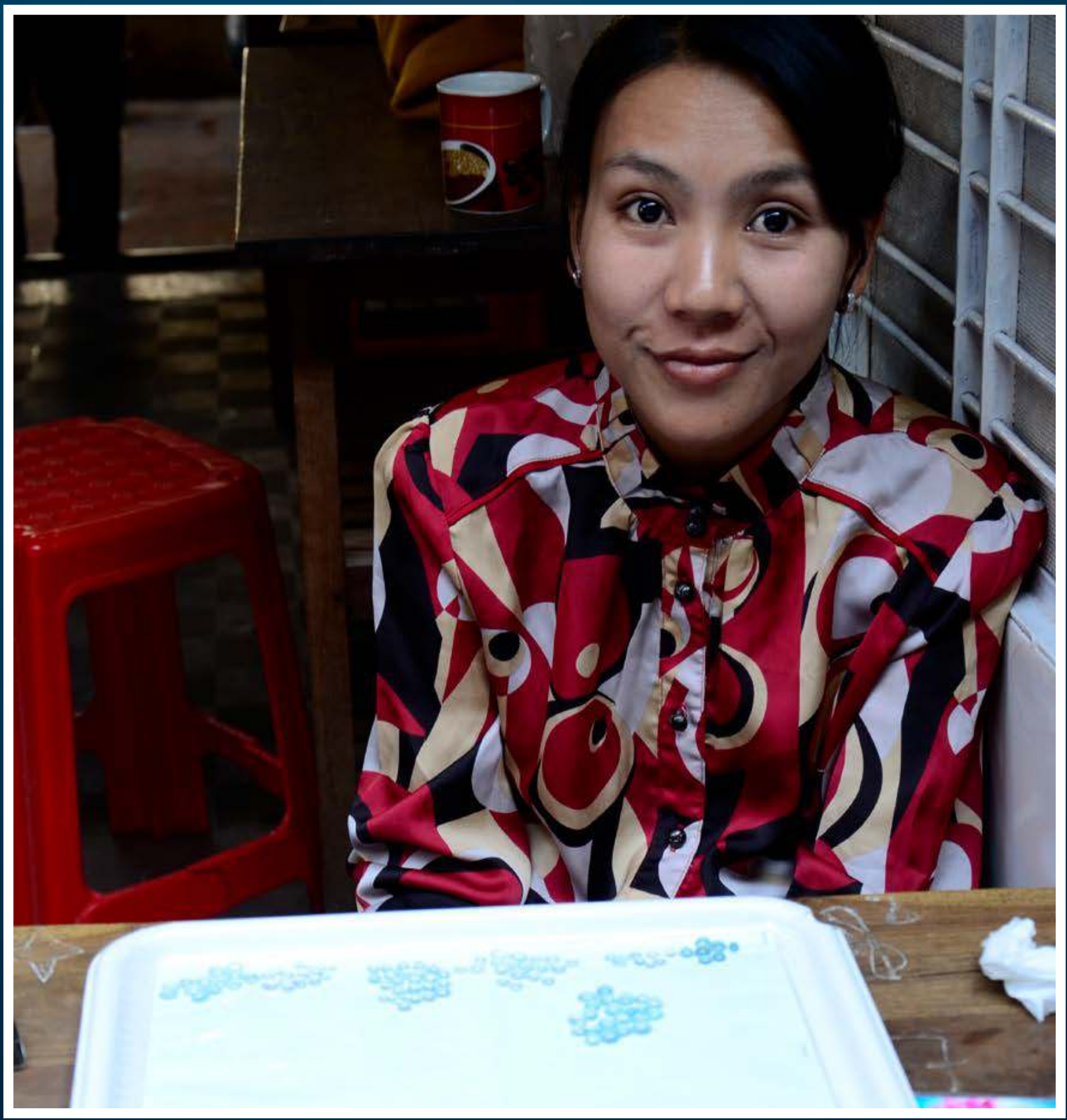
Facette

MAGAZINE

INTERNATIONAL ISSUE NO.27, JUNE 2021



SCIENTIFIC GEMMOLOGY / AFGHAN EMERALDS /
NEW PEARL SPECIES / AGE DATING / MACHINE LEARNING
SSEF AT AUCTION / FREE ONLINE COURSES

SSEF
SCHWEIZERISCHES GEMMOLOGISCHES INSTITUT
SWISS GEMMOLOGICAL INSTITUTE
INSTITUT SUISSE DE GEMMOLOGIE

Dear Reader

With this new issue of the SSEF Facette, I would like to present you again a summary of our recent activities and research.

The past year with the global Corona pandemic has been a worldwide challenge and certainly has had a deep impact in all our personal lives, but also in the way we all work in the jewellery trade and at gem laboratories. I do hope that you managed to protect your family and business in these difficult times, and would like to express my heartfelt wishes, that the ongoing vaccination campaign will allow you soon to get back to a more 'normal' life in the near future.

From a business point-of-view, the pandemic has definitely accelerated the digital transformation of the trade, with the arrival of newly emerging gem trading platforms and a wide array of online learning opportunities for the trade and consumers alike.

At SSEF, the focus in the past year was mostly on making our gemmological expertise easily accessible online. This led to the launch of our free online SSEF courses in April this year, available already now in English, French, simplified Chinese with modules about ruby, sapphire, emerald, diamond, and pearls. I invite you to check out this unique and freely accessible trove of information about gems and refer you also to the article about the SSEF online courses in this issue of the Facette.

Apart from this, we have been busy with the relaunch of our Scientific Gemmology Course, during which participants learn hands-on how to use advanced instrumentation to analyse gemstones in a laboratory setting. The new course scheduled for July 2021 is already booked out, showing us that this kind of training with a scientific focus is a need for the trade and labs alike.

We are also very pleased to announce a new course about the history of gems and jewellery scheduled for October 2021. This new course is developed in collaboration with Vanessa Cron, an eminent art and jewellery historian who has broad experience in our industry. I am proud to say that this new course at SSEF is unique worldwide, as it combines the art history of jewellery making with our knowledge about mining history and our gemmological expertise in analysing gems set in jewellery.

Please check out our SSEF website to find all relevant information about our options for gemmological education.

The past months, filled with numerous home office hours, have been very productive for SSEF in terms of research. Several projects were launched or successfully completed. As it is our policy to make our research openly accessible, our findings were published and announced to the public in scientific articles and press releases throughout the year. Specifically, I would like to mention here the ground-breaking study about the use of machine learning methods as a versatile tool to analyse gemstones, notably for origin determination. Machine learning, often marketed under the buzzword artificial intelligence, supports our gemmologists in their analysis of gemstones. A detailed account of how new research findings and instrumental developments at SSEF have continuously shaped and extended our knowledge and expertise is presented in this new edition of Facette.

Finally, I would like to thank you for your continuous support and trust in our services. I can guarantee you that we continuously strive to maintain the highest levels of scientific expertise when it comes to testing your gems and jewellery.

I wish you great reading pleasure with this new issue of SSEF's Facette, and also wish you successful and exciting new business opportunities in the months to come.

Please stay safe and healthy.

Sincerely yours,

Dr. Michael S. Krzemnicki
Director SSEF

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COVER PHOTO ▷

At the jade market in Mandalay (Myanmar)

Photo: M.S. Krzemnicki, SSEF

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IMPRINT
Annual publication by **Swiss Gemmological Institute SSEF** Aeschengraben 26, CH-4051 Basel SWITZERLAND
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ISSN : 2296-214X | All images ©SSEF unless otherwise stated

THE SCIENCE OF GEM TESTING AT SSEF: A FASCINATING TALE

△ **Photos: SSEF.**

Science,
"any system of knowledge that is concerned with the physical world and its phenomena and that entails unbiased observations and systematic experimentation. In general, a science involves a pursuit of knowledge covering general truths or the operations of fundamental laws."

Encyclopedia Britannica

Gemmology is a science with its foundations more than a hundred years ago, specifically driven by the emergence of synthetic stones and cultured pearls in the gem trade in the early 20th century. As with any other domain of science, gemmology has evolved in the past decades tremendously through scientific discoveries and instrumental developments. And it is this innovation which has and continues to constantly shape our knowledge about gems in the past, present, and in future.

Commonly, gemmology is described as a sub-discipline of mineralogical sciences. But a closer look reveals that gemmology is in fact very interdisciplinary, as it connects mineralogy (the study of gems as minerals), geology (the formation of gems), mining (prospection and extraction), forensics (testing and tracing of gems), with biology (formation of biogenic gem materials), sustainability (impact on local communities), and social and historical science (use and significance of gems in history and society), to name a few (Figure 2). It is this wealth of interconnections with other scientific branches that makes gemmology such a fascinating world to dive into for scientists. But gem science reaches much further, as the colourful fabric of knowledge provided by scientific studies elucidates and feeds the fascination in the trade and public alike, see for example the success and circulation of gem-related topics on social media in recent years.

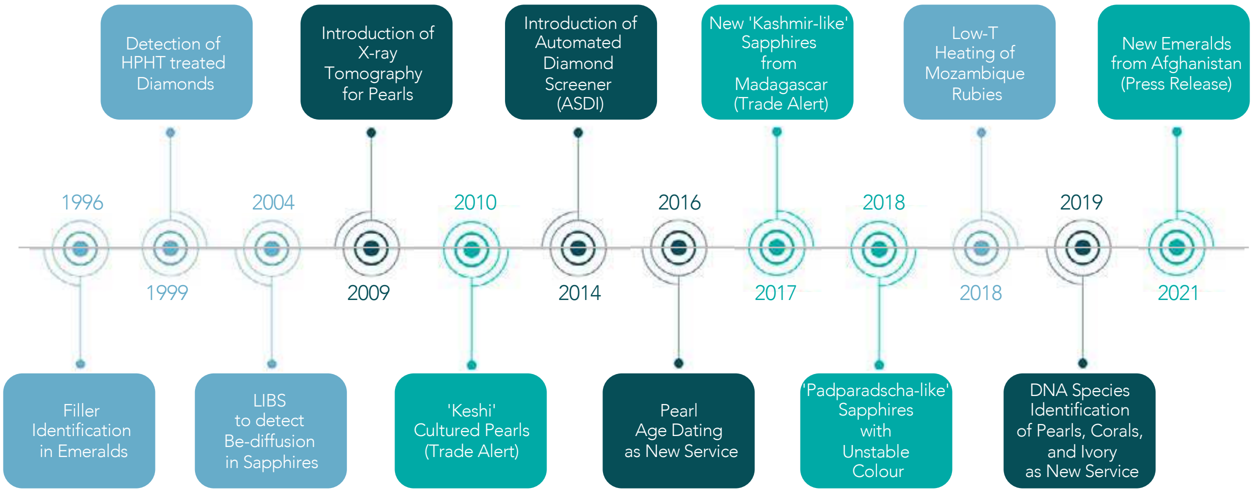
△ **Figure 2:** **The interdisciplinary nature of gemmology. Figure: M.S. Krzemnicki, SSEF.**

Scientific research at SSEF:

Since its beginnings nearly 50 years ago, the Swiss Gemmological Institute SSEF is a driving force and at the forefront of scientific innovation in gemmology. Founded as a non-profit organisation by Swiss trade associations in 1972, the acronym SSEF (Schweizerische Stiftung für Edelstein-Forschung; in English: Swiss Foundation for the Research on Gemstones) was specifically chosen to express its main duty as a non-profit organisation to carry out research on gems with the aim of supporting the trade and maintain the confidence of the public in gems and jewellery.

We are proud to be part of this mission in gemmological research, with many staff members at SSEF working since 10, 20 or even more years. Looking back at the gemmological legacy of our former directors George Bosshart and Prof. Dr. Henry A. Hänni and their teams at SSEF, we see numerous scientific highlights, such as the first scientific study of the Dresden Green Diamond (1989, see Figure 3), a detailed description of the distinguishing characteristics of Kashmir sapphires (1990), or the identification of fissure filling substances in emeralds (1996), to name a few.

△ **Figure 3: The Green Dresden diamond (approx. 41 ct) set in a brooch on the original volume of the 1733 inventory of the Green Vaults (Dresden, Germany). Photo: R. Bosshart (1988).**



△ **Figure 4:** **Timeline of selected scientific discoveries and innovations at SSEF in the past 25 years with new treatment detections (light blue), new analytical methods and services (dark green), and new materials and deposits (bluish green). Figure: M.S. Krzemnicki, SSEF**

As the timeline of scientific discoveries and innovations at SSEF reveals (Figure 4), research is an ongoing process with our curiosity and trade issues as driving forces. Such developments are only possible with a team of specialised experts in-house and external collaborations with other research labs and universities.

It is our philosophy to share our research findings not only with the scientific community, but also with the trade and interested public. Consequently, we have published in the past few decades numerous articles in scientific and trade journals alike, and have presented our findings to students at SSEF and broader audiences through courses, lectures, webinars and last but not least on social media (check out our accounts on Instagram, LinkedIn, and Twitter).

Examples of scientific innovation by SSEF:

In the past decades, SSEF has been very active in presenting the trade our newest achievements and solutions for a variety of important trade issues and challenges. This is only possible by constantly exploring and advancing state-of-the-art analytical methods (e.g. GemTOF mass spectrometry), including machine learning algorithms for data visualisation (see article in this Facette, pages 12-13).

To start with a few contributions of SSEF about new treatments: we were the first laboratory worldwide to show the usefulness of LIBS (laser induced breakdown spectroscopy) as a rather low-cost option to detect beryllium-diffusion treated fancy sapphires, and supported labs around the globe as they sought to upgrade their gem testing protocols with this new technology. A more recent press release (September 2018) revealed criteria on how to detect low-temperature heating, specifically applied on rubies from Mozambique (Figure 5).


SSEF
PRESS RELEASE

CONTACT: Dr. Michael S. Krzemnicki FGA

New research by SSEF studies methods for detecting low-temperature heated rubies from Mozambique

…EL, SWITZERLAND: SEPTEMBER 12, 2018 – Since their discovery in early 2009, the ruby …osits near Montepuez in Mozambique have produced an impressive number of …ptional-quality stones, including iconic unheated gems such as the Rhino Ruby (22.04 …, the Scarlet Drop (15.95 cts) and the Eyes of the Dragon (a pair of rubies weighing 11.26 …s and 10.70 cts), all of which were analysed by the Swiss Gemmological Institute SSEF. But from the very beginning, there has been evidence in the market of lower-quality rubies from Mozambique that have been heated with or without a flux (borax), resulting in healed fissures with residue, and in some cases heavily-fractured material that has been lead-glass filled.

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

△ **Figure 5:** SSEF press release from September 2018 announcing to the trade new detection criteria for low-temperature heated rubies from Mozambique, together with a heated ruby from Mozambique. Photo: M.S. Krzemnicki, SSEF.

Concerning newly discovered gem deposits, we would like to mention here two major recent contributions: first about a new deposit near Ambatondrazaka in Madagascar providing sapphires of velvety blue colour and excellent quality, and how to distinguish these new stones from sapphires from Kashmir (trade alert and scientific publication, March 2017). And secondly, a very detailed study about excellent new emeralds from the Panjshir valley in Afghanistan, which can compete with the finest qualities of Colombian material in colour and quality (press release and scientific publication in March 2021, see Figure 6 and also article in this Facette, pages 10-11).


SSEF Newsletter March 2017-03-27

Trade alert:
'Kashmir-like' sapphires from Madagascar are entering the gem trade in large sizes and quantities

by Dr. Michael S. Krzemnicki, SSEF

In the last few weeks, the Swiss Gemmological Institute SSEF analysed an important number of sapphires from a new deposit at Bemainty, near the small town of Ambatondrazaka in Madagascar, which were submitted to us by several reliable independent sources. This new gem-rush in Madagascar has produced in the last few months an impressive amount of sapphires, fancy coloured sapphires, and padparadschas of partly exceptional size and quality (Krzemnicki 2017 in SSEF Facette www.ssef.ch/research-publications/facette/ and upcoming Journal of Gemmology, Perkins 2016, Perkins & Pardieu 2016, Pardieu et al. 2017) and seems to be a new gem source more important than anything we have seen in recent years.

PRESS RELEASE

FOR IMMEDIATE RELEASE
CONTACT: Dr. Michael S. Krzemnicki FGA

SSEF scientists author first published study of new high-quality emerald type from Afghanistan

BASEL, SWITZERLAND, MARCH 24, 2021 – The first detailed study characterising an emerald type from Afghanistan that has recently become available in the gemstone trade has been prepared by a team of scientists from the Swiss Gemmological Institute SSEF, and published in the most recent edition of Journal of Gemmology. One of the challenges posed by such emeralds is that they are on occasion mislabeled as being Colombian, for they closely match South American specimens not only visually, but also in terms of their gemmological properties.

To conduct the study, the SSEF research team tested and analysed more than 100 gem-quality emeralds from the Panjshir Valley in Afghanistan, ranging in size from 1 carat to more than 30 carats.

△ **Figure 6:** Press releases about new 'Kashmir-like' sapphires from Madagascar (published March 2017) and new emeralds from Afghanistan (published March 2021). Source: SSEF.

When it comes to new materials and technical innovation in testing, we can mention here our studies about HPHT treated diamonds and synthetic diamonds, based on which we developed new analytical tools (SSEF diamond spotter & ASDI) for the diamond trade and jewellery and watch producers.

Another good example is our detailed report about so-called 'Keshi' cultured pearls (trade alert March 2010 and subsequent scientific publications), which were introduced in an undisclosed fashion in the market, and which caused quite a challenge in the trade at that time. This achievement finally resulted in a meeting of international pearl testing laboratories in September 2010 in Bahrain, during which a worldwide harmonised standard was agreed on how to address this pearl issue (see www.lmhc-gemmology.org). Other examples are our announcement (and scientific publications) about radiocarbon age dating of pearls and DNA species determination for pearls, corals and ivory (Figure 7), all offered in collaboration with specialised research labs as services to our clients since several years. As this tree of knowledge in gemmology is further growing, we at SSEF are proud to be, as in the past, a strong and reliable branch to nurture its expansion.


FEATURE ARTICLE

DNA Fingerprinting of Pearls, Corals and Ivory: A Brief Review of Applications in Gemmology

Laurent E. Cartier, Michael S. Krzemnicki, Bertalan Lendvay and Joana B. Meyer

ABSTRACT: This article reviews the extraction of DNA (deoxyribonucleic acid) from biogenic gem materials (pearls, corals and ivory) for determining species identification and geographic/genetic origin. We describe recent developments in the methodology adapted for gem samples that is minimally destructive, as well as the successful DNA fingerprinting of cultured pearls from various *Pinctada* molluscs to identify their species. The DNA analysis methods presented here can also potentially be used for fingerprinting corals and ivory.

The Journal of Gemmology, **36**(2), 2018, pp. 152–160 http://dx.doi.org/10.15506/JoG.2018.36.2.152
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△ **Figure 7:** Scientific publication about DNA species determination and applications at SSEF as a client service. Photo: SSEF & Journal of Gemmology.

New scientific knowledge may lead to new conclusions

As with all science, new achievements and discoveries increase our knowledge. What we know today is more than what we knew in the past. This process is ongoing and is actually a driving force for all innovation and evolution. Whether in medical sciences, or in physics and astronomy, new scientific discoveries are made every day somewhere in the world, and we all profit from this even in our daily life, as the current global pandemic and related research initiatives and successful findings have shown exemplarily.

Whenever we have finalised a research project and established unambiguous criteria to detect a new treatment or to assess the origin of a gemstone, we will inform the public about our findings (e.g. by a press release, and/or publication in an openly accessible journal). Most importantly, however, we will apply with the date of this publicly accessible publication these new criteria on stones submitted for testing. By doing so, we offer the trade the most up-to-date testing expertise, well in line with our slogan: SSEF, The Science of Gem Testing™. We are convinced that this strategy supports the trade and acts as a safeguard against new and undisclosed challenges arriving in the market.

As a consequence of this policy, however, it may occur in rare cases that SSEF is not able to reproduce a conclusion expressed on a previous SSEF report due to new research findings, the availability of additional data, or even in cases where a gemstone or pearl might have been modified at a time after testing at SSEF. This is not related to a mistake, but to a fact inherent to all science, that any conclusion – whether expressed on a gemmological report or a doctor's note - is based on the latest scientific knowledge and instrumentation, available at the time of examination.

Although we understand that such a change of result for a gemstone is a difficult issue for a client, it must be acknowledged that both scientific knowledge and instrumentation to test gemstones and pearls are rapidly evolving as shown above. It is our policy to be very transparent with a client if such a case occurs and to inform the client verbally and with a written letter about the scientific reasons for such a change.

In summary, it is the mission of SSEF since its foundation about 50 years ago to invest great means to address challenges with new (undisclosed) treatments and origins found in the market. We can reassure you that also in future we will be doing our utmost to develop pertinent scientific instrumentation and continuously review our standards in an independent and scientific manner.

*** Dr. M.S. Krzemnicki**

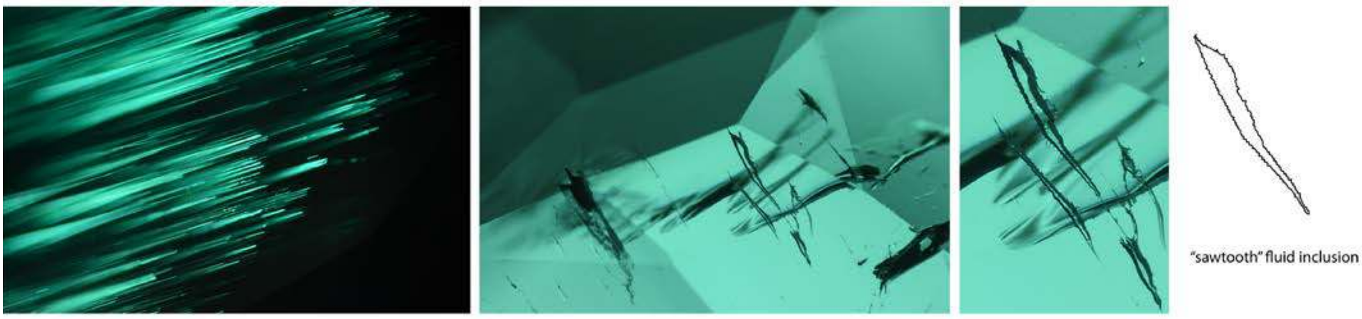
NEW TYPE OF EMERALD FROM AFGHANISTAN

△ **Figure 1:** The Panjshir Valley in Afghanistan and a specimen of excellent quality from this new type of emerald from the Panjshir valley. Panjshir valley photo: Wiki Commons.

Since many decades, the Panjshir Valley in Afghanistan has been well-known as a source of gem-quality emeralds (Bowersox et al. 1998 and references therein). The best quality of these stones has some resemblance to Colombian emeralds and is highly appreciated and sought after in the trade. This is underscored by the fact that a 10 ct Afghan emerald (with SSEF report) was sold at auction in 2015 for US$ 2.275 million (Christie's 2015)—amounting to the highest recorded per-carat price for any emerald from a non-Colombian locality.

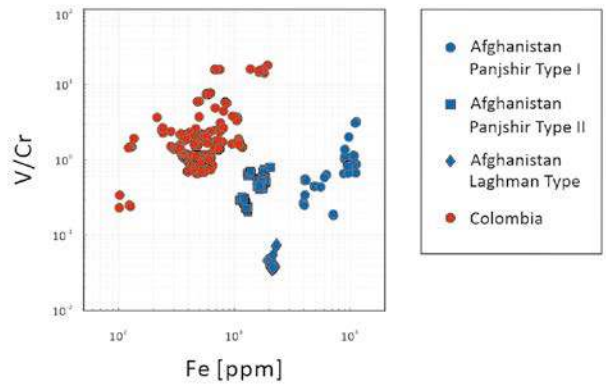
Recently, a new type of emerald from Afghanistan has entered the gemstone trade in addition to the more 'classic' Panjshir emeralds described above. This new material is even closer in resemblance with the finest quality of emeralds from Colombia, not only in visual appearance and quality, but also in terms of gemmological properties. Due to this, some of this new material from Afghanistan has been occasionally mislabelled in the trade as being Colombian.

In a new study published by an SSEF research team in March 2021 in the Journal of Gemmology (Krzemnicki et al. 2021) this new material from Afghanistan is described in detail based on a study of more than 100 gem-quality emeralds from the Panjshir Valley in Afghanistan, ranging in size from 1 carat to more than 20 carats.



△ **Figure 2:** Fine parallel hollow channels and spiky fluid inclusions with 'sawtooth' outline in this new type of emerald from Afghanistan. Photos: M.S. Krzemnicki, SSEF

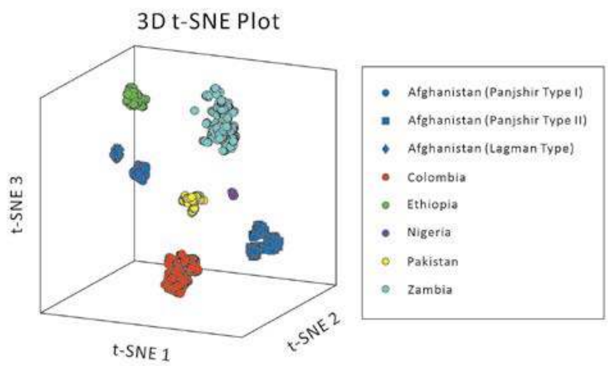
This new type of Afghanistan emerald is characterised by very fine and parallel hollow channels and spiky to tubular fluid inclusions (multiphase), often showing a distinct 'sawtooth' outline (Figure 3), both quite similar to inclusion features observed in Colombian emeralds. Although we occasionally observed some chevron-like growth features, the honeycomb-like pattern ('gota de aceite') that is characteristic of emeralds from Colombian emeralds has not been observed to date in these new emeralds from Afghanistan.



△ **Figure 3:** Chemical plot comparing Colombian emeralds (red dots) with emeralds from Afghanistan (blue icons). The new type of emeralds from Afghanistan (Panjshir type II, blue squares) can be clearly separated from Colombian stones. Diagram: M.S. Krzemnicki & H.A.O. Wang, SSEF

The chemical composition of these Afghan emeralds is astonishingly similar to Colombian emeralds. Only a careful trace element analysis of the stones revealed differences, with the most frequent being a higher iron concentration in the new-type Afghan samples, when compared to emeralds from Colombia (Figure 3). However, the iron concentration in Afghan materials is still much less than that found in emeralds mined in Zambia, Brazil and Russia, to name a few.

To develop reliable means of distinguishing the Afghan emeralds from others in the marketplace, we compared hundreds of emeralds from different origins using an unsupervised machine learning statistical algorithm (t-SNE: t-distributed stochastic neighbour embedding). Through a compilation of 56 elements in the t-SNE calculation, the emeralds from Afghanistan could be further characterised and differentiated from Colombian samples (Figure 4).



△ **Figure 4:** A much better separation of emeralds from different geographic origins is achieved by using an unsupervised machine learning algorithm (t-SNE) to visualize their chemical composition. By this statistical approach, the new type of emeralds from Afghanistan (Panjshir type II, blue squares) is distinctly separated from Colombian emeralds. Diagram: H.A.O. Wang, SSEF

To conclude, this research project perfectly shows how the science of gemstone testing is constantly evolving. We at SSEF are proud to be at the forefront of such efforts in providing gem labs and the trade with new scientific knowledge about these fascinating new emeralds.

A full PDF copy of the article published in the Journal of Gemmology can be downloaded from the SSEF website.

*** Dr. M.S. Krzemnicki**

SSEF INTRODUCES MACHINE LEARNING ALGORITHM FOR DATA VISUALIZATION

In January 2021, the Swiss Gemmological Institute SSEF published a scientific article in the Journal of Analytical Atomic Spectrometry (Figure 1) about multi-element analysis of gemstones and machine-learning-assisted data visualization, with a particular focus on the origin determination of emeralds (openly accessible via https://doi.org/10.1039/D0JA00484G).

Our latest research is related to the unique capability of our Time-Of-Flight mass spectrometer (GemTOF, see www.gemtof.ch) to acquire almost all chemical elements simultaneously, even at very low trace levels. As a result of this, GemTOF enables the operator to first measure the gemstone, and then determine which elements are of interest (e.g. for origin determination). This is in contrast to a conventional LA-ICP-MS analysis where the elements of interest have to be selected prior to analysis, thus requiring the operator to make prior assumptions about the composition of the gemstone to be analysed. As such, less frequently occurring elements may be missed, even though they can be part of an important and characteristic chemical signature for the origin determination of gemstones.

△ **Figure 1.** Inner cover page of the JAAS journal highlighting SSEF's recent research paper about multi-element analysis of emeralds using GemTOF. Image courtesy of JAAS.

Analytical Protocol for GemTOF

Each gemstone contains a unique set of chemical elements ('chemical fingerprint') which is related to its geological environment (type of host rock) and formation conditions. By analysing thousands of reference samples from different gemstone deposits, SSEF has accumulated a huge chemical 'fingerprint' database over many years. Specifically, when applying sophisticated analytical methods such as mass spectrometry (in our case GemTOF) for trace element analysis, it is absolutely crucial to operate such a method following a very strict and rigorous analytical protocol. In the JAAS peer-reviewed article, we thus present a detailed step-by-step analytical procedure for gemstone analysis including a discussion of how to select appropriate analytical parameters and calibration methods. We further present methods to correct artefacts and to track the stability (performance) of the instrument over time, and discuss data integrity.

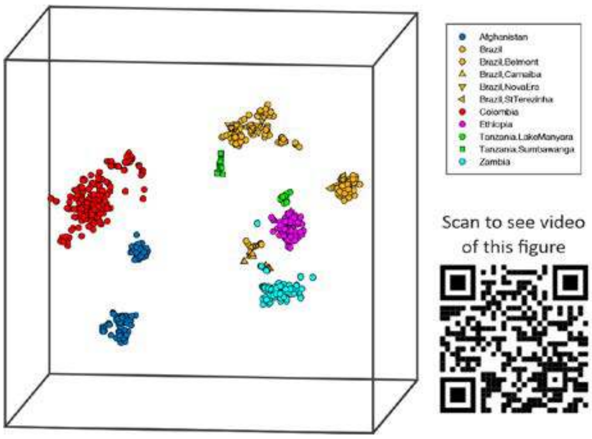
Machine Learning Algorithm for Data Visualisation

A 'chemical fingerprint' database of a specific type of gemstone may contain over 50 different elements (high-dimensional dataset). For us as human-beings, it is impossible to visualise such a high-dimensional dataset directly (because we only live in a 3D world!). To overcome the problem of using numerous bivariate or three-dimensional chemical plots to gain information about the chemical relationship of a gemstone, we apply a machine learning algorithm, called t-SNE, which reduces the complexity of the dataset and clusters gemstones based on their elemental similarity in a 3D model. The t-SNE algorithm is an unsupervised machine learning algorithm. This means that it uses for its calculation no a priori information about the country of origin. The visualisation result is thus solely based on the closeness of the multi-element composition of gemstones.

Case study: Emeralds and their Origins

As a case study we compared results of 168 emeralds originating from different gem deposits. Starting with the multi-element dataset of these emeralds (analysed by GemTOF), we applied the machine learning t-SNE algorithm to successfully reduce the high-dimensional chemical dataset into a three-dimensional data plot. By this, we were able to visualise the t-SNE clustering of the selected emerald into well separated groups and sub-groups (see Figure 2 and for a 3D online clip scan the QR code).

Based on our research, the unsupervised machine learning t-SNE algorithm has proven to be a very versatile method for data visualisation. As such, it provides our gemmologists valuable information assisting them for the origin determination of gemstones.



△ **Figure 2.** Re-visualisation of emerald dataset grouped by elemental similarity using t-SNE shows that the clusters of emerald data points coincide with their origin information. The calculation is based on 56 elements and without a priori origin information. Scan the QR code to see the 3D figure in a video.

Machine Learning vs Artificial Intelligence

Artificial Intelligence (AI) is the buzzword of the moment, similar to nanoscience a few years ago. Even for gemstone testing, it is in the headlines. Despite the buzz around this term in the media and in marketing, it must be stated that AI in its true sense cannot be simply migrated and applied to gemmology given the complexity of coloured gemstone testing. In fact, most successful stories about AI use very simple and well-defined training datasets, such as for example millions of photos showing readily identifiable objects of a man, a car or a watch, to name a few. As soon as a new photo arrives, the trained AI algorithm reacts and categorizes the item in the new photo accurately. Think about it, can it recognize a not-yet labelled airplane in a new photo? Probably not.

The same applies to gemstones. Geology is the science which investigates and describes the complex and dynamic processes of rock formation. Consequently, gemstones which form in many different geological settings (deposits) reflect the complex local geological history, as well as the dynamics of the geochemical environment in which they formed. Even if one would collect as many reference samples as possible from specific gem-deposits, it is unlikely to cover the entire mining areas and mining histories of all of these deposits. So, a simple and readily identifiable dataset for gemstones is not available for AI applications in its true sense.

The future has started: Successful application of Machine Learning at SSEF

In the author's opinion, machine learning methods are much more promising for gemstone testing. In the case of SSEF, the choice of an unsupervised non-linear machine learning algorithm has proven to be fit-for-purpose for gemstone testing at SSEF (see article in JAAS by Wang & Krzemnicki 2021). Unsupervised in this context means that a priori knowledge about the origin of a gemstone is not taken into account for the calculation. By using machine learning, our aim is to extract from the large chemical dataset the common and statistically relevant features of each single gemstone and to finally draw general observations for the gemstones from specific geological and geographical origins. As our study on emeralds from different origins has proven, this approach is very successful and as such is supporting the work of gemmologists in order to obtain a consistent and reliable origin determination of gemstones.

Interested readers will find a detailed description of machine learning methodology for gemstone testing in the above mentioned scientific article in JAAS by Wang & Krzemnicki 2021. A more practical application is described in the paper about new emeralds from Afghanistan, published in 2021 by Krzemnicki et al. in the Journal of Gemmology (see also page 10-11 of this Facette).

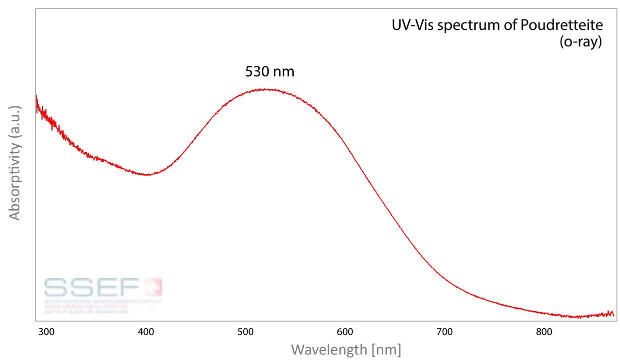
*** Dr. H.A.O. Wang**

A GEMMOLOGIST'S DELIGHT: POUDRETTEITE, MUSGRAVITE, TAAFFEITE, AND GRANDIDIERITE

In recent months, the SSEF received again a number of very rare collector stones for testing. These included poudretteite, musgravite, taaffeite, and grandidierite of exceptional quality.

Poudretteite, ideally $KNa_2B_3Si_{12}O_{30}$, is a very rare cyclosilicate. It was first discovered in the mid-1960s in the famous mineral locality Mount St. Hilaire, Quebec, Canada. These tiny crystals were recognized as a new mineral only about 20 years later (Grice et al. 1987). It was named after the Poudrette family, who operated the quarry which to this day is famous as an occurrence of various unique and rare minerals. Since 2000, this rare borosilicate is also known from Mogok (Myanmar). To date only very few gem-quality stones of slightly pink to saturated purplish pink colour have been found in Mogok, usually of rather small size (Smith et al. 2003).

△ **Figure 1: Poudretteite of 1.53 ct set with diamonds in a ring. Photo: SSEF.**



△ **Fig. 2: UV-Vis absorption spectrum of poudretteite of purplish pink colour. Spectrum: SSEF.**

The poudretteite submitted for testing was set in a ring together with colourless diamonds (Fig. 1). The stone of 1.53 ct (declared weight) was characterized by a beautifully saturated purplish pink colour and an excellent purity. Its well-proportioned cutting style resulted in vivid pink to purple hues due to multiple internal reflections, a consequence also of the distinct pleochroism of poudretteite.

Our analyses of this gem were highly consistent with chemical and spectroscopic data published for poudretteite from Mogok (Smith et al. 2003). The attractive puplish pink colour is related to a broad absorption band at about 530 nm (in the o-ray spectrum, Figure 2). This absorption band might be linked to traces of manganese, which was found as a trace element (about 150 ppm Mn) in our sample. It is well known that manganese can lead to pink to purple colours in silicates such as tourmaline, beryl (morganite, red beryl), grossular garnet, and spodumene (kunzite), as well as rhodonite and is even presumed to cause the subtle purple colours of lavender jadeite (Ren Lu, 2012). In light of this, more research about poudretteite would be desirable in order to better understand not only the cause of its colour, but also how it forms and why it is so rare.

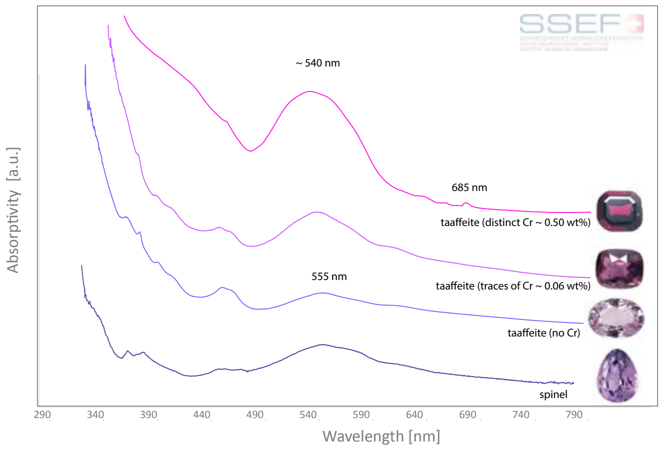
△ **Figure 3: Six taaffeites (1.9 ct to 8.1 ct) and a musgravite (8.2 ct) ranging in colour from light (greyish) purple to purplish red, and purplish grey to greenish grey. Photo: SSEF.**

Two other rare encounters in the gem trade are taaffeite and musgravite, which can only be separated by sophisticated analysis. Taaffeite, ideally $BeMg_3Al_8O_{16}$, is a very rare collector mineral named after Mr Richard Taaffe, who by chance discovered the first specimen in 1945 in a jewellery shop in Dublin (Ireland). Due to its visual appearance, the specimen was offered to him as a spinel and only after his lucky discovery was it described as a new mineral species. To date, it is the only mineral which was first discovered as a faceted gemstone! In contrast to this, musgravite, ideally $BeMg_2Al_6O_{12}$, is named after the type locality Musgrave Range in central Australia where it was first discovered in 1967.

Although renamed to magnesiotaaffeite-2N'2S (formerly taaffeite) magnesiotaaffeite-6N'3S (formerly musgravite) due to structural considerations, the original names taaffeite and musgravite are still commonly used in the gem trade and evoke appreciation by collectors worldwide.

Both gem-quality taaffeite and musgravite are found in a range of colours from colourless to purple and purplish grey to greenish grey, with purple being the most appreciated colour.

They are rare in gem-quality and have been found mostly in small sizes in Sri Lanka, Tanzania, Madagascar, and Mogok (Myanmar). In the past few months, the SSEF had the chance to analyse few taaffeites and a musgravite of exceptional quality (Figure 3).



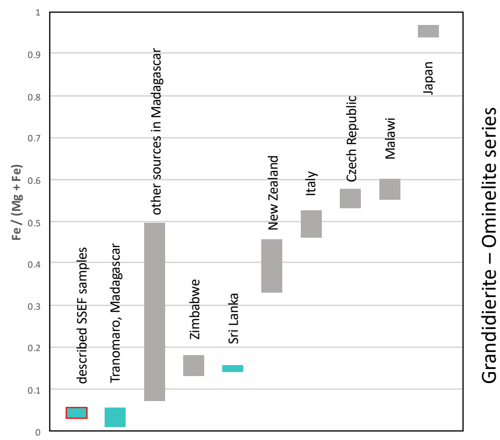
△ **Figure 4: Comparison of absorption spectra of taaffeite and spinel. Spectra: SSEF.**

Interestingly, the colour of most of our analysed specimens is related to iron (Fe), resulting in absorption spectra similar to Fe-bearing Mg-Al spinels of purple to greyish purple colour with a Fe-related absorption maximum at about 555 nm. With the presence of chromium, the colour shifts to a more pronounced purplish red due to an additional chromium-related absorption band at about 540 nm (and occasionally small characteristic Cr-absorption lines at 685 nm) (see Figure 4). Similar spectral comparisons were already documented by Schmetzer et al. 2000, and by this author in 2017 in SSEF Facette 23, page 9.

△ **Figure 5: Two grandidierite specimens of 3.5 and 7.5 ct submitted to SSEF for testing. Photo: L. Phan, SSEF.**

And finally, we received in the past few months two faceted grandidierite specimens of 3.5 and 7.5 ct for testing. Grandidierite $(Mg,Fe^{2+})Al_3BSiO_9$ is a rare aluminium boro-silicate and forms a solid solution series with its iron-dominant analogue ominelite by substituting Mg^{2+} with Fe^{2+} (Dzikowski et al. 2007). Gem-quality grandidierite is so far only known from Sri Lanka (Schmetzer et al. 2003) and Madagascar (Vertriest et al. 2015, Bruyère et al. 2016) close to the town of Tranomaro (see also SSEF Facette No. 24, 2018). Its attractive greenish blue colour is related to the presence of low amounts of iron.

The two attractive specimens were meticulously investigated using advanced analytical methods (including GemTOF, see www.gemtof.org), as such samples offer the rare opportunity to gain more data about this rare mineral and gemstone. Plotting our chemical data with published Mg-Fe ratios (Bruyère et al. 2016 and references therein) reveals that these two specimens originated from Madagascar.



△ **Figure 6: Mg-Fe ratio plot of the grandidierite-ominelite series from selected occurrences (data from Bruyère et al. 2016 and references therein). Only Sri Lanka and Madagascar have provided gem-quality grandidierite to date.**

In summary, to be able to study gemmological rarities of such fine quality is a dream come true for any gemmologist and especially for our gem experts at SSEF. As such, these specimens offer plenty of new scientific insights into the colourful world of minerals and gems.

*** Dr. M.S. Krzemnicki**

DNA FINGERPRINTING AND AGE DATING OF PEARLS AND CORALS AT SSEF

△ **Figure 1:** A selection of pearls from different species. DNA fingerprinting can help us in identifying which species a pearl came from. Photo: Michael Krzemnicki, SSEF.

Pearl testing was long limited to determining whether a pearl is natural or cultured, and whether a pearl has been treated or not. As we have considerably invested in pearl research in recent years, we have achieved significant breakthroughs, namely DNA fingerprinting for species identification and radiocarbon age dating. In 2020, after seven years of research, we officially launched our DNA fingerprinting services for pearls and precious corals. In 2017, SSEF became the first gem lab in the world to introduce radiocarbon age dating of pearls as a service to clients.

Species identification creates important opportunities to better understand historic pearl trading routes and the origins of notable pearls. In combination with age dating technology, it is also possible to gain previously inaccessible scientific insights into how pearls form. Our work on DNA is carried out in collaboration with the Institute of Forensic Medicine at the University of Zurich, one of Switzerland's leading forensic institutes. Our radiocarbon age dating work is done with ETH Zürich.

DNA in pearls: 8 species can now be identified

DNA fingerprinting of pearls was first developed by SSEF and published in an academic journal in 2013 (DNA Fingerprinting of Pearls to Determine Their Origins, Meyer et al). The quasi non-destructive method has since been refined further, and the amount of material required from the pearl for testing has been considerably reduced to an infinitesimal amount.

The advances on DNA fingerprinting in this past year have been made possible by a substantial expansion of our DNA reference database and capabilities, which now include eight oyster species that produce the vast majority of pearls found in the natural and cultured pearl trade.

The eight pearl species that can be distinguished conclusively using these DNA fingerprinting methods are:

- *Pinctada radiata* (Persian Gulf & Ceylon pearl oyster)
- *Pinctada imbricata* (Atlantic pearl oyster)
- *Pinctada fucata/martensii* (Akoya pearl oyster)
- *Pinctada maxima* (South Sea pearl oyster)
- *Pinctada margaritifera* (Tahitian black-lipped pearl oyster)
- *Pinctada mazatlanica* (Panama pearl oyster)
- *Pinctada maculata* (Pipi pearl oyster)
- *Pteria sterna* (Rainbow-lipped pearl oyster)

Update on DNA in precious corals

Our methodology used for DNA fingerprinting of precious corals was outlined in great detail in a peer-reviewed openly-accessible publication in Scientific Reports last year (Lendvay et al., 2020). This method uses minute amounts of DNA recovered from precious coral used in jewellery to identify their species. This is vital given that a number of precious coral species are listed on the Convention on International Trade in Endangered Species (CITES) Appendix III, and thus need to be correctly identified and declared in order to be legally traded.

The DNA fingerprinting technology developed represents a game-changing way of assessing the species identity of precious corals found in the trade. Importantly, the technique is quasi non-destructive, requires considerably less sample material than other methods, with testable DNA being recovered from as little as 2.3 milligrams (0.0115 carats) of material.

In summary, if DNA extraction is successful and DNA fingerprinting can be carried out, SSEF can identify a coral item as one of the following:

• *Corallium rubrum* (Mediterranean red coral)
• *Corallium japonicum* complex (includes aka, moro, oxblood varieties)
• *Hemicorallium sp.*(includes deep sea Midway coral, garnet coral and Miss coral)
• *Pleurocorallium secundum* (Midway and Rosato coral)
• *Pleurocorallium elatius* complex (includes angel skin, boké, magai and momo varieties)
• *Pleurocorallium sp.* (*Pleurocorallium* which does not belong to *Pleurocorallium secundum* or the *Pleurocorallium elatius* complex)

DNA analysis is complemented by morphological and gemmological analyses for species identification. More detailed information on these different complexes can be found here: https://www.ssef.ch/dna-fingerprinting/

DNA fingerprinting on three natural pearls

We recently received three saltwater natural pearls for testing (Figure 2) The pearls exhibited an attractive range of colours from light grey to dark grey and brownish grey, mostly with distinct purple, rosé and green overtones, also known as the 'orient of pearls'.

△ **Figure 2:** **DNA testing on these three pearls (9-15 ct) showed they were from *Pteria sterna*. Photo: Luc Phan, SSEF.**

Spectroscopic testing indicated that a Pteria sterna species origin was very likely for these pearls. To confirm this result we carried out additional DNA fingerprinting analysis. The results were conclusive and showed 100% concordance with a single sequence of that species present in our reference database. Historically, many important natural pearls in antique and historic jewellery originate from Mesoamerica (Figure 3) and were brought to the royal courts in Europe after the conquest of the Americas by the Spanish, as they were already before treasured by the indigenous cultures (Cariño & Monteforte, 1995). This was further supported by radiocarbon dating, which revealed a historic age for these three pearls.

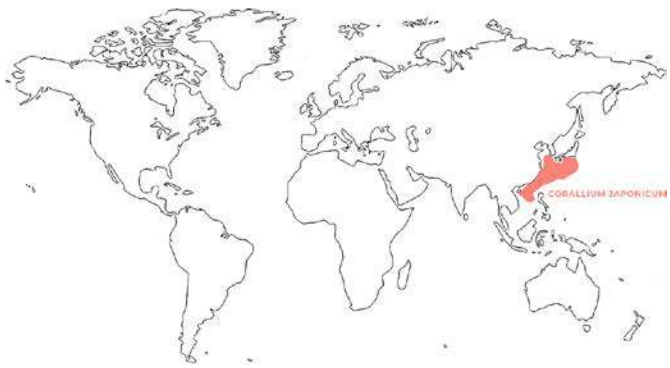
△ **Figure 3:** **Map indicating where *Pteria sterna* is commonly found based on literature. Map: SSEF.**

△ **Figure 4:** A strand of red precious coral tested at SSEF, and for which DNA fingerprinting analysis was subsequently performed on three randomly selected beads. Photo: L. Phan, SSEF.

Examples of tested precious coral items

The precious coral strand in Figure 4 contained 55 carefully selected coral beads of exceptional size (diameter from 9.15 mm up to 20.00 mm). Given that it is not possible, using conventional gemmological techniques, to conclusively identify the species from which a coral sample comes from, we carried out DNA fingerprinting. Approximately 0.05 ct (10 mg) of substance was carefully extracted from within the drill holes of three selected precious coral beads. The resulting DNA analysis concluded that the three sampled beads from this coral necklace belonged to the *corallium japonicum* complex. This complex includes the following three taxa: *Corallium japonicum*, *Corallium nix* (white skeletal axis), *Corallium tortuosum* (pink skeletal axis) (sensu Tu et al. 2015). In this specific case, morphological and other analyses concluded that the three beads could be attributed to *corallium japonicum* (Japanese red coral), which is the most widely used of these species in the jewellery trade, and includes aka, moro, oxblood varieties. Given that this species is listed by CITES, having access to such information is important for the trade. Given that the strand was homogeneous, it is highly probable that all the beads in the necklace are from this species. This is noteworthy as *corallium japonicum* is highly sought-after in the trade and by collectors.

Another interesting item we examined was a coral sautoir (Figure 6) designed by Suzanne Belperron, one of the most influential jewellery designers of the 20th century. The item consisted of a sautoir with 123 coral beads and a carved coral, and a pendant with 7 partly carved corals (up to 23.00 mm diameter). The corals were accentuated by black intersections of polished onyx and slightly frosted colourless quartz.



△ **Figure 5:** Map indicating where *Corallium japonicum* is commonly found based on literature. Map: SSEF.

On this item both a carved bead and bead were sampled, in both cases less than 10mg of material was taken for DNA analysis. In both cases, the sequenced samples were attributed to the *Pleurocorallium elatius* complex. Three taxa belong to this complex: *Pleurocorallium elatius*, *Pleurocorallium konojoi* and *Pleurocorallium carusrubrum* (red skeletal axis) (sensu Tu et al. 2015). Identification of a specific species within this complex by SSEF is thus based on a combination of DNA, morphological and other analyses. The sampled beads were identified as being from *Pleurocorallium elatius*. This species is by far the most widely used of these three species in the jewellery trade, and includes the desirable angel skin, boké, magai and momo varieties.

△ **Figure 6:** A coral sautoir designed by Suzanne Belperron. DNA fingerprinting of two samples showed they could be attributed to the *Pleucorallium elatius*, a precious coral species found in Asian waters. Photo: A. Chalain, SSEF.

A combined age dating and DNA fingerprinting approach

A number of natural pearl and precious coral samples were tested at SSEF this past year, and were further examined using both DNA fingerprinting and age dating, as can be seen above. The ability to date and trace pearls and precious corals back to their species-related and geographic origins can provide greater transparency, as well as supply important and fascinating information about modern and historic items. We look forward to further combining and expanding these techniques in future.

*** Dr. L.E. Cartier**

NEW PEARL OYSTER SPECIES: PINCTADA PERSICA

We recently tested a pearl jewellery set that consisted of 63 natural pearls, with 61 of them being strung on a thread and two additional loose natural pearls. Part of these pearls were of very remarkable size, reaching a maximum weight of 32 ct. The pearls exhibited an attractive colour, subtly ranging from slightly cream to cream.

We assume that these pearls are rather historic in age, which was confirmed by radiocarbon dating on three randomly selected pearls. The analysed trace elements revealed that a large majority of these pearls were saltwater natural pearls, except for three pearls which were freshwater natural pearls. This is not rare in historic natural pearl jewellery, as pearls were often collected and mixed together unknowingly.

The same pearls were further analysed using DNA fingerprinting and led to interesting findings. One of the pearls was conclusively identified as being from the *Pinctada radiata* species (Persian Gulf & Ceylon pearl oyster), a species that can produce pearls commonly called 'Basra pearls' in the trade.

Interestingly, the other two sampled pearls were attributed to another species: *Pinctada persica* or *Pinctada margaritifera persica*, which is a rare member of the *Pinctada margaritifera* species complex. To our knowledge, this is the first time that pearls from *Pinctada persica* have been reported. To date this species has only been found exclusively in the Persian Gulf (Ranjbar et al. 2016).

This case study shows the potential that DNA fingerprinting has to uncover previously unreported species of both pearls (and precious corals) used in jewellery and also to document species and geographic origins for pearls. In continuing this research, we are convinced that we will discover many new secrets about pearls in future.

*** Dr. L.E. Cartier & Dr. M.S. Krzemnicki & Dr. B. Lendvay**

NEW COPPER-BEARING TOURMALINES FROM NIGERIA

△ **Figure 1: New type of copper-bearing tourmaline from Nigeria (left) compared with a copper-free 'lagoon' tourmaline from Namibia (right). Both stones are about 60 ct and of exceptional quality. Photo: A. Chalain, SSEF**

Copper-bearing tourmaline from Nigeria is known in the trade since about two decades (Milisenda 2001, Henricus, 2001; Smith et al., 2001; Zang et al., 2001). The first reported material from Nigeria was rather of aquamarine- to amethyst-like colours, but shortly after it was followed by a limited and sporadic production of more saturated to 'electric' blue and vivid green material (Furuya, 2004). In gemmological literature these copper-bearing tourmalines are also described as type I and type II Nigerian material (Abduriyim et al. 2006).

Recently, we received a very interesting copper-bearing tourmaline of exceptional size (60 ct) and purity which was characterised by a beautiful slightly greenish blue colour, very similar to the colour of copper-free tourmalines from Namibia and other sources, known in the trade also as 'lagoon' tourmalines (Figure 1).

Based on chemical analyses (GemTOF) and statistical data analyses, the Nigerian origin of this new copper-bearing tourmaline could be well established. Interestingly, however, this new material contained not only copper and manganese, but also quite a distinct amount of iron. This results in a weak Fe^{2+} absorption band at about 700nm superposed on the copper bands in the absorption spectrum. This contribution influences the colour of the stone and explains its colour similarity with copper-free 'lagoon' tourmalines which owe their colour mainly to the Fe^{2+} absorption band (Merkel & Breeding, 2009).

For the time being, and based on the relatively distinct concentration of copper in the described tourmaline from Nigeria, we consider that this specific stone may be called Paraiba tourmaline in the trade. A more detailed study of this new and attractive material from Nigeria is currently under way. Our findings and nomenclature considerations will be published soon in a short article in an upcoming issue of the Journal of Gemmology.

*** Dr. M.S. Krzemnicki**

CANARY TOURMALINE FROM ZAMBIA

△ The two Canary tourmalines (5.2 ct and 19 ct) which were recently analysed at SSEF. Composite photo: Wikimedia commons & SSEF.

Tourmaline is a mineral group of complex boro-silicates and is well known to produce gemstones in a wide range of beautiful colours. A specifically attractive variety is vivid yellow elbaite tourmaline, which owes its colour to manganese. Known in literature also as tsilaisite, this elbaite tourmaline variety goes in the trade with the name 'Canary tourmaline', a very fitting comparison to the yellow feathers of the canary bird.

In the past few months, we had the pleasure of examining two Canary tourmalines, both of exceptional purity. With a size of 19 ct, the larger of these two stones was particularly striking as its well-proportioned cutting style resulted in vivid reflections due to multiple internal reflections. In the trade, such a colour is also known as 'electric' or 'neon' yellow.

These tourmalines were first discovered in early 1982 in pegmatites in the Lundazi district of eastern Zambia. Since then, this area has produced only a rather limited number of gem-quality tourmalines (Schmetzer & Banks 1984, Shigley et al. 1986, Rossman & Mattson 1986). Most of these vivid yellow tourmalines are heat treated, which shifts their colour from brownish yellow to a more vivid slightly greenish yellow colour hue (Bank 1982, Shigley et al. 1986). As with other gem tourmalines, the detection of such heat treatment is often not straightforward, and more research needs to be done in future to establish more robust criteria to distinguish unheated stones from heated ones.

Considering, however, that heat treatment of these tourmalines is an established trade practice since many decades and the stability of the resulting colour, these Canary tourmalines are truly an attractive addition to the colourful realm of gem-quality tourmalines.

*** Dr. M.S. Krzemnicki, SSEF**

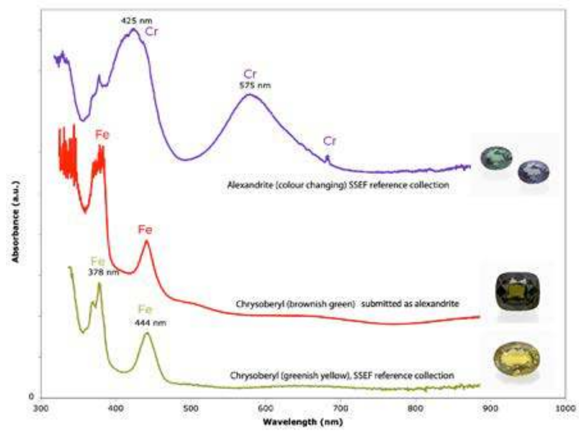
TO BE, OR NOT TO BE, THAT IS THE QUESTION: CHRYSOBERYL VERSUS ALEXANDRITE

△ **Figure 1: An impressive chrysoberyl submitted to SSEF as 'alexandrite' (left) compared to a real alexandrite (right) showing a distinct colour change due to the presence of chromium. Photo: A. Chalain, SSEF**

The mineral chrysoberyl $BeAl_2O_4$ is a highly appreciated gemstone due to its rarity, brilliance, and beauty and comes in attractive colours commonly ranging from colourless (chemically pure) to yellow, yellowish green, green, and brownish green to dark brown, mostly related to the presence of iron in its crystal structure. In case of the presence of chromium, this mineral will show a colour-change commonly from green or bluish green in daylight to purple to reddish hues in incandescent light (e.g. tungsten lamp). In that case, the gem is called alexandrite, a sought-after variety of chrysoberyl. This chromium-related definition of alexandrite is internationally recognised and dates back to the early scientific description of this attractive gemstone first discovered in the Ural mountains in Russia in the mid-19th century.

At SSEF, we receive from time to time chrysoberyl specimens for testing which do not contain any chromium (or only very low traces), but which are mislabelled as alexandrite. Such was the case with a very large and impressive brownish green chrysoberyl we received recently at SSEF (Figure 1). This stone contained only about 0.002 wt% chromium, but about 600 times more iron (about 1.2 wt% Fe_2O_3), so in no way could qualify as alexandrite.

To set the record straight: to be called alexandrite, a chrysoberyl has to fulfil three basic criteria: 1) It has to show a moderate to distinct colour change observed under standard lighting situations (daylight and incandescent light). 2) It has to contain a distinct amount of chromium and 3) as a consequence has to show a distinct absorption band at about 575 nm (related to Cr^{3+}) (see Figure 2). Although greenish brown to yellowish brown chrysoberyl may show a slight colour shift towards a slightly more brownish hue in incandescent light, such stones do not qualify as alexandrite, as their colour is mainly or completely related to iron.



△ **Figure 2: Absorption spectra showing the difference between iron-related chrysoberyl and alexandrite showing a distinct colour change resulting from a chromium absorption band at about 575 nm. Figure: M.S. Krzemnicki, SSEF**

We at SSEF consider it very important that gemstone variety names are carefully and correctly applied based on internationally accepted nomenclature. We are confident that this is in the best interest of the gem trade and finally the consumer who wants to trustfully buy a valuable gemstone.

For interested readers: More about the application of variety names at SSEF is found in the last Facette, issue 26 (2020) and in a SSEF presentation (2019) about gemstone varieties (see https://www.ssef.ch/presentations/).

*** Dr. M.S. Krzemnicki**

VISIT TO THE MONG HSU RUBY DEPOSIT IN MYANMAR (BURMA)

△ **Figure 1:** Panoramic view of the Loi Saung Htauk mining area, Mong Hsu. Photo: M.M. Phyo, SSEF

Mong Hsu is one of the reputed ruby deposits in Myanmar (Burma). It is located about 250km southeast of Mogok, in the Shan State, in northeastern Myanmar. It is 923km in distance from the capital Yangon and is an 8-hour drive from Taunggyi, the capital of the Shan state located in central Myanmar. In March 2020, we visited to Mong Hsu Ruby mining area with the aim of studying the geological setting of the ruby deposit and to get first-hand information about the current mining activity (Figure 1). During our visit, we were able to collect numerous ruby samples in rock matrix and as rough crystals.

The Mong Hsu ruby deposit was first discovered in 1992. This new and important source of rubies was then studied and described in several research papers by Hlaing (1991, 1993, 1994), Jobbins (1992), Clark (1993), Kammerling et al. (1994), Smith and Surdez (1994), Peretti et al. (1995), to name a few of the early publications. Mong Hsu ruby is commonly characterised by a violet to dark colour in the core and a saturated red colour in the rim of ruby crystals. In order to improve the colour, most of thr rubies from Mong Hsu are traditionally heat-treated. In recent years, however, Mong Hsu rubies of gem-quality are often spared from heating even when showing some minor dark colour zones, driven by the demand of the market for unheated Burmese rubies (Figure 2).

Although the area is primarily known for ruby, some local researchers noticed that further precious materials such as sapphire, spinel, and diamond, gold can be found east of Than Lwin river, beyond the Mong Hsu gem mining area.

When we visited the Mong Hsu deposit in early 2020, mining was temporarily halted as mining policy and permits were being reviewed by the government. But we were still able to visit several mines and to collect research specimens during our fieldtrip. It was challenging to access all mining areas around Mong Hsu because of ongoing rebel activity in the area. As a consequence, we focussed our visit and study mostly to the Loi Saung Htauk gem mining area in Mong Hsu.

This successful fieldtrip was a first step to studying the geology of the Mong Hsu ruby deposit and to collect ruby samples for further research. We hope to learn more and do further studies, both gemmological and geological, in Mong Hsu in future. We greatly appreciate and thank the Myanmar Gem Enterprise for their hospitality and assistance during our visit. Special thanks also goes to the local miners for their generous welcome to us and for donating research samples.

*** Dr. M.M. Phyo**

△ **Figure 2:** Detail of ruby necklace of exceptional quality containing 92 unheated rubies from Mong Hsu. Photo: L. Phan, SSEF

△ **Figure 5:** Price negotiation in the market. Photo: M.M. Phyo, SSEF.

△ **Figure 3:** Mong Hsu Road Bridge (Entrance to Mong Hsu City). Photo: M.M. Phyo, SSEF.

△ **Figure 6:** Mong Hsu rough ruby in matrix. Photo: M.M. Phyo, SSEF.

△ **Figure 4:** Mong Hsu ruby crystals in rock matrix (fine-grained marble). Photo: M.M. Phyo, SSEF.

△ **Figure 7:** Research expedition group photo, Dr. Ja Mu, miner , Mr. Aung Kyaw Htun, Mr. Kyaw Min Lwin, Dr. Myint Myat Phyo (SSEF) and Ms. Thiri in front of the Union of Myanmar Economic Holding L.td Mine (from left to right). Photo: unknown.

HEATED RUBY FROM MONG HSU (MYANMAR) WITH BLUE ZONE

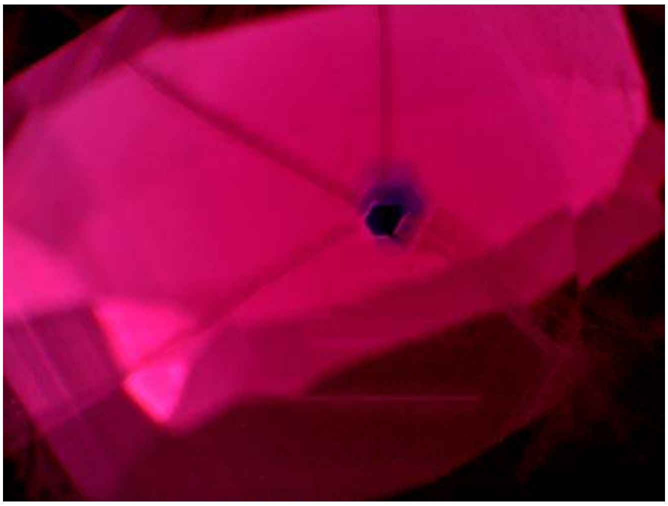
△ **Figure 1:** At the marble-related ruby mines in Mong Hsu. Photo: M. M. Phyo, SSEF.

Rubies from Mong Hsu, located about 250 km southeast of the Mogok Stone Tract, entered the gem trade in the early 1990s. Since this time the Mong Hsu mines remain an important source for Burmese rubies, specifically for stones of smaller sizes (2 ct and below).

Rubies from Mong Hsu generally show a saturated red colour, but often contain dark blue (to dark grey) zones (Figure 2), which may to some extent negatively influence the red colour of these rubies. In addition, these ruby crystals are often quite fractured. As a consequence, a large majority of these rubies are heat treated in oxidizing conditions to get rid of the blue zones. The heating is often assisted with a borax flux to artificially 'heal' pre-existing fractures.

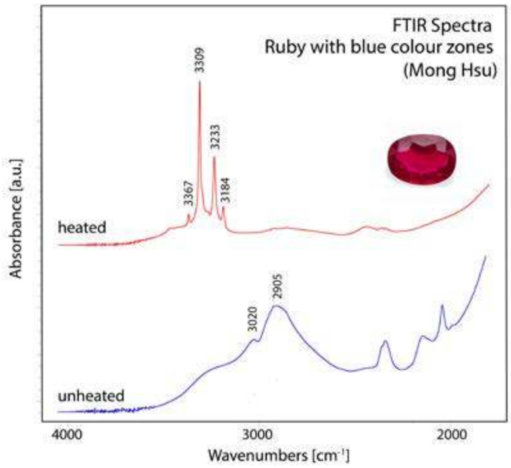
In the past few years, however, we can see a shift of preference in the high-end trade and by consumers towards untreated gems. Therefore, suppliers of Mong Hsu rubies do not necessarily heat most of their material anymore, but rather try to keep them as unheated stones. By carefully choosing an appropriate cutting style and orientation they succeed in many cases to minimize the negative effect of the blue colour zones and fissures.

For quite a long time, blue zones in Mong Hsu rubies were considered in the trade as a good indicator that the stone was unheated. Unfortunately, it was later revealed that this simple criterion is not valid in all cases.



△ **Figure 2:** Dark blue zones, a common feature in rubies from Mong Hsu. Photo: M.S. Krzemnicki, SSEF.

△ **Figure 3:** Two small but distinct blue colour zones in the pavilion of the described heated ruby from Mong Hsu. Photo: M.S. Krzemnicki, SSEF



△ **Figure 4:** FTIR spectrum (in red) of heated Mong Hsu ruby (0.63 ct) with blue colour zoning compared to an unheated Mong Hsu ruby (in blue). Figure: M.S. Krzemnicki, SSEF

Recently, we had the chance to test a series of Mong Hsu rubies ranging in size from 0.54 ct to 2.01 ct. Testing at SSEF means that each of these rubies is fully characterised, based on microscopic observations, chemical and structural analyses. Interestingly, one of these rubies showed small but distinct blue colour zoning (Figure 3). However, it also revealed an infrared spectrum (FTIR) with distinct OH^- related absorption peaks that are characteristic for heat treated rubies from Mong Hsu (red coloured spectrum in Figure 4).

In contrast to this, all other Mong Hsu rubies from this series of stones were unheated. They not only showed blue colour zones but also FTIR spectra with broad absorption bands (blue coloured spectrum in Figure 4) related to finely dispersed inclusions of the Al-hydroxides diaspore and boehmite (Smith 1993), typical for unheated rubies from Mong Hsu.

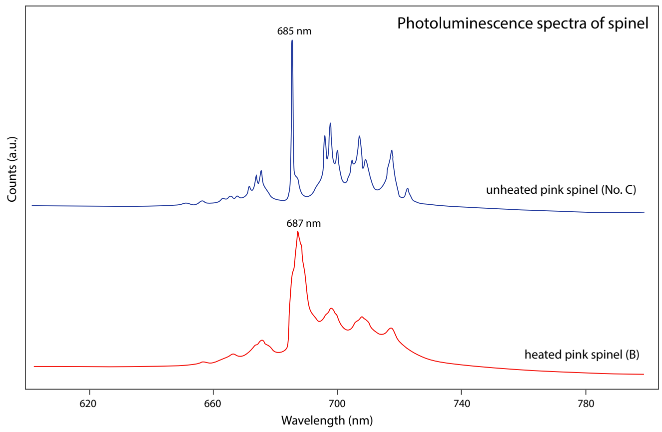
To summarize, the described heated ruby can be considered a valuable specimen to remind gemmologists that a blue colour zone in a Mong Hsu ruby, although often encountered in unheated stones, can also occur in a heated stone. Only by combining microscopic observations and spectroscopic results is it possible to fully characterise a gemstone and to come to reliable and correct conclusions.

*** Dr. M.S. Krzemnicki**

HEATED SPINEL FROM TAJIKISTAN

△ **Figure 1:** Antique necklace containing three spinels from Kuh-i-Lal in Tajikistan. To our surprise, the spinel in the centre turned out to be heated. Photo: L. Phan, SSEF

In a gem lab, always expect the unexpected. At least this can be said about this antique spinel necklace that we received a few months ago for testing at SSEF. The necklace contained three reddish pink spinels (A-C), each with an estimated weight of about 8 ct, and set together with a fine selection of colourless diamonds in an antique floral design. The spinels were nearly free of any inclusions except for a few tiny colourless forsterite inclusions. In combination with trace element analyses, the origin of these spinels could be unambiguously attributed to the famous spinel mines near Kuh-i-Lal, located in the Pamir mountains in southern Tajikistan, close to the Afghan border. This deposit is known since historic times as a source of excellent reddish to pink spinel specimens. Already described by Al-Biruni (973-1047 AD) in his book on gems, spinel from Kuh-i-Lal was appreciated as an imperial gem throughout history. In ancient times named "Balas rubies" (from the Arabic balakhsh for Badakhshan or Balashan) their identity as spinel was only unveiled with the advent of modern mineralogy at the beginning of the 19th century. In fact, the famous historic Timur 'ruby' and Black Prince 'ruby' are both very impressive polished spinels from this ancient deposit, and are today part of the royal collection of the Queen of England.



△ **Figure 2:** Photoluminescence spectra showing an unheated spinel (C, above) and the heated spinel (B, below) both part of the described antique necklace. Figure: M.S. Krzemnicki, SSEF

The unexpected surprise with this historic item was revealed when analysing the photoluminescence of these three spinels. The centre stone (spinel B) clearly showed a peak shift of the main chromium-emission band to 687 nm together with a peak broadening of all emission lines when compared to the much more structured and narrow emission lines of the other two spinels. In scientific literature, this peak shift and broadening effect is well documented as a characteristic feature for both synthetic spinel (see e.g. Krzemnicki 2008) and heat-treated spinel (Saeseaw et al. 2009, Widmer et al. 2015). Based on our analyses, a synthetic formation of the centre spinel (B) could be definitively excluded. Instead, and to our big surprise, this spinel had at some stage been heated.

Several studies about the effect of heat treatment on spinel have shown that in most cases there is no or only very limited success to enhance the colour or transparency with this treatment. As a positive consequence of this obvious lack of reaction to heating, we can still say today that a large majority of spinel in the market are unheated. They need only to be cut and polished to create exceptional gems for jewellery.

The reason why the central spinel (B) in this necklace was heated and at what moment this occurred remains a mystery to us. We guess that the heat treatment was done in the 18th or 19th century, prior to the setting into the necklace. We further assume that the heating was done rather by accident. Perhaps the spinel was unknowingly mixed with corundum, for which already at that time there was a tradition of heating in order to enhance the colour of corundum. Although the detection of this heat-treated spinel may be seen as a disappointment for the client, it has definitely added to the mystery and interest for us as gemmologists.

*** Dr. M.S. Krzemnicki**

AGE DATING OF COBALT SPINEL

Radiometric U-Pb dating is a promising tool in gemstone testing and is used at SSEF as an advanced analytical procedure since several years. However, this method is usually only applicable when the gemstone presents sufficient traces of radiogenic elements either in its crystal structure or within a solid inclusion in the gemstone.

Examples for which such age dating was carried out at SSEF were already presented in the past few issues of the SSEF Facette (see for example: Age dating of sapphires and inclusions, see Facette 24, in 2018; Age dating of titanite inclusion in Mogok ruby, Facette 25 in 2019; Age dating of gems, Facette 26 in 2020). In most cases, U-Pb dating was presented for rubies and sapphires.

Last year, we received a cobalt spinel of an attractive blue colour for testing. Based on our gemmological testing, a Vietnamese origin was most likely, although gem-quality cobalt-blue spinels of similar colour are known from other deposits in Sri Lanka, East Africa, and Madagascar. Luckily enough, this spinel contained a small zircon inclusion at the surface near the girdle, on which we were able to carry out radiometric U-Pb dating.

Due to the small size of our GemTOF laser spot, we were able to do several analyses on the same zircon inclusion, revealing two different ages. The core of the zircon provided a calculated age of about 160-190 million years, whereas the outermost rim gave an age of about 46 million years. Such an age difference between core and rim regions is a common feature in zircon and is well documented in scientific literature. Zircon, being a small but very resistant accessory mineral grain in many rocks is often accumulated in sediments after the erosion of their primary rock. As such these old so-called detrital zircons, get re-involved in later geological events, such as the regional metamorphism event in the Paleogene and early Neogene during the collision of the Indian plate with the Eurasian continent which resulted in the formation of the Himalayan mountain range.

The cobalt spinels from Luc Yen in Northern Vietnam formed in marbles during this geologically rather young event. Occasionally, as in our case, they included a much older zircon grain hosted in the carbonate sediment. As a consequence of this rather young regional metamorphosis the zircon itself had grown a thin outer rim of a young age (46 million years) around its older core (120-160 million years), which we assume represents a previous geological event in the Jurassic period in Central Asia.

Based on our analyses, we can conclude that the investigated cobalt spinel formed at about 46 million years or some time later. A formation prior to the age of the rim of the zircon is impossible, as it would not be possible for the zircon to form a rim of such a young age if already included long before within the spinel. Consequently, this dating excludes all deposits related to the geologically much older Pan-African orogeny (about 600 million years ago), which formed cobalt spinels and many other gemstones in East Africa, Madagascar, and Sri Lanka. Our date fits well with Ar-Ar dates on phlogopite that formed syngenetically (at the same time) with marble-type ruby from Luc Yen (Garnier et al. 2006).

As it is our standard since 2020, radiometric dating is carried out on any gemstone whenever possible (it mostly depends on the presence of zircon inclusions at or very near to the surface). This service comes at no additional cost for our clients. In case such analyses are successful, we do indicate age dating in the comments section of our SSEF report and add a special letter, providing the interested reader the broader context of our dating results on the specific gemstone.

Based on the reactions from our clients, auction houses and the public, we see that this free additional service is considered highly fascinating, as it adds an intriguing scientific 'facet' to the beauty and brilliance of a gemstone.

*** Dr. M.S. Krzemnicki**

GEMTOF SUCCESSFULLY PASSED G-CHRON 2019 PROFICIENCY TEST ON ZIRCON U-PB DATING

The quality and consistency of analytical data is important for gem labs in order to provide replicable results to gemmologists over a long period of time. In addition, the accuracy compared to internationally recognised standards allows us to perform inter-lab comparisons or track instrument performance and troubleshoot problems proactively. Following this guideline, SSEF participated at the end of 2019 in the proficiency test G-Chron 2019, set up by the International Association of Geoanalysts (IAG, http://www.geoanalyst.org/g-chron/). This test was specifically devoted to the U-Pb dating of minerals (especially zircon) in geological materials.

In an internal report, distributed by IAG in 2020, SSEF successfully passed this internationally coordinated test. This confirms the suitability and confidence of the age dating method currently applied in our lab on zircon inclusions in various gems, e.g. sapphire and ruby. With an accurate zircon formation age, gemmologists are able to deduce an estimated formation age of the host gemstone. This information may well support gemmologists in origin determination. As an example, it is thus possible to clearly distinguish between sapphires from Kashmir (formed ca. 25 million years ago, due to the Himalaya orogeny) from similar-looking sapphires from Madagascar (formed ca. 550 million years ago, due to the Pan-African orogeny).

Round-Robin Blind Test with 'Rak-17' Zircon

In this first round-robin blind test, high purity zircon samples were dispatched at the end of 2019 to more than 60 laboratories worldwide, all of which routinely do U-Pb dating of zircons. The name of the sample 'Rak-17 Zircon' used for this international test refers to the site of sampling near Rakke Compass, 2.3km south of the town of Stavern (Norway), where about 150 kg of rock material was collected back in 2017. After a complex preparation procedure, which included milling, sieving, magnetic separation, heavy liquid separation and acid leaching, about 630 g of high purity zircon fragments were ready to be shipped to the laboratories participating in the G-Chron 2019 test.

We received a sample of about 100 mg as <1mm fragments which were then embedded in epoxy resin and polished (Figure 1) at the University of Basel. In the following two months, three GemTOF operators analyzed the 'Rak-17' zircon samples on six separate days, subsequently applying our SSEF in-house developed age dating protocol for zircons, the same as used in all our age dating calculations for zircon inclusions in gemstones. In total, our results were summarised from 29 analyses on this sample in order to balance minor fluctuations in instrument performance due to different operators.

△ **Figure 1. Tiny fragments of the 'Rak-17' zircon. The largest fragment is about 1.5mm in size. The GemTOF analyses at SSEF were carried out on a random selection of these fragments. Photo: SSEF.**

Age dating at SSEF based on international standards

Our reported age for 'Rak-17' is 296.9 ± 2.18 million years (mean ± one standard error). In other words, this means that the age of the zircon is probably between 294.72 and 299.08 million years based on the radiogenic isotope ratio of ^{206}Pb and ^{238}U measured by GemTOF. Based on the final report, a reference age of the sample was assigned to be 295.56 ± 0.21 million years (mean ± one standard error), which was determined by chemical abrasion isotope dilution thermal ionization mass spectrometry (CA-ID-TIMS). This method is considered to be one of the most accurate methods for U-Pb dating of zircon, although its analytical procedure is time-consuming and complicated and only dedicated laboratories can conduct such analysis.

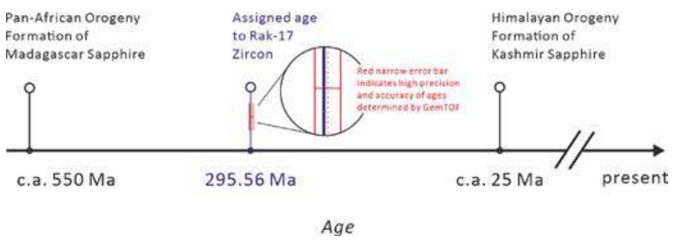
By comparing both results, we can say that the age determined at SSEF agrees very well with the internationally recognised age of the 'Rak-17' zircon sample. Secondly, our age dating provided a narrow error range, as illustrated in Figure 2. This indicates that our measurement was both precise and accurate. To understand the difference between the terms precision and accuracy, see Figure 3.

SSEF successfully passed international G-Chron test

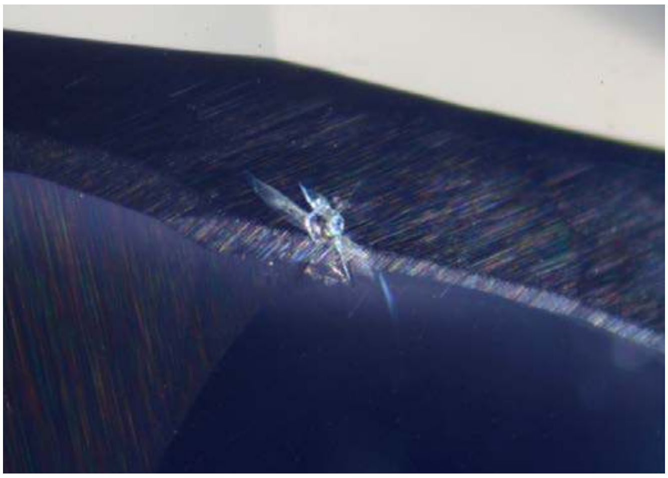
We are very proud to confirm that our GemTOF instrument successfully passed the international proficiency test G-Chron 2019. This is a major step in our analytical excellence, and shows the accuracy of SSEF's U-Pb dating procedure on zircon inclusions. It allows us to deliver highly confident age dating results to our gemmologists, assisting them in their task to determine the country of origin of gemstones. But foremost also to communicate such gemstone ages to our clients and their customers with a special letter attached to the gemstone report, thus adding a further fascinating facet to the story and provenance of such a gemstone.

For the near future, we look forward to developing U-Pb dating protocols for further mineral inclusions, which are additionally found as beautiful encounters when looking into gemstones with a microscope.

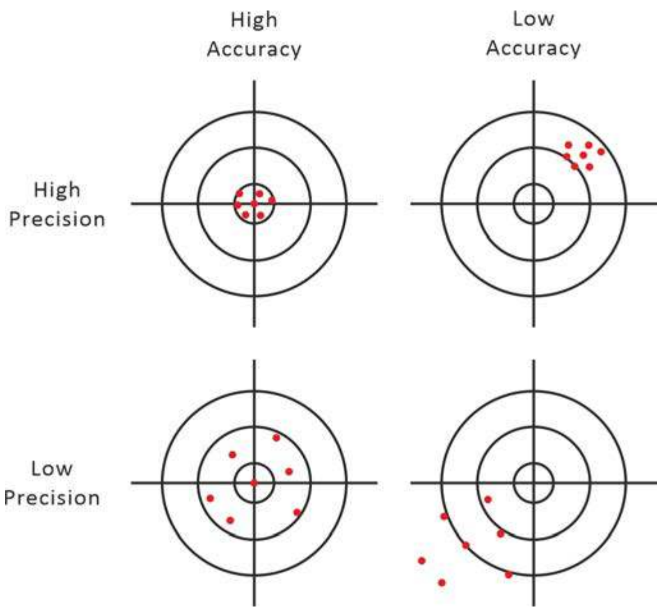
*** Dr. H.A.O. Wang**



△ **Figure 2.** Comparing precision and accuracy of GemTOF measurements on 'Rak-17' (red error bar and dashed line) to its assigned age (blue line), as well as the relative large formation age difference between Madagascar and Kashmir sapphires. Indicating our U-Pb dating method on zircon inclusions can provide highly confident separation of host sapphires from these two origins. Figure: H.A.O. Wang, SSEF.



△ **Figure 4:** Zircon inclusion located near the surface of a sapphire, such an inclusion can be used for radiocarbon dating. Photo: M.S. Krzemnicki, SSEF.



△ **Figure 3.** Difference between precision and accuracy illustrated by shooting on a target. Figure: H.A.O. Wang, SSEF.

ZIRCON INCLUSION ANALYSIS FOR SAPPHIRE ORIGIN DETERMINATION

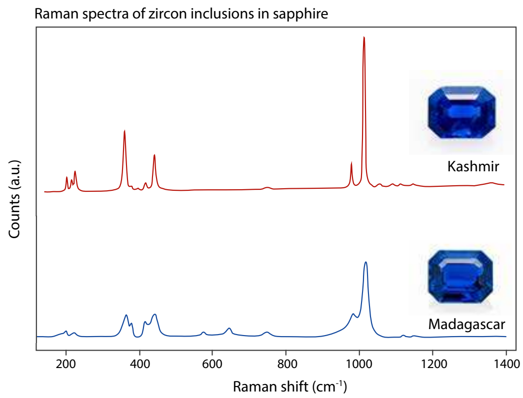
△ **Figure 1:** Left side: Blue zircon (heated) of 16 ct. Right side: Acicular zircon inclusions in Kashmir sapphire (magnification 50x). Photos: L. Phan and M.S. Krzemnicki, SSEF

Zircon $ZrSiO_4$ is a very intriguing mineral, not only because it can be used as an attractive gemstone (Figure 1) but also due to the fact that it can contain minute traces of radioactive elements (U, Th), which decay over time to lead (Pb) isotopes. As such, zircon grains or zircon inclusions provide geoscientists (and gemmologists) a very robust and well-studied tool for radiometric age dating of rocks, minerals or gems, and consequently also allow us to date dynamic geological processes which form these rocks and minerals (see also our articles about age dating in this SSEF Facette, pages 30-31).

As a side effect of this radioactive decay, the crystal structure of zircon is affected locally. This process is known as metamictization and also results in a gradual shift of physical properties (e.g. SG, RI), known and traditionally categorised by gemmologists as high-zircon or low-zircon. The metamictization of zircon has been extensively studied in scientific literature and its peak-broadening effect on Raman spectra of zircon is well documented (Nasdala et al. 1995, Zhang et al. 2000) as is an inverse sharpening effect of the Raman peaks by annealing of metamict zircons (Nasdala et al. 2001, Wang et al. 2006, Wanthanachaisaeng et al. 2006).

Since many years, the SSEF is using Raman spectroscopy of zircon inclusions as a very important method to detect heat treatment (see for example SSEF Facette No. 17, 2010, page 12), but also as a method to support origin determination of gemstones, notably ruby and sapphires.

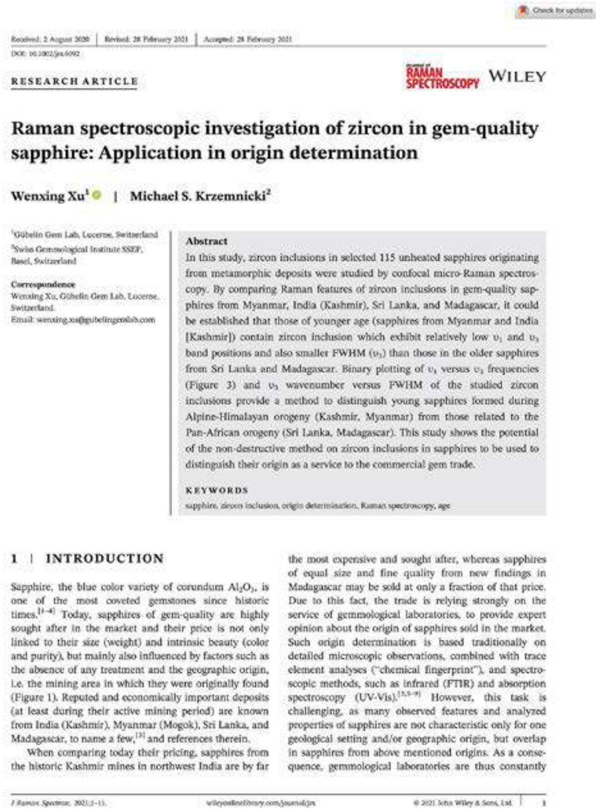
In a recent research project, the SSEF teamed up with Dr. Wenxing Xu, gemmologist and researcher at the Gübelin Gemlab to establish a joint Raman database of zircon inclusions in sapphires with a well-documented



△ **Figure 2:** A comparison of Raman spectra shows that zircon inclusions in Kashmir sapphires are characterised by narrow and well defined Raman peaks, whereas zircons in metamorphic sapphires from Madagascar (an example from Bemainty, near Ambatondrazaka) exhibit much broader Raman bands as they are distinctly more metamict. Figure: M.S. Krzemnicki, SSEF geographic provenance. As already known before (Block, 2011), the state of metamictization in zircons is also related to their geographic origin, mainly due to differences in their age of formation. Figure 2 shows a striking example of how Raman spectra on zircon inclusions can help to unambiguously separate sapphires from Kashmir from similar-looking velvety blue sapphires from Madagascar. As a geologically young formation, zircon inclusions in Kashmir sapphires reveal very narrow Raman peaks. The much older metamorphic sapphires from Madagascar, however, contain zircons which are distinctly more metamict and as a result they show Raman spectra with much broader Raman bands.

With the new study, we have been able to extend our database considerably, and thus to better document the usefulness and importance of Raman spectroscopic analyses on zircons as a meaningful tool for gemstone origin determination. Our latest scientific results have been recently published in the Journal of Ramanspectroscopy (Xu & Krzemnicki, 2021).

Interested readers will find more information about this paper here: https://doi.org/10.1002/jrs.6092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Received: 2 August 2020 | Revised: 28 February 2021 | Accepted: 28 February 2021
DOI: 10.1002/jrs.6092

RESEARCH ARTICLE

JOURNAL OF RAMAN SPECTROSCOPY WILEY

Raman spectroscopic investigation of zircon in gem-quality sapphire: Application in origin determination

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Abstract
In this study, zircon inclusions in selected 115 unheated sapphires originating from metamorphic deposits were studied by confocal micro-Raman spectroscopy. By comparing Raman features of zircon inclusions in gem-quality sapphires from Myanmar, India (Kashmir), Sri Lanka, and Madagascar, it could be established that those of younger age (sapphires from Myanmar and India [Kashmir]) contain zircon inclusion which exhibit relatively low υ_1 and υ_3 band positions and also smaller FWHM (υ_3) than those in the older sapphires from Sri Lanka and Madagascar. Binary plotting of υ_1 versus υ_3 frequencies (Figure 3) and υ_3 wavenumber versus FWHM of the studied zircon inclusions provide a method to distinguish young sapphires formed during Alpine-Himalayan orogeny (Kashmir, Myanmar) from those related to the Pan-African orogeny (Sri Lanka, Madagascar). This study shows the potential of the non-destructive method on zircon inclusions in sapphires to be used to distinguish their origin as a service to the commercial gem trade.

KEYWORDS
sapphire, zircon inclusion, origin determination, Raman spectroscopy, age

1 | INTRODUCTION

Sapphire, the blue color variety of corundum Al_2O_3, is one of the most coveted gemstones since historic times.[1–4] Today, sapphires of gem-quality are highly sought after in the market and their price is not only linked to their size (weight) and intrinsic beauty (color and purity), but mainly also influenced by factors such as the absence of any treatment and the geographic origin, i.e. the mining area in which they were originally found (Figure 1). Reputed and economically important deposits (at least during their active mining period) are known from India (Kashmir), Myanmar (Mogok), Sri Lanka, and Madagascar, to name a few,[3] and references therein.

When comparing today their pricing, sapphires from the historic Kashmir mines in northwest India are by far the most expensive and sought after, whereas sapphires of equal size and fine quality from new findings in Madagascar may be sold at only a fraction of that price. Due to this fact, the trade is relying strongly on the service of gemmological laboratories, to provide expert opinion about the origin of sapphires sold in the market. Such origin determination is based traditionally on detailed microscopic observations, combined with trace element analyses ("chemical fingerprint"), and spectroscopic methods, such as infrared (FTIR) and absorption spectroscopy (UV-Vis).[3,5–9] However, this task is challenging, as many observed features and analyzed properties of sapphires are not characteristic only for one geological setting and/or geographic origin, but overlap in sapphires from above mentioned origins. As a consequence, gemmological laboratories are thus constantly

J Raman Spectrosc. 2021;1–11. wileyonlinelibrary.com/journal/jrs © 2021 John Wiley & Sons, Ltd. 1

REFERENCES

Block T (2011) Raman spektroskopische Untersuchung von Zirkon- and Apatit-Einschlüssen in Saphiren verschiedener Lagerstätten, Master thesis, Friedrich-Schiller-Universität Jena, Germany.

Nasdala L, Irmer G, Wolf D (1995) The degree of metamictization in zircons: a Raman spectroscopic study. Eur. J. Mineralogy 7:471–478.

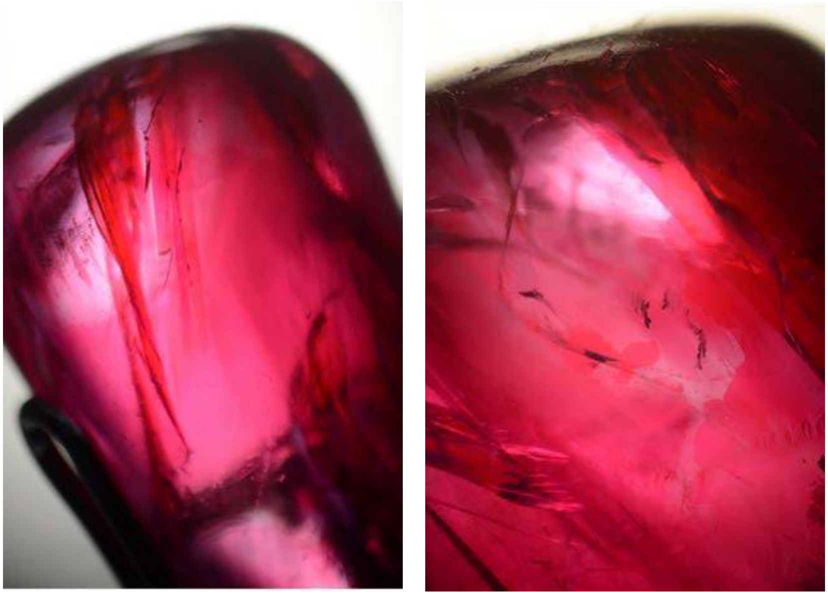
Nasdala L, Wenzel M, Vavra G, Irmer G, Wenzel T, Kober B (2001) Metamictisation of natural zircon: accumulation versus thermal annealing of radioactivity-induced damage. Contrib. Mineral. Petrol. 1412:125–144.

Wang W, Scarratt K, Emmett JL, Breeding CM, Douthit TR (2006) The effects of heat treatment on zircon inclusions in Madagascar sapphires. Gems & Gemology 42:134–150

Wanthanachaisaeng B, Häger T, Hofmeister W, Nasdala L (2006) Raman- und fluoreszenz-spektroskopische Eigenschaften von Zirkon-Einschlüssen in chrom-haltigen Korunden aus Ilakaka und deren Veränderung durch Hitzebehandlung. Gemmologie 55:119–132.

Zhang M, Salje EKH, Farnan I, Graeme-Barber A, Daniel P, Ewing RC, Clark AM, Leroux H (2000) Metamictization of zircon: Raman spectroscopic study. J Phys Condens Matter 12:1915–1925.

DYED CORUNDUM FROM BURMA

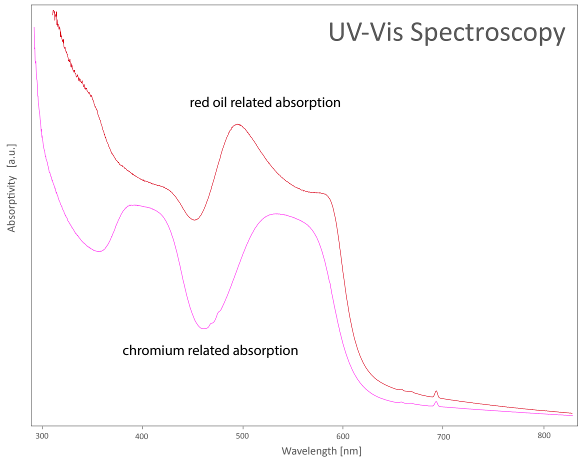


△ **Figure 1 (left):** Dyed corundum from Burma (Myanmar), mimicking a beautiful pinkish red ruby. Photo: J. Xaysongkham, SSEF. **Figure 2 (center and right):** Fissures filled with red oil in this treated (dyed) corundum. Photos: M.S. Krzemnicki, SSEF.

It cannot be repeated often enough: any gemstone which contains fissures is prone to be treated with fissure filling substances, either by using a colourless or coloured substances (e.g. oil). Even when the stone comes from a famed mining source such as the Mogok Stone Tract in Burma (Myanmar).

A very instructional example was recently submitted to SSEF. This drop-shaped stone of 10 ct contained numerous fissures and visually looked like a beautiful pinkish red ruby (Figure 1). Although confirmed by EDXRF chemical analyses to be a corundum, the very low chromium concentration made its vivid colour quite suspicious. These doubts were confirmed by closer microscopic investigations which revealed, that this Burmese stone was in fact originally only a light pink sapphire which had been dyed by filling the numerous fissures with red oil (Figure 2). Infrared and UV-Vis absorption spectra (Figure 3) readily confirmed the presence of coloured oil in this treated corundum.

*** Dr. M.S. Krzemnicki**



△ **Figure 3:** UV-Vis absorption spectra of the described dyed corundum showing the chromium related absorption bands of the pink sapphire and the absorption spectrum registered when analysing through a fissure that was filled with red oil in this specimen. Figure: R.Schmid, SSEF.

BEWARE OF SYNTHETIC RUBY WITH 'ZIRCON-LIKE' CLUSTER INCLUSIONS

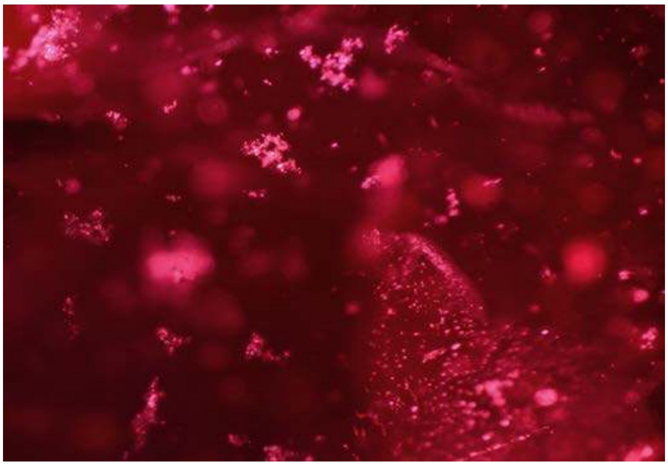
△ **Figure 1:** Flux-melt synthetic ruby of 4.27 ct contining numerous 'zircon-like' clusters. Photo: A. Chalain, SSEF.

Synthetic stones are rather rare guests at SSEF, as most of them are sorted out already before submission to SSEF based on their telltale characteristics. Those which finally come to us are therefore rather uncommon or even tricky cases (see e.g. SSEF Facettes No. 22, 2016, page 14; and No. 25, 2019, pages 12-13), which may even have fooled other gemmologists and gem labs alike.

Very recently, we tested a tricky case of a synthetic ruby (Figure 1) of 4.27 ct, submitted to SSEF as a natural stone accompanied by two lab reports confirming its natural origin. Under the microscope, the submitted stone showed 'zircon-like' cluster inclusions (Figure 2). They were somehow reminiscent of zircon clusters commonly observed in rubies from Vatomandry in Madagascar.

Raman spectroscopic analyses, however, revealed that these clusters are in fact made of an unknown solid substance. Their Raman spectra were not matching with zircon, xenotime or any other natural inclusion commonly found in corundum. Additionally, the stone contained no further natural inclusion, such as rutile, monazite, apatite, or amphibole, as could be expected in a natural ruby of this size, specifically from Vatomandry. In addition, this stone showed a very strong red UV-reaction (typical for iron-poor rubies), which is in contradiction to rubies from Vatomandry that usually show a dull red UV reaction due to their distinct iron concentration.

Detailed chemical analyses using both EDXRF and LAICPMS clearly excluded a natural origin for this stone. This conclusion could be drawn mainly due to the presence of exotic trace elements, actually related to the flux-melt synthesis but not to any geological process. These exotic elements included amongst others: manganese, antimony, rhodium, zirconium, and platinum. Another interesting aspect was the complete absence of vanadium in this synthetic ruby (detection limit with LAICPMS is below 0.06 ppm!). Every natural ruby contains some traces of vanadium, as this element is geochemically linked to chromium, which acts as colouring element (chromophore) in rubies.



△ **Figure 2:** Numerous 'zircon-like' clusters of an unknown inclusion in the described synthetic ruby. Photo: M.S. Krzemnicki, SSEF

Similar synthetic rubies are known since quite some years (e.g. Atichat et al., 2012, GIT Conference Proceedings). Due to their 'zircon-like' clusters, they are rather difficult to recognise and may even fool an experienced gem trader and gemmologist.

*** Dr. M.S. Krzemnicki**

A NEVER-ENDING STORY: RECHECK SERVICE AND REPORT VALIDITY CHECK ON MYSSEF.CH FOR EMERALDS

△ **Figure 1:** This emerald was submitted six times to SSEF. Photo: M.S. Krzemnicki, SSEF

Imagine life as an emerald. Just born in the rocks and growing, you get joggled and bruised by mother nature and later by the mining process. So, already in your young age you carry quite some scars and fractures, which reduce your true beauty considerably and may not make it so easy to find a good mate (emerald buyer).

But there is hope, some drops of oil may help, or even immersion in a bath of artificial resin?
and wow, what a change is possible…

Many emeralds are submitted more than once to SSEF. The reason is not only a recut of the stone, but mostly due to the fact that fissures in emeralds are cleaned or filled again and again. This is no problem, as long as at each stage a new report is made to reflect the current situation of the stone. Not to do so, and especially selling an emerald without correct disclosure of the latest fissure filling status is unethical.

To avoid any later trouble, we thus suggest our clients to use our recheck service (offered at a reduced fee) before making important buying decisions when a stone is offered to you with an older SSEF report.

At this point we also would like to remind our clients, that a statement about fissure filling on a SSEF report always reflects the time of testing at SSEF. This is specifically mentioned in the comments section of our report. Please also check carefully the photo on our report and compare it with the stone offered with the report. If the stone looks considerably better and shows distinctly less fissures, then there is a good option that the stone is not anymore in the same situation as it was when tested at SSEF. And finally, please always check your report's validity on our www.myssef.ch website, to determine if the report presented to you is valid and correct.

*** Dr. M.S. Krzemnicki**

GEMMOLOGICAL STUDY OF THE MEDIEVAL KÖNIGSFELDER DIPTYCHON

△ **Photo courtesy of the Historic Museum of Berne, Switzerland**

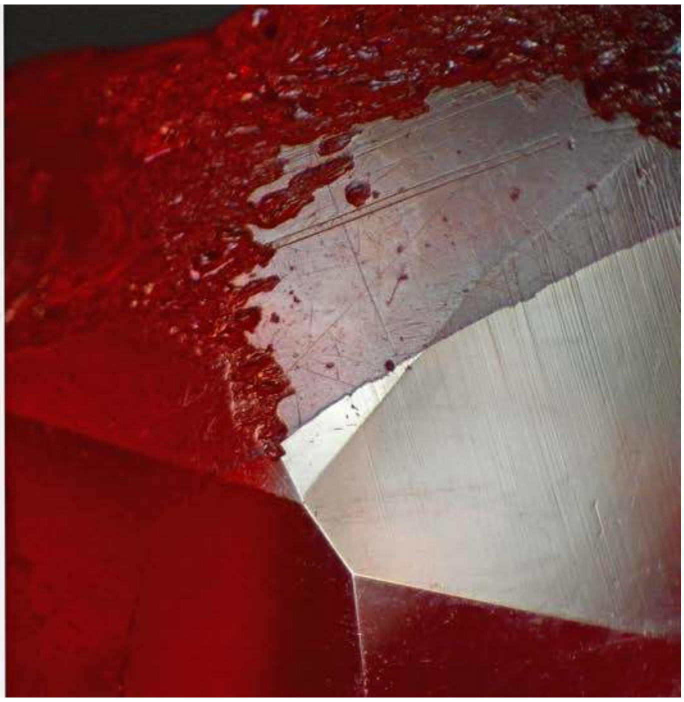
In 1298 AD, the king of Hungary Andreas II presented to his wife Queen Agnes a stone-set wooden altar piece as a royal wedding present. This small medieval artwork, known today as the Königsfelder diptychon, was originally made in Venice. The city was at that time an important trading centre known for the craftsmanship and artistry of its local jewellers and goldsmiths. After the death of her husband in 1301, Queen Agnes first moved to Vienna, and later to the catholic convent in Königsfelden (Switzerland) where this small altar piece was described in a contemporary inventory of 1357 AD as "ein gröss tavelen mit cristallen und mitt zwein grosen steinen an mitteninne gewürket mit gestein und bêrlen" (simplified transcription; Stammler 1895). Today the gem-set diptych is one of the highlights of the medieval collection of the Historic Museum of Berne, in Switzerland's capital city.

In a recent research collaboration with the Historic Museum of Berne, SSEF was invited to inspect this medieval masterpiece for a first gemmological investigation of the stones set in the item. As a preliminary result of this research project, we found that the two wings of the wooden altar are dominated by ornamental stones, such as various varieties of chalcedony and jasper, with two onyx plates in the centre, and additionally a few blue cobalt-glass cabochons and natural pearls. The filigree portraits of saints with their gloriole made of tiny seed pearls are covered as a protection by rock crystal plates, probably from Alpine sources.

A meticulous study of the stone settings and a comparison of photos of this item from the late 19th century to photos taken very recently revealed that this medieval artefact was repeatedly repaired in the past few centuries up to the mid-20th century. We assume that in most cases these repairs were carried out to fix the stones which had fallen off from the wooden altar and place them back in their approximate original position.

*** Dr. M.S. Krzemnicki**

SOUVENIRS FROM THE PAST: DOUBLETS UNCOVERED AT SSEF



△ **Figure 1:** This red garnet-topped doublet is already obvious when looking carefully on the stone. Even more so, when checking the lustre difference of the garnet top and the glass base under the microscope (magnification 35x). Photos: M. Bichsel & M.S: Krzemnicki, SSEF.

From time to time, we get a flashback in gemmological history. This is specifically the case when we receive an antique ring with an 'early' Verneuil synthetic ruby showing strongly curved growth bands, or, as in the past few months, when clients submit us doublets. Doublets are manufactured stones which are made to imitate precious gemstones, at least for the unexperienced observer.

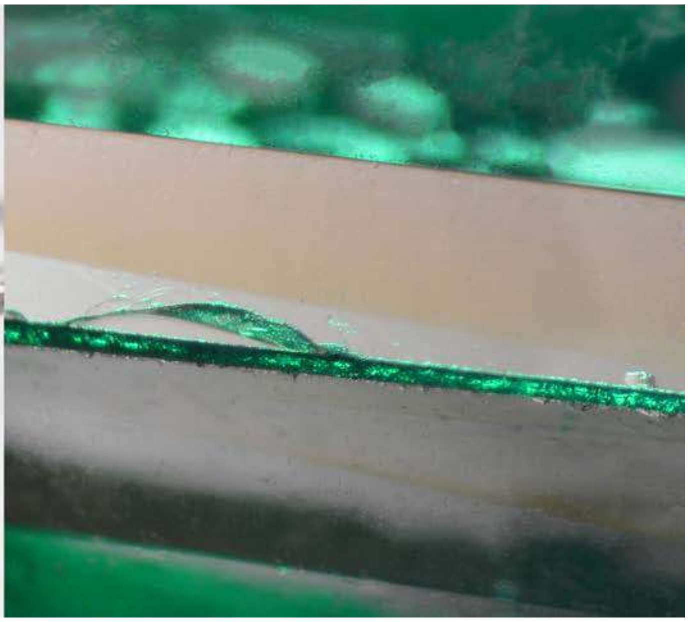
Garnet-topped doublet

The first case was a beautiful and classic red ruby, at least considered as such by the client who submitted it to SSEF. Our testing however quickly revealed already by a visual check another classic: a so-called garnet-topped doublet. These doublets consist of a small and thin chip of garnet (usually of the pyrope-almandine series), fused together with a much bigger coloured glass base, which in fact is responsible for nearly all of the colour of the stone. Characteristic features are a strong lustre difference between the small high-reflective garnet and the low-RI glass. As the garnet chip is a fractured fragment, the fused intersection between the glass base and the garnet top is not a straight plane but rather conchoidal, and furthermore not in the girdle plane but found just somewhere below the table facet. Our red stone showed exactly all these features (see Figure 1). In addition, we could observe some oriented rutile needles in the garnet top, and small to larger air bubbles in the glass and specifically at the intersection where these two materials had been fused together. Advanced testing including Raman spectroscopy well confirmed our visual and microscopic observations.

As far as for us gemmologists, this rare encounter proved to be a very nice and interesting specimen.

'Soudé emerald'doublet

The second case was a pretty necklace with three emeralds set together with small diamonds, at least at first sight (Figure 2). It all took a bad turn when we had a closer look to the item. No, the small stones were not diamonds but actually a mix of cubic zirconia and colourless glass. And the three green stones were not natural emeralds but proved to be manufactured products, historically known in the trade as 'Soudé-emerald' doublets. These doublets are made using two pieces of colourless beryl (for the crown and the pavilion) joined together by a green glue. Under the microscope, the green glue between the two colourless parts was readily observed along the girdle (Figure 2). As it is well-documented for such doublets, numerous flat air bubbles were found in the green layer of glue. In addition, the glue showed already some features of ageing and drying out towards the edges of the stone. The colourless parts of the doublet contained many tiny and parallel hollow channels and some elongated fluid inclusions, characteristic for natural beryl. Advanced testing with EDXRF and Raman confirmed the conclusion of this unusual necklace containing rather classic imitations of emerald and diamond.



△ **Figure 2:** Three 'Soudé emerald' doublets in a necklace with diamond imitations. The green layer of glue between the colourless beryl of the crown and pavilion can be readily seen along the girdle of these doublets. Photos: A. Chalain & M.S. Krzemnicki, SSEF.

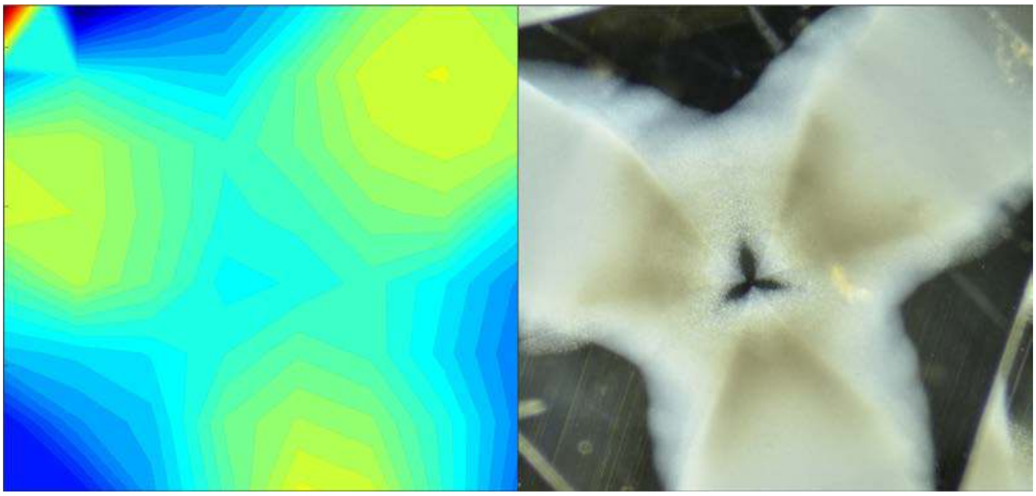
TWO EXCEPTIONAL ASTERIATED DIAMONDS

△ **Figure 1:** Two exceptional asteriated diamonds received at SSEF. From left to right: octahedron showing six brownish lobes (3.72 ct); flat half-octahedron showing three lobes (3.77 ct); sideview of the second stone showing the three-dimensional nature of the lobes. Photos: A. Chalain.

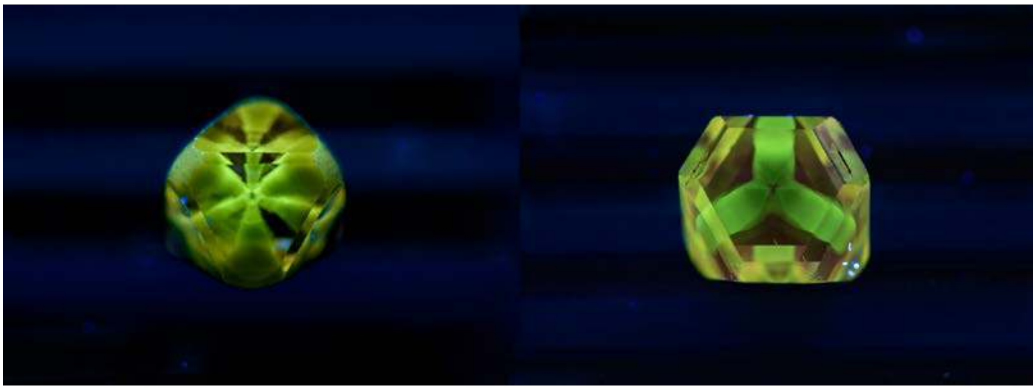
Recently, SSEF received two so-called asteriated diamonds for authentication. Asteriated diamonds are rare and highly prized amongst collectors for their beautiful and unique appearance. The two stones received in our lab were no exception. The two polished rough crystals (3.72 and 3.77 ct) contained brownish to whitish clouds of microscopically small inclusions that formed a star-shape in three dimensions that is visible with the naked eye.
One of the two stones is an almost perfect octahedron with resorbed corners and edges that have been partly polished (see Figure 1). It shows six lobes of inclusion clouds that radiated from the centre of the crystal to its corners. The other stone had a flattened shape with one three- and one six-sided face on opposite sides. The star-shaped clouds in this stone formed three petals that extended from a point close to the centre of the six-sided face towards the corners of the triangular (octahedral) face.

At first glance, the second stone looked similar to a macle (a twin occurring along a plane parallel to the octahedral face), however macles usually have two trigonal (octahedral) faces on opposite sides and show re-entrant angles. Both features were absent on this stone. A more likely explanation for its shape is that the stone represents only half of an octahedron that is truncated at the centre of growth in a plane parallel to one of the octahedral crystal faces. This would result in the described shape while also explaining why three instead of six lobes of inclusions were visible in this stone. There were no visible remnants of the missing three lobes near the hexagonal face, indicating that the stone was not cut or cleaved to achieve this shape. Instead, the shape may have occurred naturally in the Earth's mantle, due to a restriction in growth on one side.

A three-dimensional model of the two stones can be viewed by scanning the following QR-code with your smartphone:



◁ **Figure 2:** left: map of the intensity of the hydrogen-related 3107cm^{-1} peak obtained on the triangular side of the half-octahedron. Dark blue: low intensity, yellow-green: high intensity. Right: microphotograph of the same stone showing approximately the same section of the stone at the same orientation. Width: 3.3 mm. Images: SSEF.



◁ **Figure 3:** yellow-green fluorescence seen under LWUV light (365 nm). Left: octahedral stone showing six lobes, right: flat stone showing three lobes. In both cases, the fluorescence is most intense in the H-rich zones. Photos: A. Chalain, SSEF.

Infrared (IR) spectroscopy revealed that both stones contain traces of aggregated nitrogen and are relatively rich in hydrogen. IR-mapping was performed on the flat three-lobed stone. A series of measurements was performed following an imaginary grid on the triangular face of the diamond. The intensity of the peak at 3107 cm^{-1} caused by the VN3H defect, was measured in each spot and the result used to create a 'map' that shows the distribution of this defect within the stone in 2-d (see Figure 2). The H-rich zones seen in the map agree exactly with the position of the visible lobes, confirming previous measurements on asteriated diamonds (Rondeau et al. 2004).

When viewed under conventional long-wave ultraviolet (UV) light (365 nm), the two stones show a relatively strong yellowish to green fluorescence that is strongest in the H-rich lobes (see Figure 3). DiamondView imaging did not reveal the same features. Instead, both stones show an irregular pattern of weak blue fluorescence. Additionally, the stone with six lobes showed weak greenish fluorescence towards the octahedral corners when viewed using the DiamondView instrument. No phosphorescence was observed.

The star-shaped internal features seen in asteriated diamonds are a form of sector zoning that develops when cuboid and octahedral sectors grow simultaneously. Hydrogen is incorporated preferentially into the cuboid sectors, whereas nitrogen concentration is higher in the octahedral sectors. The petal shape of the growth structure can be explained by variations in relative growth of the two types of sectors. The appearance of the cuboid sectors is caused by light scattered on 'disk-crack-like' inclusions that can be opaque or transparent and have been shown to contain graphite (Howell et al. 2013 and references therein).

*** Dr. L. Speich & J.-P. Chalain**

REFERENCES

Howell D., Griffin W., Piazolo S., Say J.M., Stern R.A., Stachel T., Nasdala L., Rabeau J.R., Pearson N.J., O'Reilly S.Y.: A spectroscopic and carbon-isotope study of mixed-habit diamonds: Impurity characteristics and growth environment, American Mineralogist 98 (2013), 66-77.

Rondeau B., Fritsch E., Guiraud M., Chalain J.-P., Notari F.: Three historical 'asteriated' diamonds: growth history and sector-dependent impurity incorporation, Diamond & Related Materials 13 (2004), 1658-1673.

A NEW LED DAYLIGHT SOURCE FOR DIAMOND COLOUR GRADING

In 2020, a novel light source for the colour grading of diamonds was developed in a collaboration between SSEF and the Department of Physics, University of Basel (see Figure 1). In contrast to many of the models on the market, the new light source uses state-of-the-art LED (Light Emitting Diode) lights instead of incandescent bulbs or fluorescent tubes to produce light very similar to natural daylight. It is compliant with the newly published standard ISO 24016 "Jewellery and precious metals – Grading polished diamonds – Terminology, classification and test methods" and, unlike most commercially available instruments, allows the addition of a customizable percentage of UV-light, for research purposes.

Advantages of LED

Conventional LED typically emit large amounts of blue and yellow-green light and their emission spectrum shows a gap in the blue-green, while natural daylight possesses a more continuous spectrum (Figure 1). This discrepancy can lead to differences in perceived colour when such light is used in judging the colour of gemstones. Hence, filtered incandescent light is often used in commercially available lighting for colour evaluation.

LED lights consume only a fraction of the energy of incandescent bulbs and produce very little heat. They provide a stable light output and require very little maintenance while having a very long lifespan (of the order of 100.000 hrs) – much longer than e.g. fluorescent lamps (Lamarre 2002, King et al. 2008). Furthermore, other light sources require a warmup period of several minutes before producing consistent light that meets the standard set out in ISO 24016 while the rise and fall time for LED is in the nanosecond range. These factors make LED very attractive and easy to work with in a laboratory environment.

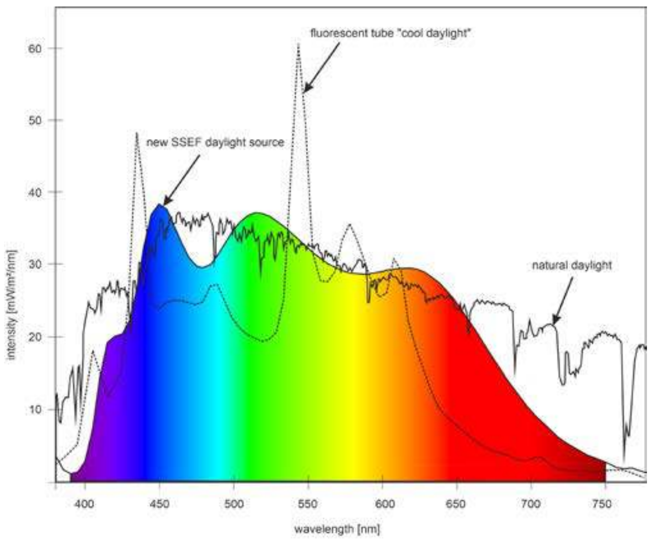
Our new light source uses a new type of LED which produce a spectrum that is almost continuous over the wavelength range of visible light and is thus a good approximation of natural daylight resulting in a Colour Rendering Index (CRI) of 97. While the colour temperature and illuminance of the two lamps is comparable, the fluorescent lamp shown in figure 2 achieves a CRI of only 75%.

△ **Figure 1:** New LED light box at SSEF that was developed in collaboration with the Electronics Department, University of Basel. The new light box adheres to the requirements set out in the new standard ISO 24016 and is more comfortable to work with than conventional light sources for colour grading. Photo: L. Phan, SSEF.

Current standard for diamond colour grading

Historically, diamonds were graded in daylight and while difficult, attempts were made to make the lighting as reproducible as possible. Sometimes impractical notions were proposed, such as facing northwards or colour grading only between 10 am and 2 pm, ideally in cloudy weather. Today, more convenient daylight equivalent artificial light sources are available and facilitate colour grading in a truly standardised setting.

The newly published standard ISO 24016 specifies the exact lighting conditions to be used for colour grading of diamond, such as colour temperature, intensity and distance of the stone in question to the light source. Additionally, the standard states that reflections and distractions from the environment should be avoided. Cabinets for colour grading are thus normally painted in a neutral colour such as grey. Our new light source, while adhering to the conditions stated above, benefits from using modern LED lights.



△ **Figure 2:** Spectrum of natural daylight (black line; obtained by M. Steinacher at the University of Basel, slightly cloudy sky behind a window) compared to a lamp with standard 'cold daylight' fluorescent tubes (dashed black line) and our new LED daylight source (black line with spectral colours). The spectra of the artificial light sources were obtained ca. 20 cm away from the light source, as specified in ISO 24016. The newly developed light source is a good approximation of natural daylight. Figure: SSEF.

Complementary ultraviolet (UV) LED allows for the addition of calibrated amounts of UV-light. This is another step in approximating natural light since natural daylight extends into the lower wavelength ultraviolet (UV) region as well as containing visible light. This can even be observed when behind a window. Some gemstones, notably certain diamonds, can react to these small amounts of UV light and can show a bluish or milky appearance, an effect referred to as visible fluorescence. Similarly, rubies can show visible fluorescence that in turn can intensify their colour. With our new light source, we will be able to study this effect in a controlled environment and assess its implications on perceived colour in diamond as well as other gemstones.

This new innovative light box for colour grading will soon be available in different sizes through our subsidiary company SATT Gems www.sattgems.ch

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GLOSSARY:

ISO 24016:2021

The ISO standard 24016 defines conditions and procedures for the grading of unmounted polished diamonds larger than 0.25 ct, including criteria for colour grading. It states that grading shall be carried out using a light source simulating D55 or D65 in a neutral viewing environment. Evaluation of colour is to be carried out with the stone 20 cm away from the light source, where the illuminance of the light source shall be 2200 lx.

CRI (Colour Rendering Index) – describes the ability of a light source to faithfully reproduce the colour of an object when compared to a standard light source. For light sources with colour temperatures above 5000 K, as is the case here, D65 is used as a reference. A value between 0 and 100 is assigned with CRI values near 100 meaning that the light source renders the colour of an object nearly as well as D65.

D55 and D65 – standard illuminants (theoretical light sources) defined by the International Commission on Illumination (CIE) to represent daylight. D65 is comparable to the average Western or Northern European daylight at noon and has a colour temperature of 6500 K, while D55 represents mid-morning or mid-afternoon daylight with a colour temperature of 5500 K.

Colour temperature – describes the proportion of 'warmer' red and yellow wavelengths versus 'cooler' blue wavelengths in a light source. A higher value means that the light source emits a higher proportion of 'cooler' wavelengths. The term is derived from physics where a temperature value in Kelvin (K) is given. It is based on the temperature of an ideal black-body radiator that would emit light comparable to the light source. Daylight, for example, varies in colour temperature from 5000 to 6500 K. The colour temperature of a light source can influence our perception of the colour of an object.

REFERENCES

ISO 24016:2020: Jewellery and precious metals — Grading polished diamonds — Terminology, classification and test methods.

Lamarre C.: Light emitting diodes as light sources in portable gemmological instruments, Journal of Gemmology 28 (2002), 169-174.

King J.M., Geurts R.H., Gilbertson A.M., Shigley J.E.: Color grading "D-to-Z" diamonds at the GIA laboratory, Gems & Gemmology, Vol. 44, No. 4 (2008), 296-321.

DIAMOND FRAUD UNCOVERED

△ **Figure 1:** The yellowish diamond on the right was fraudulently labeled as Top Wesselton (rare white+ or F after current CIBJO nomenclature). The diamond on the left is a CIBJO masterstone for an F colour (lowest possible F colour). Photo: SSEF.

As in the past, the SSEF is regularly asked by the Swiss police authorities to act as a gemmological adviser in criminal cases. Usually, these are fraud cases, involving undeclared or mislabeled gemstones or their imitations.

In a recent case with about 20 stones submitted by the police, we not only found diamonds with incorrect grading labels (Figure 1) and undisclosed fissure-fillings (Figure 2), but also cubic zirconia that was fraudulently mislabeled as diamond and sealed in a plastic card.

These examples unfortunately highlight the risk for consumers when buying diamonds without proper documentation by an internationally recognised laboratory.

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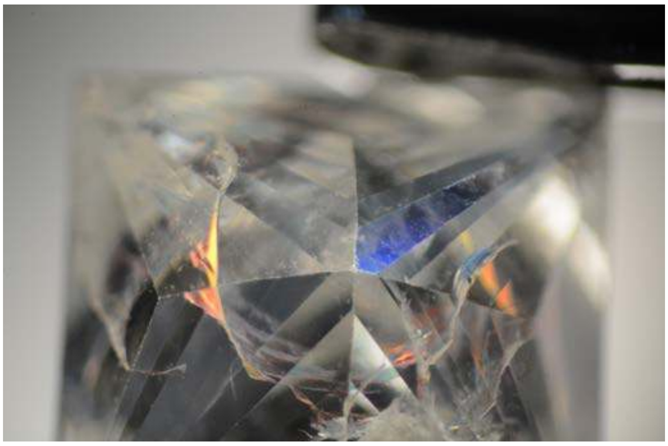
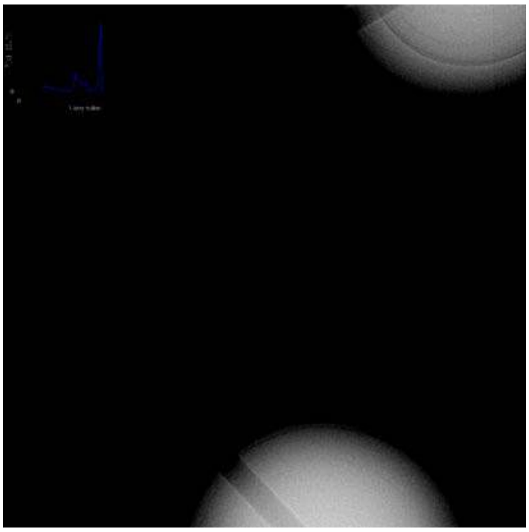


△ **Figure 2:** Beautiful flash effect seen under microscope in this fissure-filled diamond, but not nice as it was not disclosed! Photo: SSEF.

△ **Figure 3:** Beware the seal: This is not a diamond but cubic zirconia! Photo: SSEF.

NATURAL PEARL NECKLACE WITH ONE IMITATION PEARL

△ **Figure 1:** Natural pearl necklace containing one imitation pearl. Photo: A. Chalain, SSEF.



△ **Figure 2:** The imitation pearl is strung between these two natural pearls partially visible on the top and bottom of this radiography. As the imitation pearl is transparent to X-rays, it leaves a black 'hole' between these two natural pearls strung on the pearl strand. Photo: SSEF.

Even after having tested literally hundreds of natural pearl necklaces in the lab, it does not mean that we can't expect surprises.

In the last SSEF Facette (No. 26, page 40) we described the astonishing case of a cultured pearl necklace with one natural pearl mixed into the pearl strand. As a recent addition to this club of extravaganza, we can present this year the following beautiful pearl necklace (Figure 1). Our testing not only revealed the presence of 40 natural pearls of a quite remarkable diameter (8-11 mm), but in addition one imitation pearl consisting of a plastic bead covered by a 'lacquer' coating that seeks to mimic a pearly lustre (Figure 1). Interestingly, the imitation was mostly transparent to X-rays, which had all SSEF gemmologists gravitating towards the black 'hole' present in the radiography of this necklace (Figure 2). It was only through the brave intervention of Luke Pearlwalker that we could avoid larger damage to our team.

As these cases show, the addition or substitution of a pearl during repair and restringing of a pearl necklace obviously may sometimes lead to surprising results.

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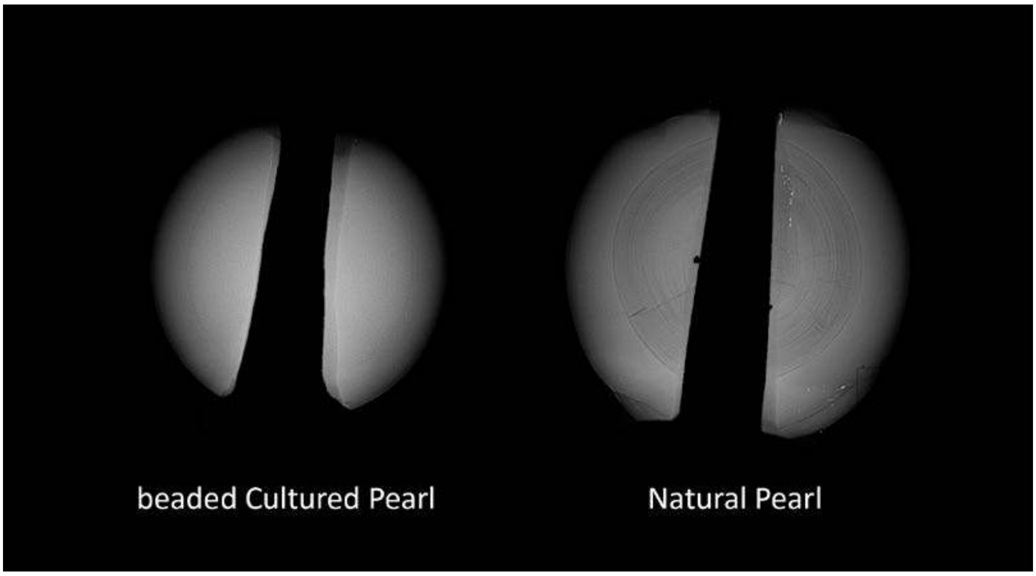
CULTURED PEARLS IN A BRACELET OF HISTORIC DESIGN

An antique-style bracelet with diamonds and pearls was recently submitted to SSEF for testing (Figure 1). Despite the complex setting, we were able to analyse all the pearls and found, that five of the pearls in this bracelet were in fact beaded cultured pearls (Akoya type), whereas the remaining 26 were saltwater natural pearls (Figure 2).

Apart from gemmological testing, we are in such cases always curious to determine as far as possible the authenticity of such items that have a 'historic look' In the case of the above-described bracelet, detailed microscopic investigation of the setting revealed that the cultured pearls were glued into the setting and not fitting the pre-existing bezel settings. We assume that the cultured pearls were introduced into the bracelet during a jewellery repair as replacements for presumably lost or damaged natural pearls. In addition, the diamonds (old cut) in the bracelet showed well-preserved facet edges and nearly no wear marks, both not to be expected in any jewellery of real historic provenance.

△ **Figure 1:** The bracelet in question. Photo: M. Bichsel, SSEF.



◁ **Figure 2:** X-ray radiographies of a beaded cultured pearl and a natural pearl from the described bracelet. Photo: SSEF.

We thus assume that the described bracelet with five beaded cultured pearls is much younger and was only designed to look 'antique'.

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NATURAL PEARLS DYED GREEN

△ **Figure 1:** Natural pearl necklace treated with a green dye. Photo: A. Chalain, SSEF

The body colour of pearls is normally related to the presence of natural colour pigments produced by the mollusc during pearl formation. Another option is to colour pearls artificially, with dyeing being the most readily available method. Often applied to rather low-quality freshwater cultured pearls, these treated cultured pearls commonly come in fancy colours, which make it obvious that they were treated.

Natural pearls which have been dyed are much rarer. In most cases, these treated natural pearls were dyed in a way to create only a subtle shift of colour considered more attractive.

A natural pearl necklace submitted recently to SSEF can be considered a rarer but excellent example of such dyed natural pearls. Visually, the 41 natural pearls in this necklace showed a slight greenish hue, blending nicely with the purplish to bluish overtones ('pearl orient') present at the surface of these pearls (Figure 1). A closer look with the microscope, however, clearly revealed green colour concentrations around the drill-holes (inset in Figure 2) of these pearls, a tell-tale sign of artificial dyeing. The treatment is further confirmed by Raman spectroscopy, with characteristic Raman peaks related to the green dye in addition to the aragonite peaks (marked A) of the nacre itself.

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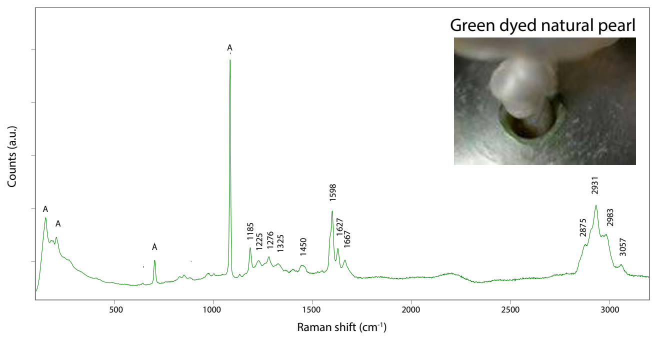

△ **Figure 2:** Raman spectrum of the green dyed nacre of one of these treated natural pearls from the described necklace. Spectrum: W. Zhou, SSEF; Inset Photo: M.S. Krzemnicki, SSEF.

PAIR OF SAUTOIRS BY RENÉ LALIQUE

René Lalique (1860-1945) was one of the most ingenious and creative designers of jewellery and glass objects at the end of the 19th and beginning of the 20th century. He significantly contributed to the Art Nouveau and Art Déco periods. Born in a small village in Champagne, a region famous for sparkling wines located in the Northeast of France, he came to Paris in the 1870s where he started his training in a jewellery workshop and later opened up his own atelier. This is where he developed and produced his characteristic floral designs, often integrating enamel, glass, and organic gem materials in his masterfully crafted pieces.

We recently had the pleasure of investigating a pair of sautoirs created by René Lalique dating from the end of the 19th century (Figure 1). The pair of sautoirs were made in a geometric floral design, each highlighted with a pendant containing a slightly baroque drop-shaped saltwater natural pearl (Figure 2). In addition, the centre of the larger sautoir was accentuated by a small button-shaped assembled cultured blister (a so-called mabé) of matching colour, presumably an early product of pearl cultivation. Original drawings of the design are documented in a book by Sigrid Barten (René Lalique, Schmuck und Objet d'Art 1890-1910, Prestel-Verlag, München 1989).

Based on the provided documentation, these two pearl sautoirs were formerly in the collection of Countess Edmond de Pourtalès, who was a leading figure of the Parisian society in the late 19th century. The initials 'E' and 'M', artistically integrated into the necklace design (Figure 2), are presumably a reference to the first names of her husband 'Edmond' and herself 'Mélanie'.

△ **Figure 2:** Details of the pearl sautoirs, showing the pearl pendant with black and white enamel and small purplish amethyst cabochons (left side) and the intials "E" and "M", artistically integrated into the necklace design. Photo: M. Bichsel, SSEF.

JADEITE JADE TESTED BY SSEF RECENTLY SOLD AT SOTHEBY'S HONG KONG

△ **Figure 1:** Selection of jadeite jades of exceptional quality which were analysed by SSEF and recently sold at the Sotheby's auction in Hong Kong. Photo: A. Chalain, SSEF

In the past few months, SSEF has again tested jadeite jade jewellery and carvings of outstanding quality. Among these was a jadeite jade bangle of 70 mm diameter characterised by a subtle range of green to vivid green colours, which sold for 30 million HK$ (ca. 3.5 million CHF) in April 2021 at Sotheby's Hong Kong, among other jadeite jade items accompanied by SSEF reports (Figure 1).

The testing of jadeite jade requires a rigorous analytical protocol, including chemical (e.g. EDXRF), structural (FTIR and Raman spectroscopy) and UV-Vis absorption analyses, apart from classic methods (UV reaction, RI, SG). Firstly, this is due to the fact that jadeite jade used in jewellery consists of polycrystalline aggregates (i.e. rocks), which may contain grains/crystallites of other rock-forming minerals, such as amphiboles or feldspars to name a few. The compositional complexity is further amplified by the fact that jadeite ($NaAlSi_2O_6$), mineralogically a member of the pyroxene group, forms solid solutions with other pyroxenes, such as kosmochlore ($NaCrSi_2O_6$), diopside ($MgCaSi_2O_6$), and notably with the intermediate pyroxene member omphacite $(Ca,Na)(Mg,Fe^{2+},Al)\ Si_2O_6$. As such, many jadeites may contain certain amounts of these structurally related pyroxene members, shifting the chemical composition of such an item away from ideally composed pure jadeite. Nomenclature issues may thus arise from a scientific mineralogical point of view, which also affect the gem trade (see for example Franz et al. 2014).

In addition, jadeite jade of lower quality is often deeply impregnated with oil, wax or even artificial resin (known as B-jade in the Asian trade), or even dyed (C-jade). Thus, meticulous testing is also necessary to detect any such treatment applied to jadeite jade.

The above-presented examples of green jadeite jades of very fine quality are more straightforward in testing, as they are basically pure jadeite, only with substitution of minor amounts of chromium (and some iron) on the aluminium site of its crystal structures. The presence of chromium accounts for a beautiful saturated emerald green colour, which poetically may also be referred to as 'Imperial green' in the trade.

Jadeite jades of very fine quality are characterised by a pronounced translucency as an additional attribute of beauty. This effect is a result of the fine and densely interlocked texture of jadeite-jade. It results in a very attractive 'glowing' effect through the scattering of light when illuminated by a light source, thus greatly contributing to the beauty of these treasures of nature.

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HISTORIC EMERALD PARURE AT SSEF

To analyse historic jewellery items of outstanding quality and documented provenance is always a highlight at SSEF.

This was the case again last year with an outstanding emerald and diamond parure (Figure 1), which finally sold for ca. US$ 1.2 million at Sotheby's Geneva in November 2020. The jewellery suite consisted of a necklace with a pendant, a pair of ear-pendants, and two fittings, all set with a fine selection of colourless diamonds and small emeralds in an artistic floral design characteristic of the late 18th century.

Gemmological testing was carried out on the 14 main emeralds of this jewellery item and revealed that they all originated from Colombia, showing only a minor amount of oil in fissures.

Based on the provided information, this emerald jewellery suite has a documented historical provenance, linked to the Spanish noble family of Manuel de Guirior y Portal, viceroy of New-Granada (today Colombia, Venezuela, Ecuador and Panama) and Peru in the late 18th century. Given to his wife Maria Ventura de Guirior, it was then passed on for generations within the family and was referenced as the Virreina Suite in the family archives.

NEW SERVICE: GEMTRACK™ FOR ANY GEM OR PEARL RESUBMITTED TO SSEF

In 2019, SSEF successfully launched the GemTrackTM service, which tracks the journey of a stone through the gem trade. Normally, such a GemTrack document is issued on client request when we analyse a cut gemstone (loose or set) which we have analysed before as a rough stone. Since its launch, we have issued GemTrack documents for numerous gemstone species, including ruby, sapphire, emerald, and tsavorite garnet, to name a few (see also SSEF Facette No. 26, 2020; pages 12-13).

As the documentation and tracking of gemstones becomes more important for the trade, we have decided to offer our GemTrack as an on-request service for any gemstone or pearl which is resubmitted to SSEF. We are able to do so, as we have stored the data of all gemstones and pearls for which SSEF has ever issued a report since SSEF was founded back in 1974. As such, we can compare and ultimately confirm, that a gemstone or pearl which is submitted to us today is the same item which had been analysed previously by SSEF. This comparison and confirmation is feasible regardless of whether the gemstone or pearl is loose, mounted in jewellery, or has been recut in the meantime.

Such a document can support the trade in a number of cases such as for example:

- A gemstone originally in a vintage setting which is now loose and slightly recut/repolished.
- A gemstone of historic provenance (e.g. documented in auction catalogue) which is now loose and slightly recut/repolished
- To document that a gemstone has a tracking history in the trade and is not from recent mining production.

We are convinced that our new and extended GemTrack service comes very timely as it supports the gem trade in its endeavour to document and track the journey of gemstones and pearls through time and within the trade. In addition, we consider it a very valuable option to add a fascinating facet of storytelling to prestigious and important gems and jewels, many of which have been analysed repeatedly over time by SSEF.

Please don't hesitate to contact us if you have any further questions about GemTrack.

SCHWEIZERISCHES GEMMOLOGISCHES INSTITUT
SWISS GEMMOLOGICAL INSTITUTE
INSTITUT SUISSE DE GEMMOLOGIE

SPECIMEN

SSEF GEMTRACK™ DOCUMENT

SAPPHIRE RING

Testing by SSEF (Report No. AAAAA)

Date of Testing:	16 June 2009
Declared Weight:	4.38 ct
Measurements (approx.):	9.70 x 7.45 x 6.10 mm

LOOSE SAPPHIRE

Testing by SSEF (Report No. BBBBB)

Date of Testing:	12 January 2021
Weight:	4.165 ct
Measurements:	9.61 x 7.23 x 6.03 mm

TRACKING RECORD

1 The sapphire set in a ring (declared 4.38 ct) was submitted to SSEF and meticulously analysed and characterised on the 16th of June 2009.

2 Based on the provided documentation, the sapphire ring was sold on 29th of November 2009 at auction in Hong Kong.

3 After a slight recut, the sapphire (4.165 ct) was resubmitted to SSEF and extensively analysed on the 12th of January 2021.
Gemmological analyses by SSEF indicate a Burmese origin for this sapphire.

Based on the consistency of the analysed properties, trace-element chemistry, microscopic inclusions and other internal features, we confirm that the sapphire of 4.165 ct described in SSEF Gemstone Report No. BBBBB is the same as the sapphire analysed in 2009 (SSEF Test Report AAAAA).

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

Mandatory document verification: www.myssef.ch

UNDER THE FOCUS: ORNAMENTAL STONES

△ **A selection of ornamental stones prepared for the Summer ID Quiz. Photo: H.A. Hänni.**

In Corona times where gemmological meetings are cancelled, practical exercises in groups cannot take place, it is vital to offer pieces of information to the gemmological community to keep our 'fire' burning. Last year the author delivered a quiz via internet to the members of the Swiss Gemmological Society. They had to visually (based on a photo, Figure 1) identify a number of ornamental stones, from clear cases to more complicated guess opinions. After a couple of days the results were delivered, and no winner was acclaimed as it was more about training one's gem knowledge on an individual basis. Some people may have seen or heard about pietersite, tugtupite or graphic granite for the first time. Ornamental stones, by the way, are from the mineral/rock kingdom, usually opaque with an interesting colour and/or pattern.

Preparing the material to assemble this set of cabochons I realised how little was known about these mineral aggregates or rocks. While names were easily disseminated in the trade, especially of healing stones, sound scientific information on mineral identification and composition, or physical characteristics is scarce.

Against this background a project appeared as an interesting venture: What is the hardness of different ornamental stones? A hardness scale is long standing for minerals: the Mohs' hardness scale, introduced for homogeneous materials. But how is the resistance against abrasion of massive or polycrystalline mineral assemblages tested or quantified?

In the literature dating back approx. 130 years back, there are articles from August Rosiwal (1860-1923) on the grinding hardness of minerals and rocks. He worked on the mechanical resistance of construction materials too. He measured the loss of volume of a normalised body treated under repeatable conditions. As carborundum was just invented as an abrasive, he used natural corundum of a given grain size as an abrasive. In his scale of grinding hardness, quartz got a relative value of 117, later 100.

As Idar-Oberstein is a world centre for gemstone cutting and trading, I thought it would be a good source of testing material to update the grinding hardness concept. Groh & Ripp, an internationally renowned cutting and trading company was ready to deliver 25 samples of ornamental stones. They were cut precisely into 20x20 mm cubes, six of each kind, to get representative results. At the University of Basel, the sample cubes were abraded under controlled conditions, with grit 400 SiC, pressed with a weight of 4 kg against the iron lap. The weight loss was measured and a relative grinding hardness (GH) to quartz was calculated.

△ **The lapping machine from Basel University charged with sample cubes for the relative grinding hardness measurements. Photo: H.A. Hänni.**

The sampled rocks were also investigated by petrographer Prof. Dr. L. Franz in order to identify existent mineral components, relative amounts and texture. For many of the ornamental stones these were the first qualitative and quantitative analyses done on petrographic thin sections.

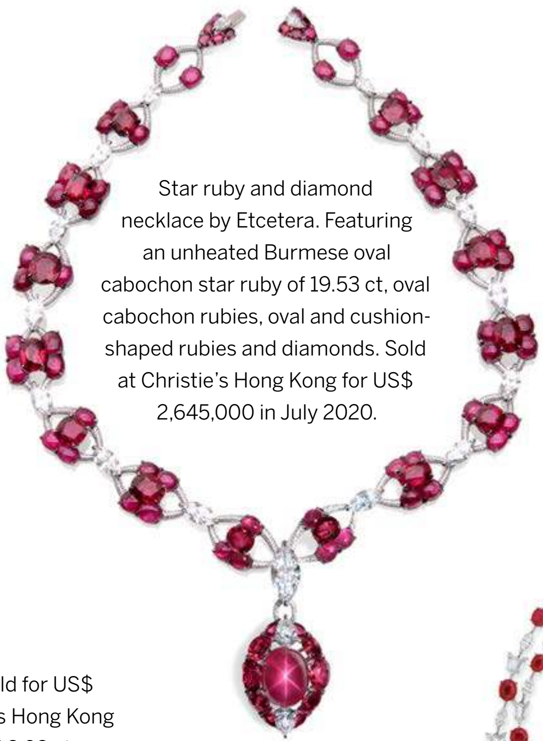
△ **Sample cubes of ornamental stones for grinding hardness (GH) measurements in preparation. Photo: H.A. Hänni.**

Interestingly, GH values varied from 20 (Verdite) to chalcedony 174. SiO_2 as quartz with a GH value of 100 is thus much less resistant to abrasion than SiO_2 as chalcedony! Fibrous or granular textures seem have an important influence on relative GH values.

More results will appear soon in the upcoming Journal of Gemmology and Zeitschrift der Deutschen Gemmologischen Gesellschaft.

*** Prof. Dr. H.A. Hänni, senior research associate SSEF**

Ring with a no-heat pigeon blood red ruby (6.06 ct) from Burma. Sold at Christie's Hong Kong in July 2020 for US$ 1,285,000. Photo: Christie's.



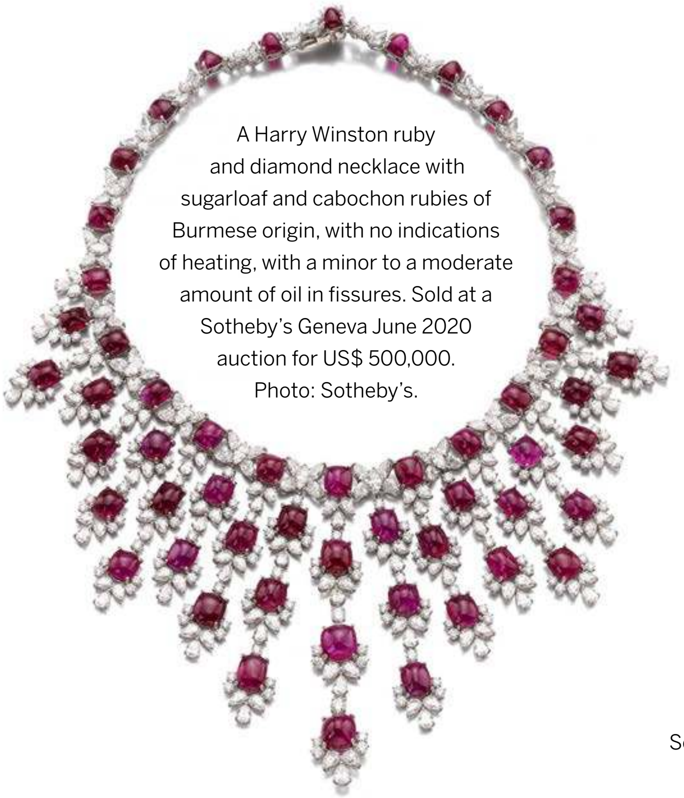
Star ruby and diamond necklace by Etcetera. Featuring an unheated Burmese oval cabochon star ruby of 19.53 ct, oval cabochon rubies, oval and cushion-shaped rubies and diamonds. Sold at Christie's Hong Kong for US$ 2,645,000 in July 2020.

Pair of unheated Burmese rubies mounted in earrings (9.42 ct and 6.79 ct). Sold for US$ 1,177,000 at Christie's November 2020 Hong Kong sale. Photo: Christie's.

Pair of ruby and diamond earrings sold for US$ 650,000 at the November 2020 Phillips Hong Kong jewels auction. The rubies of 3.34 ct and 3.03 ct were both no-heat Burmese and of pigeon blood red colour. Photo: Phillips.

Ruby and diamond necklace by Faidee featuring 35 unheated Burmese rubies (total 51.28 ct). Sold at a Christie's auction in Hong Kong in November 2020 for US$ 1,333,000. Photo: Christie's.

Unheated Burmese ruby of 13.01 ct in a ring by JAR. Sold at Christie's Geneva November 2020 auction for US$ 1,040,000. Photo: Christie's.



A Harry Winston ruby and diamond necklace with sugarloaf and cabochon rubies of Burmese origin, with no indications of heating, with a minor to a moderate amount of oil in fissures. Sold at a Sotheby's Geneva June 2020 auction for US$ 500,000. Photo: Sotheby's.

A ruby and diamond ring by Graff with an unheated East African ruby of 9.44 ct that sold for US$ 358,000 in Geneva at a Sotheby's auction in November 2020. Photo: Sotheby's.

3.25 ct no-heat Burmese pigeon blood red ruby in ring. Sold at Sotheby's Hong Kong in July 2020 for US$ 145,000. Photo: Sotheby's.

3.05 ct no-heat Burmese pigeon blood red ruby in ring. Sold at Sotheby's Geneva in November 2020 for US$ 345,000. Photo: Sotheby's.

6.41 ct unheated Burmese ruby in a ring. Sold for US$ 2,833,000 at Sotheby's Hong Kong in October 2020. Photo: Sotheby's.

Unheated Kashmir cushion-shaped sapphire (43.10 ct) of royal blue colour, in a bracelet. Sold for US$ 6,030,000 at Christie's New York in December 2020. Photo: Christie's.

105.89 ct Ceylon sapphire with no indications of heating set in a ring. Sold for US$ 1,790,000 at Sotheby's Geneva in June 2020. Photo: Sotheby's.

Oval pyramidal cabochon sapphire of 21.73 carats from Kashmir of royal blue colour and with no indications of heating. Sold for US$ 1,722,000 at Christie's New York in December 2020. Photo: Christie's.

Unheated cushion-shaped sapphire of 14.70 ct from Kashmir. Sold for US$ 1,330,000 at Christie's Hong Kong in July 2020. Photo: Christie's.

Necklace with three unheated Kashmir sapphires (12.81 ct, 6.50 ct, 2.74 ct). Sold for US$ 1,487,000 at Christie's Hong Kong sale in July 2020. Photo: Christie's.

Kashmir cushion-cut sapphire (19.24 ct) with no indications of heating. Achieved US$ 1,532,500 at the Sotheby's New York October 2020 sale. Photo: Sotheby's.

An Art deco sapphire and diamond brooch by Cartier featuring a 12.64 ct unheated Kashmir sapphire of royal blue colour. Sold for US$ 1,530,000 at the Christie's New York December 2020 sale. Photo: Christie's.

Burma no-heat sapphire of 80.86 ct set in a necklace. Sold at Christie's New York sale in December 2020 for US$ 1,110,000. Photo: Christie's.

Ring with a 19.42 ct unheated Kashmir sapphire, sold at Phillips' New York December 2020 auction for US$ 877,000. Photo: Phillips.

Sapphire ring with an unheated Kashmir stone of 12.77 ct. Sold for US$ 719,000 at a Sotheby's HK July 2020 auction. Photo: Sotheby's.

Pair of pendent earrings with two unheated sapphires from Kashmir (11.06 ct and 9.20 ct). Sold for US$ 1,037,000 at the Sotheby's Hong Kong October 2020 sale. Photo: Sotheby's.

16.08 ct Colombian emerald set in a Harry Winston ring, with no indications of clarity modification. Achieved US$ 803,000 at the Sotheby's Hong Kong October 2020 sale. Photo: Sotheby's.

21.86 ct Colombian emerald with a minor amount of oil, set in a ring. Sold at Sotheby's New York December 2020 auction for US$ 3,650,000. Photo: Sotheby's.

Emerald and diamond necklace (circa 1860) with emeralds from Colombia with none to moderate amounts of oil in fissures at the time of testing. Sold for US$ 487,000 at Sotheby's Geneva in June 2020.

An emerald and diamond parure from circa 1770. The fourteen largest emeralds are of Colombian origin, with a minor amount of oil in fissures. Sold for US$ 1,081,000 at Sotheby's Geneva auction in November 2020.

16.04 ct Colombian emerald set in a ring, with no indications of clarity modification. Achieved US$ 719,000 at the Sotheby's Hong Kong July 2020 sale. Photo: Sotheby's

Colombian emerald (9.26 ct) with no indications of clarity modification set in a ring with diamonds. Sold at Sotheby's Hong Kong in October 2020 for US$ 1,240,000. Photo: Sotheby's.

Emerald and gold sautoir with a hexagonal step-cut emerald of 172.41 carat (Colombia, minor oil). Realised US$ 537,500 at the Christie's December 2020 auction in New York. Photo: Christie's.

10.00 ct Colombian emerald with no indications of clarity modification, set in a ring. Sold at Bonhams's Hong Kong sale in November 2020 for US$ 452,000. Photo: Bonhams.

Emerald and diamond earrings with four emeralds (9.00, 8.85, 2.11 and 2.02 ct) from Colombia with no indications of clarity modification (three of the stones tested by SSEF). Sold for US$ 1,039,000 at Christie's Hong Kong in November 2020. Photo: Christie's.

Emerald and diamond ring by Bulgari, with a 6.38 ct Colombian emerald with no indications of clarity modification. Sold at a Phillips Hong Kong July 2020 sale for US$ 403,000. Photo: Phillips.

A pearl necklace with twenty-five pearls saltwater natural pearls and two cultured pearls, with no indications of artificial colour modification ranging from 7.15 to 16.90 mm in size. Sold at Sotheby's Paris for US$ 546,000 in June 2020. Photo: Sotheby's.

A button-shaped light brownish grey saltwater natural pearl (18.23 - 18.56 x 14.26mm) mounted in a Bulgari ring. Sold for US$ 172,000 at a Sotheby's Geneva November 2020 sale. Photo: Sotheby's.

A pair of natural pearl and diamond earrings with two drop-shaped saltwater natural pearls. Sold for US$ 248,000 in November 2020 at a Sotheby's Geneva auction. Photo: Sotheby's.

Saltwater natural pearl earrings. Sold at Christie's Hong Kong in July 2020 for US$ 64,417. Photo: Christie's.

Late 19th century natural pearl and diamond tiara with 8 saltwater natural pearls. Sold at Christie's Geneva in July 2020 for US$ 133,000. Photo: Christie's.

Freshwater natural pearl brooch with a button-shaped natural pearl (14.20 - 14.50 x 11.40 mm). Sold at Christie's Hong Kong for US$ 31,000 in July 2020.

Natural saltwater graduated pearl necklace with pearl diameters ranging from 7.50 to 11.50 mm. Sold at Il Ponte Casa D'Aste auction (Milano) in November 2020 for US$154,000.

Earrings with four drop-shaped and button-shaped saltwater natural pearls. Price realised US$ 77,000 at a Christie's Geneva November 2020 auction. Photo: Christie's.

Natural pearl and diamond necklace with 85 saltwater natural pearls. Sold by Christie's Geneva in July 2020 for US$ 721,000. Photo: Christie's.

Pair of Paraiba tourmaline and diamond pendent earrings, of 2.59 ct (heated) and 2.32 ct (heat treatment not determinable) respectively. Sold for US$ 406,000 at Sotheby's in Hong Kong in October 2020. Photo: Sotheby's.

Coloured sapphire (11.89 ct) unheated from Ceylon in a ring with diamonds. Sold at Christie's New York December 2020 sale for US$ 87,500. Photo: Christie's.

Purple sapphire (17.07 ct) in a ring, SSEF testing concluding a Madagascar origin and no heat. Sold for US$ 89,000 at Phillips Hong Kong in November 2020. Photo: Phillips.

Red spinel from Burma (Myanmar) of 7.64 ct later mounted in a ring. Sold at Bonhams London in November 2020 for US$ 62,000.

Cat's eye chrysoberyl (12.03 ct) of Ceylon origin, with no indications of treatment, and with a strong cat's-eye effect (chatoyancy) mounted in a gold ring with carved rock crystal and diamonds. Sold for US$ 61,287 at a Sotheby's auction in Hong Kong in July 2020. Photo: Sotheby's.

Two purplish pink sapphires (4.26 ct and 4.06 ct) mounted in pendent earrings. Realised US$ 45,159 at the Sotheby's Hong Kong July 2020 sale. Photo: Sotheby's.

Conch pearl (36.28 grains) and diamond brooch / pendant. Sold for US$ 35,742 at Sotheby's October Hong Kong auction. Photo: Sotheby's.

Ring set with a 10.54 ct cabochon Paraiba tourmaline, the stone being of Brazilian origin, with indications of heating and minor amount of oil in fissures at the time of testing. Price achieved was US$ 21,000 at Sotheby's Hong Kong's July 2020 sale. Photo: Sotheby's.

Fancy sapphire and diamond ring, with an unheated Madagascar fancy sapphire that showed an unstable colour subsequent to a colour stability test. It sold for US$ 22,680 at Sotheby's New York in December 2020. Photo: Sotheby's.

Emerald necklace designed by Edmond Chin for Boghossian. Featuring 28 emeralds from 1.48 to 10.41 ct (total 117.6 carats) all without indications of clarity modification and from Colombia. Accompanied by documentation from the Muzo mine. Sold for HKD 54,250,000 (US$ 7 million) at Christie's Hong Kong in November 2020. Photo: SSEF.

FREE ONLINE COURSES ON MAJOR GEMS IN ENGLISH, FRENCH AND SIMPLIFIED CHINESE

In April 2021, SSEF launched a series of free-of-charge, online courses, entitled 'Understanding Gemstones'. With each covering a specific gem, the courses are comprehensive and self-paced by the student, who is able to start and complete them at any time via our Internet-based learning platform.

The courses are available in English, French and simplified Chinese. The gems currently covered are diamonds, emeralds, pearls, rubies and sapphires. We plan on adding more gems and languages to the selection of courses in the future.

Each course provides students with an introduction to the selected gem, its history, properties, information about how it is formed, the locations from which it is sourced, treatments that it may be subject to, and, when relevant, its synthetic counterparts.

At the end of each course, students are presented with a quiz, and if they pass are awarded a certificate of completion for that unit.

This new online offering builds on our in-person courses, which began more than two decades ago and range from introductory practical gemmology all the way to scientific gemmology. As a non-profit Swiss foundation, SSEF's mission is to carry out gem research and provide gem education.

We have the privilege of testing many of the world's most famous and exceptional gemstones, and as a consequence have amassed a vast quantity of knowledge that we would like to make available to the industry and jewellery buying public. Recent advances in online learning and technology enables us to launch these online courses, to share our knowledge and passion about gemstones, to a wide international audience at no cost to students.

We invite you to sign up for these courses and welcome your feedback and questions (education@ssef.ch).

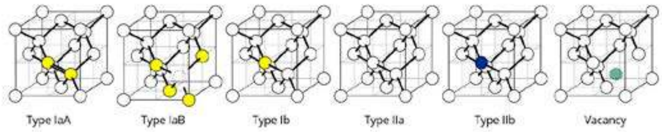
*** Dr. L.E. Cartier**

△ Learn all about the different sources of natural and cultured pearls. Map: SSEF.

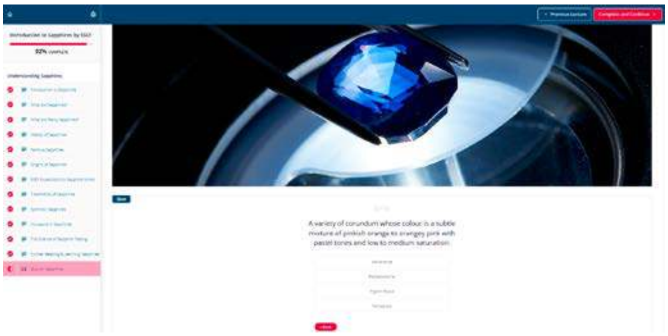
△ Royal blue? Kashmir? Explore colour terms and sapphire origins with the new free online course on sapphires. Photo: SSEF.

△ Expand your knowledge on the major sources of gem-quality emeralds in today's market. Photos: SSEF.

△ Want to learn more about ruby cutting and the different shapes commonly found in the trade? Photos: SSEF.



△ The different diamond types found. The online course also covers an overview of grading and scientific testing of diamonds. Illustrations: L. Speich, SSEF.



△ A quiz at the end of each course tests your knowledge.

NEW COURSE ON THE HISTORY OF GEMS AND JEWELLERY

In 2021, we are launching a new advanced training course entitled 'Gems & Jewellery: History, Identification and Important Trends' This course is unique in that it combines the history and significance of gems in historic and modern jewellery. It is taught in collaboration with jewellery historian Vanessa Cron. It will be taking place for the first time in October 2021.

The course will explore the different uses of gems through history, and how these link with different periods of jewellery. Through this approach, students will learn about criteria to identify historic jewellery that contains gems, and gain insight into possible criteria for valuation. Students will also learn about fakes and imitations through time, and criteria to identify these. This course is taught in small groups, and will include workshops and practical work.

Who is this course for?

This course is ideal for people who are already active in the gem and jewellery trade. Linking gemmology knowledge to deeper knowledge about jewellery pieces will provide you with different perspectives on how to identify gems and jewellery from different ages. Expand your knowledge about the gems and jewellery you buy and sell. And gain a competitive edge by learning to identify key features using a loupe and microscope.

The 5-day course focuses on the following themes:

- THE GEM FACTOR: Cultural history and evolution
- THE TECHNICAL FACTOR: The hands behind the jewels
- THE DESIGN FACTOR: History of jewellery design
- UNDERSTANDING THE VISIBILITY FACTOR: How knowledge is shared
- IDENTIFYING TRENDS AND VALUE: Jewellery valuation

For more details about this course, visit our website: https://www.ssef.ch/courses or contact us by email (education@ssef.ch).

△ Antique jewellery and the world of gems and pearls found in these jewels is examined in the new course at SSEF. Photos: British Library & SSEF.

△ The Hope Spinel. Photo: Bonhams

△ A superb antique Indian emerald, diamond and enamel Sarpech sold by Christie's in 2012 and tested by SSEF. Photo: SSEF.

SSEF NOW A GEM-A GAPP CENTRE

Since 2020, SSEF is an approved practical provider for Gem-A's practical endorsement courses, a Gem-A Approved Practical Provider or so-called GAPP Centre. This means that Gem-A students who need to fulfill practical endorsements for both Gemmology Foundation and Gemmology Diploma courses can do this at SSEF. As has been the case for many years already, students can sit their Gem-A Gemmology and Diamond exams at SSEF.

We are pleased to continue our longstanding collaboration with Gem-A, and to now provide this practical endorsement option for students based in Switzerland and nearby.

In 2021 these practical endorsement courses will take place:

- 01 – 03 November 2021 Gem-A Gemmology Foundation Practical Endorsement
- 01 – 05 November 2021 Gem-A Gemmology Diploma Practical Endorsement

For more information see: https://www.ssef.ch/gem-a-courses-exams/

HOW DO PEARLS FORM?

We often get the question of how pearls form, both natural and cultured pearls. It can be hard to describe it in words. And the theory of the sand grain is still very widespread even though after having studied thousands of natural pearls we have never found a grain of sand in one.

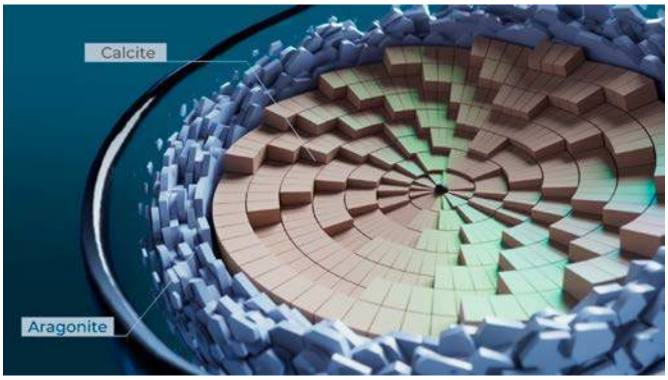
In an attempt to better share our understanding of how both natural and cultured pearls form, we worked with a 3D animation video company to illustrate schematically how these could form. As a result, we now have two short videos available online that share the process. They are complemented by wonderful footage from Andy Bardon and Josh Humbert from pearling regions.

If you are interested in learning more about pearl formation and the different types of pearls, sign up for the ATC pearl course 22-23 November 2021.

*** Dr. L.E. Cartier**

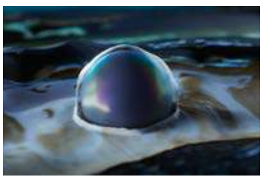
△ Scan this QR code to watch the natural pearl video

△ Scan this QR code to watch the cultured pearl video



△ Schematic buildup of a natural pearl with organic matter, calcite and aragonite.

△ Cultured pearl technician at work in Ahe, French Polynesia. Photo courtesy of Andy Bardon.



△ A natural pearl within a pearl sac in the mantle region of the oyster.

◁ A bead and mantle tissue piece inserted into the gonad of an oyster can lead to the formation of a beaded cultured pearl.

SSEF COURSES
in 2021

2020 saw international travel come to a near halt and so there was less activity in our courses at SSEF. However, we are pleased that this gave us time both to launch free online courses, revamp existing courses and develop new courses for 2021. The Scientific Gemmology Course (SGC) is back in a new format where we focus on portable scientific instruments for gemmological analysis. And we're happy to unveil a new course that will focus on the history of gems and jewellery.
In 2021, we will again be offering a wide range of courses. The SSEF Basic Gemmology Course (23 August – 03 September and 29 November - 10 November 2021) and the SSEF Basic Diamond Course (11 - 15 October 2021) offer good introductions, and participants can graduate with a certificate after taking theoretical and practical examinations. For more in-depth courses we offer Advanced Training Courses on coloured gemstones, pearls, small diamonds, and we are launching this year a course on the history of gems and jewellery. Finally, the Scientific Gemmology Course (SGC) is an ideal course for those interested in learning about the advanced instruments used in laboratory gemmology today.
As we became a Gem-A approved practical provider in 2020, we now also offer ODL Gem-A students the possibility of taking the practical workshops with us in Basel.

ADVANCED PEARL COURSE

This two-day pearl course (22-23 November 2021) 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 a good opportunity for practicing and expanding your skills and knowledge of pearls. The course also offers an introduction into the use of UV-visible spectrometry, EDXRF, X-ray radiography and luminescence for pearl testing in a scientific laboratory.

ADVANCED COLOURED GEMSTONES COURSE

The advanced coloured gemstone training course is an intense gemmological programme that offers a detailed hands-on approach to identifying treatment and origin of ruby, sapphire and emerald. The last remaining spots are available for the course 12 – 16 July 2021 and 18 – 22 October 2021. 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 GEMS & JEWELLERY COURSE

This new advanced training course 'Gems & 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. It is taught in collaboration with jewellery historian Vanessa Cron.

ADVANCED SMALL DIAMOND COURSE

The SSEF small diamond course (28 – 30 September 2021), which focuses on diamonds of a diameter between 0.7 and 3.8 mm, mainly used in the watch industry, enables participants to themselves perform the quality control of such small diamonds. These courses are aimed at people working in the jewellery and watch industry, and can be tailored to your company's specific needs. Previous gemmological experience is welcome but not a requirement.

SCIENTIFIC GEMMOLOGY COURSE

The one-week Scientific Gemmology course has been revamped and is back in our course offerings in 2021. The focus remains 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.

SSEF COMPANY COURSES

The SSEF Swiss Gemmological Institute can personalise a course based on your or your company's specific requirements. This course format is especially suited for companies that need specific gemmological training for their employees. In 2020, a number of companies (including Cartier, Hermès, and Rolex) 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 **2022 course dates**: check our website, follow us on social media (Instagram, LinkedIn, and Twitter) or subscribe to our newsletter (https://www.ssef.ch/newsletter/).

△ **Participants of the Advanced Training Course on Coloured Gemstones at SSEF in July 2020. Photo: SSEF.**

CONGRATULATIONS:

The Swiss Gemmological Institute SSEF wants to express its congratulations to the following persons for graduating from the following courses in 2020 and early 2021:

Basic Gemmology Course

- Elena Staub
- Mayank Umrigar
- He Qiming
- Silvia Magi
- Claudia Vanotti
- Charlotte Angéloz
- Lulu Bühlmann-Yu
- Axelle Dorado
- Anaëlle Tock
- Andrew Hajjar
- Tanja Nievergelt

Basic Diamond Course

- Norbert Paul Sarr
- Thomas Weller

Advanced Gemstone Course

- Claire Mestrallet
- Elli Abramov
- Sunny Ben David
- Yevhen Katrusha
- Thomas Weller
- Andrew Hajjar
- Sarah Degen
- Lilith Schacherer
- Astrid Bosshard
- Renée König
- Archit Rakyan

△ **Participants in the September 2020 Basic Gemmology Course at SSEF. Photo: SSEF.**

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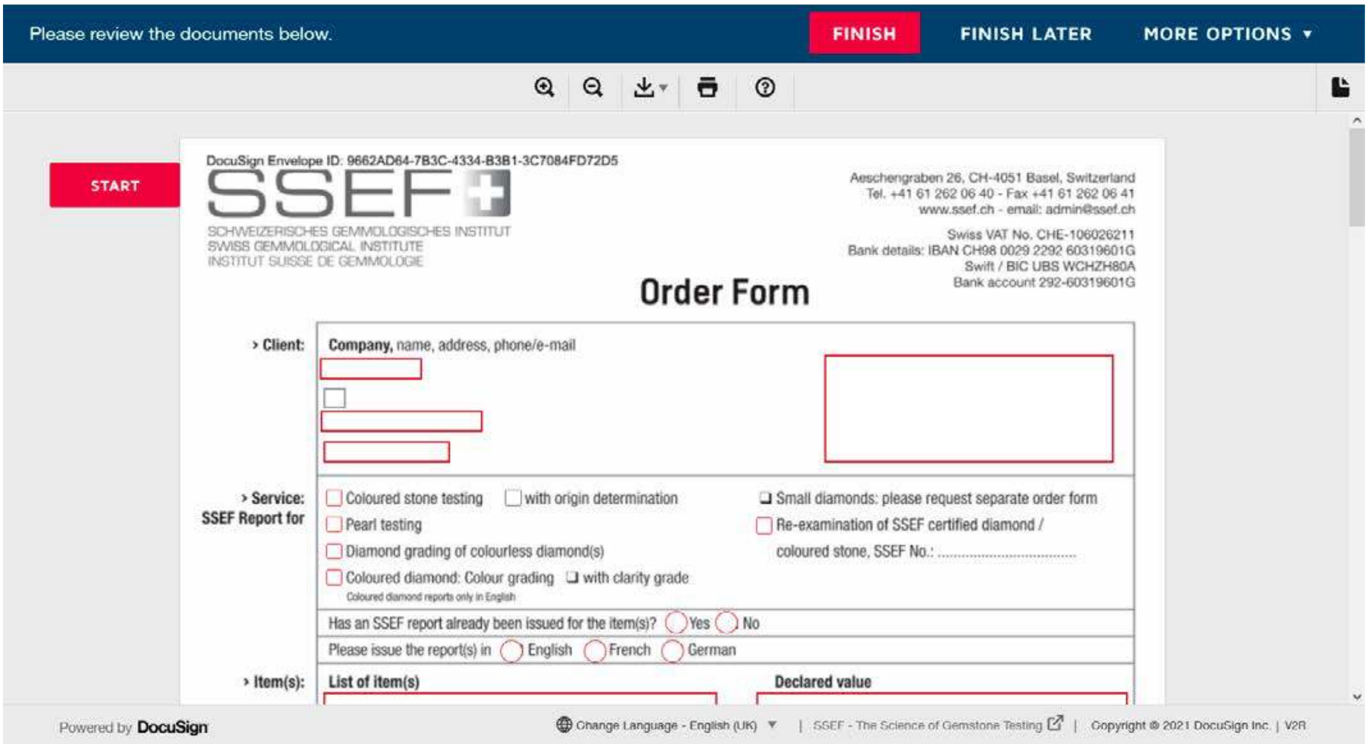
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Bank details: IBAN CH98 0029 2292 603196010G
Swift / BIC UBS WCHZH80A
Bank account 292-60319601G

Order Form

› Client: Company, name, address, phone/e-mail

› Service: SSEF Report for
- Coloured stone testing
- with origin determination
- Pearl testing
- Diamond grading of colourless diamond(s)
- Coloured diamond: Colour grading
- with clarity grade

Coloured diamond reports only in English
- Small diamonds: please request separate order form
- Re-examination of SSEF certified diamond / coloured stone, SSEF No.: ....

Has an SSEF report already been issued for the item(s)? Yes No

Please issue the report(s) in English French German

› Item(s): List of item(s) Declared value

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In order to simplify testing submissions to SSEF we now provide clients the option of filling out a digital order form. These new order forms are quicker and easier to fill out, given that the signing process can be carried out fully digitally. https://www.ssef.ch/order

Please note that all gems or jewellery submitted to SSEF for testing require an order form to be filled out and signed.

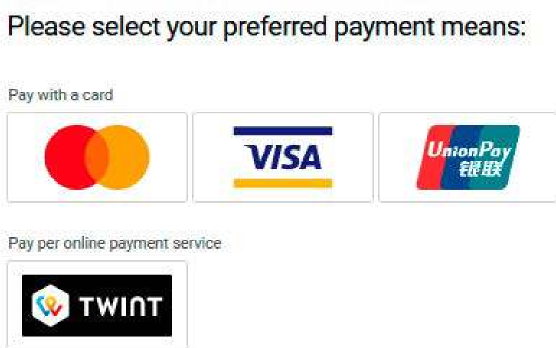
If you prefer to continue filling out the traditional PDF form, this will continue to be available on our website.

PAY YOUR INVOICES BY CREDIT CARD

It is now possible to pay for testing invoices and course invoices by credit card online through a dedicated platform on the mySSEF website. We accept Mastercard, Visa and UnionPay for online credit card payments. When making a payment, please add the correct SSEF invoice number. If you have any questions you can contact us at any time by email (admin@ssef.ch) or phone (+41612620640).

The secure payment page can be accessed here: https://myssef.ch/payments

This same mySSEF website must be used for report verification, which is mandatory to check the validity of an SSEF report. Your reports can easily be verified on this dedicated website: https://myssef.ch



SSEF-FERRARI SHUTTLE SERVICE

FREE SHIPPING TO SSEF IN 2021.
FOR DESTINATIONS AND CONDITIONS SEE WWW.SSEF.CH

DAILY SHUTTLE BETWEEN GENEVA - SSEF

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

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

WEEKLY SHUTTLE BETWEEN LONDON, PARIS, MONACO - SSEF

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

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

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

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

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

ON REQUEST SHUTTLE BETWEEN SPAIN, TAIPEI - SSEF

call Ferrari **Spain** office **+34 915 572 648**
call Ferrari **Taipei** office: **+886 2 25078511**

Costs: on request

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

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

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

ON REQUEST SHUTTLE BETWEEN ITALY, ANTWERP - SSEF

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

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

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

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

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

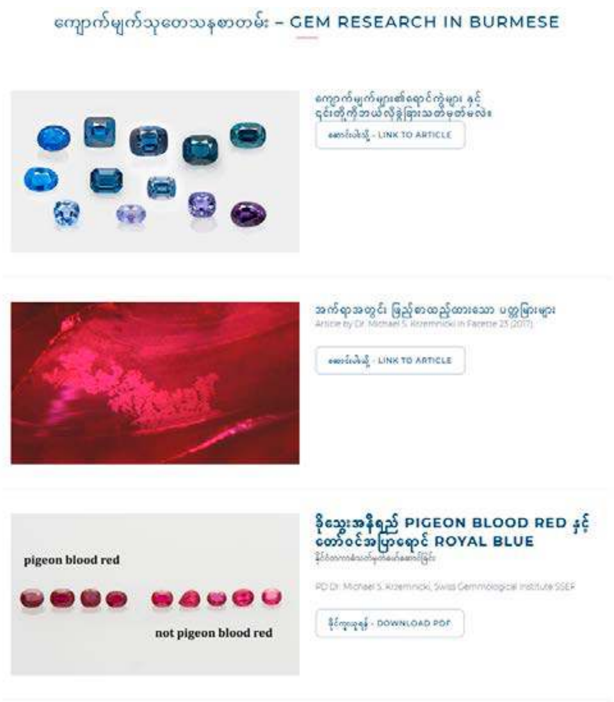
ON REQUEST SHUTTLE GERMANY - SSEF

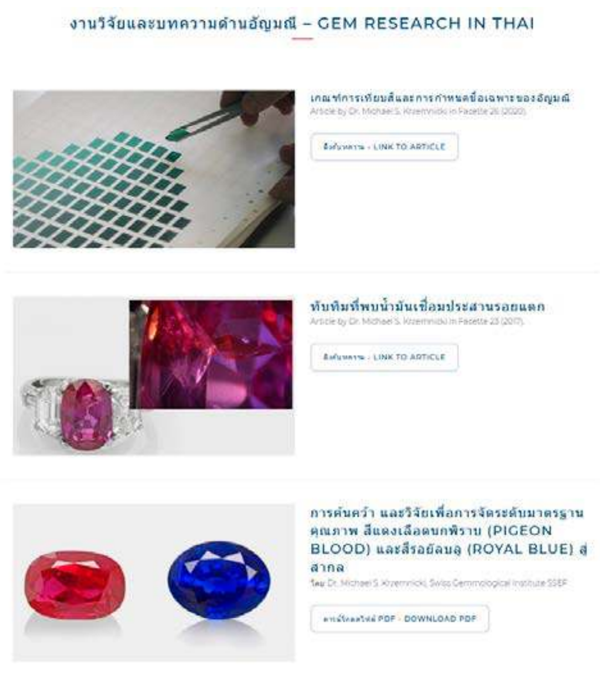
call Ferrari contractor office **Germany**
(Gerhard Enz GmbH) **+49 711 4598 420**

Costs: 350.- Swiss Francs per round trip and an additional liability fee of 0.035%
Example 1: declared 100'000 SFr > shipping costs: 275 SFr
Example 2: declared 1'000'000 SFr > shipping costs: 590 SFr

For all other destinations, please contact us. Pricing and conditions for shuttles may be subject to change.

SSEF RESEARCH IN BURMESE, CHINESE AND THAI





In our mission to share research findings to the wider gem community, we have translated a number of gem research articles into Burmese, Chinese and Thai languages.

These include overview articles on colour varieties of gems, pigeon blood and royal blue colour terms, and oil in rubies. The aim of translating these articles is to share our new research and testing methodology with traders and consumers in Burma, China and Thailand. All the articles are freely available online on our website.

Burmese: https://www.ssef.ch/gem-research-in-burmese/

Simplified Chinese: https://www.ssef.ch/zh-hans

Thai: https://www.ssef.ch/gem-research-in-thai/

ISO DIAMOND GRADING STANDARD

In September 2020, the International Standards Organisation ISO published the first-ever standard for diamond grading ISO 24016:2020 entitled "Jewellery and precious metals — Grading polished diamonds — Terminology, classification and test methods". It is purchasable either in English or in French on: https://www.iso.org/standard/79795.html . SSEF was happy to contribute to the development of this standard through Jean-Pierre Chalain's (head of SSEF's diamond department) involvement as convener for the international working group which drafted the standard.

The project for this ISO standard originates from a CIBJO initiative and was facilitated by the use of the CIBJO diamond grading standard PAS 1048 which served as a foundation for the final standard. It was supervised by the ISO Technical Committee for jewellery and precious metals chaired by Dr. Jonathan Jodry and was drafted by its working group 2.

This new standard was warmly welcomed by Dr. Gaetano Cavalieri, president of The World Jewellery Confederation CIBJO who announced "a historic moment for our industry" in a press release dated Sept. 23, 2020 (see: www. cibjo.org).

This new standard comes in addition to the ISO standard 18323:2015 for "Consumer Confidence in the Diamond Industry". This last standard describes the terminology that shall be used when trading diamonds, treated diamonds or synthetic diamonds. It was confirmed in 2020 through a systematic international voting process which occurs every five years at ISO.

In January 2021, the working group 2 of ISO TC 174 received a new work item proposal for drafting a standard on the quality control of small diamonds. This proposal was accepted in April 2021 following an international ballot vote and the work has been initiated.

IAJA AND JEWELERS CIRCLE

The International Antique Jewelers Association (IAJA) is a consortium of antique and period jewellers around the globe that was recently founded. The IAJA is committed to safeguarding the integrity and ethical behaviour of the industry by fostering the understanding and appreciation for antique jewels.

As part of IAJA's activities, they have initiated The Jewelers Circle. This is an international online trading platform that intends to expand the trade show model in support of the jewellery industry's current needs. Recognising a demand for a safe alternative to in-person trade events, where the fine and antique jewelry industry can source and sell products, gemstones, timepieces and other collectibles, The Jewelers Circle created a digital environment that allows approved vendors the ability to do so.

Developed for the trade by the trade, this portal will enable year-round transactions and connections that would normally take place at traditional trade shows. The platform utilizes proprietary technology designed with the direct input of the founders of the International Antique Jewelry Association (IAJA) to ensure easy navigation and an overall seamless experience.

SSEF is proud to be a partner of The Jewelers Circle and we support new initiatives such as this one which seek to foster networking and education in the trade. https://jewelerscircle.com/

NEW CIBJO WORKING GROUP FOR VARIETAL NAMES

△ **Padparadscha or not? that's the question. This photo groups padparadscha sapphires together with orange, pink and fancy sapphires which were tested recently at SSEF. Photo compiled by M.S. Krzemnicki, SSEF.**

In 2020, The World Jewellery Confederation CIBJO created a new working group to discuss nomenclature issues, mainly regarding the naming of colour varieties of gemstones (CIBJO CVN). From SSEF, Dr. Michael S. Krzemnicki and Jean-Pierre Chalain are participating in this working group of gemmological experts.

The naming of colour varieties of gemstones is an issue in the trade since many decades. In fact, there are two points which have to be addressed:

1) what is the correct definition for a variety name (e.g. emerald) ?

2) where to set the limit between two varieties of the same mineral, specifically if there is visually only a gradual colour shift separating one from the other.

Interested readers are referred to the lead article of the last SSEF Facette (No. 26, pages 6-9), where the procedures and internal standards of SSEF in this context are presented. An even more detailed insight is given in a lecture presented by Dr. Krzemnicki at international conferences in Europe, the USA, and Asia and is accessible online on our website (see www.ssef.ch/presentations).

It is the aim of this international working group to further harmonise the naming of gemstone varieties and by doing so to finally strengthen consumer confidence in the gem and jewellery trade.

*** Dr. M.S. Krzemnnicki**

CIBJO CONGRESS

Due to the pandemic, there was no CIBJO congress in 2020. Nevertheless, major CIBJO initiatives and projects of this past year are summarised in this article.

In 2020, many webinars were organised by CIBJO. This form of virtual conferences are surely a new form of communication that CIBJO has used to keep contact and discussions thriving in the jewellery trade at a time when in-person meetings were strongly discouraged. A series of approximately 45 different webinars with discussion and leading insights from experts in gemmology and in various trade issues.

All throughout the year, the different CIBJO commissions were working hard on updating their CIBJO blue books. Most of these documents are now available on: www.cibjo.org/introduction-to-the-blue-books-2/

In February 2021, CIBJO also launched a new website strictly dedicated to diamonds. Its purpose is to present to both the trade and end consumers in a very simple and understandable language the terminology that applies when buying or selling diamonds or synthetic diamonds.

www.whatisadiamond.org

It is also worth noting in this article that CIBJO recently confirmed the Swiss Federation of the Watch Industry FH as a new CIBJO member. This shows the importance of CIBJO in bringing together different parts of our industry in order to strengthen consumer confidence.

*** J.-P. Chalain**

INVITED KEYNOTE LECTURES IN CHINA

In October 2020, Dr. Michael S. Krzemnicki was invited as a keynote speaker to the Wuhan International Gems & Jewelries Conference. This annual event is organised by the Gemmological Institute of China at the University of Geosciences (Wuhan). In 2020, it was held as an online conference due to the Corona pandemic and international travel restrictions.

In his first conference contribution, Dr. Krzemnicki was talking about variety names of coloured gemstones and the standards and procedures to distinguish and separate between colour varieties at SSEF. The second webinar focused on age dating as a new testing method to investigate gemstones (e.g. U-Pb radiomateric age dating) and biogenic gems (radiocarbon dating) in a gem lab.

For more information about the conference see: https://www.aconf.org/conf_175825/contribution.html

GEMFLIX EPISODE ON THE SCIENCE OF NATURAL PEARLS

With the onset of COVID-19, many industry talks and events went online. Although Gem X is a private social club for jewellery enthusiasts that was founded in New York City in 2017, it has since expanded to become a global community of friends, mentors and collaborators. A series of online talks about gems entitled 'Gemflix' was launched in 2020.

In September 2020, Dr. Michael S. Krzemnicki & Dr. Laurent E. Cartier of SSEF were invited to an episode of Gemflix to talk about natural pearls and latest scientific research in pearls. The event was guest hosted by Kimberly de Geer, PR specialist at BVLGARI and a member of Gem X Core.

Viewers were given an opportunity to peer into the process used to test some of the world's most famous pearls, like the Marie Antoinette, La Peregrina and Cowdray, and to identify masterful fakes. In addition to provenance and pearl grading, we discussed exciting advances in testing, like radiocarbon age dating that is revealing old trade routes and more about the lives of oysters.

We thoroughly enjoyed this format. This talk and the Gemflix archives can be viewed on the GemX website (www.gemx.club).

CIBJO – JEWELLERY INDUSTRY VOICES

With the arrival of Covid-19 and the abrupt (temporary) end to international travel, there was strong demand for gemmological exchanges and discussions. These moved online, and the World Jewellery Confederation CIBJO seized the opportunity and launched a webinar format with industry experts entitled 'Jewellery Industry Voices' (JIV). These discussions have been excellently organised and moderated by Dr. Gaetano Cavalieri, Edward Johnson and Steven Benson.

In July 2020, CIBJO organized a JIV webinar about the opportunities for sustainability in the pearl industry. Dr. Laurent E. Cartier of SSEF was invited to share his experiences linked to his research on this topic. He was joined by Peter Bracher (Paspaley Pearls, Australia), Jacques-Christophe Branellec (Jewelmer, Philippines) and Jeremy Shepherd (Pearl Paradise, USA).

In May 2021, Dr. Michael S. Krzemnicki was invited to join a conversation about origin in gemstones. This includes the role of a gem lab in research and education. Also, as responsible sourcing is becoming increasingly important in our industry, the role of origin is expanding to cover many other aspects in gem supply chain. He was joined by Dr. Assheton Stewart Carter (TDI, United Kingdom), Monica Stephenson (Anza Gems, USA) and Richa Goyal Sikri (Singapore) to thoroughly discuss the role of origin in gems today and in future.

These webinars are conversations about important issues in the trade, and can be consulted for free on CIBJO's Youtube channel or the dedicated page on their website (http://www.cibjo.org/webinars/).

STATEMENT BY THE SSEF FOUNDATION BOARD

The SSEF Foundation Board looks back upon a special year and is confident about the future. Since March 2020, SSEF staff have not been able to travel, as jewellery fairs have been cancelled or postponed worldwide. We want to use this page to share some reflections and updates from the Foundation Board.

The Swiss Gemmological Institute SSEF is part of the Swiss non-profit SSEF foundation. In addition to being under the aegis of the Swiss Federal Department of Home Affairs, SSEF is by law also required to have an independent foundation board. The board is not involved in the daily business of the lab, instead it provides oversight and strategic vision.

The members of the Foundation Board represent different parts of our trade, and work to support the mission of the SSEF lab. The Board is also guardian of the full independence of the SSEF as a non-profit organisation. The Foundation Board rarely makes public statements, and we hereby want to reiterate our support and vision for the SSEF lab.

The worldwide reputation of SSEF as a leading gemmological laboratory has been built through years of meticulous and dedicated work, scientific research, state-of-the art instrumentation, and collaborations with universities and research laboratories in Switzerland and abroad. The main asset, however, is the highly professional, long-standing and motivated SSEF team carrying out testing and research as a service to the trade.

In the past few years, research at SSEF using new advanced instruments and methods has resulted in an important extension of our scientific knowledge in gem testing. This is important as it keeps us abreast of both new treatment methods which constantly evolve over time, and the discovery of new gem deposits, which are rarely openly disclosed.

For many years, the trade (and end consumers) have been considering geographic origin as an important factor when assessing a gemstone. As the origin is rarely fully documented from its source, gemmological laboratories play a major role in geographic origin determination. Over the years, a gemmological laboratory may thus see a gemstone several times. Due to the constant evolution of scientific knowledge, it may happen in rare cases that a previous conclusion about the treatment status or origin has to be changed based on new scientific evidence.

SSEF continues to proceed in full transparency the well-established strategy of many years: to always follow the latest scientific knowledge. The Foundation Board acknowledges that the Swiss Gemmological Institute SSEF has to occasionally change a conclusion based on new scientific evidence. SSEF reports are issued based on the scientific knowledge at the time of testing, as indicated on each report and order form. If during a later re-evaluation our results change due to new scientific evidence, then the opinions presented on a report will also be changed. Clients who submit their gemstones to SSEF know this and have to accept that this is an essential part of how science proceeds.

Our testing policy is based on scientific evidence and it's an approach to which SSEF has adhered for many years. It has proven to be correct and has contributed to the high reputation of SSEF in the trade and beyond. The Corona pandemic has not changed anything about this, we thus look with confidence into the future.

*** M.A. Christen, President of the SSEF Foundation Board**

MELISSA WOLFGANG AMENC NEW IN THE SSEF FOUNDATION BOARD

The SSEF team would like to welcome Melissa Wolfgang Amenc, our newest member of the SSEF Foundation Board since June 2021. Mrs Wolfgang Amenc is a sixth-generation gem and jewellery dealer at Golay Fils & Stahl in Geneva, Switzerland. She is an active member of various gemmological associations, including the Swiss Gemstone Dealers Association (ASNP) and the Swiss delegation at CIBJO. In addition, she is the Co-Founder & President of The Glitterati (www.theglitterati.ch), a non-profit association creating synergies for women in the jewellery & watch industry through support, education & mentoring.

We are very glad to have her on board at SSEF with her expertise and commitment and we look forward to working closely with her as part of the SSEF board for many years to come.

CLOSE UP: ALEXANDER KLUMB, MSC, FGA

Alexander Klumb is working at SSEF since nearly 10 years. He started as a young student in Geosciences with a student job at SSEF, and got more and more involved in our gem testing procedures. After completion of his Master thesis at the University of Basel in 2014, he joined our team of gemmologists, where he has since become a gemmological expert with a strong focus on testing of coloured stones and pearls. In 2016, he successfully passed the FGA diploma examinations of the Gemmological Association of Great Britain with a diploma thesis about the Usambara effect in gemstones, which was later published as a summary in Gem-A's Gems & Jewellery.

Working with gemstones in a laboratory such as SSEF means not only to analyse client stones, but also to participate in research and to be eager to learn every day more about the fascinating scientific 'facets' of gems. With his geological background and training, Alexander is ideally positioned in his job as gemmologist, for which the study and understanding of the geological setting of gem deposits is a prerequisite to carry out origin determination of gemstones. As part of his ongoing research in gems, he thus joined the SSEF expedition to Brazil in 2018 to collect first-hand samples from the pegmatites in Paraiba and Rio Grande do Norte.

Over the past few years, the SSEF team has grown, thus bringing together people of different ages and cultures. To move forward successfully, such enterprise requires staff who are willing and able to interact and to play along harmonically like in a classic symphony orchestra. Alexander, with his strong musical background as a trumpet player in a brass band is perfectly fitting in our team whether in our main office in Basel or on tour when we are playing live, offering our on-site services around the world.

*** Dr. M.S. Krzemnicki**

DONATIONS

As in previous years, we are grateful for numerous donations we received in 2020 and 2021 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 of educating course participants and to give them the opportunity to learn gemstone & pearl testing on a wide variety of untreated and treated materials.

PEARL DONATIONS

Cygnet Bay Pearls (Australia), Henry A. Hänni (GemExpert, Basel), Kamoka Pearls (French Polynesia), Laurent Cartier (Basel), Paspaley Pearls (Australia), Dominik Biehler (E. Färber, Munich, Germany), Andy Muller (Hinata Trading, Kyoto, Japan)

GEMSTONE DONATIONS

Henry A. Hänni (GemExpert, Basel), Tin Hlaing (Myanmar), Miemie Tin-Htut (Silkeneast Ltd., Bangkok), Tsarina Jewels Co. Ltd. (Bangkok), Claudio di Roma (Switzerland), J. Belmont (KV Gems, Bangkok), Amit Jain (Napra Gems, Antwerp), Alex Leuenberger (Aline AG, Switzerland), Andreas G Palfi (Namibia), Ronny Totah (Horowitz & Totah SA, Geneva), Theo Düblin (Basel, Switzerland), Pierre-Yves Chatagnier (Tsara International, France), Charles Abouchar (Abouchar SA, Geneva)

PUBLICATIONS

Cartier, L.E., Krzemnicki, M.S., Gysi, M., Lendvay, B. and Morf, N.V., 2020. A Case Study of Ivory Species Identification Using a Combination of Morphological, Gemmological and Genetic Methods. Journal of Gemmology, 37(3), 282-297.

Cartier, L.E., 2020. The Journey of Ethics - A Review of Responsible Sourcing Developments in the Gem Sector. InColor, Winter 2020 (45), 30-35.

Cartier, L.E., 2020. Precious coral in jewelry: new discoveries. GemGuide, November / December 2020, 1-4.

Hänni. H.A., Franz, L., Wang, H.A.O., 2020. Deep Purple – Vesuvianit (Idokras) aus Pakistan. Z.Dt.Demmol.Ges. 60/1-2. 59-64.

Hänni. H.A., Franz, L., Wang, H.A.O., 2020. Deep Purple Vesuvianite (idocrase) from Pakistan. The Australian Gemmologist. Vol. 27, Nr.3. 136-139.

Hänni, H.A., 2020. The Beryl Group – an Overview. J.Gemmol.Assoc. Hong Kong, Vol. XLI,48-54.

Krzemnicki, M., Cartier, L., Lefèvre, P. and Zho, W., 2020. Color varieties of gems–Where to set the boundary? InColor, Winter 2020 (45), 92-95.

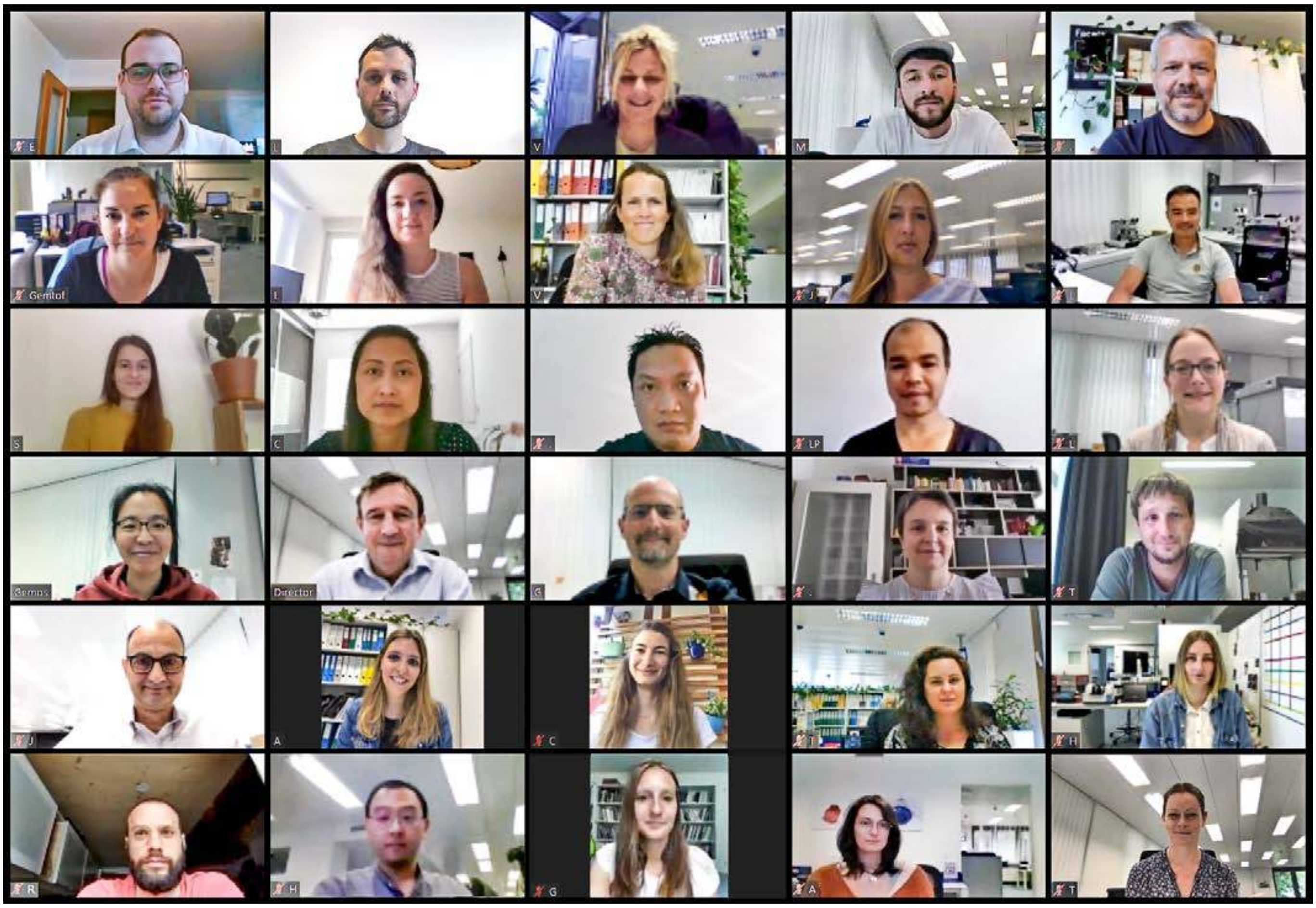
Krzemnicki M.S., Wang H.A.O., Büche S., 2021. A New Type of Emerald from Afghanistan's Panjshir Valley. Journal of Gemmology, 37(5), 474-495.

Lendvay, B., Cartier, L.E., Gysi, M., Meyer, J.B., Krzemnicki, M.S., Kratzer, A. and Morf, N.V., 2020. DNA fingerprinting: an effective tool for taxonomic identification of precious corals in jewelry. Scientific Reports, 10(1), pp.1-12.

Wang H.A.O., Krzemnicki M.S., Büche S., Degen S., Franz L., Schultz-Guttler R., 2021. Multi-Element Correlation Analysis of Cu-bearing Tourmaline using LA-ICP-Time of Flight-MS. EUG Conference abstract volume. https://doi.org/10.5194/egusphere-egu21-16170

Wang H.A.O., Krzemnicki M.S., 2021. Multi-element analysis of minerals using laser ablation inductively coupled plasma time of flight mass spectrometry and geochemical data visualization using t-distributed stochastic neighbor embedding: case study on emeralds. Journal Anal. Atomic Spectrometry, 36, 518-527.

Xu W., Krzemnicki M.S., 2021. Raman spectroscopic investigation of zircon in gem-quality sapphire: Application in origin determination. Journal of Raman Spectroscopy, 2021, 1–11, https://doi.org/10.1002/jrs.6092



△ 2020 was a year full of online meetings for the SSEF team to stay connected. Photo SSEF.

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