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SSEF RELOCATION / COLOUR TERMS / NEW SAPPHIRE SOURCES
DIAMOND RESEARCH / SPINEL / PEARL ANALYSIS / SSEF AT AUCTION
SSEF COURSES / SSEF IN ASIA / ON-SITE TESTING

SSEF
SCHWEIZERISCHES GEMMOLOGISCHES INSTITUT
SWISS GEMMOLOGICAL INSTITUTE
INSTITUT SUISSE DE GEMMOLOGIE

Dear Reader

It is for me a great pleasure to present you the 22nd issue of the SSEF Facette, summarizing all major achievements the Swiss Gemmological Institute SSEF has accomplished in recent months, but also and more importantly, to inform you about our latest research focussed on diamonds, coloured gems, and pearls.

Our annual magazine this time is a special issue, as it not only covers the past few months, but actually two years since the last SSEF Facette. The reason for this one year interruption in publishing was that we were very busy end of last year with the relocation of the SSEF laboratory into new premises. Since January 2015, we are now working in a modern and spacious laboratory in the centre of Basel, more than double the space we had before. I am very happy that this relocation went through so smoothly and would like to thank all involved parties, the SSEF Foundation Board members, the SSEF team, the architects; and last but not least also you as our customer supporting us by your continuous confidence in our services. Only this made such a major step possible for SSEF.

We are confident that these new premises are not only more convenient for us in our daily work, but also allow us to offer you even more expanded services at the most advanced scientific level. As part of our commitment in utmost quality and reliability, the SSEF has recently invested in state-of-the-art scientific equipment such as a digital microfocus radiography and CT scanner, but also has expanded its team to currently 27 highly motivated and experienced staff members.

Having seen in the past few months again the most outstanding and intriguing gems, pearls, and jewels offered in the trade and at auction worldwide, we at SSEF feel very privileged, as we do not only see and touch these items, but are able to analyse them meticulously with our analytical equipment to uncover their most hidden secrets of beauty and to challenge our scientific curiosity.

In this spirit I wish you a very successful and exciting 2016 with lots of business opportunities despite the rather difficult current market situation.

Dr. Michael S. Krzemnicki
Director SSEF

M.S. Krzemnicki

COVER PHOTO ▷

Kanase miner near the Man Sin mine in the Mogok Stone Tract (Myanmar).

Photo: M.S. Krzemnicki, SSEF

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SSEF HAS INAUGURATED NEW STATE-OF-THE-ART LABORATORY IN BASEL

On the of 12th February 2015, the Swiss Gemmological Institute SSEF inaugurated its new state-of-the-art laboratory in Basel with an official ceremony. For the inauguration ceremony a select representation of the Swiss gem, jewellery and watch industries, as well as international industry leaders including CIBJO President Dr. Gaetano Cavalieri gathered at the new premises, ideally located within eyesight of Basel's main railway station at Aeschengraben 26.

The official inauguration of these new 630 square meter large premises was the final act of a huge relocation project, which started in 2013. At that time it became obvious, that the continuous growth of SSEF in terms of staff and instrumentation could not be accommodated in the previous location with its 290 square meters in the heart of the city. The SSEF Foundation Board thus took the decision to look for a new location which would allow for major expansion.

Looking back in history, the SSEF has only twice relocated in the last 40 years. The first twenty years from 1974 - 1994, the SSEF was located in a small apartment at the Löwenstrasse in the centre of Zurich, close to the famous Bahnhofstrasse which has shops of all major international and Swiss jewellery brands.

△ SSEF in 1978: Main laboratory room at the SSEF in Zurich (1974 - 1994) with (from right) George Bosshart, first director of SSEF (1974 - 1990) and Prof. Dr. Henry A. Hänni, director of SSEF from 1990 - 2009, Françoise Tschudin and Margret Fritsche. Photo: SSEF

In 1994, the SSEF moved to the Falknerstrasse in the city of Basel, occupying one floor of about 90 square meters in a building owned by the Guild of Goldsmiths and Bankers of Basel ('Ehrenwerte Zunft zu Hausgenossen'). With the steady expansion of the SSEF in the following years, two further floors within the building were integrated into its premises to be able to accommodate a growing number of staff, instruments, but also students of our expanding teaching centre.

△ SSEF in 2006: Dr. Michael S. Krzemnicki, director of SSEF since 2009, in the analytics room of the SSEF laboratory at Falknerstrasse in Basel (1994 - 2014). Photo: SSEF

Since the beginning of 2015, the SSEF is now located in a very spacious and modern building very close to the main railway station and the banking district of the city of Basel. With its modern infrastructure and interior design planned by Blaser Architekten these new premises with more than double the space of the previous ones are the ideal and state-of-the-art working place for the SSEF for years to come. Equipped with the latest amenities including a public WIFI in the client reception zone and in the course room, this new gem of a laboratory is fully operational since beginning of 2015 and will allow for further growth of SSEF services, teaching and research capabilities in the future.

Apart from numerous classical gemmological instruments such as microscopes, refractometers, UV lamps, light boxes, hydrostatic balances, spectroscopes, dichroscopes the SSEF operates the following analytical instruments for gemstone and pearl analysis. ✶

A selection of Instruments currently in use at SSEF: FTIR Nexus / FTIR Nicollet / Portable FTIR (Bruker Alpha) / Micro-FTIR (Bruker Lumos) / Raman microspectroscopy (Renishaw InVia and Ramanscope) / Portable Raman spectrometer (by SSEF) / portable UV-Vis spectrometer (by SSEF) / UV-Vis-NIR spectrophotometer (Varian Cary 500) / ED-XRF (Quant'X) / Portable ED-XRF (Bruker S1Titan 800) / Diamension / DiamondView / DiamondScope / Automated Spectral Diamond Inspection ASDI (by SSEF) / Radiography (Faxitron) / Digital Radiography and Tomography (Yxlon Cougar) / X-ray Microtomography (Scanco) / GeigerCounter / Laser Induced Breakdown Spectroscopy (LIBS) / Laser Ablation Time-of-Flight Mass Spectroscopy (operational in July 2016)

△ Dr. Michael Krzemnicki, Director of SSEF, cutting the ribbon during the inauguration ceremony. Photo: SSEF

△ Jean-Pierre Chalain, Head of the Diamond department, presenting the ASDI machine to our guests. Photo: SSEF

△ Course room in the new SSEF premises, perfectly fitting for our SSEF courses from basic to advanced and scientific level (see SSEF course program). © M. Fritschi, Foto-werk GmbH

△ Modern and spacious client reception zone at the new SSEF. © M. Fritschi Foto-werk GmbH

△ Modern working situation for gemmologists at the SSEF. Photo: SSEF

COLOUR AND COLOUR TERMS

Coloured gemstones offer a fascinating range of colours. Within each gemstone species, colour may vary considerably due to chemical or structural variations. Although there are certain general colour preferences for gemstones - such as pure red, blue and green, it is finally the individual perception which may decide upon the personal preference of a certain colour hue. In this respect, it is important to remind that cultural, geographical and historical preferences exist, which may explain why specific colours are considered more attractive in certain markets (such as for example pink and other pastel colours in Japan) or during certain periods.

Gemmological reports generally include a description of colour to characterise the analysed gemstone. Since the beginning - more than 40 years ago, SSEF has applied for both, rubies and sapphires, a very descriptive colour terminology on its reports, based on visual colour observation in comparison with selected masterstones, Munsell charts and ColorScan® reflecting colour charts (by AGL). Based on meticulous observations under standardized light by at least two gemmologists, the colour of ruby and sapphire is indicated in terms of its hue (with a possible secondary hue such as for example 'purplish' as prefix) and saturation using the categories medium, medium strong, or strong saturation.

Pigeon blood 'red' and 'royal blue':

In addition to this more normative colour terminology, the trade uses for certain gemstones additional colour terms, with 'pigeon blood red' for rubies and 'royal blue' for sapphires being leading examples (Figure 1). Both terms have been used for centuries to describe, respectively, only the finest quality rubies and sapphires, which aside from their distinct colours are stones of superior quality, and hence are among the most coveted of gems. Thus, historically, these terms were not used simply as pure colour terms but were also connected to quality.

But, while commonly understood to refer to fine quality stones of specific hues of saturated red and blue, until now there never has been definite agreement as to the precise colours and quality criteria that correspond to the two terms. Nonetheless, due to increased demand from the trade for more independent assessments, gemmological laboratories have of late begun to use these colour terms on their reports. But in the absence of an international standard, the use of both terms on lab reports tends not only to be inflationary, but frequently ambiguous. This trend is - in our opinion - contradicting the terms' historical connotation.

As a consequence of this situation, the SSEF has studied colour perception and description extensively in the last few years and compared the findings with historical and recent literature about this issue. As a consequence of our research, we have then developed our own strict criteria defining which rubies and sapphires qualify for the colour terms 'pigeon blood red' and 'royal blue' - mentioned in the comments section of SSEF reports.

SSEF Colour criteria:

For a ruby or sapphire to qualify for the term 'pigeon blood red' or 'royal blue', respectively, the colour has to be an intense, saturated and homogeneous red or blue. The exact ranges of hue, saturation and tone are defined by sets of masterstones, carefully selected from natural rubies and sapphires of a wide range of colours.

'Pigeon blood red' is best described as a red colour, with no apparent colour modifiers (such as blue or brown). A minute purplish tint is acceptable. The body colour of pigeon blood red rubies is complemented by a strong fluorescence when exposed to ultraviolet light. This fluorescence is caused by high chromium content combined with low iron content, and results in the distinct 'inner glow' coveted by ruby connoisseurs.

△ **Figure 1: 'Pigeon blood red' ruby and 'royal blue' sapphire, both from Burma (Myanmar). Photo: SSEF - Please remember that the colour reproduction here does not represent the exact real colour.**

◁ **Figure 2:** Although partially of saturated blue colour (near the girdle), this sapphire reveals distinct colour zoning and a 'window' situation in the centre of the stone, and thus does not fit with our criteria for 'royal blue'. Photo: SSEF

Historically, the term 'pigeon blood red' was introduced for rubies which formed in marbles of the Mogok Stone Tract in Burma (Myanmar), and which are characterised by a very low iron concentration. With the discovery of additional ruby deposits in marbles in Burma, such as Mong Hsu, and in other countries, this term is no longer restricted to rubies from the Mogok region. Nonetheless, most rubies from places other than Burma contain higher concentrations of iron that suppress fluorescence, and consequently do not comply with the lab's criteria.

'Royal blue' is best described as a saturated blue colour, either pure or with a very slight purplish tint. While 'royal blue' is a term that was historically coined for the best quality of sapphires originating from the Mogok area in Burma, sapphires from other metamorphic deposits, such as those found in Madagascar, Sri Lanka, and Kashmir, may also display the properties required to qualify for the 'royal blue' term. They owe their colour mostly to a combination of low to medium content of iron and traces of titanium resulting in a dominating absorption band in the yellow part of the visible spectrum caused by the Fe^{2+} - Ti^{4+} intervalence charge transfer process. Such sapphires have been formed during metamorphic processes within the earth's crust.

Quality criteria:

As described above, to be qualified for the terms 'pigeon blood red' and 'royal blue' by the SSEF, any ruby or sapphire has to fit a rigid set of quality criteria as a prerequisite, in agreement with the historic understanding of these trade terms. In the following, we would like to highlight these quality criteria in more detail.

In terms of quality, these colour terms can only be applied to rubies and sapphires that exhibit fine qualities, and have not undergone any modification of colour and/or clarity.

Any type of treatment (such as heating, fissure filling, etc.) **disqualifies them** from being described using these colour terms.

Furthermore, **they must be relatively free of eye-visible or dark inclusions**. Both, sapphires and rubies may contain very fine rutile needles in zones, poetically also described as 'silk'. If not too dense, this fine rutile 'silk' in fact has a softening effect of colour by evenly distributing the light within the cut gemstone. A similar effect is achieved especially in sapphires from Kashmir, where zones of tiny submicroscopic particles are scattering the incoming light, resulting in the coveted 'velvety' blue colour of some of these gems.

Another required criterion is the absence of any visible colour zoning within the gemstone when viewed from above (and slightly tilted by 20° on each side). Apart from their **homogeneous colour distribution**, they should show **distinct internal reflections**, basically a result of their **well-proportioned cutting style**, and have no distinct 'window' effect (direct transmission of light due to inferior proportions) or loss of light resulting in larger black areas within the gem when looking from above on the table facet (Figure 2).

The size of the stones is not considered a criterion, meaning that small rubies and sapphires may also qualify for these colour terms.

A harmonised standard to protect the trade

In November 2015, the Swiss-based Swiss Gemmological Institute SSEF and the Gübelin Gem Lab, recognised as the leading laboratories for coloured stone testing worldwide, agreed to harmonise their standards for the colour terms 'pigeon blood red' and 'royal blue.' A comparison of the independently created sets held by both laboratories, Gübelin and SSEF, has shown that they are very consistent. In addition to this, the two labs mutually compared their quality criteria, and found them to largely coincide. A few minor changes were agreed upon to further harmonise the standards the two labs apply. The goal of this harmonisation is to standardise the usage of these terms for the benefit of the international gemstone trade and to foster a responsible and meaningful application of these terms in the trade. The press release about this harmonisation was published on 4th of November 2015 and we are glad to say that we received many very positive reactions about this harmonisation step.

Colour and colour terms: how far should we open Pandora's box?

Finally, the author would like to remind readers what has been stated in the introduction of this article about colour perception and preference. I personally think that with the excessive use of colour terms (as a selling argument), the trade has moved into a difficult situation where a term becomes more important (and price relevant) than actually the individual beauty and attractiveness of a gemstone. The SSEF has not been at the forefront of the usage of these two colour terms, but has tried - by creating a harmonised standard with Gübelin Gem Lab - to react to this demand from the market by defining a strict and meaningful set of criteria for the application of the two historical terms 'pigeon blood red' and 'royal blue'.

△ **Figure 3:** **The wheel of colour of natural corundum offers many attractive options for the trade. Photo: M.S. Krzemnicki, SSEF**

Given the current situation, it is not the intention of SSEF to invent a number of additional fancy colour terms such as what has been proposed by other laboratories. We think that such an approach does not clarify the situation for the trade and final consumers, but runs the risk of further blurring the perception that there are in fact a wide range of possible colours of corundum. Although it may seem quite easy to define such additional colours by choosing a specimen ideally representing that colour, we consider it very difficult to establish well-defined limits between such fancy colour terms within the three-dimensional colour space (hue, saturation and brightness); and with each new colour term (category) that is created, this complexity increases.

Having analysed a huge amount of rubies and sapphires in the past 17 years at SSEF, I personally have been most excited by the huge range in colour possible for corundum (Figure 3) and not only in the narrow range represented by the terms 'pigeon blood red' or 'royal blue'. It has been and will always be my greatest pleasure to look at a gemstone 'in real' and to discover its individual beauty, colour and brilliance without just relying on an attributed colour term. I hope that the trade itself is able to see the opportunities this approach offers in comparison to using simplistic terminology to describe a multitude of colours.

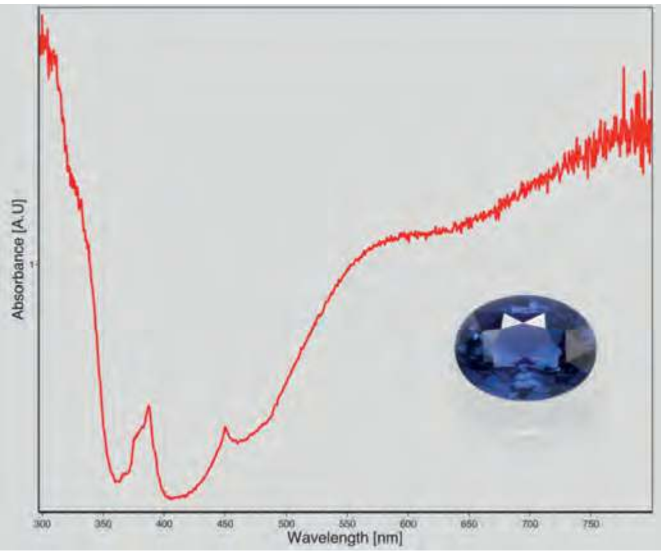
✶ **Dr. M. S. Krzemnicki.**

NEW SOURCES OF SAPPHIRES AND RUBIES

Sapphires from Nigeria:

Since more than a year, sapphires from Nigeria (WestAfrica) have entered the market in great number and sometimes in large sizes (reportedly up to 300 ct). These sapphires originate from basaltic rocks from the Mambilla Plateau in Taraba State in Eastern Nigeria (see also Pardieu et al. 2014), but are often more attractive in colour than the previously known dark blue material from the same area or from other basaltic sources around Jos in the centre of Nigeria. In the past few months, SSEF had the chance to analyse a small number of samples originating from that new find.

As expected, these sapphires are basaltic in origin and thus characterised by a high iron concentration, resulting in very distinct absorption features due to ferric iron and Fe^{2+} - Fe^{3+} intervalence charge transfer.



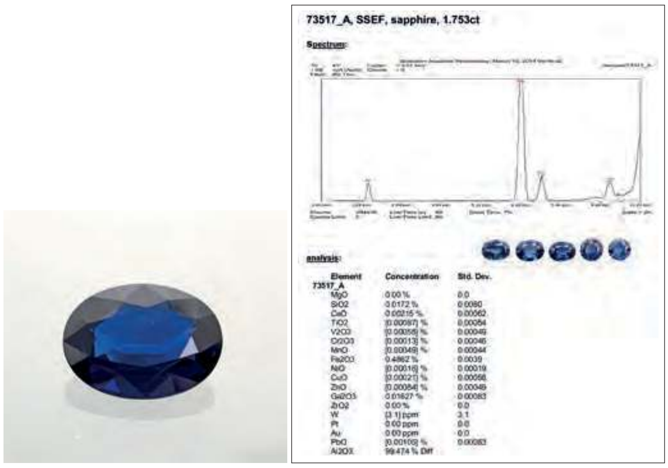
△ UV-vis-NIR absorption spectrum of a Nigerian basaltic sapphire. Photo: M. S. Krzemnicki, SSEF

Based on our preliminary analytical data and microscopic observations, these sapphires show a close similarity with other basalt-type sapphire deposits, such as Cambodia (Pailin) and Australia to name a few. As with other sapphires of basaltic type, SSEF is thus only disclosing the origin as 'Basaltic deposit'.

Sapphires from Kanchanaburi (Thailand):

This deposit is not new, as it has been known since many years. Close to Bo Ploi, this deposit has produced mostly dark blue sapphires, which in their best qualities are very clean with only tiny rutile needles in zones, dust lines and finely dispersed fluid platelets and few twinning planes. In contrast to many other basaltic sapphires, many of them do not show milky banding of sub-microscopic particles and may be visually mistaken as Burmese sapphires of dark colour.

In such cases, careful spectroscopic analyses and chemical trace element determination is required to safely identify this as basaltic material.


73517_A, SSEF, sapphire, 1.753ct

Spectrum:

analysis:

Element	Concentration	Std. Dev.
73517_A		
MgO	0.00 %	0.0
SiO2	0.0172 %	0.0080
CaO	0.00215 %	0.00062
TiO2	[0.00087] %	0.00054
V2O3	[0.00058] %	0.00049
Cr2O3	[0.00013] %	0.00046
MnO	[0.00049] %	0.00044
Fe2O3	0.4862 %	0.0039
NiO	[0.00016] %	0.00019
CuO	[0.00021] %	0.00058
ZnO	[0.00084] %	0.00049
Ga2O3	0.01627 %	0.00083
ZrO2	0.00 %	0.0
W	[3.1] ppm	3.1
Pt	0.00 ppm	0.0
Au	0.00 ppm	0.0
PbO	[0.00109] %	0.00083
Al2O3	99.474 % Diff	

△ Dark blue sapphire from Kanchanaburi (Thailand) of nearly 20 ct, and a series of samples from the same deposit (SSEF collection) together with a typical chemical analysis (ED-XRF). Photo: L. Phan, SSEF

Rubies from Andilamena (Madagascar):

The area of Andilamena in NE-Madagascar has been known for years (Pardieu et al., Hughes) to produce rubies and sapphires. Most of the ruby material which came so far from (illegal) mining sites in the jungle in the area was however of rather low quality with lots of fractures, thus prone to be filled with lead-glass to make it saleable for the trade. Apart from this low quality, already then few stones of beautifully saturated colour and fine transparency were uncovered. Recently, however, new material of exceptional quality from this source has entered the gem market. A number of ruby samples were recently analysed at SSEF and compared with rubies from the same locality from our SSEF collection (including some from the H.A. Hänni Gemstone Collection). These analyses reveal similarities of this material with rubies from Montepuez (Mozambique) and Didy (Madagascar), all discovered in amphibolite-related host-rocks. With the depletion or slowing down of production of traditionally important mines (e.g. Mogok) these new sources of rubies have started to play a major role in the ruby trade, as they offer new and also more affordable alternatives for jewellers and consumers. ✶

△ Two rubies from Andilamena (Madagascar) on a UV-vis-NIR absorption spectrum. Photo: M. S. Krzemnicki, SSEF

SAPPHIRE FROM ANDRANONDAMBO (MADAGASCAR)

Recently, the SSEF received a sapphire of exceptional quality and size for testing (Figure 1). The sapphire of 33 ct was characterised by a saturated blue colour, - poetically also known as royal blue - and a highly attractive velvety appearance due to submicroscopic dispersed inclusions, in some ways similar to what is also highly appreciated in sapphires from Kashmir.

But in contrast to sapphires from Kashmir, the investigated sapphire exhibited a dark blue dense colour zone (parallel to the basal pinacoid, Figure 2) located at its girdle, a feature characteristic for 'Kashmir-like' sapphires from Andranondambo in Southeast Madagascar (Kiefert et al. 1996, Krzemnicki, SSEF Facette 20, 2013). In combination with further inclusion features and the analysed chemical and spectral properties, the origin of this unheated sapphire was readily concluded.

△ **Figure 1:** Sapphire from Andranondambo (Madagascar). Photo: SSEF

△ **Figure 2:** Dark blue colour zone in a sapphire from Andranondambo (SSEF reference collection), as it is characteristic for this sapphire deposit. Photo: M. S. Krzemnicki, SSEF

The island of Madagascar has produced a number of outstanding gems in the last decades and therefore gained much importance in the gem trade in recent times. Although classical and more historic gem sources still fetch a premium in the market today, we consider this sapphire from Andranondambo with its outstanding size and beauty a perfect example of the fact that quality and not a classical origin 'label' should ultimately be considered the main criterion for any gemstone in the trade. ✶

△ Sapphire mining in Andranondambo, SE-Madagascar. Photo: Michael Krzemnicki, SSEF

LOW-TEMPERATURE HEATED RUBIES FROM MOZAMBIQUE

Heating of rubies from Mozambique at rather low temperatures is nothing new. Immediately after the discovery of this new deposit close to Montepuez in 2009, it was obvious that part of the new material required heat treatment before it could be sold - a situation very common for any gemstone mining operation. Much of this material finally entered the trade as heavily treated lead-glass filled stones (Figure 1), causing some trouble in the trade as it was and still is often not fully disclosed to consumers at the final sales point. To fill the fissures with lead glass, these rubies have to be heated above the melting temperature of the glass doped with lead or other heavy elements. Apart from this low-quality material, the SSEF has sporadically seen since that time Mozambique rubies of high quality that had presumably been heated to slightly enhance their colour.

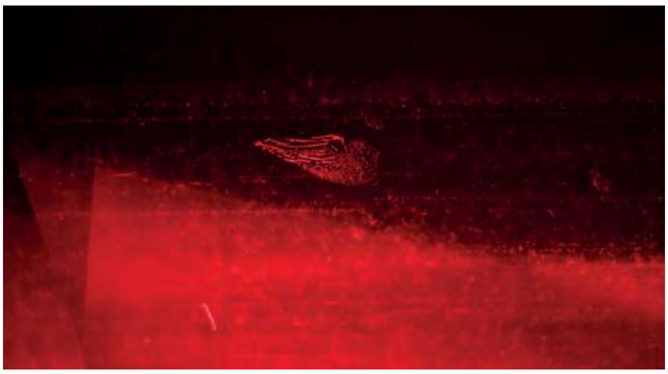
△ **Figure 1:** Rubies from Mozambique, from left to right: untreated, heated, heated and fissure filled with lead glass. Photo: M. S. Krzemnicki, SSEF

Recently, there have been more such rubies reported in the market (see also Pardieu et al. 2015), which as always for low temperature treated corundum, may be quite challenging to detect without proper equipment. A typical case was submitted in March 2015 to the SSEF (Figure 2). As with all heat treated rubies and sapphires, the detection of a possible heat treatment at SSEF is based on a combination of meticulous microscopic observation and analytical data, in this case mostly FTIR analyses.

◁ **Figure 2:** This stunning ruby of 11 ct from Mozambique contained features that are characteristic for low-temperature heat treatment. Photo: L. Phan, SSEF

The microscopic examination of this 11 ct ruby revealed typical inclusion features of Mozambique rubies, such as fine bands of minute dispersed particles and small rutile needles. In addition, the ruby also contained tiny but very characteristic modified healing fissures and atoll-like discoid tension cracks caused by the low-temperature heating within the stone (Figure 3).

Due to the fact that the heating at low temperatures shifts the colour of certain Mozambique rubies slightly more to the red (by reducing a bluish colour component), such heated material will continue to enter the market in the future to a certain extent. Furthermore, as such a heating can be applied rather easily at any stage to a ruby, it is necessary to remind that any statement about the absence of a treatment is only valid at the time the gemstone has been tested by a laboratory (see also important notes on each SSEF report). Therefore, any gemstone including rubies from Mozambique may need re-evaluation of its treatment status, especially if it has passed through several hands within the trade. ✶ **Dr. M. S. Krzemnicki, SSEF**



△ **Figure 3:** Tiny modified healed fissure resulting from the heat treatment of this ruby. Photo: M. S. Krzemnicki, SSEF

THE CHALLENGE: IDENTIFICATION OF A RAMAURA SYNTHETIC RUBY

Similar to fashion trends, gemmological issues challenging gem-testing laboratories have changed over time. In the 1980s, synthetic coloured stones threatened the trade. But since the early 1990s, the challenge has switched to treatment and disclosure issues, such as flux-assisted heating (of rubies mainly), fissure-filling of emeralds, beryllium-diffusion of corundum, and rather lately low-temperature heating of corundum. As a consequence of this change, identification of synthetic gemstones produced decades ago may become occasionally very challenging especially for younger gemmologists, as such material is nowadays reappearing only sporadically and is so much out of focus of current gemmological research and teaching. The following may thus be taken as a good example to illustrate this challenging situation.

Recently, the SSEF received a ruby of 6.02 ct set in a ring for testing (Figure 1) accompanied by documents claiming it to be an unheated ruby of natural formation but of unknown geographic origin.

◁ **Figure 1**: 6.02ct ruby in ring. Photo: V. Lanzafame, SSEF

Chemical analyses (by ED-XRF) revealed a rather 'normal' trace element pattern, with equal amounts of chromium and iron and traces of gallium, as might be expected for example of rubies from Montepuez (Mozambique) or Winza (Tanzania). Much to our surprise, detailed microscopic investigation however showed features very similar to what can be expected in flux-melt synthetic rubies. Apart from the lack of any natural solid or fluid inclusion within this ruby, we found marked parallel zoning and numerous very fine veil-type healed fissures filled with granular-looking orange material (Figure 2). Such granular fillers are most characteristic and specific for flux-melt synthetic rubies.

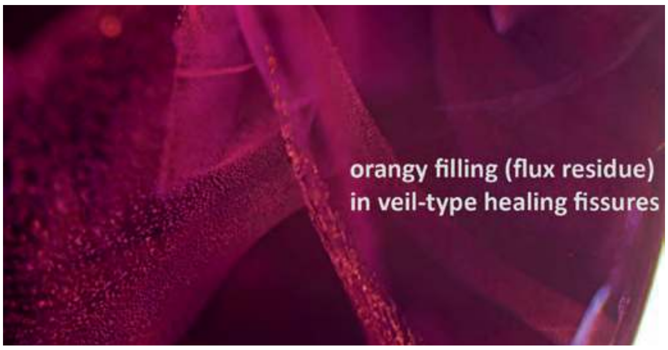
To fully understand this situation, we did full analytical characterisation of this ruby by LA-ICP-MS (Laser Inductively Coupled Plasma Mass Spectrometry), FTIR, and Raman, and compared the results with flux-synthetic ruby references from our SSEF collection (and the H.A. Hänni gemstone collection).

A large surface reaching cavity filled with granular orange substance (Figure 3) provided clues not only to identify the material as synthetic, but also to identify that this stone had been produced by the US company J.O. Crystal, which market their product as Ramaura™ synthetic rubies (http://www.ramaura.com) since more than twenty years.

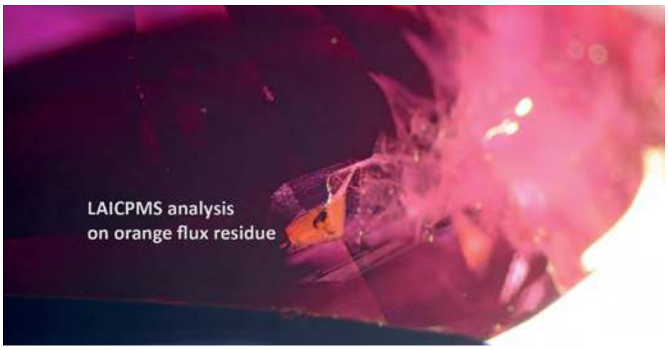
By its visual appearance, this orange foreign material could also be misinterpreted as naturally occurring iron hydroxide. However, LA-ICP-MS trace element analyses on the orange material in the cavity revealed that it is highly enriched in exotic elements such as boron, lead, bismuth and lanthanum, characteristic and in fact required components of the flux in which Ramaura synthetic rubies grow (Kane 1983, Schmetzer 1986, Muhlmeister et al. 1998). Comparing our data with Ramaura synthetic rubies from the SSEF collection showed that they were highly matching not only in their trace element concentration, but also inclusion features and Raman spectrum of the granular orange flux residue.

What made this synthetic ruby an intriguing case is its rather 'natural looking' chemical composition as detected by ED-XRF, with equal amounts of chromium and iron and traces of gallium. However, the absence of any titanium and vanadium in the investigated ruby (and in the Ramaura synthetic reference, for both confirmed by LA-ICP-MS) should make a gemmologist cautious, as these two elements are usually present in any natural ruby at trace levels due to geochemical reasons.

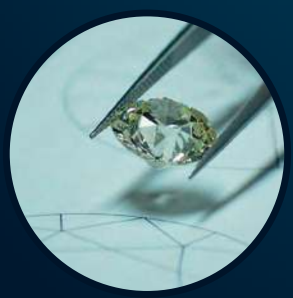
Although the inclusions are quite characteristic of its synthetic formation for an experienced gemmologist, they may be misinterpreted (and obviously had been so, before SSEF tested the specimen) as naturally occurring iron-hydroxide residues due to the fact that gem labs (and the trade) are nowadays only rarely exposed to such challenging synthetic samples. ✶ **Dr. M. S. Krzemnicki, SSEF**



△ **Figure 2**: Orangey filling (flux residue) in veil-type healing fissures. Photo: M. S. Krzemnicki, SSEF



△ **Figure 3**: Large surface reaching cavity filled with a granular orange substance that was analysed with LA-ICP-MS. Photo: M. S. Krzemnicki, SSEF



SPINEL FROM MAHENGE (TANZANIA) AND ITS HEAT TREATMENT

△ **Figure 1**: Exceptional spinel of 104 ct from Mahenge (Tanzania) together with a few small faceted spinels and spinel crystals from the same locality. Photo: M. S. Krzemnicki, SSEF

In 2007, the discovery of a huge pinkish-red spinel crystal of 52 kg in the carstic marbles at Ipangko south of Mahenge (Tanzania) resulted in a sudden supply of spinels (up to 100 cts) of a vibrant pinkish red colour, which immediately mesmerized the market.

Apart from visiting this gem deposit in 2009 for a geological study, the Swiss Gemmological Institute SSEF has had the privilege of analysing some of the most outstanding spinels from this gem deposit in recent years, including a highly attractive specimen of 104 ct (Figure 1).

In contrast to corundum, for which heat treatment is highly effective to improve colour and clarity and thus applied on large numbers of stones, heated spinels are still very scarcely found in the market. This is due to the fact that there is commonly none to only minor clarity improvement achieved through heat treatment (Seasaw et al. 2009, Smith 2012).

From the spinels analysed by the SSEF in the past few months, only very few were found to be heat-treated. These spinels from Tanzania of 7 ct and 8 ct both showed an attractive pinkish-red colour, but were characterised by tiny dispersed inclusions. Similar to heated corundum, both specimens contained few heat induced atoll-like discoid tension fractures. But as they were very small, an untrained gemmologist may easily overlook them. However, the photoluminesence spectra of both spinels were characterised by a distinct broadening of all chromium emission bands and a shift of the main emission line (to 687 nm), well-established criteria for the detection of heat treatment of spinel (Saeseaw et al. 2009, Smith 2012). ✶

△ **Figure 2**: Small discoid atoll-structures are found in these heated spinels similar to those in corundum and other gems modified by heat treatment. Photo: M. S. Krzemnicki, SSEF

DIAMOND RESEARCH

Undisclosed natural diamonds mixed in a parcel of synthetic diamonds

In order to maintain its leading position in gemmological research, SSEF regularly purchases gemstones of new origins, treated gemstones from new sources and synthetic stones of new productions.

Recently, our Diamond Department acquired a parcel of small colourless synthetic diamonds produced in Europe by the HPHT method. The complete study of these series of melee size synthetic diamonds (SSEF Research project 80602) is part of our continuous survey of new productions of stones that may possibly be tested by the ASDI instrument.

The total weight of the purchased parcel is 0.59 ct, consisting of 52 round brilliant polished stones, their diameters ranging from 0.84 mm to 2.15 mm. Their declared colours range from D/E to G/H and their declared clarities range from VVS to SI.

The SSEF standard procedure for this kind of study consists of the traditional observations both with a gemmological binocular and under the SWUV & LWUV lights. FTIR analyses are conducted using a Bruker LUMOS micro-infrared spectrometer and Photoluminescence analyses at low temperature are induced by the green laser of a Renishaw Raman spectrometer. Finally, the screening of the parcel is performed with the ASDI instrument for both its Raman detectability and its SWUV transparency.

Various analyses showed that among the 52 stones there was indeed no diamond-simulant.
But surprisingly the one-phonon infrared absorption region of 7 diamonds shows inconsistent features with synthetic diamonds: concentrations of aggregated nitrogen atoms in the form of A and B aggregates over 1'000 ppm, very high platelets peaks, no C-centres, one sample even shows only B aggregates. In fact, these are natural diamonds mixed in a parcel of synthetics. The natural origin of these 7 diamonds was further confirmed by photoluminescence analyses. Additionally, these 7 natural diamonds absorb SWUV light and therefore are correctly identified by the ASDI instrument as natural diamonds.

We announced to the supplying synthetic diamond producer the unexpected presence of natural diamonds among the parcel of synthetic diamonds that he delivered. He immediately apologized and admitted that being 'only' a European synthetic diamond producer, his company subcontracts the polishing operations of his rough synthetic diamonds to an Asian cutting factory and consequently he has no control over the goods that he receives back before delivering the final orders of polished stones to his clients.

The presence of undisclosed natural diamonds in a parcel of synthetic diamonds has two unusual consequences:

- Assuming that some polished synthetic diamonds are exchanged (intentionally or not) with natural diamonds in some Asian polishing factories, these synthetic diamonds may be reintroduced into other parcels (intentionally or not) at a later date
- Unaware gemmologists that would order synthetic diamonds and would instead be delivered with partially natural diamonds might consider these natural diamonds as references for synthetic diamonds, which would later create critical confusions in terms of their gemmological identification.

✶ **J.-P. Chalain, SSEF**

MICRO - FTIR LUMOS FOR SMALL DIAMONDS

Melee-size diamonds and small baguette diamonds now analysed with LUMOS

Recently, SSEF acquired a new spectrometer. It's a micro-infrared spectrometer manufactured by the company Bruker and branded LUMOS. This new instrument has useful applications for a wide variety of gemstones. Currently, at SSEF it is mainly dedicated to Fourier Transform Infrared (FTIR) analyses of melee-size diamonds and of diamond baguettes.

Compared to other FTIR spectrometers already used at SSEF for more than 20 years, the LUMOS has two major advantages. First, its IR beam passes through a magnification system, therefore it's spatial resolution is much higher and consequently, compared to traditional FTIR spectrometers, its signal to noise ratio is much higher. This is highly appreciated when checking the FTIR spectrum of diamonds smaller than 1.10 mm.

Secondly, it is equipped with a mechanised sample holder that can be programmed to shift position automatically and enables the automatic FTIR analyses of several diamonds in a row. Additionally, by emplementing an automatised diamond-type identification software this new instrument operates even more efficiently. ✶

NEW RESEARCH ON JADEITE JADE

A team of researchers from the University of Basel along with Prof. Henry A. Hänni (SSEF research associate) and other authors carried out extensive mineralogical and petrographic investigations of jadeite boulders from north-central Myanmar. Based on the petrography of these samples the study proposed a classification system for these boulders. The research showed that the strong chemical and textural inhomogeneity renders a classification of these rocks by common gemological methods rather difficult. The study demonstrated that a fast and non-destructive identification of the different kinds of pyroxenes and the accessory minerals is well possible using Raman and infrared spectroscopy. ✶

REFERENCE

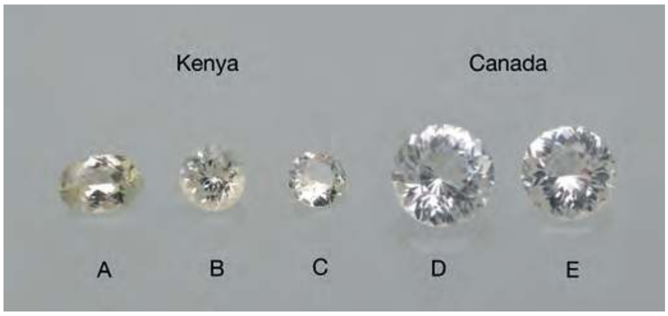
Franz, L., Sun, T.T., Hänni, H.A., de Capitani, C., Thanasuthipitak, T., Atichat, W., 2014. A Comparative Study of Jadeite, Omphacite and Kosmochlor Jades from Myanmar, and Suggestions for a Practical Nomenclature. Journal of Gemmology, 34(3), 210-229.

COLOURLESS DIOPSIDE FROM KENYA AND CANADA

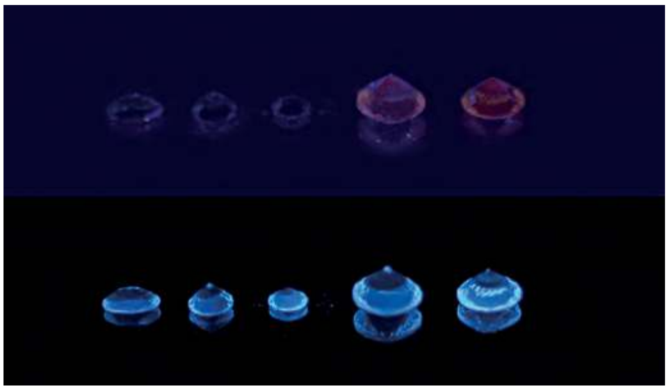
Diopside, a calcium magnesium clinopyroxene ($MgCaSi_2O_6$) and end-member of the diopside-hedenbergite series (pyroxene), is a rather rare gem species in the trade. Commonly found in greenish brown stones (mostly due to iron content) to dark brown cabochons with an oblique star effect, its most attractive variety is emerald-green Cr-diopside from Russia (Ural) and a few other localities, owing its attractive colour to the incorporation of traces of chromium. Gem-quality colourless to near colourless - thus chemically rather pure - diopside has already been described from the Mogok Stone Tract (Themelis, 2008), Tanzania (Milisenda & Wehr, 2009) and Canada (Robinson & Wight 1997).

Recently, the SSEF analysed three small samples from Kenya with a very subtle yellowish tint due to minor iron (A: 0.40 wt% FeO, measured by ED-XRF) and two absolutely colourless samples from Canada (Figure 1). Raman analyses revealed for all five samples distinct vibrational peaks, perfectly fitting with our diopside references. Vanadium and chromium, both responsible for greenish to intense green colours, were below detection limit in our studied samples.

Interestingly, only the diopside from Canada showed a distinct orange reaction under long wave ultraviolet light, whereas the samples from Kenya remained inert (Figure 2). When exposed to shortwave ultraviolet, all investigated samples showed an equally bluish white reaction. This observation of varying UV reactions of diopside is not new and has already been reported in literature (Henkel 1988 - 1989, Robinson & Wight 1997). In our case, however, this property allowed a quick separation of diopside from Kenya and Canada. See article M.S. Krzemnicki, in Journal of Gemmology, 2014 vol. 34, issue 4. ✶



△ **Figure 1:** Samples A-C are from Kenya, sample D-E from Canada. Photo: M. S. Krzemnicki, SSEF



△ **Figure 2:** The picture above shows the reaction of the 5 samples under LWUV, where the three Kenyan samples show no reaction. The lower picture shows the reaction under SWUV. Photo: M. S. Krzemnicki, SSEF

POLYCRISTALLINE KYANITE

The Swiss Gemmological Institute SSEF received two blue translucent samples, a water worn pebble and a faceted stone of 1.72 ct cut from the same piece (Figure 1). The material was bought in Arusha (Tanzania) in December 2013 by Mr Farooq Hashmi.

△ **Figure 1:** Water-worn pebble and cut stone, both polycristalline kyanite. Photo: M. S. Krzemnicki, SSEF

Standard gemmological methods quickly revealed the anisotropic polycrystalline character of the material (always bright in the polariscope). Consequently, the RI value could only be determined approximately (1.72). Since the identity of the material was not evident after this initial standard testing, it was analysed by Raman spectroscopy, which immediately revealed a distinct kyanite spectrum. The blue colour of kyanite is linked mainly to an intervalence charge transfer (Ti^{4+} - Fe^{2+}, both elements found in trace concentrations in our samples) through the replacement of two Al^{3+} ions on adjacent crystal sites (Platonov et al., 1998; Henn & Schollenbruch, 2012; Krzemnicki, 2013), a colouring mechanism well known also in metamorphic blue sapphires.

Microscopic observation revealed an interesting treacle-like appearance (similar to polycrystalline hessonite) due to kyanite grain boundaries (Figure 2). To the author's knowledge, this is the first time that polycrystalline kyanite of gem quality has been reported. Mr. Hashmi has not encountered any other examples of this material on previous or subsequent buying trips.

See article M.S. Krzemnicki, in Journal of Gemmology, 2014 vol. 34, issue 4. ✶

△ **Figure 2:** Treacle-like appearance in polycristalline kyanite due to grain boundaries. Photo: M. S. Krzemnicki, SSEF

QUARTZ WITH RADIATING HOLLOW FIBRES

During the 2014 Tucson Gem Shows in Arizona, USA, gem dealer German Salazar (Bogotá, Colombia) showed interesting quartz with radiating hollow fibres sold as 'trapiche quartz' from Colombia. Originally found in 2011 by artisanal miners in the Boyacá and South Santander Departments, about 300 miles (480 km) north of Bogotá by road, this material only recently found its way into the gem market.

The hexagonal sample investigated at SSEF had been cut perpendicular to the c-axis near the base of the original quartz crystal and was polished into a slightly curved cabochon of 25 ct. It was characterised by fine and slightly curved fibres (presumably hollow) extending radially from a nearly inclusion-free centre of spiky outline (Figure 1). They are interpreted as syngenetic growth channels perpendicular to the growing prism faces, very similar to so-called comet-structures in corundum and other gems (Gübelin & Koivula, 2008). It was not possible to identify any mineral phase within these fibrous structures by Raman microspectroscopy.

Although this pattern is vaguely reminiscent of the trapiche growth phenomenon shown by some minerals (e.g., ruby), the observed pattern of fibres is not the result of skeletal crystal growth, which by definition characterises trapiche stones. Thus, we suggest for this beautiful quartz with star-like radiating fibres rather the poetical fancy term 'Polaris quartz' instead of the misleading trade name 'trapiche quartz'.

See article M.S. Krzemnicki, B.M. Laurs, in Journal of Gemmology, 2014 vol. 34 , issue 4. ✶

Photo: L. Phan, SSEF

COLOURLESS CHRYSOBERYL FROM MOGOK

Chrysoberyl is found in various colours, mostly yellow to green and brown due to iron, light green to bluish green (vanadium) or as the colour-changing variety alexandrite (due to chromium). In rare cases, chrysoberyl is also found in colourless and chemically rather pure crystals. Recently, the authors had the opportunity to study a tabular colourless chrysoberyl reportedly originating from an alluvial placer in the Mogok Gemstone Tract in Myanmar.

The most interesting feature in this sample were small nail-head spicules oriented along the c-axis of the chrysoberyl, similar to the ones observed in synthetic emeralds and occasionally also in natural gems such as sapphire, spinel, tourmaline and quartz (Schmetzer et al., 1999, 2011; Choudhary and Golecha, 2007).

An examination of these nail-head inclusions with Raman micro-spectroscopy revealed the presence of CO_2 in a completely enclosed hollow spicule and secondary iron (hydro)oxide in a hollow tube reaching the surface of the specimen. The colourless inclusions at the ends of the enclosed growth tubes were identified as entrapped chrysoberyl inclusions.

See article K. Schmetzer & M.S. Krzemnicki, in Journal of Gemmology, 2015 vol. 34(5), p. 434-438. ✶

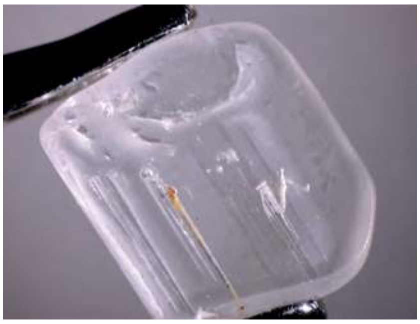


Photo: M. S. Krzemnicki, SSEF

ZIRCON SHOWING ASTERISM

Recently, Martin Steinbach, a collector of star stones from Idar-Oberstein (Germany), submitted to the SSEF a zircon with a star effect (asterism), which - to the knowledge of the author - so far had not been described in literature for this gem.

The zircon specimen (13 ct) revealed a moderate star with four intersecting branches, of which one was very weak, thus resulting in a six to eight rayed star depending on illumination. The zircon was quite included and thus rather translucent. In addition to this, the centre of the star was further pronounced by bright reflections on planar micro-features from the overhead light source. The most intense branch (Figure 1) of the star is due to a set of very fine short tubes, whereas the three weaker branches are caused by three sets of oriented micro-features. Due to the highly included nature of the specimen, the crystallographic orientation of the observed microstructures could not be determined.

Raman micro-spectroscopy of the inclusion features revealed no Raman peaks except of zircon, so they are interpreted as micro-fissures or a different type of microstructure. Based on the similarity of these complex micro-structures to the ones described by Hänni and Weibel (1988) for heated cat's-eye zircon, it seems probable that the star effect in this specimen is also the result of a heating process. This is supported by the Raman spectrum of this zircon, which is characterised by very sharp and pronounced vibrational peaks, as it would be expected in metamict and translucent zircons only after heat treatment (Zhang et al., 2000; Nasdala et al., 2002; Wang et al., 2006; Krzemnicki, 2010) or in well-crystallized (non-metamict) and commonly transparent zircons.

See also: Krzemnicki M.S. and Steinbach M.P., 2015. Gem Notes: Zircon showing asterism. Journal of Gemmology, 34(8), 671-673. ✶

◁ **Figure 1:** 13 ct star zircon.
Photo: V. Lanzafame, SSEF

NEW GREEN ORNAMENTAL MATERIAL FROM ARIZONA, USA

Early 2015, the SSEF received a green ornamental material from Arizona (USA) to investigate its nature. This material originally was surface-collected by Charles Vargas on the San Carlos Apache Reservation in Arizona and was introduced 2014 at the Tucson Gem Shows by Warren Boyd FGA (Apache Gems, San Carlos, Arizona).

As obvious from the picture (figure 1), and particularly with the microscope, this material consisted of multiple phases that differed in colour and lustre. Standard gemmological testing was inconclusive, so a thin section was cut from one of the rough fragments for a detailed mineralogical study using a petrographic microscope, Raman microspectroscopy, and X-ray fluorescence (EDXRF).

Astonishingly, this in-depth study revealed that this ornamental material is a volcanic rock. It consisted mainly of brecciated masses of green volcanic glass, penetrated by secondary calcite veins (white). In places the volcanic glass showed wavy flow structures together with a few primary magmatic phenocrysts of plagioclase feldspar and biotite. Additional small vacuoles in the rock were filled with chalcedony and opal (amorphous) and zeolite. This ornamental rock makes an attractive addition to the gem market, especially as it is relatively tough and hard, and thus shows a high lustre combined with an attractive colourful brecciated texture.

Photo: M. S. Krzemnicki, SSEF

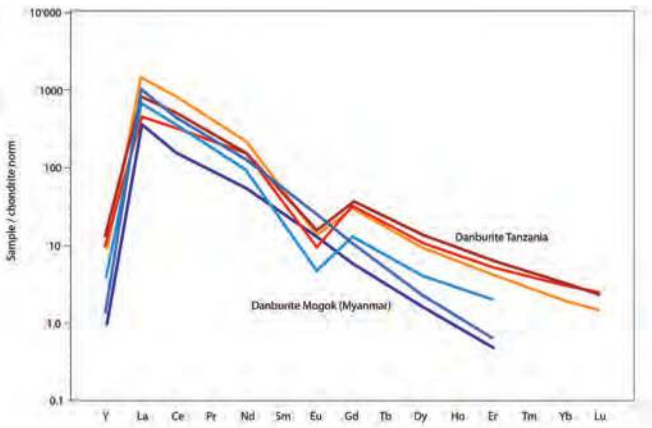
See also: Krzemnicki M.S. and Franz L., 2015. Gem Notes: Saguaro Stone, a new ornamental material from Arizona (USA). Journal of Gemmology, 34(7), 567-569. ✶

REE IN DANBURITES

The calcium-boron-silicate danburite is a rather rare collector's stone, mainly known in colourless to slightly yellowish to brownish colours from a limited number of deposits worldwide. Since 2013, new and attractive vivid yellow danburite has entered the gem trade. This new material originates from the Manyara region in northern Tanzania and has been cut in gems up to 18 ct.

As part of a research collaboration with Christopher Smith from the American Gemological Laboratories AGL, we have analysed a selected number of Tanzanian danburites with LA-ICP-MS to get detailed data about their trace element content, and compared these with samples from Mogok in Burma (Myanmar) (Figure 1).

△ **Figure 1:** Part of the studied danburites for this research project. Photo: M. S. Krzemnicki, SSEF



△ **Figure 2:** Chondrite normalized REE diagram of the analysed danburites. Note the logarithmic scale of the vertical concentration axis. Diagram: M. S. Krzemnicki, SSEF

Calcium-bearing silicates often contain a wide range of trace elements, notably rare earth elements (REE), which substitute for calcium. Due to the fact that REE with even atomic numbers are more abundant than the odd numbered neighbours (so-called Oddo-Harkins rule), they are often displayed in a diagram normalized to a chondrite standard (stone-meteorite).

Plotting our REE data in a chondrite normalized diagram (Figure 2) revealed a trend of the lighter REE (La, Ce, Pr, Nd, Sm) being enriched in the danburites from both Tanzania and Myanmar. In contrast to this, the analysed danburites from Tanzania contained a significantly higher amount of heavy REE (Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, and Y) compared to the Burmese samples. This trace and ultra-trace element pattern may help to distinguish the origin of such danburites in future.

See forthcoming article C.P. Smith and M.S. Krzemnicki in the Journal of Gemmology in 2016. ✶

CASE STUDY: EMERALD FROM THE ANCIENT MINES IN EGYPT OR NOT?

The Swiss Gemmological Institute SSEF received an impressive polished and drilled transparent emerald of 200 ct together with three small highly weathered beryl fragments, which reportedly all originated from the ancient emerald deposits in Egypt.

These mines have been known since ancient times and represented one of the most important source of emeralds for many centuries during the ancient Egypt, Greek, Roman and Byzantine periods, together with the mines in the Habachtal in Austria (Jennings et al. 1993, Shaw et al. 1999, Giuliani et al. 2000). Located at remote sites such as in the rugged coastal hills near the small community of Marsa Alam at the Red Sea (Jennings et al. 1993), these ancient mines, also known as the 'Emerald mines of Cleopatra', have been abandoned since many centuries with only very episodic and unsuccessful mining activities since then (Jennings et al. 1993). Although a major source of emeralds (according to literature) in ancient times, only a rather restricted number of specimens are known today, mostly in archaeological museums.

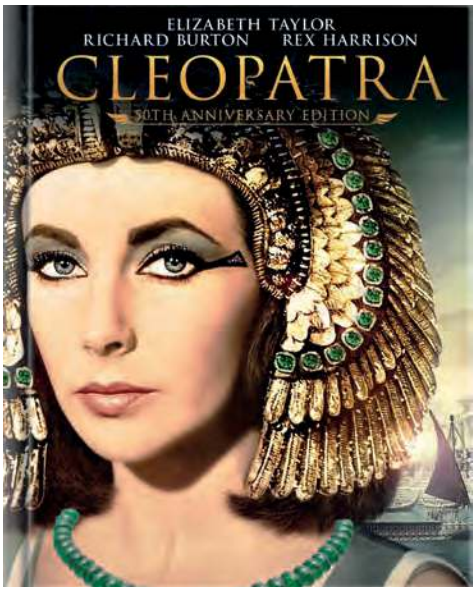
Microscopic examination of the large polished emerald bead revealed many fractures, filled with a slightly brownish (aged) oil to modify its clarity. Apart from this, the sample contained basal fluid-platelets, arranged in 'patchy' layers throughout the emerald. Furthermore, the sample showed irregular to partly rectangular two-phase fluid inclusions, similar to emeralds from Brazil and other sources. Inclusions described from Egyptian emeralds such as quartz, biotite, brownish oxidised amphibole needles, and growth tubes, partially filled with brownish Fe-hydroxide (Jennings et al. 1993) were not observed. Another argument against an Egyptian origin was the mere size of the specimen (200 ct), by far surpassing any known ancient emerald of this quality from this locality (Jennings et al. 1993). Documented large emeralds from Egypt are generally cut in hexagonal shapes, actually often just representing slightly polished hexagonal emerald crystals, and very often are nearly opaque and full of inclusions and fractures (Grundemann et al. 1993, Jennings et al. 1993, Aurisicchio et al. 2005). They often also show distinct colour zoning (with a distinct green zone at the surface and a very light green internal zone (Grundemann et al. 1993), a feature not observed in the studied emerald bead.

Photo: M. S. Krzemnicki, SSEF

The chemical data of emeralds from 'schist-type' emerald deposits, forming during regional metamorphism is rather uniform (Grundmann et al. 1993), regardless of their geographic location (e.g. South Africa, Zambia, Austria, Brazil, Egypt). Thus the chemistry of these emeralds is rather unspecific: generally iron (Fe) distinctly dominates chromium (Cr), and they often contain distinct amounts of Mg and Na. Based on the chemical data of the studied emerald bead, no specific geographic origin can be deduced.

Based on the microscopic observations and analysed data, we can conclude that the studied emerald bead is distinctly different from Egyptian emeralds as described in literature. Thus an origin from the ancient emerald mines from Egypt can be nearly excluded. Based on the present data, the material is much more likely originating from emerald mines either in Africa (e.g. Nigeria) or South America (Brazil).

See article M.S. Krzemnicki et al., in Journal of the Gemmological Association of Hong Kong, 2015, vol. 36, p. 46-49. ✶



UPDATE ON DOUBLETS IN THE GEM TRADE

Assembled cut gemstones, glued together along the girdle plane are classic samples in a gemmologists practical education. But during a visit of 2014 Asia World Jewellery Fair in Hong Kong a modern variation of the doublet technique was encountered. A convincing alternative is offered as substitutes for expensive stones like emerald, tanzanite, paraiba tourmaline (Fig 1). These doublets consist of natural gemstone elements, assembled by a coloured glue layer. As the material is correctly disclosed by the producers and pretty easy to recognise as a substitute by a professional, it does not represent really a danger to the trade. However, for the untrained public, these look-alikes have a very convincing appearance.

An improvement of the doublet concept is the use of matching "original" material for the doublet parts: As an example natural sapphire for the crown, that brings hardness, lustre, and brilliance, but also natural inclusions, and a Verneuil synthetic sapphire as pavilion, that brings the appreciated colour. In this specific modern variation of the doublet, the contact line is exactly in the girdle plane, and a colourless glue was used. The presence of natural inclusions of the pretended material in the upper part and the fact that bubbles in the glue layer are quite rare makes such a doublet more difficult to identify, especially when set.

Present material

With surprise we became aware of a booth at Hong Kong Jewellery and Gem Fair with perfectly looking faceted doublets in colours that resemble gemstones in fashion, like red tourmaline, tanzanite, mandarin garnet, paraiba tourmaline, and emerald. These doublets were produced by Viktor Kämmerling, a German gemstone cutter from Idar-Oberstein. The company is producing doublets in the third generation for nearly 100 years. In their product flyer, they describe in detail their assembled alternatives to expensive gemstones. Their substitutes are made of colourless beryl (for emerald substitutes) or colourless topaz (for spessartine, tanzanite, paraiba tourmaline, red tourmaline) or colourless tourmaline (for another paraiba tourmaline substitute). For all these doublets the strikingly correct colour comes from the glue layer between crown and pavilion. Stones are typically between 2 and 10 ct and are sold at a prize per carat.

Another company, Gemstones Corp. of Jaipur (India), was showcasing another type of doublets during Inhorgenta 2015. Their samples comprised further colours or even bi-coloured stones. They were correctly sold as quartz doublets at very low costs, the majority as oval facetted stones of approximately 8 carats.

For fashion jewellery, doublets may be reasonable alternatives for more expensive gemstones. However, they have to be correctly disclosed throughout the whole trade chain and to the final consumer as what they are: **doublets, assembled composite stones** based on the CIBJO gemstone book nomenclature.

See also: Hänni, H.A. & Henn, U. (2015) Gem Notes: Modern Doublets from Germany and India. Journal of Gemmology, 34 (6), 479-482.

✶ **Prof. H.A. Hänni, FGA**

△ **Figure 1**: Doublets as gemstone substitutes produced by Viktor Kämmerling, Idar-Oberstein and material from Gemstones Corp. Jaipur, India. These composite stones are between approx. 2 and 9 ct and provide the illusion of the intended gemstone such as emerald, tourmaline and so on. Photo: Henry A. Hänni

COBALT DIFFUSION-TREATED SPINEL

Cobalt spinel has gained much interest in the gem trade in recent years, mostly due to its attractive and vivid blue colour (Shigley & Stockton 1984, Chauviré et al. 2015, Pardieu 2012, Senoble 2010, Hanser 2013, see also Facette 20, 2014). Cobalt-spinel is known only in limited quantities and rather small sizes, e.g. from Luc Yen in Vietnam or from Sri Lanka and Madagascar.

Since early 2015, larger amounts of treated spinels of saturated blue colour have entered the gem trade in Bangkok, the result of a new diffusion treatment applied on cut spinels of rather greyish colour, using cobalt as a colouring agent to produce a vivid blue colour (Saesaw et al. 2015, Peretti et al. 2015).

For an experienced gemmologist this material is however easy to spot, as it contains numerous glassy residues in artificially healed fissures, partly filled with precipitated acicular cristallites (devitrification) (Figure 1), very similar to the ones in flux-assisted heated corundum.

△ **Figure 1:** Glassy residues in artificially healed fissures. Photo: M. S. Krzemnicki, SSEF

△ **Figure 2:** A cut section of a cobalt diffusion-treated spinel. Photo: M. S. Krzemnicki, SSEF

Apart from this, a chemical analysis (e.g. ED-XRF) will reveal a cobalt concentration much higher than the one in untreated cobalt spinel.

Cutting a section through this treated material clearly reveals the blue diffusion zone along the outline and along some fissures within the originally rather weak coloured and heavily fractured spinels (Figure 2). It is however not linked to the glassy residues enclosed within the spinels, thus we assume that these glassy residues in artificially healed fissures represent a flux-assisted heating process prior to the subsequent Co-diffusion process. Due to the rather deep diffusion of cobalt, facet-related colour variations known from Ti-diffusion treated sapphires have not been observed in our specimens. The specimens were kindly donated by Thamrong Charasaiya, A. Di Salvo, and Jeffery Bergman in Bangkok. ✶

NEW METHOD FOR PEARL ANALYSIS: X-RAY PHASE CONTRAST AND SCATTERING IMAGING

Traditionally, pearl testing is mainly based on X-ray radiography (Anderson 1931, Strack 2006, Sturman 2009). This method can help to visualize slight variations in X-ray attenuation within a pearl. These variations are linked to the presence, concentration, and orientation of organic matter or voids within the calcium carbonate pearl matrix. In recent years, X-ray microtomography (Xray-µCT) has strongly contributed to a better understanding of the spatial distribution of such internal features (Wehrmeister et al. 2008, Krzemnicki et al. 2010).

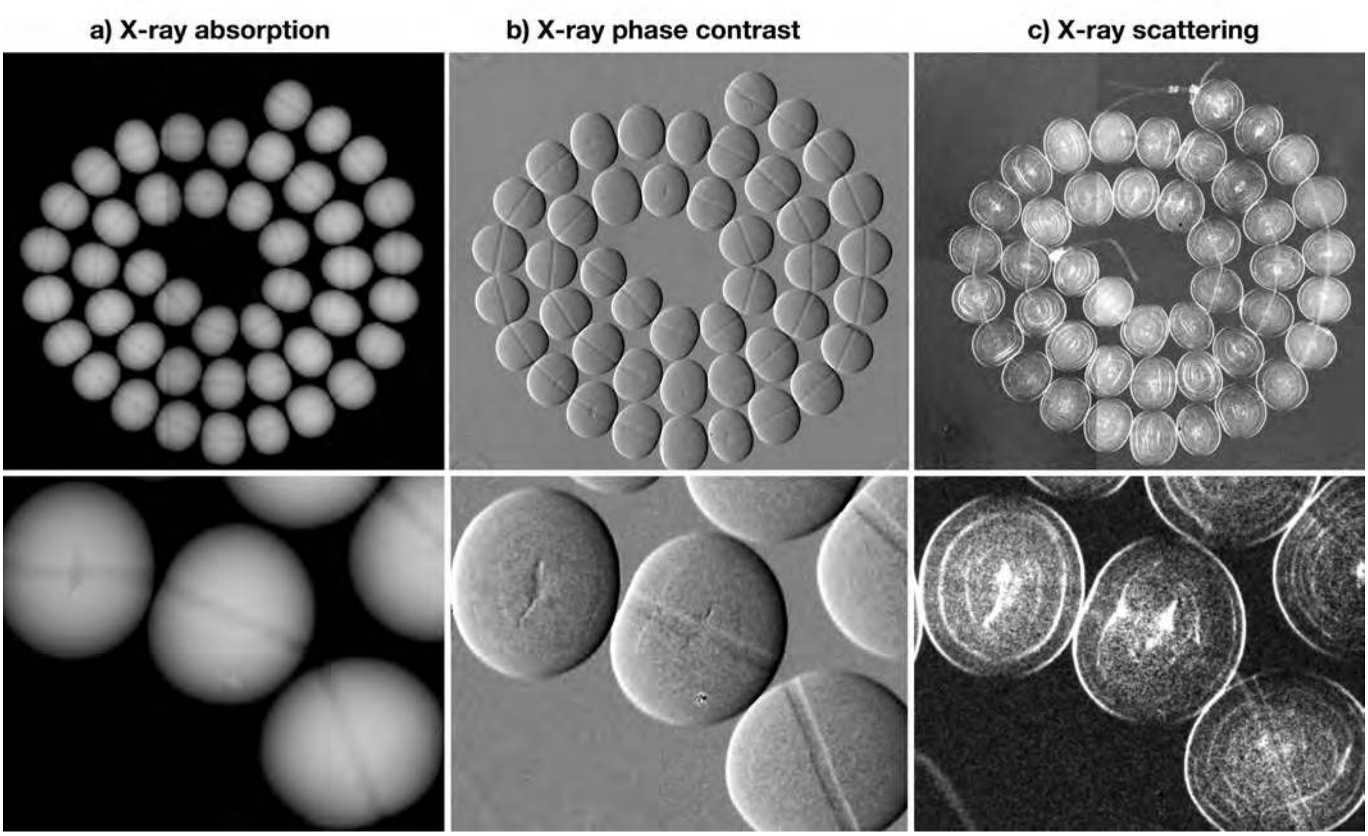
Although widely used in gemmological laboratories, conventional X-ray radiography has a number of limiting factors due to instrument parameters (e.g. focal size of the X-ray tube), analytical geometry (X-ray exposure is cone-shaped, resulting in lateral geometrical distortions of any 3D-object on the detector) and dynamic range and resolution of detectors (or X-ray films). But the most limiting factors are intrinsic properties of the pearl, such as its spherical geometry and thus variable path length (and attenuation) of the transmitted X-rays, and the tiny dimension and geometric orientation of internal structures (e.g. organic matter in the centre of the pearl).

In the past few months, the SSEF has developed a new analytical approach to analyse pearls in collaboration with CSEM, the Swiss Centre for Electronics and Microtechnics, based on ground-breaking research at the synchrotron facility of the Paul Scherrer Institute (PSI) in Switzerland and the University of Tokyo (David et al. 2002, Momose et al. 2003, Pfeiffer et al. 2006 and 2008). This new pearl testing method uses an X-ray interferometer to simultaneously produce X-ray radiography, X-ray phase contrast and X-ray scattering (also known as X-ray darkfield) images (Revol et al. 2011).

Phase contrast X-ray imaging substantially improves contrast information compared to conventional attenuation-based methods. Especially for biological samples (e.g. tissues or conchioline) made up of low-Z elements, the phase contrast effect is much more pronounced than the X-ray attenuation (Zhu et al. 2010). In addition to this, X-ray ultra small angle scattering visualises microstructures in much greater detail than with conventional radiography.

For this research collaboration with CSEM, we have analysed numerous natural and cultured pearl samples from various pearl oyster and mussel species simultaneously by conventional X-ray absorption, X-ray phase contrast, and X-ray scattering (darkfield) imaging techniques (Figure 1). The results of this research reveal that this new analytical approach is very promising to visualize tiny internal features within pearls. It may thus be especially helpful to in challenging situations to separate natural pearls from beadless cultured pearls.

Further research is ongoing to explore in more detail the future options of this new pearl testing method. For more details see Krzemnicki et al. 2015. X-ray Phase Contrast and X-ray Scattering Images of Pearls in Swiss Geoscience Meeting Abstract Volume 2015 and International Gemmological Conference Abstract Volume 2015. A more detailed article is in preparation. ✶



△ **Figure 1**: Comparison of a) X-ray absorption (attenuation), b) X-ray phase contrast, and c) X-ray scattering images of a strand of 44 beadless freshwater cultured pearls from China (*Hyriopsis cumingii*). Images: M. S. Krzemnicki & V. Revol, SSEF & CSEM

NEW: PEARL STRUCTURES VISUALISED BY NEUTRONS

In the last few months, the SSEF has started a number of research projects in collaboration with scientists at the Laboratory for Neutron Scattering and Imaging at the spallation source SINQ of the Paul Scherrer Institute PSI near Villigen, Switzerland.

A so-called spallation reaction occurs when a beam of ultra-fast protons (at about 80% of the speed of light) produced by a proton-accelerator hits a lead target, resulting in the 'vaporisation' of neutrons from the atomic nucleus of the lead. After slowing down their speed, these neutrons can then be used for scattering and imaging experiments very similar to X-rays.

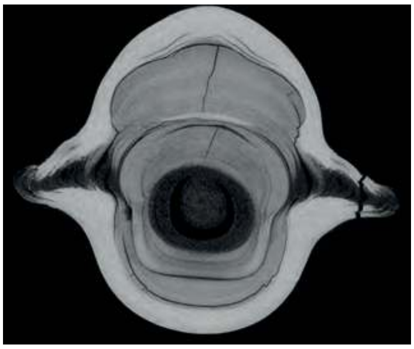
But in contrast to X-rays, which get more absorbed by materials containing chemical elements with higher atomic numbers, neutrons may be easily transmitted through metals such as lead or steel. They are however strongly absorbed by hydrogen, thus enabling the visualisation of hydrogenous substances in great detail. As a consequence, neutron radiography can be used as a complementary method to X-rays, especially for materials such as pearls, which contain both organic matter (conchioline) and crystalline substances (nacre).

To better understand this new method and its possibilities and limitations for pearl analysis, we selected in total 32 pearls, including freshwater and saltwater natural pearls from various shell species and beadless and beaded cultured pearls from main pearl producing molluscs. These well-characterised pearls were then analysed at the ICON beamline of the PSI. This research project in collaboration with Dr. E.H. Lehmann and his group of scientists was carried out by Carina Hanser as part of her Master thesis, under the supervision of Dr. Michael S. Krzemnicki, Assistant Professor at the University of Basel. Similar to X-rays, we analysed these pearls not only by neutron radiography (attenuation imaging), but also by neutron tomography, neutron phase-contrast and neutron darkfield (scattering) techniques.

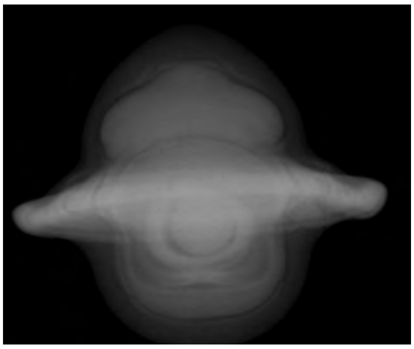
As an exemplary case, we present here the results of a natural pearl of 3.67 ct from Pinctada maxima, originating from Australia (Figure 1) and kindly donated to SSEF by Paspaley for research. As the photo shows, this pearl is characterised by a saturn-like outline, accentuated by a brown ring of organic substance (conchioline). The X-ray microtomographical section (Figure 2) through this pearl reveals in great detail the complexity of the organic-enriched inner part of this pearl (less absorption results in grey to dark grey zones). The neutron radiography (Figure 3) shows the very same structures, but with the hydrogenous conchioline as a strongly absorbing medium (white).

See also: C. Hanser (2015) Comparison of Imaging Techniques for the Analysis of Internal Structures of Pearls. Unpublished Master thesis, University of Freiburg, Germany. ✶

△ **Figure 1**: Natural pearl from Pinctada maxima, Australia, kindly donated by Paspaley. Photo: C. Hanser, SSEF



△ **Figure 2**: X-ray microtomography section through this pearl. Photo: C. Hanser, SSEF



△ **Figure 3**: Neutron radiography of the same pearl. Photo: C. Hanser, SSEF

'IMPERIAL PEARL NECKLACE' PROVES TO BE FAKE AND THE PROBLEM OF 'AGEING' OF PEARLS BY TREATMENT

Early 2015, the SSEF received an impressive pearl necklace for testing, which reportedly dated back to Imperial China (Figure 1). Our testing however quickly revealed that it was in fact a very recent artefact made of beadless freshwater cultured pearls, deliberately 'aged' by artificial colour modification and combined with a few lapis lazuli beads and heavily included sapphires.

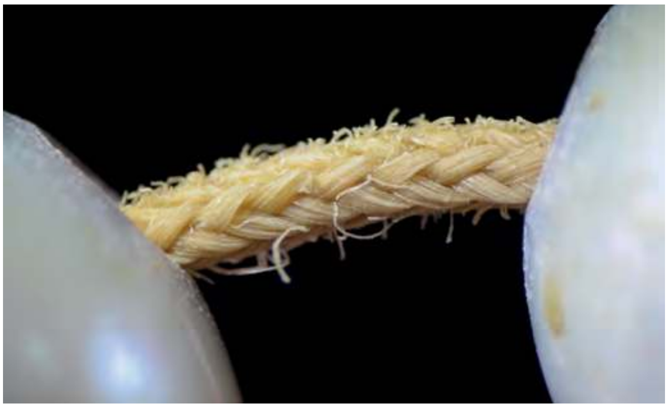
Due to the presumed significance of this item, we took a closer look at its making and found numerous further hints of its fabrication. The necklace was strung on braided synthetic elastic fibres. Such threads are rarely used for natural pearl necklaces and certainly not for historic items (Figure 2). Into these fibres, numerous tiny seed pearls were strung which showed clear evidence of dyeing after drilling.

△ **Figure 1**: Testing at SSEF revealed this reportedly Chinese Imperial pearl necklace to be a fake. Photo: L. Phan, SSEF

They were all characterised by dark brown colour concentrations around their drill holes (Figure 3), a well-known feature of such artificial colour modification.

The most important feature however was observed on the surface of the beadless freshwater cultured pearls (7 - 12.5 mm diameter). All these pearls showed numerous blemishes on the nacreous surface with traces of brownish dye (Figure 4). In contrast to the small pearls, there was however no artificial colour concentration around the drill holes. Based on these observations, we assume that these beadless freshwater cultured pearls were deliberately damaged and subsequently dyed to obtain a visual 'ageing' effect. This treatment was applied on these pearls before they were drilled for subsequent stringing on the thread.

It is not the first time that we have received pearls, which were dyed and somehow damaged to simulate a historic age. 'Ageing' methods are well known in the trade of antiques (see also P. Craddock, 2009: Scientific Investigation of Copies, Fakes and Forgeries). The present case has shown that it is very important to carefully observe and analyse all parts (including setting) of such an item to fully understand its forged nature. ✶



△ **Figure 2**: Thread made of braided synthetic elastic fibres. Photo: W. Zhou, SSEF

△ **Figure 3**: Dark brown colour concentrations around the drill holes of these dyed seed pearls. Photo: W. Zhou, SSEF

△ **Figure 4**: Surface blemishes with distinct brown dye concentrations result in an 'ageing' effect. Photo: W. Zhou, SSEF

‘HISTORIC’ NECKLACE WITH CULTURED PEARLS

Recently, the SSEF received an attractive antique styled necklace with five large drop-shaped pearls ranging from 15 to 42 ct for testing (Figure 1). Due to the closed-back setting of these pearls, we had to unset the pearls in acetone.

To our surprise, their identity as cultured pearls was unveiled immediately after unsetting. Each of these cultured pearls exposed an oval half-sphere cut from a freshwater shell, which was covered partially by nacre (Figure 2).

Multiple radiographies supported these findings, along with X-ray luminescence and X-ray fluorescence analyses, which confirmed the freshwater origin of the bead and the saltwater origin of the nacre covering these beads.

Although this result was rather disappointing for the owner of this antique styled necklace, it is an interesting case for gemmologists working with historic items. ✶

△ **Figure 1**: Necklace with five large drop shaped pearls. Photo: V. Lanzafame, SSEF

△ **Figure 2**: Unmounted pearls photographed in two different orientations revealing the freshwater shell beads. Photo: V. Lanzafame, SSEF

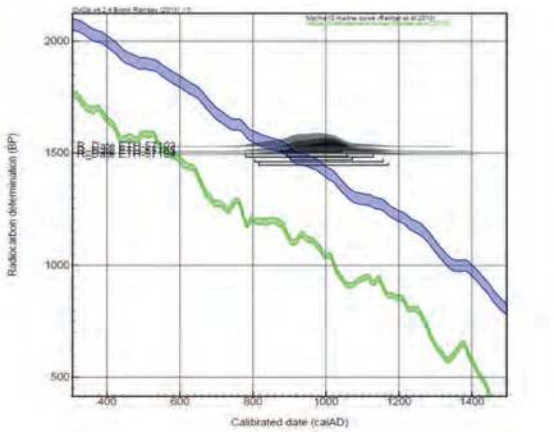
DATING OF 1000 YEAR OLD PEARLS FROM AN ARCHAEOLOGICAL SHIP WRECK

About five years ago, the SSEF started its research on radiometric age dating of pearls (see also SSEF Facette 17, 2010). Pearls - calcium carbonate ($CaCO_3$) concretions formed in molluscs by biomineralization - contain traces of radiogenic ^{14}C. Thus, it is in principle possible to date a pearl based on the ratio of radiogenic to stable carbon isotopes, similar to age dating of bones or tissues or other archaeological artefacts.

In 2014, the SSEF received through Dr. Hubert Bari a small number of highly interesting pearl samples from a find which later became property of the Qatar Museums Authority. These pearls originated from a shipwreck discovered in 2003 by an Indonesian fisherman in the Java Sea, north of the town of Cirebon on the north coast of Java (Indonesia). Under the aegis of the Indonesian Ministry of Fisheries the wreck was excavated in the following two years. Soon after discovery, it became clear that the wreck was in fact a merchant ship from the 10th century (AD), which presumably had foundered due to being overloaded. Among many ceramics of Chinese origin (about 300'000 objects), there were also glassware, terracotta, metals, ore, and some polished and rough gemstones, small pearls, and a few jewellery items.

△ **Figure 1**: 1000 year old pearls from the Cirebon wreck donated by Dr. Hubert Bari to SSEF for research and used in our radiometric study. Photo: L. Phan, SSEF

For our study in collaboration with Dr. Irka Hajdas (ETH Zurich), we randomly chose three of these pearls for age dating, using the ultra-sensitive Accelerator Mass Spectrometer (AMS) at the Laboratory of Ion Beam Physics (Swiss Federal Institute of Technology ETH) in Zurich.



△ **Figure 2**: The three analysed pearls from the Cirebon ship wreck reveal an age of approx. 1000 years.

The radiometric age dating on these three pearls not only revealed a very homogeneous age for all of them, but with a radiometric age of approx. 970 years (before present, see Figure 2) also confirmed the previous dating of the ship wreck, mainly based on ceramics and also the historical context of this ancient merchant ship and its cargo. With this age, these pearls are among the oldest pearls known today, and to our knowledge the only ones, which have been directly dated by radiocarbon age dating, with as a result corresponding to dated items found in the wreck, for example a sealed ceramic with a date corresponding to 970 AC, +- 3 years.

Half of the pearl find is today property of the Qatar Museums Authority and the second is property of the Government of Indonesia.

✶ **Dr. M. S. Krzemnicki, SSEF**

SSEF REPORTS AT AUCTION

The past few months have been quite challenging for large parts of the trade. A general downturn of the global economy resulted in a rather cautious buying mood of the general public. In combination with a number of regional political issues, these factors had and still have quite an impact on the jewellery but especially the diamond trade.

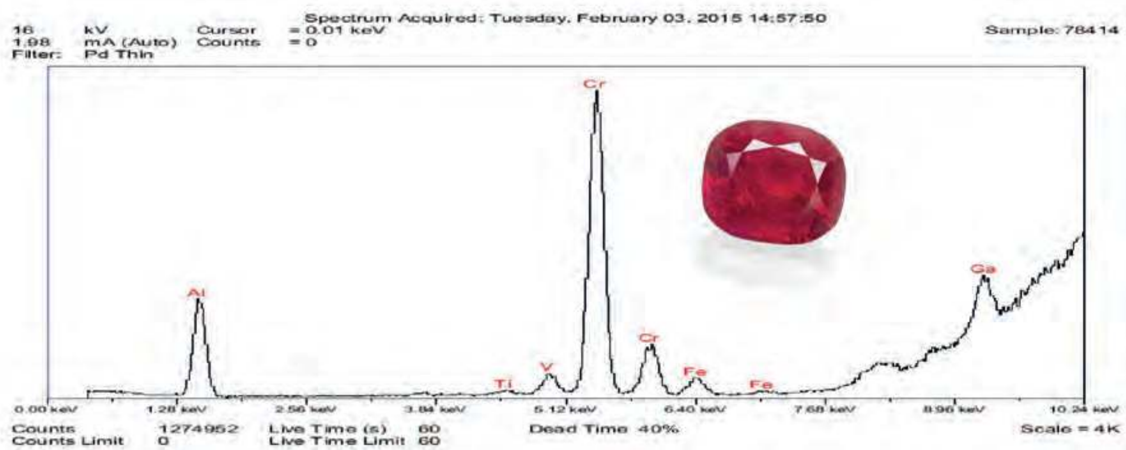
In contrast to this, however, auction houses have lately strengthened their performances, mostly driven by world-record prices paid for a number of highly prestigious jewels. These record-breaking results are achieved when such jewels contain gems of exceptional quality from famous deposits such as Mogok (Myanmar) for rubies or Kashmir (India) for sapphires, to name a few, or when they are backed with well documented historical provenance. Parallel to this trend, documentation of such jewels by gemmological reports from internationally reputed laboratories has become much more important over the past few years.

Since many years, the Swiss Gemmological Institute SSEF has been working closely with all major international auction houses, testing their most prestigious gems and pearls for their catalogues. As such, it is for us a great scientific pleasure to be able to analyse some of the most outstanding and exceptional items ever formed by nature at the SSEF laboratory. In the following, we would like to highlight a select number of iconic items, which all were sold in the last few months at auction with SSEF reports, many of them achieved world record prices.

Ruby, the Star of the Season:

For **rubies** - being again the star of the season - we have to start our listing with the '**Sunrise ruby**', a highly impressive Burmese ruby of 25.59 ct, which was sold for US$ 30 million at Sotheby's Geneva in May 2015 (SSEF report 78414). This ruby showed a beautifully saturated red colour, poetically also referred to as 'pigeon blood red', and was set in a Cartier ring together with two colourless diamonds in a very classical design.

◁ The 'Sunrise Ruby' set in a Cartier ring © Sotheby's International



▷ Chemical analysis (ED-XRF) of the 'Sunrise ruby'. © M.S. Krzemnicki, SSEF

Another highlight was the sale of the '**Graff ruby**' in November 2014 at Sotheby's Geneva for US$ 8.6 million (SSEF report 45948). Interestingly, Mr Laurence Graff - the new owner of the stone - was buying this exceptional Burmese ruby of 8.62 ct for the second time in less than a decade. He first acquired it in 2006 for a then record price of US$ 3.6 million at Christie's auction in St. Moritz. Being fascinated by its rich colour, he named it thereafter the 'Graff ruby'. With a price more than double that of 2006, this ruby perfectly illustrates the price trend for gems of finest quality in recent years.

◁ The 'Graff ruby' ring © Sotheby's International

The '**Queen of Burma**' ruby ring which was sold in November 2014 by Christie's Geneva for US$ 6 million (SSEF report 72285) is another item with interesting provenance. This impressive Burmese ruby of approx. 23 ct was set in a ring by Cartier, and was originally sold in 1937 to His Highness, the Maharajah of Kutch (India). The highly attractive ruby is characterised by a vivid pinkish red colour combined with an excellent clarity, rarely encountered in rubies of this size.

◁ The 'Queen of Burma' ruby ring Photo: J. Xaysongkham, SSEF

Vibrant Hong Kong set the pace with two further Burmese rubies, a **Cartier brooch with a 10 ct Burmese ruby** of exceptional quality which sold for US$ 8.4 million at Christie's in November 2014 (SSEF report 74530), and just very recently, the '**Crimson Flame**' a Burmese ruby of 15.04 ct, sold in December for US$ 18.3 million at Christie's (SSEF report 80282).

◁ The 'Crimson Flame' ruby unmounted
Photo: V. Lanzafame, SSEF

◁ Cartier Brooch
Photo: L. Phan, SSEF

Another beautiful example is the '**Mogok's Fiery Red**' ruby suite designed by Fai Dee. This suite was sold in two lots for US$ 10.3 million at Christie's Hong Kong in December. Consisting of a necklace of 32 rubies (SSEF report 82001) and a pair of ear-pendants of four matching rubies (SSEF report 82002) this exceptional selection of Burmese rubies totalled nearly 75 ct.

△ Close-up of the 'Mogok's Fiery Red' ruby necklace. Photo: SSEF

With Mozambique being a new and important source of excellent rubies, it was a pleasure for us to see an outstanding necklace with twenty two vivid red rubies from Mozambique - named the '**Flare of Crimson**' - fetching with US$ 3.17 million a world record for any Mozambique ruby jewellery at the spring sale of Tiancheng International in Hong Kong (SSEF report 78836).

Apart from these individual gems, a number of highly valuable and exceptional layouts of rubies were sold at auction recently. A perfect example is the **ruby necklace by Etcetera** designed by Edmond Chin in a very modern and artistic latticework pattern. The necklace of 48 highly matching Burmese rubies with a total weight of 120.74 ct sold at Christie's Hong Kong in June for US$ 13 million (SSEF report 79458).

△ Detail of the Etcetera ruby necklace revealing its artistic latticework design. Photo: L. Phan, SSEF

△ The 'Flare of Crimson' ruby necklace with 22 matching rubies from Mozambique.
Photo: L. Phan, SSEF

Sapphires, the blue brothers of ruby:

Sapphires, the blue brothers of ruby, have been again very strong in the past few months at auction. In contrast to rubies, however, there is not only one origin dominating by far all others, but with Kashmir, Burma and Ceylon three classical sources accounted for exceptional auction highlights.

◁ The 'Blue Belle of Asia' loose and set in a necklace. Photo: L. Phan, SSEF

A stunning sapphire from Ceylon of 392.52 ct - also known as the '**Blue Belle of Asia**' - was sold by Christie's Geneva in November 2014 (SSEF report 72359) for US$ 17.5 million, a world record for any sapphire sold at auction so far. Reportedly discovered in Pelmadulla (Ceylon) in 1926, this sapphire had been in a private collection for many years before it made a splendid reappearance at this auction.

◁ 91.95 ct Burmese sapphire sold at Poly Auction. Photo: L. Phan, SSEF

Burmese sapphires of exceptional size and quality set further auction highlights, such as the **octagonal Burmese sapphire of 91.95 ct** (SSEF report 76207), set as a centre stone in a diamond necklace signed Boucheron. It was sold in April 2015 in Hong Kong at Poly Auction for US$ 3.8 million.

◁ Pair of Burmese sapphire earclips, Cartier. © Sotheby's International

Another fine example is a matching **pair of Burmese sapphires** (15.77 ct and 16.90 ct), set in Cartier ear clips (SSEF report 78416), which was sold by Sotheby's Geneva in May 2015 for US$ 3.4 million.

◁ Exceptional Burmese sapphire of 118.88 ct. Photo: J. Xaysongkham, SSEF

The **most expensive Burmese sapphire** at auction in the 2014 - 2015 period however sold just recently for US$ 4.2 million at Christies Geneva last November. This sapphire (SSEF report 73209) is characterised by a very impressive size and weight of **118.88 ct** and a highly attractive 'royal blue' colour combined with an excellent clarity.

As usual, the highest prices per carat were paid for Kashmir sapphires of exceptional quality, which for their velvety blue colour and their rarity are highly sought after by collectors.

In November 2014, Sotheby's Geneva sold an octagonal step-cut Kashmir sapphire of 27.54 ct (SSEF report 60162) for US$ 5.98 million, at that time a world record for any Kashmir sapphire sold at auction.

△ From left to right: Cartier brooch with 30,23 ct Kashmir sapphire, 35.09 ct Kashmir sapphire (unmounted) and 27.68 ct 'Jewel of Kashmir'. Photos: Sotheby's International and SSEF

In 2015, this world record was broken several times, starting in May in Geneva with a **Cartier sapphire brooch** (SSEF report 78415), containing a 30.23 ct Kashmir sapphire which sold at Sotheby's for US$ 6.16 million, and an important ring with an antique cushion shaped **Kashmir sapphire of 35.09 ct** (SSEF report 77675), which sold for US$ 7.45 million at Christie's.

And finally in October, the '**Jewel of Kashmir**', an exceptional royal blue sapphire of 27.68 ct (SSEF report 77842) sold for US$ 6.7 million at Sotheby's in Hong Kong, setting a new world record price per carat for Kashmir sapphires.

△ Pair of Colombian no-oil emeralds 13.56 ct and 12.91 ct (unmounted). Photo: L. Phan, SSEF

◁ Pink sapphire of 49.04 ct (unmounted). Photo: L. Phan, SSEF

◁ Emerald from the Panjshir valley. Photo: L. Phan, SSEF

However, the most surprising result for us was achieved not by a blue but a pink sapphire of 49.04 ct (SSEF report 73644) from Ceylon, a classical source for such attractive stones. This gemstone of an exceptionally vivid colour and excellent clarity sold for US$ 2 million - nearly 10 times its original estimate - at Christies Geneva in May 2014.

Emeralds:

In recent years, fine quality emeralds have emerged out of the shadows again and gained much attention, with some auction highlights especially by the end of 2015.

In May, Christie's Geneva sold a pair of **antique emerald bangles** for US$ 1.76 million. These bangles in Art Deco style are possibly of royal Indian provenance and each contain 23 rectangular Colombian emeralds of highly matching colour and quality (SSEF report 79094).

In November, a 19th century jewellery item - known as '**Elena's emerald and diamond necklace**' - was sold for US$ 2.6 million at Christie's Geneva (SSEF reports 79794-79805 and 80244).
Princess Hélène d'Orléans (1871 - 1951), named also Elena d'Aosta, received this impressive necklace which was later named after her from her godfather, Henri d'Orléans, Duke of Aumale, at the occasion of her marriage with Prince Emanuele Filiberto of Italy (1869 - 1931), Duke of Aosta, on 25 June 1895 (di Savoia & S. Papi, Gioelli di Casa Savoia, 2002).

At the same sale in Geneva, a **pair of exceptional emerald ear-pendants** were sold for nearly US$ 4 million, containing two Colombian emeralds of beautifully saturated green colour (SSEF report 75378). Both emeralds showed no indications of clarity modification, thus adding to their rarity.

An interesting result was achieved later in December at Christie's auction in Hong Kong for an exceptionally pure **emerald from the Panjshir valley** (Afghanistan), a historic source of fine emeralds despite recent decades of political turmoil. The 10.11 ct emerald (SSEF report 82231) sold for US$ 2.3 million, a world record price for an Afghan emerald.

△ The 'Elena's emerald and diamond necklace', an impressive historic layout of Colombian emeralds of very fine quality. © Christie's International

Pearls, tear drops of the moon:

Natural pearls of exceptional quality have been offered in the last few months at auction. Being the worldwide reference for pearl testing, we at SSEF are very proud that we were able to analyse all natural pearls of high value offered at auction recently and get scientific insights into their beauty and structure.

Drop-shaped pearls are highly sought after, not only for the beauty of their shape, but certainly also linked to the mythological connotation of natural pearls as tears or dew falling into the sea under moonlight.

This necklace sold for US$ 7 millions at Sotheby's Geneva in May 2015. As a new trend, we have also seen astonishingly high prices for coloured natural pearls, mostly originating from *Pinctada margaritifera* (blacklipped pearl oyster) and *Pteria sterna* (rainbow-lipped pearl oyster or Pacific wing oyster). The fascination of these pearls lies in their subtle range of greyish colours, often superposed by distinct and colourful overtones, the so-called orient of pearls.

△ Impressive natural pearl and diamond necklace. © Christie's

△ Pair of ear-pendants by Harry Winston. Photo: SSEF

△ Single strand necklace with 50 natural pearls. Photo: L. Phan, SSEF

In May 2014, a single highly impressive and **perfectly drop-shaped pearl** of approx. 220 grains (calculated weight) was sold at Christie's Geneva for US$ 3.1 million (SSEF report 73704).

In the following months, three exceptional pairs of drop-shaped pearls set in ear-pendants were offered at auction. The first, a pair of **ear-pendants by Harry Winston** was sold in November 2014 by Christie's Geneva for US$ 3.5 million (SSEF report 74804), containing two slightly cream coloured pearls of approx. 100 grains each.

In May 2015, Sotheby's Geneva sold an exceptional pair of **natural pearl and diamond ear-pendants by Petochi** for US$ 3.2 million (SSEF report 78649). In the same week, Christie's Geneva sold a very fine pair of **pearl ear-pendants** for US$ 1.8 million (SSEF report 79743). Astonishingly, both pairs of ear-pendants were quite similar in design, highlighted by a button-shaped pearl at the top and a drop-shaped pearl suspending.

Apart from these single pearls, a few impressive pearl necklaces were sold, such as a **single strand necklace with 50 natural pearls** of highly matching round shape, white colour and fine pearl lustre (SSEF report 79533). This necklace sold at Sotheby's Geneva in May for US$ 3.88 million. At the same time, Christie's Geneva sold an equally outstanding **single strand necklace with 43 natural pearls** for US$ 3.94 million (SSEF report 79742). The highest price however was paid for a **two strand necklace** with a Cartier clasp containing an exceptional selection of 78 natural pearls of impressive size (diameter up to 13.95 mm) and highly matching appearance (SSEF report 79686).

In November 2014, Christie's Hong Kong sold an important **coloured pearl necklace** (see above) beautifully designed with a Burmese ruby as centre stone topping a large pearl tassel for US$ 2.4 millions (SSEF report 76783).

In April 2015, Christie's New York sold an exceptional **four strand necklace of 289 coloured pearls** setting a new world record price of US$ 5.1 millions (SSEF report 78724).

△ Left: The 'Cowdray Pearls' Photo: SSEF. Right: Annie, 1st Viscountess Cowdray, Lady Pearson (1860 - 1932) wearing The Cowdray Pearls. Painted by Sir William Orpen R.A. RHA (1878 - 1931)

This record was then finally even topped by Sotheby's Hong Kong, when they sold in October the '**Cowdray pearl necklace**' (including a pair of pearl ear-clips) for US$ 5.3 million. This necklace, formerly from the collection of Viscountess Cowdray, Lady Pearson (1860 - 1932) contains 42 pearls of partly very impressive size (diameter up to 12.90 mm) and highly attractive rosé, purple and green overtones (SSEF reports 67726 and 67685).

Jadeite, stone of heaven:

△ The Hutton Mdivani jadeite necklace with an Art Déco clasp designed by Cartier. Photo: L. Phan, SSEF
Barbara Hutton wearing her jadeite necklace with her first husband, Prince Alexis Mdivani, photographed in 1933 at the Metropolitan Opera House in New York. Private Collection

In the Far East, jadeite is among the most appreciated and sought after gems. In the past few months, the SSEF has analysed a number of outstanding jadeite items, among them two, which were sold at auction in Hong Kong.

First, the '**Hutton-Mdivani jadeite necklace**' with an Art Deco clasp designed by Cartier which sold for a stunning world record of US$ 27.4 million at Sotheby's Hong Kong in April 2014. This necklace of 27 perfectly round slightly graduated jadeite beads of beautifully matching green colour and outstanding translucency (SSEF report 73188) was presented to Barbara Hutton as a wedding gift from her father when she married Alexis Mdivani in 1933.

A second highly interesting **jadeite bead necklace** was sold in June 2015 at Christie's Hong Kong for US$ 2.18 million (SSEF report 78695). Each of the 33 beads of the necklace was characterised by a saturated green vein within a nearly colourless matrix crossing each bead perpendicular to the drill-hole, thus resulting in a very attractive design of the necklace.

Spinel, a new star on the horizon:

And finally, we would like to highlight two exceptional spinels, which were recently auctioned.

◁ 'The Hope spinel' (50.133 ct). © Bonhams

In September, the '**Hope spinel**', a very fine pink spinel of 50.133 ct from the classical Kuh-i-Lal mines in the Pamir mountains (Tajikistan) sold for a world record price of US$ 1.4 million at Bonhams in London (SSEF 81343). Based on the provided documentation, this spinel was originally part of the extraordinary gem and pearl collection of Henry Philip Hope (1774-1839) together with the blue Hope diamond and other gem treasures.

Finally, in December an outstanding **colour changing cobalt spinel of 25.79 ct named** '**The Electric Romance**' was sold for US$ 230'000 at Tiancheng International in Hong Kong (SSEF report 81880). What made this spinel special was its impressive size (compared to the commonly small sizes of Cobalt spinel) and its very attractive colour-change from blue in daylight to purple in incandescent light, as is occasionally seen in spinel coloured by cobalt. It is very understandable that this spinel reportedly had been mistaken for a sapphire and had been kept in a private vault for over 50 years until its true and exceptional identity was uncovered only recently.

In conclusion, this journey through the auction highlights of the last few months shows how the market for highly prestigious gems and jewellery has strengthened its performance, but also reveals that SSEF reports are internationally highly accepted based on our reputation as leader in origin determination of coloured stones and natural pearl identification. We do not take this as granted and constantly strive to further expand our gemmological knowledge and analytical capacities to meet the highest expectations of our international clients and the public which rely on our expertise. ✶ **Dr. M. S. Krzemnicki, SSEF**

△ The colour change cobalt spinel ring photographed under daylight and incandescent light. Photo: L. Phan, SSEF

ICONIC RUBIES FROM MOZAMBIQUE ANALYSED AT SSEF: THE 'RHINO RUBY' AND THE 'EYES OF THE DRAGON'

Since its discovery in 2009, rubies from Mozambique of exceptional quality have entered the gem market. These gems immediately gained a lot of attraction in the market. The best of this material is characterised by a very homogeneous and beautifully saturated red colour and an exceptional purity, very difficult to match by rubies from other sources. Very fine and dispersed particles and tiny platelets are common features in these rubies, but do not or only slightly affect the clarity of these rubies of high quality.

In 2011, Gemfields acquired a 75% interest in Montepuez Ruby Mining Limitada, a new joint venture company created in collaboration with a partner from Mozambique. Since 2014, Gemfields is successfully selling these rubies as rough stones at several auctions in Singapore. As highlights of their sale in December 2014, Gemfields offered an exceptional rough ruby of 40.23 ct originating from their Montepuez mining site, named the 'Rhino ruby'. In June 2015, the highlight of their Singapore auction was a pair of rough rubies of a total weight of 45 ct, which was later named the 'Eyes of the Dragon' by the new owners.

After cutting, these iconic rubies from Mozambique were submitted to SSEF for testing. The 'Rhino ruby' had been cut into an impressive pear-shaped ruby of 23.2 ct, whereas the 'Eyes of the Dragon' were finally mastered into a pair of rubies of 11.3 ct and 10.7 ct, highly matching in shape and size and exceptional quality.
✶ **Dr. M. S. Krzemnicki, SSEF**

△ 23.2 ct 'Rhino Ruby'. Photo: SSEF

△ The 'Eyes of the Dragon' rubies. Photo: SSEF

SSEF COURSES
in 2016

2015 was a busy year for the SSEF Education Department. Our courses have a strong international reputation and we see more and more gemmologists, jewellers and gemstone professionals from very different countries attending our courses. It's interesting to have participants from so many different gemmological and international backgrounds.

In 2016, we will again be offering a wide range of courses. The SSEF Basic Gemmology Course (25 July - 09 August; 14 - 29 November) and the SSEF Basic Diamond Course (24 - 28 October) offer good introductions, and participants can graduate with a certificate after taking theoretical and practical examinations. For more in-depth courses we offer Advanced Training Courses on coloured gemstones, pearls and small diamonds.

ADVANCED PEARL COURSE

This three day pearl course takes place twice a year (20 - 22 April; 17 - 19 October). It is ideally suited for participants (max. 6) who want to know more about how pearls are formed, about possible treatments, and how natural and cultured pearls can be identified and separated. SSEF's important collection of shells and pearls offers a good opportunity for practicing and expanding your skills and knowledge of pearls. The course also offers an introduction into the use of UV-visible spectrometry, EDXRF, X-ray radiography and luminescence for pearl testing in a scientific laboratory.

ADVANCED COLOURED GEMSTONES COURSE

The advanced coloured gemstone training course (25 - 29 April; 09 - 13 May; 10 - 14 October) is an intense gemmological programme that offers a detailed hands-on approach to identifying treatment and origin of ruby, sapphire and emerald. In this course we demonstrate the possibilities and limitations of treatment detection and origin determination of corundum and emerald. Participants will have the opportunity of analysing and testing numerous samples from our collection.

SMALL DIAMOND COURSE

The SSEF small diamond course (09 - 11 November), which focuses on diamonds of a diameter between 0.7 and 3.8 mm, mainly used in the watch industry, enables participants to themselves perform the quality control of such small diamonds. These courses are aimed at people working in the jewellery and watch industry, and can be tailored to your company's specific needs. Previous gemmological experience is welcome but not a requirement.

SCIENTIFIC GEMMOLOGY COURSE

In 2016, the one-week Scientific Gemmological course will take place 4 - 8 July. During this course, participants learn about techniques and applications of instruments like X-Ray fluorescence spectrometry, UV-Visible-NIR spectroscopy, LIBS (Laser Induced Breakdown Spectroscopy), Raman and FTIR spectrometry in the field of gemmology, as performed at the Swiss Gemmological Institute SSEF. Advanced gemmological education is a requirement.

SSEF 'À LA CARTE' COURSE

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 2014 and 2015, several companies, such as Cartier, Christie's, Piaget and Türler and benefited from such courses that were tailored to specific topics including small diamond quality control, diamond treatments or learning to identify coloured gemstones from different origins.

If you or your company are interested, please contact us to discuss how a gemmological course can be tailored to your needs. ✶

CONGRATULATIONS

The Swiss Gemmological Institute SSEF wants to express its congratulations to the following persons for graduating from the following courses in 2014 and 2015:

SSEF Basic Gemmologist Certificate:

- Jeffery Bergman
- Aruna Maridass
- Sabina Weber Sauser
- Iman Yusuf Iman
- Lisa Ehrle Lanz
- Florence Flühmann
- Sarah Tombez
- Julia Blank
- Riki Waldstädter
- Michael Rytz
- Ueli Rogger
- Isabelle Vetter
- Anabela Karim
- Aigul Jamasheva
- Zeudi Cabiddu
- Beatriz Bretscher
- Caroline Phan
- Elena Aapro
- Bruno Wyler
- Talah Almutlaq
- Aline Debusigne

SSEF Basic Diamond Certificate:

- Katharina Achermann
- Mathias Suter
- Patrick Steiner
- Marie d'Adhémar
- Sandra Stalder
- Isabelle Linde
- Julia Blank
- Bettina Braun-Goldinger
- Karin Grämiger
- David Jegger
- Ly Phan
- Alexandre Klumb
- Leonora Hyseni
- Taner Hatipoglu
- Silvia Vuillemin
- Flore Primault
- Aliona Wüthrich
- Linda Hodel
- Riki Waldstädter
- Aigul Jamasheva
- Maria San Román
- Corina Muff
- Carina Silke Hanser

Only participants that pass the final exam receive the SSEF Basic Gemmologist or Basic Diamond Certificate. The qualification requires theoretical knowledge as well as practical skills in gemstone testing or diamond grading.

Advanced Gemmologist Certificate:

COURSES ON PEARLS

- Rebecca Ardessi
- Makiki Shiraishi
- Alexander Klumb
- Luc Phan
- Taner Hatipoglu
- Luca Rossi
- Vikram Tongya
- Dragica Dubravac
- Antoinette Starkey
- Riki Waldstädter
- Anabela Karim
- Mathilde Meissirel
- Jean-Francois Moyersoen
- Hao Wang

COURSES ON SMALL DIAMONDS

- Samira Bader
- Véronique Rouiller
- Elodie Lancon
- Christine Guillemaut
- Dino Patricio
- Carolina Maridor
- Michelle Picosson
- Chiara Parenzan
- Bo Wang
- Maria Incoronata Maddamma
- Laura Junod
- Claudia Henry
- Laurentina Correia
- David Heulin
- Roberto Bergamo
- Giorgia D'Anza
- Riki Waldstädter
- Taner Hatipoglu
- Federico Baldan
- Delphine Bonvalot
- Farid Tifaou
- Lucie Pechin
- Dorotea Rosato
- Carole Widmer
- David Aranda
- Michel Clerc

COURSES ON TREATMENT AND ORIGIN OF COLOURED STONES

- Sumeet Chordia
- Milena Bohnert
- René Kluser
- Andrea Rosi
- Mario Soetrisno
- Emil Sutirta Tan
- Judith Braun
- Sylvia Schmutz
- Caroline Liang
- Jean Kim
- Francesca Valentini-Orme
- Hélène Robert
- Geoff Young
- Maria Cristina Barioglio
- Ali Badrig
- Guiseppina Di Lorenzo
- Anabela Karim
- Lucia Musilli
- Rohan Soni
- Ricki Waldstädter
- Win Thanthike
- Myint Myat Phyo
- Puneet Bafna
- Antoinette Starkey
- Cyril Delarue
- Naheta Abishek
- Mathilde Meissirel
- Mirhta Sudarma
- Raphael Abramov
- Hendro Susanto

Scientific Gemmologist Certificate:

- Martin Metin
- Dorian Eckmann
- Maya Musa
- Edward Joseph Rweyemamu
- Sebastian Hänsel
- Julia Griffith
- Andrew Fellows
- Elizabeth Gleave
- Cathryn Hillcoat
- Claire Mitchell
- Charles Evans
- Astrid Bosshard
- Alessandra Marzoli
- Jeffery Bergman
- Flavio Butini
- Htnun Kyaw Swar
- Victor Million-Rousseau
- Adelmo Venturelli

SSEF AT SWISS GEMMOLOGICAL SOCIETY SGG

For many years, the SSEF, as a member of the Swiss Gemmological Society (SGS) presents several talks each year about our current research. The programme of the annual meeting in April 2015 was perfectly organised by Christoph Brack, president of the SGS, and Michael Hügi, president of the scientific commission of SGS.

From the side of SSEF, we gave presentations with an overview of gemstone treatments (H.A. Hänni, former director of SSEF), treatment disclosure and news from the SSEF (M.S. Krzemnicki), the history of HPHT treatment in diamonds (J-P. Chalain) an update on responsible standards in the industry (L. Cartier) and finally on blue cobalt spinels from Vietnam (C.Hanser). ✶

SCHWEIZERISCHE GEMMOLOGISCHE GESELLSCHAFT
SOCIÉTÉ SUISSE DE GEMMOLOGIE
SOCIETÀ SVIZZERA DI GEMMOLOGIA

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With our worldwide network of shuttles, connecting the SSEF to all major international trading hubs, the shipping of goods to the SSEF has become easier than ever before.

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- Call **your local Ferrari** office to organise the pick-up.

The service includes pick-up at your office - temporary export/import in your country and Switzerland; airfreight cargo for valuable items; Swiss customs fees; delivery to SSEF - and return transport with delivery to your office.

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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 New York, Hong Kong - SSEF

call Ferrari **New York** 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

Weekly shuttle between London, Paris - SSEF

call Ferrari **London** office +44 1753 28 78 00
call Ferrari **Paris** office + 33 1 49 96 60 60

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 Dubai (UAE), Singapore, Bangkok, Mumbai, Jaipur, Taipei - SSEF

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

Costs: 240.- Swiss Francs per round trip and an additional liability fee of 0.035%

Example 1: declared 100'000 SFr > shipping costs: 275 SFr

Example 2: declared 1'000'000 SFr > shipping costs: 590 SFr

On request shuttle between 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 between Spain - SSEF

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

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 Stuttgart (Germany) - SSEF

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

Costs: 240.- Swiss Francs per round trip and an additional liability fee of 0.035%

Example 1: declared 100'000 SFr > shipping costs: 275 SFr

Example 2: declared 1'000'000 SFr > shipping costs: 590 SFr

For all other destinations, please contact us

SATT GEMS SUBSIDIARY OF SSEF

In 2014, SSEF founded a subsidiary named SATT Gems AG. The aim of this new company is the marketing and the after sale services of instruments developed by SSEF. This applies to the four ASDI instruments recently sold in Switzerland but is not limited to them. Several additional gemmological tools and instruments are currently being developed by SSEF and will be distributed by SATT Gems AG in future. By creating SATT Gems AG, this enables SSEF to continue to focus on its main goals: testing, research and education.
More information on: www.sattgems.com ✶

ASDI UPDATED

In 2015, SSEF twice updated its own ASDI - Automated Spectral Diamond Inspection - instrument used in the lab, and these improvements will made be available for the next version of ASDI instruments ordered and produced.

The first update concerns industrial aspects. The ASDI was inspected by Electrosuisse and Electrosuisse / Montena EMC and later passed European Conformity tests for the following norms:

- 2006/42/CE (European Union Directive on machinery)
- 2006/95/CE (European Union Directive on machinery)
- EN ISO 12100: 2011 (Safety of machinery)
- EN 60204-1 (Electric equipment of machinery)
- EN ISO 13849-1: 2008 (Safety related parts of control systems)
- EN 61000-6-2 (Electromagnetic compatibility - immunity)
- EN 61000-6-4 (Electromagnetic compatibility - emission)

The ASDI instrument is a 'class A equipment', which means that it should be used in an industrial environment. In a domestic environment this instrument may cause interference in which case the user may be required to take adequate measures. These CE conformity certifications are major assets for future exportation of the ASDI instruments.

The second update of the SSEF's ASDI was the implementation of an additional horizontal digital camera for table size measurements with a precision of +/- 0,005 mm. This high resolution camera now enables SSEF to provide its clients with a comprehensive ASDI measurement report which now includes the distribution of a diamond's measurements into: four proportion grades, fourteen 0.01 mm diameter-ranges, four ovalisation categories, six girdle thickness categories, four total depth categories, three crown percentage/angle categories and three pavilion percentage/angle.

Samples of ASDI measurement reports are available in English and in French on our website www.sattgems.com ✶

NEW PROTOCOL FOR SMALL DIAMONDS

Quality control of melee-size diamonds updated

Effective from the 1st of January 2016, SSEF applies an updated service for controlling the quality of melee-size diamonds. Baguettes are not concerned, only the quality control service of round diamonds of melee-size (round polished diamonds with a diameter ranging from 1.0 to 3.8 mm) is updated.

In summer 2015, SSEF received its updated version of the ASDI instrument (see the related article in this Facette issue) with an additional camera that enables the high precision (+/- 0.005 mm) measurement of melee's table size. The embedded software also provides us with an automatic table proportion value for each single diamond without affecting the high speed authentication process.

The table size measurement is the last precise measurement that the ASDI instrument was missing in order to determine the full proportion grade of each tested diamond. As a consequence, SSEF now provides an updated version of the ASDI measurement report (see related article in this Facette issue).
Samples of ASDI measurement reports are available in English and in French on our website www.sattgems.com ✶

NEW INSTRUMENTS AT SSEF

In the last two years, the SSEF has made a number of major investments in equipment, thus expanding our testing and research capabilities considerably. This expansion of our analytical department shows our commitment to constantly evaluating and investing in state-of-the-art equipment to offer the international trade our testing services at the highest and most advanced scientific level.

Each newly acquired instrument has been extensively validated before it has been integrated into our analytical working procedure on diamonds, coloured stones or pearls.

microFTIR: Bruker LUMOS

Since many years, the SSEF is working with instruments from Bruker Corporation. With the LUMOS, the SSEF has now added a microFTIR to its range of infrared spectrometers. It allows structural analyses at microscopic magnification levels on the surface or within a transparent gemstone. Apart from diamonds, it is regularly used at SSEF to identify filler substances within surface reaching fissures of emeralds, as a complementary test to Raman microspectrometry.

The LUMOS FTIR microscope is equipped with a mechanised sample stage, thus allowing a fast and precise automated analysis of multiple samples such as series of small melée diamonds (see also article in this Facette). With its large working distance (samples up to 40 mm thickness), it is also possible to record FTIR spectra of gemstones of large size or even set in jewellery.

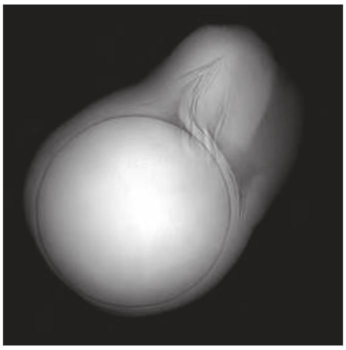
Bruker S1 TITAN 800: handheld ED-XRF

As latest addition from the same manufacturer, the SSEF has recently bought a portable ED-X-ray fluorescence spectrometer for chemical analysis of gems and pearls. The Bruker S1 TITAN 800 is the newest generation of handheld XRF instruments, equipped with a SDD (silicon drift detector) detector. Its configuration to choose from 6 - 45 kV excitation energy allows us to analyse a wide range from light to heavy elements and with a low detection limit, especially important for example to determine trace element ratios in rubies or emeralds as part of the origin determination procedure.

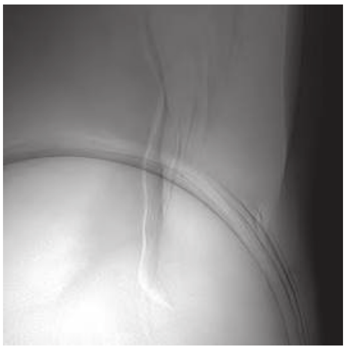
Yxlon Cougar: digital radiography

With the recent installation of the Yxlon Cougar, the SSEF has now integrated the most advanced and state-of-the-art X-ray microfocus instrument available on the market into its analytical department.

This system allows us to analyse pearls in real-time with high-resolution digital radiographies. It is further equipped with a CT-scan module, enhancing thus our capacities for microtomography of pearls and stones.



◁ Digital radiography (Yxlon Cougar) of a beaded cultured pearl (*Pinctada margaritifera*) with a wing-shaped nacre accumulation. Figure: M. S. Krzemnicki, SSEF



◁ Radiography close-up of the same beaded cultured pearl shows in great detail the curved interface between the bead and the overlaying nacre with vertical irregular cavity structures. Due to the projection of the three-dimensional pearl on a planar radiograph, the largest cavity structure seems to intrude into the bead, although it in fact runs completely in the nacreous layer covering the bead. Figure: M. S. Krzemnicki, SSEF

As a worldwide leader in pearl identification, the SSEF has invested since many years much time and effort not only in fundamental research about natural and cultured pearl formation and identification, but also in developing new analytical methods for pearl testing.

We are thus proud to have at hand an unparalleled range of state-of-the-art methods for pearl testing, either in-house at SSEF or in close collaboration with research institutions.

Currently these include:

- Digital and analogue X-ray radiography
- X-ray microtomography
- X-ray luminescence (PearlView developed by SSEF)
- Energy dispersive X-ray fluorescence
- Raman microspectrometry
- UV-Vis-NIR reflectometry

- Scanning electron microscopy
- Neutron radiography and tomography
- X-ray phase contrast and scattering (dark field)
- LA-ICP-MS for trace element analysis
- Accelerated mass spectrometry for radiometric age dating
- DNA fingerprinting

In combination with our excellent research collection of natural and cultured pearls and our long-standing experience in scientific pearl testing, we are convinced to offer our clients the most advanced and reliable service. It is our ultimate goal to maintain the confidence in this natural product, which is constantly challenged by new cultured pearl products and treatments. ✶

△ **Photo: SSEF**

SSEF CO-ORGANISES GEMMOLOGY SESSION AT SWISS GEOSCIENCE MEETING

The Swiss geoscience university community gathers annually at the Swiss Geoscience Meeting to present and discuss new research findings. The conference takes place at a different Swiss university each year. In 2015, this 2-day conference took place at the University of Basel. For the first time, a gemmology session was organised by Dr. Laurent Cartier and Dr. Michael Krzemnicki of SSEF.

The gemmology session featured a number of talks from SSEF staff, and other contributors. Carina Hanser presented her research on Co-spinel from Vietnam. Walter Balmer (SSEF research associate) shared new findings on using FTIR for Beryllium treatment detection in sapphires. Dr. Laurent Cartier spoke about origin and species determination of organic gems. Prof. Henry Hänni (SSEF research associate) gave an overview of inclusion studies in gemstones. Dr. Tashia Dzikowski delivered two talks one on coloured pearls and the other on gem corundum in the Revelstoke marble deposit in Canada. Finally, Dr. Michael Krzemnicki presented a new techniques to to visualise the structure of pearls, including X-ray phase contrast and X-ray scattering.

We would also like to thank Emilie Elmaleh (Uni Geneva) and Dr. Lore Kiefert & Dr. Klaus Schollenbruch (Gübelin Gem Lab) for their contributions. And look forward to the gemmology session at the next SGM meeting in Geneva in November 2016. ✶

13th SWISS GEOSCIENCE MEETING 2015 BASEL

INTERNATIONAL GEMMOLOGICAL CONFERENCE IN LITHUANIA

This biennial conference was held 26 - 30 August 2015 in Vilnius, Lithuania, and was attended by approximately 75 delegates and guests (Figure 1). It was organized by Dr Arùnas Kleišmantas (Vilnius University), Vilma Misiukoniene (Infobalt Lithuania, Vilnius) and Dr Jayshree Panjikar (PANGEMTECH, Pune, India) in collaboration with Vilnius University and Du Safyrai gem laboratory and museum in Vilnius. There were 37 talks and nine posters presented. The oral presentations focussed on gem corundum (11 talks), amber (5), pearls (4), diamond (3), rare gemstones (2) and other coloured stones (demantoid, emerald, jadeite, nephrite, opal, pallasitic peridot, zircon, and a general overview of sources worldwide). Additional talks covered gem mining in Australia and Myanmar, and also LED light sources in gemmological instrumentation. The poster presentations included a variety of topics: amber, jadeite, emerald, Mustard Jasper', rhinoceros horn and ambergris, synthetic ruby overgrowth on natural corundum, synthetic turquoise, treated black sapphire, and the terminology of electrum.

A pre-conference excursion on 23 - 25 August took participants on a geological and cultural tour of Lithuania, including stops at quarries for quartz sand, dolomite, clay and limestone; karst sinkholes; The Hill of Crosses; and an amber processing facility. A post-conference field trip on 31 August - 3 September visited amber museums, an ornithological station, an amber processing facility and amber collecting on the Baltic seacoast. A few participants found small pieces of amber on the beach (e.g. Figure 2).

The conference abstracts are published in a 172-page proceedings volume that can be downloaded at www.igc-gemmology.net/wp-content/uploads/2015/09/IGC34_ebook.pdf. The next IGC conference will take place in Namibia in 2017. ✶ **Brendan M. Laurs. Editor-in-Chief, The Journal of Gemmology**

◁ **Figure 2:** A small piece of amber has washed up on the beach of the Baltic Sea of Lithuania. © B. M. Laurs

△ **Figure 1:** IGC delegates and guests gather in front of the Trakai Castle in Lithuania for the gala dinner. © B. M. Laurs.

GEOLOGICAL SOCIETY OF AMERICA CONFERENCE NOVEMBER 2015

In November 2015, Dr. Laurent Cartier gave a talk at the Geological Society of America annual meeting that took place in Baltimore (Maryland). GSA meetings are the largest annual gathering of geologists and mineralogists in the US. There was a technical session devoted solely to gemmology (Gemological Research in the 21st Century: Exploration, Geology, and Characterization of Diamonds and other Gem Minerals) that was well organised by GIA's Dr. Jim Shigley and Dona Dirlam. Laurent presented recent research results on DNA fingerprinting and origin/ species determination of organic gems such as pearls, corals and ivory. ✶

SSEF LECTURES IN HONG KONG

In March 2015, Dr Michael Krzemnicki gave a lecture for private clients of Bonhams Hong Kong about the diversity of coloured gemstones. The very interested audience was eager to learn not only about the beauty and rarity of such stones, but also about the analytical challenges gemmologists face when testing such colourful gems.

In September 2015, Dr Michael Krzemnicki was invited speaker at the seminar of the Gemmological Association of Hong Kong during the Hong Kong Show, presenting the ASDI (Automated Spectral Diamond Inspection) - an industrial solution to analyse and authenticate small diamonds at high speed developed by SSEF (and now sold by its subsidiary SATT Gems). Due to the fact that the industry currently faces a threatening challenge by synthetic diamonds purposedly mixed in lots of natural small diamonds, the room was packed with gemmologists and diamond dealers, who were interested to learn more about the technology and reliability of this high-end instrument. ✶

CIBJO CONGRESS 2015

The 2015 CIBJO congress took place in the beautiful city of Salvador de Bahia, Brasil, (May 4 - 6) and was hosted by Instituto Brasileiro de Gemas e Metais Preciosos (IBGM). Invited by Dr. G. Cavalieri, President of CIBJO-The World Jewellery Confederation, H.E. Senator Eduardo Braga, Minister of Mines and Energy of the Republic of Brazil honoured the congress through his presence with a warm welcome.

In 2015, representatives of delegations contributed greatly to update the CIBJO blue books. These can be downloaded from the CIBJO website (www.cibjo.org, tab 'blue book'). We would like to specially mention the newly created CIBJO blue book for corals. ✶

FEEG SYMPOSIUM 2015 IN BELGIUM

At the beginning of 2015, Pierre Lefèvre was invited to speak at the 17th FEEG (Federation of European Education in Gemmology) symposium held in Brussels on the 17th of January. He gave a talk about the work in a scientific gem laboratory like SSEF. He shared insight showing how gemmological work is in fact quite similar to a police force's forensic department used in crime investigation. ✶

JEAN-PIERRE CHALAIN INVITED SPEAKER AT THE 2015 GEM-A CONFERENCE

The 2015 Gem-A conference, 21 - 24 November 2015, took place at the Royal Institute of British Architects (RIBA), Marylebone district in London, UK.

Jean-Pierre Chalain was invited to give a 45 minutes presentation on 'Retrospective views on the identification of the HPHT treatment of diamonds at the SSEF'. The talk covered the HPHT process applied onto type IIa diamonds for decolorizing diamonds and onto type Ia diamonds.

He insisted on the importance of long-term research collaborations with different universities, institutions, such as laboratories and museums, without which the breakthrough of the HPHT treatment detection would not have been possible. ✶

△ Photo courtesy of Gem-A

JEAN-PIERRE CHALAIN INVITED SPEAKER AT THE DDES SYMPOSIUM

The Gem & Jewellery Export Promotion Council - GJEPC invited Jean-Pierre Chalain at the Diamond Detection Exposition and Symposium which took place at the Bharat Diamond Bourse, Mumbai, India, last December, Dec. 14 - 16.

J-P. Chalain gave three talks and was also invited to join two panels. This three-days event was attended by more than 7'000 diamond professionals. Its goal is to provide the Indian diamond trade with knowledge and technological innovation and instrumentation that exists for securing their market.

The presentation of the ASDI instrument - developed by SSEF and marketed by SATTGEMS - was highly appreciated and many potential clients for an ASDI instrument in India have contacted us since. ✶

ISO STANDARD FOR DIAMOND

An ISO standard for the nomenclature of diamonds

With a kick-off meeting dated 10 September 2008, the European Committee for Normalization - CEN first met in Brussels to define the terminology used in the diamond trade. The committee was formed of representatives from different parts of the trade and from European and non-European countries. After several meetings, its final report entitled 'Consumer confidence and nomenclature in the diamond trade' was submitted to a vote of European countries in March 2009. After its European approval, this CEN document was proposed to ISO for approval.

An international vote approved the document in its ISO format in August 2015. The document is named ISO/FDIS 18323 'Jewellery - Consumer confidence in the diamond trade. In the context of this ISO nomenclature two diamond qualifiers are now synonymous to 'synthetic': 'laboratory grown' and 'laboratory created'. The complete document is available on the ISO website in English, in German and in French (www.iso.org). ✶

Close up:

DR. LAURENT CARTIER

I first met Dr. Laurent Cartier when he was an undergraduate student at the Earth Science Department of the University of Basel. He very soon got a strong interest in gemstones and pearls but was also becoming a keen and experienced traveller to remote places - a perfect combination for a young gemmologist who had just passed his FGA Diploma.

In 2010, Laurent Cartier started to work at SSEF, having finished his Master thesis about a small corundum deposit in Marosely (SE-Madagascar). For his PhD, he ventured in the following three years into new research fields, focussing on sustainability of pearl farming in the Pacific. During that time and in collaboration with SSEF, he carried out numerous research projects, including a groundbreaking research study about DNA fingerprinting of pearls, which was published in 2013 in the scientific journal PLOS ONE.

His research on social and ecological impacts of gem mining and pearl farming have not only been presented in several scientific papers about sustainability issues, but also - as part of his PhD project - resulted in the initiation and organisation of the first 'Sustainable Pearls Forum' in June 2014 in Hong Kong. This international symposium co-organised by SSEF was attended by all major pearl producers worldwide and was a huge success for all participants (www.sustainablepearls.org).He organises an annual Pearl Forum at Inhorgenta Munich bringing together leading industry players to discuss latest developments in the industry.

Since 2014, Dr. Laurent Cartier has taken over an important position at SSEF as project manager, overviewing a whole range of projects such as the development of analytical devices, new services and new products for our customers. His research activities currently focus on coloured gemstones and corals, and developing new techniques for origin determination in collaboration with different university partners. Apart from this, Laurent is also strongly involved in education at SSEF and revamping our course notes and presentations with the most up-to-date information and technology. He is also a lecturer for gemmology at the University of Lausanne.

Having spent his early years in different places and cultures - from Tramore, a small village in Ireland, to the medieval town of Ribeauvillé in Alsace (France) and now in Switzerland - mixed with his travel experiences in remote parts all over the planet, he is not only fluent in many languages, but also has a very easy access to people and a perfect eye to spot special places (e.g. Djiboutii in Hong Kong for those who know) for the SSEF team whenever we are working on-site.
✶ **Dr. M. S. Krzemnicki, SSEF**

WALTER A. BALMER, RESEARCH ASSOCIATE

We are happy to announce that Walter A. Balmer is now a research associate with SSEF. He obtained his M.Sc., in Earth Sciences from the Swiss Federal Institute of Technology (ETH) in Zurich with a major in Petrology-Mineralogy and Geophysics in May 2001. He completed his Graduate Gemologist studies at GIA Carlsbad the same year. His PhD studies focussed on the 'Genesis and Trace Element Composition of Rubies from Marble-Hosted Deposits in Morogoro, Tanzania', at Chulalongkorn University's Department of Geology in Bangkok.

From 2002 until 2005 he was a senior staff gemologist in the Gubelin Gem Laboratory in Luzern. Post Gubelin, Walter focused on lecturing at both Kasetsart University and at the Gem & Jewelry Institute of Thailand (GIT), the latter in his role as a research consultant. Walter has travelled extensively in his quest to learn about Earth Sciences (including gemmology), and he has also had the opportunity to work and lecture in a wide variety of scientific and educational organizations during his career. He has presented research at gemmological at conferences worldwide. We look forward to Walter's contribution to a number of current research projects currently underway at SSEF. ✶

NEW TEAM MEMBERS AT SSEF

2015 was a very successful year at SSEF and we recruited some new team members in order to meet the increased demand for our gemmological services.

Dr. Tashia Dzikowski joined us in February 2014 and now works as a gemmologist. She is a trained geologist, and completed her PhD at the University of British Colombia on the origin of ruby and sapphire in marble from two different localities in Canada. Her research background in corundum makes her a perfect match for the work we carry out at SSEF.

Dr. Hao Wang joined SSEF in September 2015 and is responsible for LA-ICP-MS at SSEF. He has longstanding experience with this method and brings considerable expertise into best utilizing this method's capabilities for gemstone origin and treatment questions.

A number of other staff members have joined SSEF in the past two years. The administration department has grown with the recruitment of Tania, Oezlem and Michael. The increased demand for our services has led us to expand the photography department with Vito and Caroline. Marc has joined the analytical department. Finally, Victoria has joined SSEF as personal assistant to Dr. Michael Krzemnicki. ✶

SSEF ON-SITE IN 2016

In 2016 we will be exhibiting and/or offering our on-site testing services as follows :

Hong Kong	25 February - 07 March
BaselWorld	17 - 24 March
Bangkok	23 - 27 May
Hong Kong	20 - 26 June
Bangkok	22 - 26 August
Hong Kong	08 - 18 September
Paris	on request

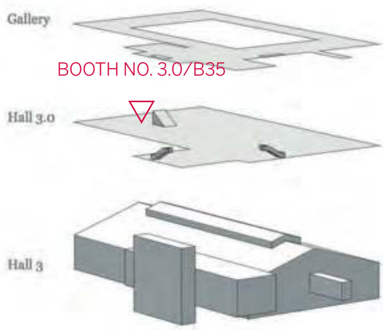
Further on-site services will be communicated through our website and in newsletters. Please subscribe to our newsletter on our website www.ssef.ch to be updated regularly about our on-site schedules, other services and news. ✶

BASELWORLD 2016

During BaselWorld 2016 (17 - 24 March), the SSEF will be once again offering its convenient gemstone testing services.

You can find us in the first floor of Hall 3 at booth No. 3.0/B35, at the same location as in 2015. The phone number at our booth (+41 61 699 51 29) remains the same, as does our high-quality express service, which may even include a nice cup of coffee and some Swiss chocolate. We are looking forward to meeting you at our booth and to testing your stones and pearls during the Basel

Show. If you would like to have a number of items analysed, we suggest you call us in advance at the SSEF office (tel. +41 61 262 06 40) to fix an appointment. This is also strongly suggested if you would like to have your items tested shortly before the show. ✶



△ Photo © BaselWorld 2013.

SSEF PRESENCE IN ASIA

Our presence in Asia was very successful in 2014 and 2015, as our services have gained importance for clients in the Far East and South East Asia, who ask for accurate and internationally renowned reports.

In 2016, the Swiss Gemmological Institute SSEF will again offer its services at two locations in Asia:

Bangkok

In Bangkok, we will be testing your prestigious gemstones in our Bangkok office at Silom road between 23 - 27 May and 22 - 26 August. Please subscribe to our newsletter on our website www.ssef.ch to be updated regularly about our on-site schedules, other services and news.

Bangkok
dates
to remember!

Hong Kong

The last year has again shown how important Hong Kong has become as a major hub for the gemstone and jewellery trade. Since many years, the SSEF is offering its services in Hong Kong for the local and international trade of prestigious gemstones and jewellery. In 2016, we will again be very active in Hong Kong, offering services at the three main Jewellery Shows in March, June and September (at AsiaWorld Expo and at the Convention Centre), but also at our location in Central during several pre-show periods. This pre-show service is only by appointment, so please contact us (phone +41 61 262 06 40, asia@ssef.ch) if you need further information about our Hong Kong services or to confirm an appointment. Apart from offering our on-site services regularly in Hong Kong, you may also use the new Ferrari shuttle services to send us your gemstones, pearls or jewellery smoothly to the SSEF (for details, see shipping instructions on the services section of our website www.ssef.ch). ✶

Hong Kong
dates
to remember!

SSEF IN PARIS

We regularly travel to Paris for on-site testing of gemstones. Our office is ideally located between Place Vendôme and Rue de la Paix. Should you wish to be informed of our on-site dates for Paris, please contact us directly. Further on-site services will be communicated through our website and in newsletters. Please subscribe to our newsletter on our website www.ssef.ch to be updated regularly about our on-site schedules, other services and news. ✶

DONATIONS

As in previous years, we are grateful for numerous donations we received in 2014 and 2015 from many pearl and gemstone dealers around the world. These donations not only support our research but also add to our collection of specimens to be used in our courses, with the aim to educate the participants and to give them the opportunity to learn gemstone & pearl testing on a wide variety of untreated and treated materials.

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

FOR PEARL DONATIONS:

Swiss Pearls (Geneva), Konrad Schmid (Chur, Switzerland), José Casares (Shanghai Gems, Geneva), Hubert Bari (Bali), John Rere (French Polynesia), Sue Hendrickson (USA), Riki Waldstädter (Vienna, Austria), Paspaley Pearls (Australia).

FOR GEMSTONE DONATIONS:

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