors on a journey through the diversity of bivalves that produce pearls, explore the subject of how pearls form and how they can be tested scientifically in order to distinguish natural from cultured pearls. SSEF was proud to contribute to this inspiring exhibition. Delving into the symbolism of pearls throughout various cultures and epochs, this initiative incorporated interactive installations, enticing visitors to explore the myriad interpretations associated with pearls.

△ **The Pearl Odyssey exhibit at GemGenève. Photo: András Barta.**

△ **Part of the exhibition focused on scientific developments -including breakthroughs by SSEF- in pearl testing over the past century. Photo: L.E. Cartier, SSEF.**

The November 2023 GemGenève also saw a rich programme of talks and panel discussions take place during the show. Some of these covered pearls, with Dr. Laurent E. Cartier moderating a panel on 'Pearls of Truth: A conversation about pearl history, meaning and testing since antiquity ' together with Violaine Bigot (Chaumet) and Kathia Pinckernelle. Dr. Cartier was invited to participate in another panel entitled 'Pearls: Challenges and New Creative Scenarios'. The other discussion he was invited to participate in was on AI and gem labs 'Comment l'intelligence artificielle disrupte l'analyse de pierres précieuses. Entre limites et opportunités'. All the talks and panel discussions can be viewed on the GemGenève website: https://digital.gemgeneve.com/

△ **Panel discussion on 'Pearls of truth' moderated by Dr. Laurent E. Cartier with Violaine Bigot and Kathia Pinckernelle during the last Gemgenève edition. Photo: GemGenève.**

SSEF at GemGenève in May 2024

SSEF will be present at the May 2024 edition of GemGenève taking place from May 9th-12th at Palexpo. Our booth number is B13 and we will be accepting goods on the setup day (May 8th) from 10am onwards. Our mobile phone number during GemGenève is: +41 79 219 72 38.

Additionally, on Thursday May 9th we'll be hosting our traditional after-work apéro event 6:30-8:00pm at Palexpo (show location), **please join us!** We always look forward to this event as an opportunity to meet our clients, students, friends and Facette readers.

JEAN-PIERRE CHALAIN : OVER 3 DECADES OF DIAMONDS AT SSEF

On March 31st 2024, Jean-Pierre Chalain – director of SSEF's diamond department- retired from SSEF and handed over the diamond department to Dr. Michael Mintrone and his team. Jean-Pierre will continue to be active in R&D on several projects at SSEF Instruments.

We take this opportunity to thank him for his immense contributions to SSEF, diamond research and gemmology. And asked him to reflect on more than 30 years of SSEF.

△ **Grading the colour of a diamond in the lab. Photo: SSEF.**

Jean-Pierre, how did you get into gemmology and first become acquainted with SSEF?

Before joining SSEF, I worked as a watch and jewellery retailer for 13 years. This initial experience gave me an understanding of the relationship with luxury customers. It also taught me a taste for meticulous work, as watchmaking requires me to be extremely meticulous and patient.

In 1992, Professor Bernard Lasnier, my DUG supervisor at the University of Nantes, asked the director of the SSEF, Dr. Hänni (Henry would later be given the title of Professor), to act as a member of Pascal Entremont's thesis committee. As I was defending on the same day as Pascal, Henry found himself a member of my jury committee too and became aware of my thesis "Towards laboratory gemmology", which describes, among other things, the contributions to gemmology of instruments such as the Raman microprobe and the mass spectrometer, two key instruments in laboratory gemmology still very relevant to the present day, 32 years later. Two years later, in 1994, Henry offered me the chance to work with him and Dr. Lore Kiefert in the SSEF laboratory in Zurich. There were three of us at the SSEF at the time, plus a part-time secretary who helped us!

Can you share some highlights of your work with diamonds at SSEF over the years?

Until recently, I was involved in all the gemmological activities of the SSEF - examination of coloured stones, pearls, research and courses - but the fact is that I have been director of the diamond department since 2001. At that time, the foundation's board gave me this title in recognition of my work - carried out jointly with Prof. E. Fritsch - on what we now know to be the HPHT treatment of type II diamonds.

In 1999, virtually nothing was known about this treatment. Lazare Kaplan and GE had announced that they would be marketing treated colourless diamonds at the same price as their untreated counterparts because, they claimed, the treatment was unidentifiable and would remain so.

In doing so, they plunged the diamond market into a very severe crisis for over a year. To discuss this issue, at its symposium in Carlsbad, the GIA named the meeting room "the War Room", and its entrance was guarded by a man dressed as an armed GI. That says it all!

Several months later, it was at the SSEF, at the invitation of De Beers, that the criteria for identifying the treatment was unveiled by our team to the other major laboratories. But it was much later that we understood why GE had dared to declare that the treatment would remain unidentifiable. Even before the treatment was announced, they had applied for a patent on the identification of the treatment. All legal measures were taken in Switzerland to ensure that this patent would not apply.

△ **With Prof. Henry Hänni (past director of SSEF) at the Diamond Trading Company's Charterhouse building in London. Photo: SSEF.**

In 2003, I described in the Gems & Gemology journal a natural diamond with crystalline defects linked to the presence of nickel. At the time, this chemical element was seen as proof that the diamond was synthetic. It now appears that nickel is probably much more frequently present in natural diamonds than previously thought.

In 2005, at the De Beers Diamond Conferences, I presented a complete study of a greenish-yellow type Ia natural colour diamond with an H2 centre (986 nm) that the Vienna Natural History Museum had lent me. Prof. Alan Collins - who was present at my lecture - had rightly published that this H2 centre was formed during the HPHT treatment of type Ia diamonds. My study showed that this centre could also be present in an untreated diamond. This is rather seldomly the case, as naturally coloured greenish-yellow diamonds are rare, but the description was worth making nonetheless.

Alongside my studies of diamonds, the development of the SSEF Spotter, the ASDI and more recently the ASDI-500 - two patented machines - were significant and pioneering contributions to the diamond market.

You have spent a lot of time and energy contributing to industry initiatives (CIBJO, ISO, LMHC), why do you feel this is so important for the trade?

My involvement in international organisations such as CIBJO, LMHC and ISO was requested by the SSEF Foundation Board. Even before working for SSEF, I was very familiar with the CIBJO rules, which I had already integrated into GemBase, a gemmological software package developed in the 1990s with J-M. Slove, a computer engineer and friend. And then Henry didn't want to deal with CIBJO, he thought it was a waste of time. And he wasn't entirely wrong. But it has to be said that it was a waste of time… for it takes away precious time from research. After all, even at SSEF there are only 24 hours in the day!

On a more serious note, the many working days and trips with CIBJO from 2001 onwards, with LMHC from 2003 onwards and with ISO from 2017 onwards have enabled me to meet some fantastic people who are passionate about their profession, whether they be dealers or experts. Their commitment to contributing to a more structured, transparent, and fair diamond and gem market is to be commended.

△ Jean-Pierre Chalain leading an LMHC meeting in Basel . Photo: SSEF.

△ At an ISO meeting on diamonds in Berlin in 2023.

Is there a diamond that passed through the lab which marked you particularly?

Yes, there was a 60 ct diamond whose yellow colour was linked to artificial irradiation followed by heating. When studied by conventional low-temperature absorption spectrometry, it had the peculiarity of showing optical centres linked to the treatment with an abnormally low intensity compared with its large size. By comparing its absorption coefficients measured in different directions, I was able to prove that the irradiation had been concentrated in the plane of the girdle. From subsequent discussions with the person who had treated the stone, I learned that he had created a lead mask to cover the diamond during irradiation, except in the plane of the girdle.

Where do you see diamond testing going as a discipline? What could SSEF look like in 50 years' time?

The differentiation between natural and synthetic diamonds is unlikely to change much in the next few years because the criteria for differentiation are based on thermodynamic fundamentals. The spectroscopic characteristics of natural diamonds are linked to crystalline defects that have evolved over millions or even billions of years, giving them properties that do not exist in synthetic diamonds, where the same optical centres only have a few days to form and possibly evolve.

The way in which these criteria are treated may evolve, thanks in particular to AI, and SSEF is already working on this, but the criteria are unlikely to change much.

I wouldn't presume to describe what SSEF will be like in 50 years' time. I have a reasoned love of doubt and caution, and I can't read crystal balls, even if they are made of rock crystal… By the way, a question for future gemmologists: how many of them are made of synthetic quartz or glass?

△ Clarity grading of a diamond in the lab. Diamonds have been Jean-Pierre's speciality since he first joined SSEF in 1994. Photo: SSEF.

Any other of your contributions that you would like to mention?

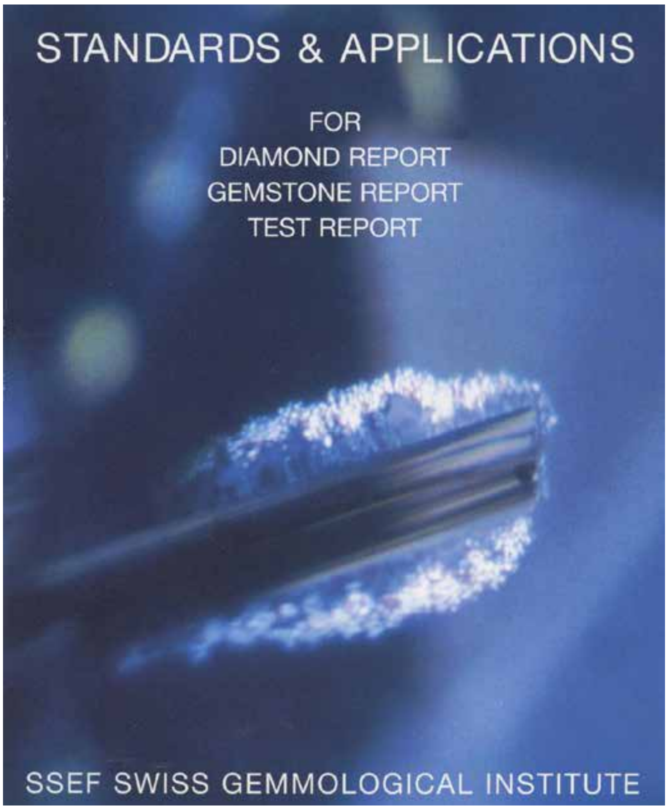
Yes, the Standard & Application document, this booklet published in 1998 by SSEF. I offered Henry to write this booklet to openly present the SSEF standard, clearly and completely. Diamond, ruby, sapphire, emerald and pearl, treatment by treatment. Left page, explanation of the treatment, explanation of the treatment statement as it appears on the SSEF examination report and opposite right, the corresponding full examination report. Nothing to hide. Everything was clear and transparent.

This book presented the SSEF standards to the entire industry. This had never been done before. It was so well received by the profession that we had to reprint it quickly.

I remember the title of the first paragraph of the first chapter. It was called "The 21st Century of Communication". It was the end of the 20th century, and we were already looking towards the future. The advent of social media in the 21st century does not belie this title!

By openly revealing its standards to the entire trade back in 1998, SSEF set itself apart from other laboratories. As a result, a few years later, SSEF played a significant role in LMHC (Laboratory Manual Harmonisation Committee) to harmonise treatment disclosure and nomenclature between the main international laboratories.

All my colleagues at the time were involved in this publication. The Foundation Board wrote the preface. And to finish with a wink, I never put my name forward in this booklet and if you wanted to find my trace in it, look at the day of issue of all the reports printed on the right-hand pages... it's my birthday!



△ Standards and Applications manual that was published in 1998 by SSEF.Photo: SSEF.

I would like to end this interview by paying a very sincere tribute to all the members of the SSEF Foundation Board whom I have known. Marc-Alain Christen of course, the president to whom I owe so much. He was a model of good manners for me. I owe him a great deal. Martin Häuselmann is taking over from him, and he has a big task ahead of him.

My sincere thanks to Henry, Michael and all my colleagues, with whom I have had the immense pleasure of sharing one of the finest professions there is, that of a passionate gemmologist.

△ Visting a gold refinery with colleagues during the CIBJO congress in South Africa in 2006.

INTERNATIONAL GEMMOLOGICAL CONFERENCE IGC IN JAPAN

The 37th International Gemmological Conference IGC was held last October in Tokyo, Japan at the prestigious National Museum of Nature and Science. The biannual IGC conference brings together many of the world's leading research gemmologists and is by invitation only. It was organised under the lead of Dr. Hiroshi Kitawaki, Dr. Ahmadjan Abduriyim, Mr. Masashi Furuya, Mr. Kentaro Emori, Ms. Yoko Okubo. SSEF was involved as a conference sponsor and assisted in both managing the IGC website and putting together the conference proceedings. Furthermore, Dr. Michael S. Krzemnicki sits on the executive committee of IGC.

A pre-conference excursion took place to the Itoigawa and Omi regions from 20-22 October 2023 to learn more about the history and geology of jadeite jade in Japan. A post-conference pearl excursion took place from 29-31 October 2023: Mikimoto Island in Mie Prefecture, an Akoya research institute and the beautiful city of Kyoto. The conference which took place over 5 days had 12 sessions of talks on a wide variety of gemmological research topics including diamonds, coloured gemstones, pearls, and new scientific methods. SSEF researchers presented a total of 6 papers as authors and co-authors during this IGC conference.

We also took this opportunity to visit the magnificent Albion Art jewellery collection in Tokyo. Heartfelt thanks to Mr. Kazumi Arikawa and Ms. Mari Ono for their warm welcome and enthusiasm in sharing their jewellery expertise.

△ **Figure 1**: Dr. Michael S. Krzemnicki giving a talk on the opening day of the IGC conference. Photo: IGC Japan.

△ **Figure 2**: Dr. Walter Balmer (SSEF Research Associate) also presenting new research in Tokyo. Photo: L.E. Cartier, SSEF.

△ **Figure 3**: Dr. Laurent E. Cartier with Dr. Ahmadjan Abduriyim (co-organiser of IGC Tokyo) and Prof. Emmanuel Fritsch who was the lead organiser of the last in-person IGC in Nantes in 2019. Photo: IGC Japan.

△ **Figure 4**: A group photo of IGC Tokyo participants on the first day of the conference when an open colloquium took place to engage with Japanese researchers and students. Photo: IGC Japan.

Dr. Hao Wang presented new findings on 'Effects of gamma irradiation on ruby and pink sapphire and potential detection methods in gem labs'. Dr. Michael S. Krzemnicki gave a talk entitled 'Phase transformations as important markers for heat-treatment detection in corundum and other gemstones'. Dr. Walter Balmer who is SSEF Research Associate and also a foundation board member of SSEF, shared research findings on 'FTIR Fingerprinting: a case study on mineral inclusion identification by FTIR applied on rubies from marble-hosted deposits'. Lastly, Dr. Laurent E. Cartier presented recent research on 'DNA Fingerprinting and age dating of historic natural pearls: a combined approach'.

The full abstract proceedings (176 pages) of the IGC conference in Tokyo can be downloaded as a PDF from the following website: https://www.igc-gemmology.org/conferences/igc-2023/

We also encourage you to visit the new IGC website (www.igc-gemmology.org) which will be gradually expanded to include archives from past conferences since 1952.

*** Dr. Laurent E. Cartier, SSEF**

GILC CONFERENCE IN TUCSON

For over two decades, the Gemstone Industry and Laboratory Conference GILC, organized by the International Colored Gemstone Association ICA has taken place just before the annual Tucson Show. It has been an event that brings the gem trade and laboratories together to discuss gemmological issues and challenges.

For the 2024 GILC Conference, Dr. Michael S. Krzemnicki (SSEF) along with gemmologists from GIA and Gübelin were invited to each give a presentation about the detection of low-temperature heating of corundum. Based on the latest research at SSEF (see also gemmological focus article on pages 6-9), Dr. Krzemnicki explained the different analytical approaches to detect heat treatment and shed light on the challenges and limitations faced by laboratories when testing corundum varieties for heat treatment detection.

These presentations sparked a lively and constructive discussion between the audience (mostly gem traders) and laboratory representatives, revealing once again how important such ongoing and respectful exchanges are for all stakeholders of the gem industry.

20TH RENDEZ-VOUS GEMMOLOGIQUES DE PARIS

The 20th conference of the Association Française de Gemmologie (AFG; French Gemmological Association) took place 13 October 2023 in Paris, with the theme 'Ethique' (Ethics). It was attended by about 150 people. AFG president Dr Érik Gonthier chaired the conference and was assisted by gemmologist Anne Valtat, who moderated events. Eight speakers gave presentations including Jean-Philippe Giordano (Corsica, France), Mathieu Moulin (Compagnie des Minéraux d'Auvergne, France), Christophe Péray (Chamonix, France), Eddy Vleeschdrager (Antwerp, Belgium), Philippe Bloch (Raymond Bloch SA, Paris, France), Dr Érik Gonthier (Muséum National d'Histoire Naturelle, Paris, France) and Hervé Obligi (Obligi, Montreuil, France).

Dr. Laurent E. Cartier of SSEF was invited to offer a retrospective on ethics within the gem and jewellery sector. In recent years, there has been a growing emphasis on ethical certification and traceability, prompting a shift towards more corporate frameworks. However, it's important to recognize that traceability solutions alone are not a panacea and must be accompanied by robust systems to uphold best practices. Lastly, following the screening of 'The Divers of Sewa,' the importance of genuine storytelling was underscored, highlighting how ethics and traceability can potentially offer genuine value to all stakeholders in the supply chain, including consumers.

△ **Speakers at the 20th Rendez-Vous Gemmologiques de Paris conference include (from left to right) Jean-Philippe Giordano, Dr Laurent Cartier, Hervé Obligi, Mathieu Moulin, Eddy Vleeschdrager, Erik Gonthier, Philippe Bloch, Christophe Péray and Pierre-Jacques Chiappero. Photo courtesy of AFG.**

SSEF AT RAMAN CONFERENCE IN GREECE

In September 2023, SSEF gemmologist Dr. Wei Zhou participated in the Raman Spectroscopy Workshop and Conference organized by the International Raman Society and the Hellenic Museum in Greece. She gave a presentation on detecting epigenetic iron staining in ruby and sapphire by using Raman spectroscopy. While attending the workshop and the conference, she shared with the audience the advantages of Raman spectroscopy as a valuable tool in the field of gemstone research and some issues have also been discussed further, such as the type of laser to be used in gemstone testing, the accuracy of the test for the relevant problems, how to reduce the background noise, and other ongoing research topics.

EUROANALYSIS CONFERENCE IN GENEVA

Euroanalysis is a biannual international conference focusing on analytical sciences organized by the European Chemical Society. After the 2021 meeting had been cancelled, the conference was held again in August 2023 at the international conference center in Geneva. The conference is a great opportunity to get updates on the newest developments in analytical chemistry and mingle with other scientists during various poster sessions and coffee breaks to discuss analytical challenges. Dr. Markus Wälle gladly took the opportunity to present some of the research done at SSEF in an invited talk and chairing one of the sessions in mass spectrometry.

His presentation was entitled “Direct Thorium-Lead dating of gem quality corundum by laser ablation ICP-TOF-MS” and showed some findings about the occasional occurrence of thorium in sapphires and rubies. This subsequentially opens the possibility to use the Pb-Th chronometer for dating, enabling distinguishing between sapphires from the East African (e.g. Madagascar, Sri Lanka) and Himalayan orogen (e.g. Kashmir, Myanmar) origin. A strong correlation of thorium with light rare earth elements together with the seemingly homogenous signal indicate a possible presence of nano-inclusions as it has been described by transmission electron microscopy (TEM) for Ta and Nb enriched sapphire. The accuracy of the Th-Pb dating could be shown by a case where it was possible to get a Th-Pb age as well as the U-Pb age of a zircon inclusion from the same gemstone. It is planned to include the findings presented at the conference in a future publication for a geochemical journal.

EuroAnalysis Geneva 2023

2023 CIBJO CONGRESS HOSTED IN THE MAGNIFICENT PINK CITY OF JAIPUR

October 3 - 5 2023, the CIBJO Congress was co-hosted by the Gem & Jewellery Export Promotion Council of India and the National Gems and Jewellery Council of India in the magnificent city of Jaipur.

CIBJO members could participate in many commissions, committees and steering committees dealing with diamonds, coloured stones, pearls, gemmology, precious metals, ethics, and education.

CIBJO also announced that it was establishing a CIBJO Academy that is being led by its founding dean Ken Scarratt. The academy will propose educational programmes and materials to professionals and end-consumers dealing with standards, operating principles and nomenclature as developed by the different CIBJO commissions and committees. Jean-Pierre Chalain of SSEF continues to be very active in CIBJO activities as a vice-president of the diamond commission.

△ **Laboratory Grown Diamond Committee meeting chaired by Wesley Hunt (center of stage), Raluca Anghel (right on stage, J-P. Chalain (left remote participation). Photo: CIBJO.**

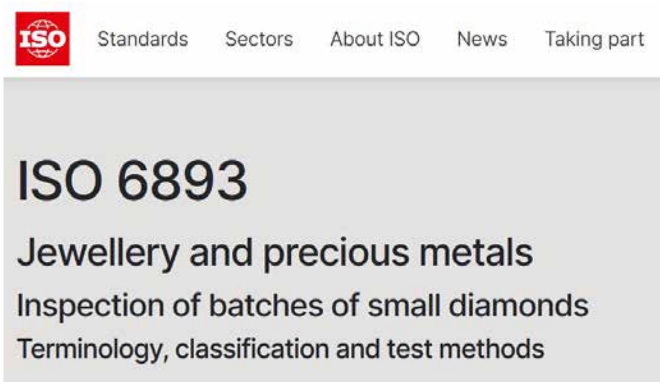
2023 also saw CIBJO revamp its website, which is rich in information on its activities and projects: https://cibjo.org/press-releases/

DIAMOND ISO STANDARDS

In addition to the International Standard ISO 18323 which sets rules for the nomenclature of diamonds and synthetic diamonds, in 2017, the Federation of the Swiss watch industry FH asked SSEF to develop a standard for the quality control of small diamonds. To start with, we first contributed to the development and in 2020 to the completion of the ISO standard 24016 Grading polished diamonds- Terminology, classification and test methods of diamonds which has become the standard of reference for the grading of diamonds.

In 2020, we launched the development of the standard for the quality control of small diamonds (ISO 6893: Inspection of batches of small diamonds). More than 10 different countries participated in the preparation of this standard. The major specificity of controlling the quality of small diamonds, as opposed to diamond grading described in ISO 24016, is the definition of sampling conditions and the sampling methodology of batches. After numerous virtual and face-to-face meetings and several series of comment sessions, at the end of 2023 the vote process took place, and all countries unanimously adopted the standard. This standard ISO 6893 will be published and will be available on the ISO website by mid of April 2024. Jean-Pierre Chalain of SSEF was convenor for both the ISO 24016 and ISO 6893 diamond standards.

This latest diamond standard completes a series of diamond ISO standards. The Federation of the Swiss watch industry FH contributed significantly, especially through its secretariat support. Dr. Gaetano Cavalieri, president of CIBJO, played a major role in making this international challenge a significant success. These three international standards are available to the international diamond trade which can use these standards to further harmonization in quality control of all diamonds, large and small.



△ **The latest ISO standard on diamonds, which will be published in April 2024. Source: ISO.**

ASDI-500 PRESENTATION IN ANTWERP

In last year's Facette, we informed you about the launch of the small diamond screening device ASDI-500. While the concept of the machine was developed by SSEF, its engineering and its marketing was contractually left to UNIMEC SA, a Swiss company established in La Chaux-de-Fonds.

In February 2023, SSEF installed the first prototype of this device in its Basel laboratory. After a rigorous three-month validation period, the machine was introduced into the testing protocol to control our clients' lots. Since then, several hundred thousand melee diamonds have been tested, and many large batches are now tested at night, a significant advantage of such automated devices.

To improve the ASDI-500 concept, SSEF regularly shared with UNIMEC its daily experiences. This enabled us to enhance the commercialised series of devices produced by UNIMEC for the diamond trade. This event showed that there is a strong interest of the international diamond trade in this new and powerful automated sorting device for small to ultra-small diamonds. This is also underlined by the fact that the ASDI-500 has been sold in the past few months since its commercial launch to major diamond trading and watch companies, and also to gemmological laboratories. In late March 2024, SSEF and UNIMEC were invited by the Diamond Bourse of Antwerp to present the ASDI-500 machine to members of the four diamond bourses in its Grand Hall.

This proof of confidence is a very encouraging sign to SSEF and UNIMEC for continuing in improving the machine with new possible functionalities, such as improving the speed from 800 to 1'000 stones per hour, extending the largest size testable to 5.00 mm, testing fancy shapes, diameter measurements and colourimetry.

For more information about the ASDI-500, please visit the website: www.ssef-instruments.ch
*** Jean-Pierre Chalain, SSEF**

ETH ZÜRICH INVITED LECTURE ON DIAMOND TRACEABILITY

In September 2023, Dr. Laurent E. Cartier was invited by the Institute of Science, Technology and Policy (ISTP) of ETH Zürich to give a lecture entitled "From Conflict to Romance: The Science, Policy and Sustainability of Diamond Traceability". The ISTP colloquium invites researchers from very diverse backgrounds to discuss the nexus of policy and science. Given the many recent developments in diamond industry initiatives, norms and rules this presentation gave an overview of issues in the sector. The audience of researchers and students from different disciplines had many interesting questions and showed yet again the importance of interdisciplinary science in tackling policy questions. Recent developments with regards to G7 rules and Russian diamonds are a key example of this.

For more information on Swiss government and customs rules pertaining to Russian diamonds, please follow this link: https://www.seco.admin.ch/seco/fr/home/Aussenwirtschaftspolitik_Wirtschaftliche_Zusammenarbeit/Wirtschaftsbeziehungen/exportkontrollen-und-sanktionen/sanktionen-embargos/sanktionsmassnahmen/faq_russland_ukraine.html

SSEF TEAM EVENT IN COLMAR (FRANCE)

At SSEF, the Christmas team event is an important tradition. It's a day in the year when the lights in the lab are switched off and when our team of nearly 40 gets together for an exciting day out. Deciding which beautiful place we want to explore is never easy as the proximity to France and Germany means that the choices are endless!

This year, our inspired and talented event planner, Véronique, decided to take us to Colmar, a beautiful medieval French city, 60km from Basel, which is highly reputed for its beautiful Christmas market.

During the festive season the old town transforms itself in the most charming and magical open-air theatre (or Christmas market?) where the streets and monuments are finely decorated and illuminated. Strolling through the cobbled streets and alleys is an true enchantment for young and old alike.

But Colmar is not only known for its Christmas market it's also a city with a rich art heritage. In the Unterlinden Musuem one can admire the Altar of Issenheim, a monumental polyptych painted by Grünewald and sculpted by Nikolaus Hagenhauer between 1512 and 1516. This magnificent altarpiece composed of seven panels of lime wood and ten sculptures was designed to allow three different presentations each revealing episodes from the lives of Christ and probably governed by the liturgical calendar.

This masterpiece was commissioned to ornament the High Altar in the Monastic complex of Issenheim, home to the Antonite Order of hospital brothers. One of this religious order's missions was to take care of the victims of 'St Anthony's fire' a Middle Age disease caused by the ingestion of rye flour made from grain contaminated with the ergot fungus. This disease led to convulsive and gangrenous symptoms which required specialised care.

Emotionally powerful, the altarpiece played its part in the patients' recovery by offering them comfort and consolation through its very realistic and harrowing presentation of the Crucifixion and the hope of recovery conveyed by the scene of the Resurrection.

A memorable visit which reminded us that Art, this versatile and ancestral communication channel, has the power to impact past and present lives, to influence societies and to heal.

And because at SSEF we love wine tasting, we wrapped up the day visiting Domaine Karcher one of the last wine producers located within the ramparts of Colmar's old town. It was a pleasure to learn about the vineyard and visiting the wine cellar which housed superb centenary oak barrels !

Colmar is easily accessible from Zurich, Paris and many large cities around, a visit around the festive season is a must !
*** Victoria de La Soujeole, SSEF**

△ **Petite Venise, wine tasting and Christmas market in Colmar. Photos: SSEF.**

△ **SSEF team in Colmar in December 2023. Photo: SSEF.**

CLOSE-UP: VICTORIA DE LA SOUJEOLE

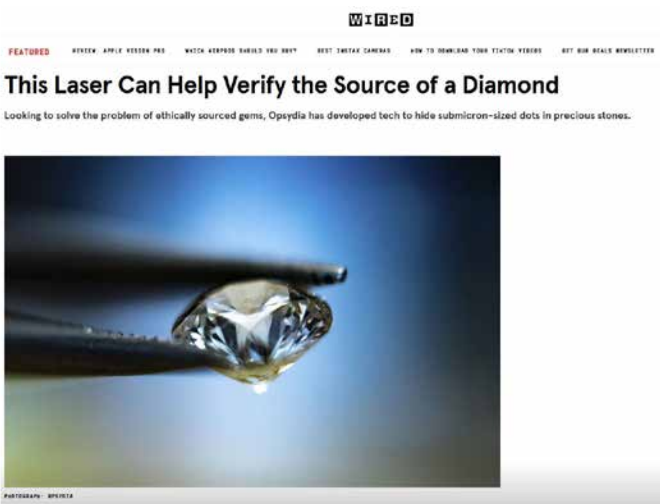
Victoria, our *Head of Operations*, is not a newcomer to the job, but actually joined SSEF already 10 years ago in 2015. Coming from Sotheby's as a Head of Catalogue Production and Jewellery Junior Expert, she immediately immersed herself in the similarly busy world of the Swiss Gemmological Institute SSEF. Starting as personal assistant of the director of SSEF, she has quickly taken operative responsibilities in the lab and by this has and is greatly contributing to the smooth operation and exceptional success of SSEF over the last few years.

She not only coordinates and manages our planning and operations inhouse and abroad but is also in direct contact with our clients in the office in Basel or at our reception desk at jewellery shows, answering any questions or special requests.

Victoria is a real team player with strong organization skills. These are great assets to manage diversity in the multicultural SSEF team in our daily operations. But let's not forget, they are also key to planning and organising our annual SSEF team event and make it a memorable and joyful day for all.

SSEF IN THE PRESS

Over the past year, SSEF has been mentioned in several press articles, highlighting our cutting-edge research and expertise in the gemstone industry. We are regularly interviewed by journalists. This emphasizes our lab's reputation in gemstone identification and authentication and reflects our position as a trusted authority in gemmological science.

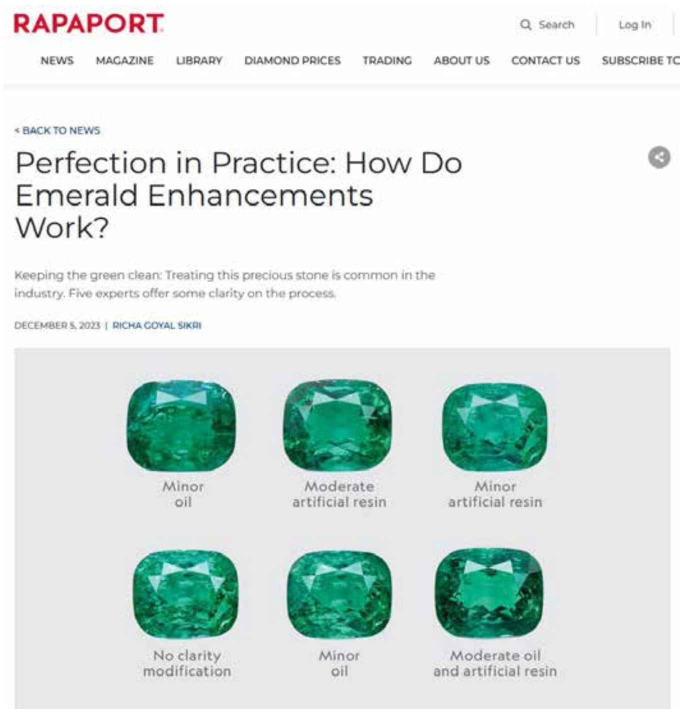


WIRED

FEATURED

This Laser Can Help Verify the Source of a Diamond

Looking to solve the problem of ethically sourced gems, Opsydia has developed tech to hide submicron-sized dots in precious stones.



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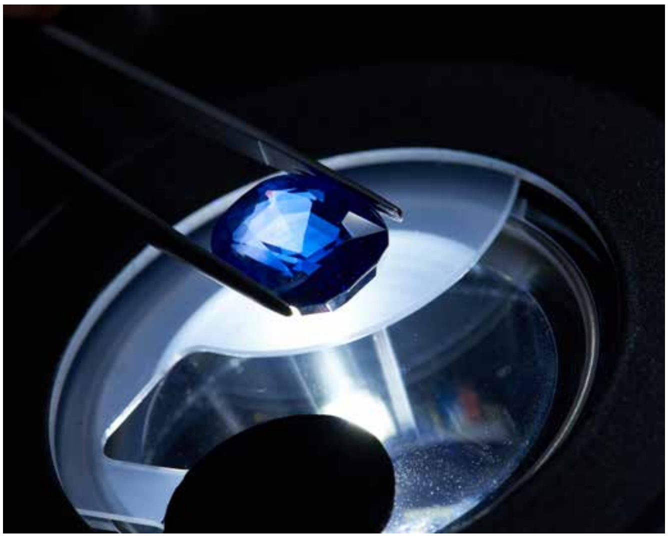
Perfection in Practice: How Do Emerald Enhancements Work?

Keeping the green clean: Treating this precious stone is common in the industry. Five experts offer some clarity on the process.

DECEMBER 5, 2023 | RICHA GOYAL SIKRI

Minor oil | Moderate artificial resin | Minor artificial resin

No clarity modification | Minor oil | Moderate oil and artificial resin



SSEF ON-SITE IN 2024

In 2024 we will be exhibiting and/or offering our on-site testing services as follows.

Bangkok	10 – 19 January 2024
Tucson	30 January – 04 February 2024
Hong Kong	23 February – 04 March 2024
GemGenève	08 – 12 May 2024
Bangkok	27 – 31 May 2024
Bangkok	14 – 23 August 2024
Hong Kong	12 – 22 September 2024
Bangkok	January 2025
Tucson	04 – 09 February 2025
Hong Kong	March 2025

DONATIONS

As in previous years, we are grateful for numerous donations we received since 2023 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.

Pearl Donations

Lu Taijin (China), Hiroki Hiraga (Japan), Andy Müller (Japan)

Gemstone Donations

Tom Stephan (Idar Oberstein), Constantin Wild (Idar Oberstein), René Kluser (Switzerland), Philippe Honegger (Switzerland), Anaïs Cartier (France), Muhammadu Shahid Abdul Waridu (Switzerland), Hashmat Azizi (Bangkok), Bart de Hantsetters (Antwerp), Michael Krzemnicki, Donald May (Hong Kong), Joseph Belmont (Bangkok), Kiefer Tang (China), Win Than Tun (Myanmar), Yianni Melas (Greece), Avant Chordia (India), William (Bill) Marcue (USA), Alex Leuenberger (Switzerland), Charles Abouchar (Switzerland), Frédéric Torroni (Switzerland)

Jewellery Donations

Kathia Pinckernelle (Geneva), Françoise Tschudin (Neuchâtel)

Book & Instrument Donations

Christophe Stucki (Geneva), Rui Galopim de Carvalho (Portugal), Pierre Lefèvre (Basel)

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Balmer W., 2023. FTIR Fingerprinting: a case study on mineral inclusion identification by FTIR applied on rubies from marble-hosted deposits. *IGC 2023 Proceedings*, 150-153.

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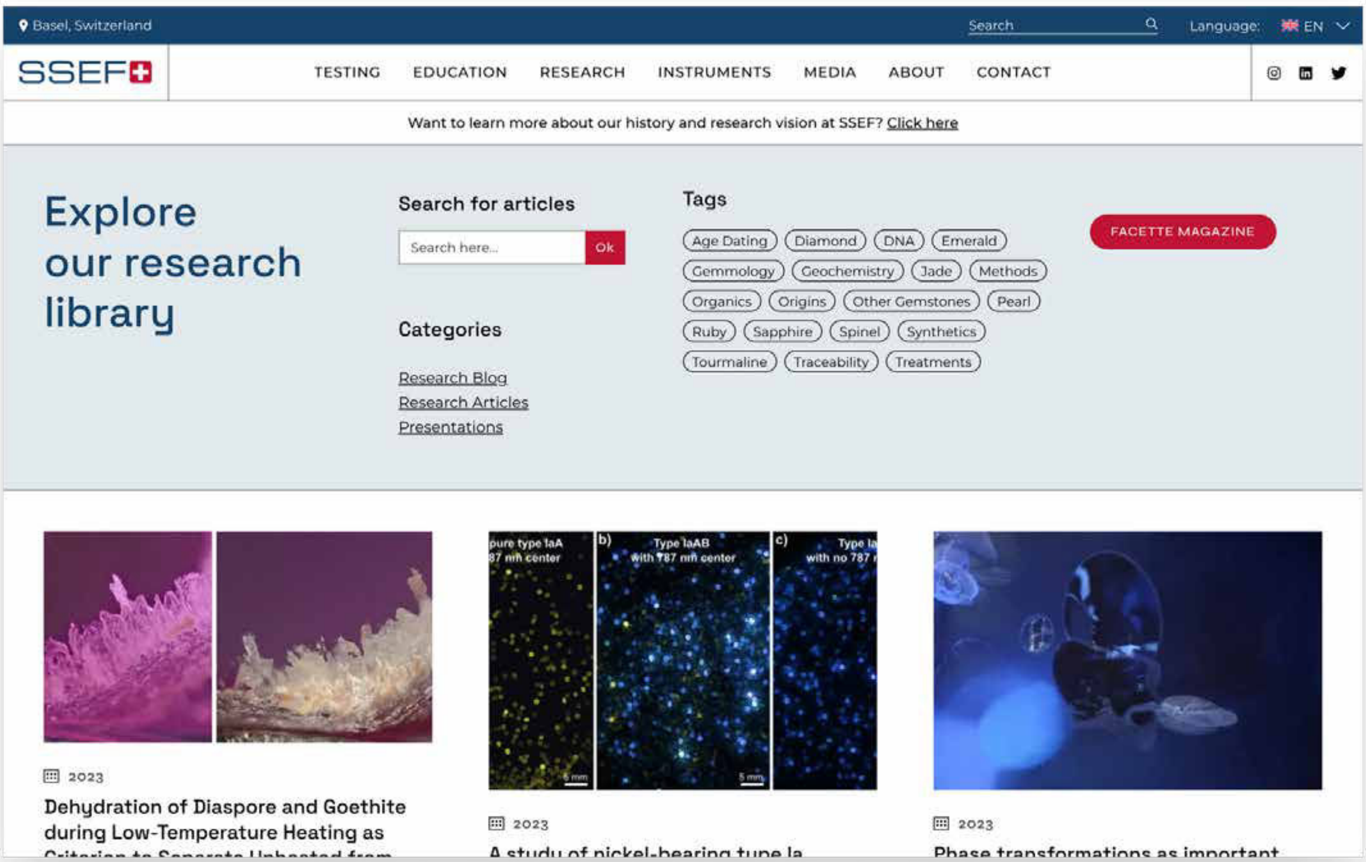

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