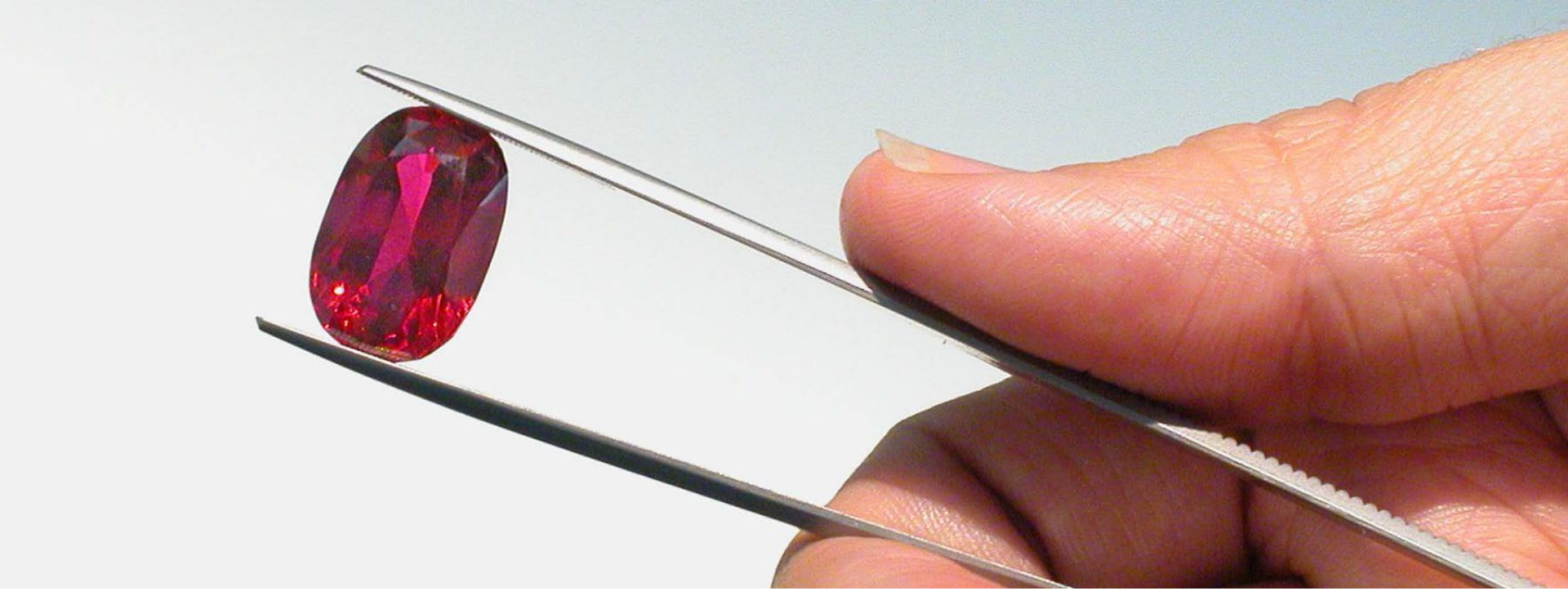


SGG Zentralkurs | May 2022

NEWS FROM SSEF

with a special focus on Emerald

Presentation by PD Dr. Michael S. Krzemnicki

EMERALD

Emerald tiara Christies 2021

EMERALD

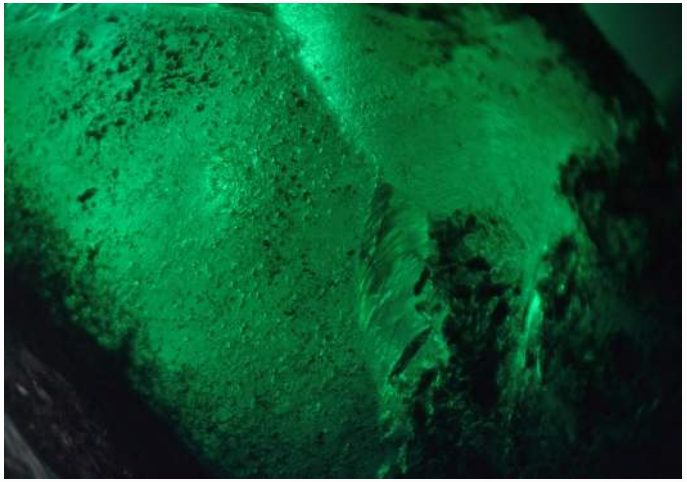
This emerald and diamond parure was given by Manuel de Guirior y Portal, the Viceroy of New Granada and later Peru, to this wife, Dona Maria Ventura de Guirior y Otazu in about 1770.

The parure was sold for US$ 1 mio at Sotheby's Geneva in November 2020.

large emerald crystal from
Muzo Emerald Colombia

Photo: Muzo International

EMERALD IMITATION

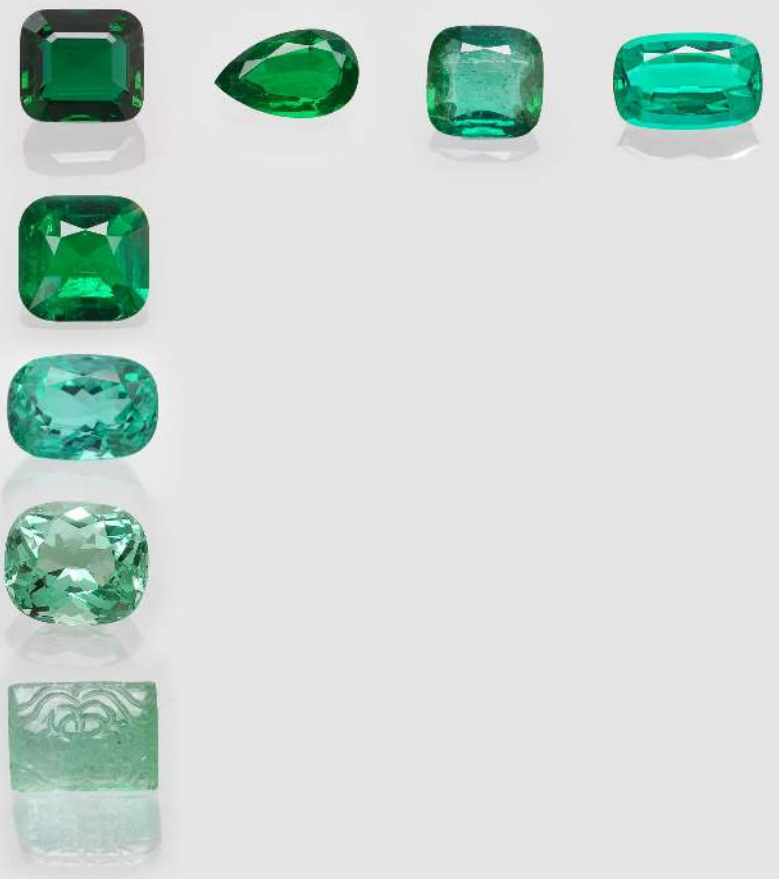


Green dyed quartz with glued on biotite flakes to imitate emerald rough.

EMERALD vs GREEN BERYL

Cr/Fe ratio increasing

saturation increasing (Cr)



strongly Fe dominated

170 ct 230 ct

But some green beryl also contain small amounts of chromium, and that is where the nomenclature complexity starts...

EMERALD vs GREEN BERYL

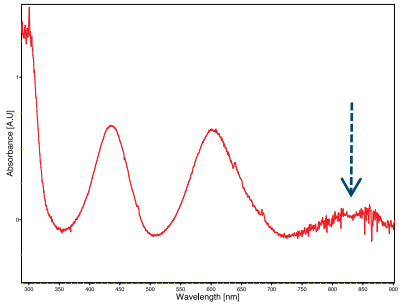
Emerald pendant
Christie's Geneva
November 2017
sold for 883'000 US$

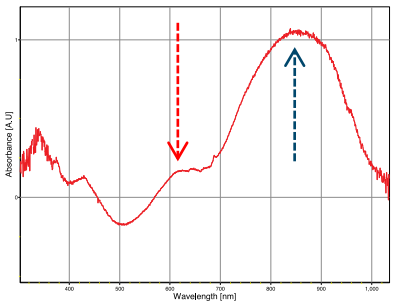
Colombian emerald
bluish green
9.5 ct

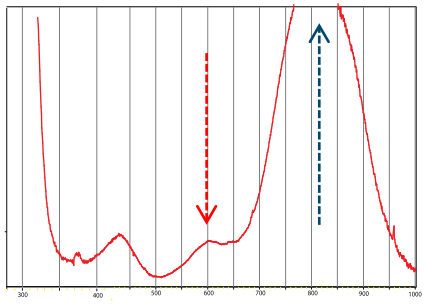
Zambian emerald
bluish green
14.5 ct

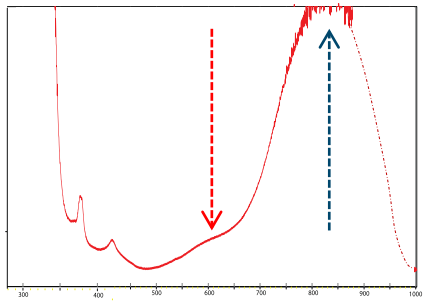
Cr-bearing green beryl
180 ct
(low Cr, high Fe)

green beryl
230 ct
(very low Cr < 0.01 wt%)

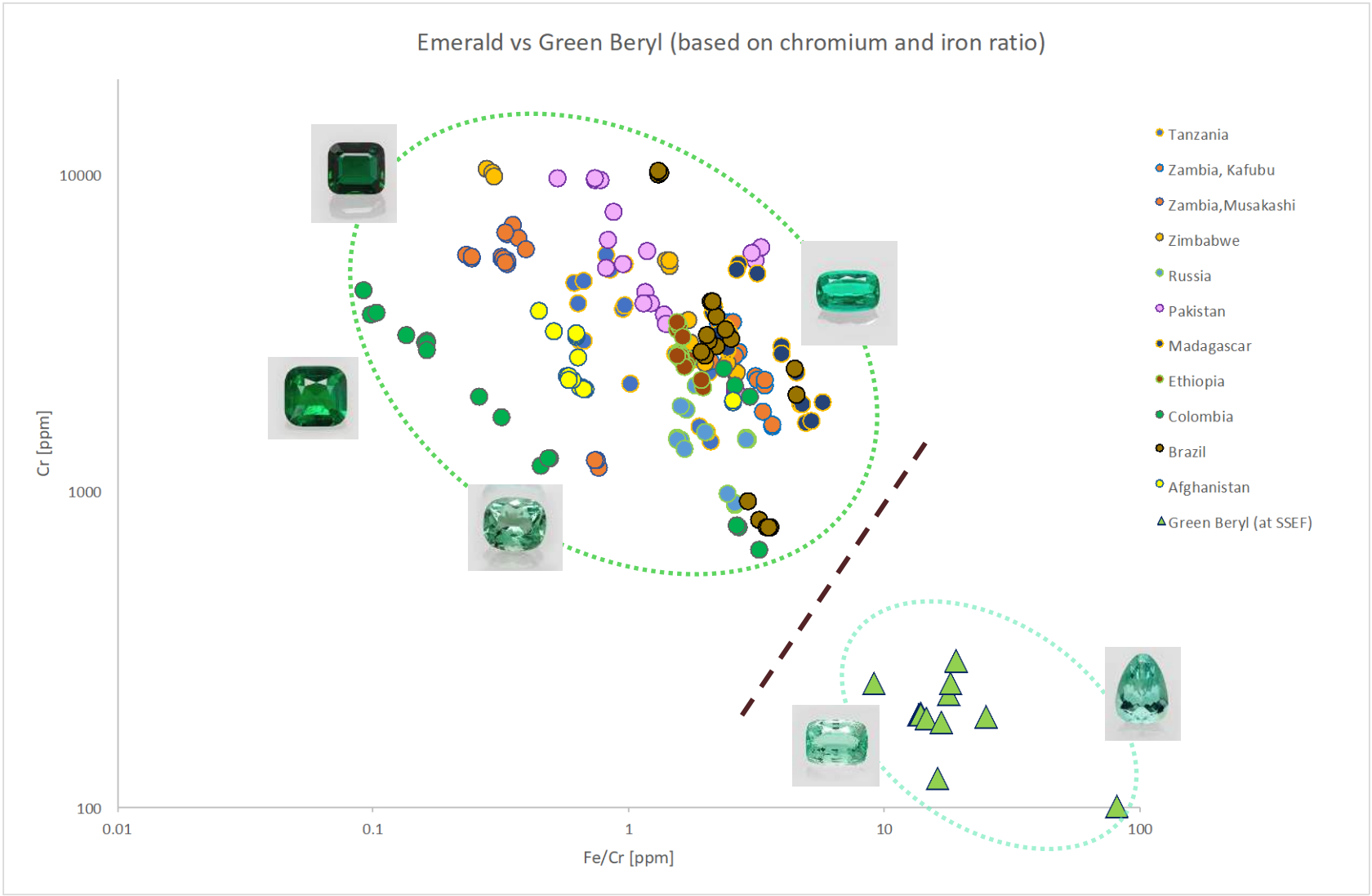




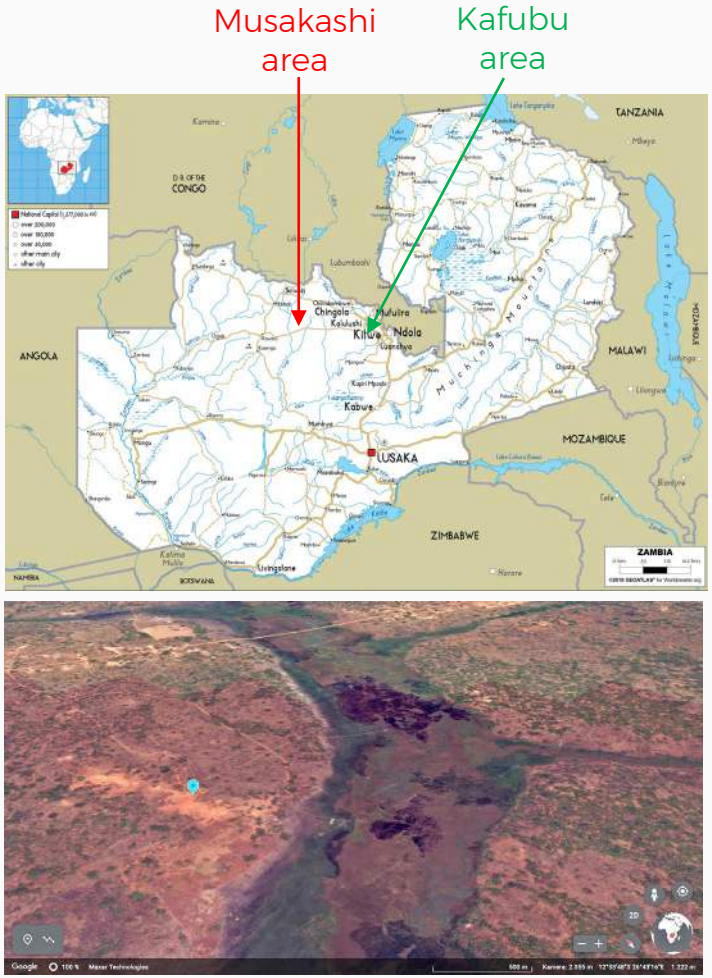




EMERALD vs GREEN BERYL



EMERALDS FROM MUSAKASHI (ZAMBIA)



Two emeralds (7.3 ct and 6.9 ct) of excellent quality from a “new” source in Zambia. Originally claimed to be from Afghanistan, we now know, that this material is in fact from Zambia.

EMERALDS FROM MUSAKASHI (ZAMBIA)

Sometimes, these batches of Zambian emeralds are mixed containing both, emeralds from the “classic” Kafubu mining area and from the “new” Musakashi area.

SSEF

PRESS RELEASE

FOR IMMEDIATE RELEASE

New emeralds from Musakashi in Zambia appear in the market

Kafubu

Musakashi

The parcel of 10 Zambian emeralds submitted to SSEF for testing, which was found to consist of nine emeralds from the Kafubu area, and one emerald from the Musakashi area. Photo: © SSEF

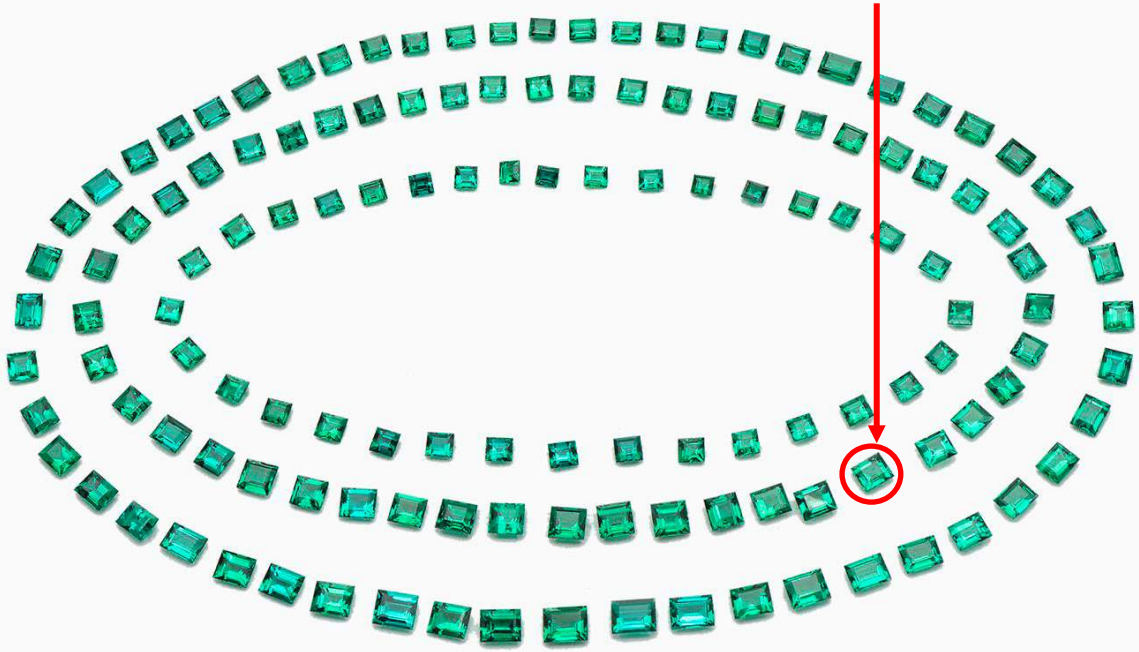
BASEL, SWITZERLAND: NOVEMBER 30, 2021 – Advanced testing using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LAICPMS) on an anomalous stone from a batch of 10 emeralds submitted to the Swiss Gemmological Institute SSEF has indicated that it is likely to have been sourced at Musakashi, in the Solwezi district of central Zambia. This suggests that production at that site has been increased. The other nine stones showed characteristics typical of production from the Kafubu area, where most of Zambia’s emeralds have been mined to date.

all Kafubu, except

Musakashi

all Musakashi, except

Kafubu

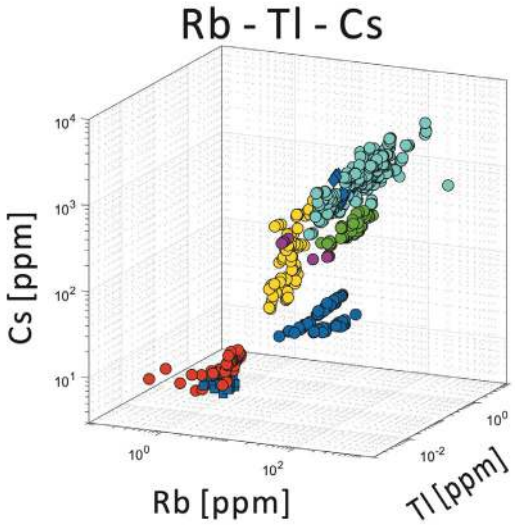


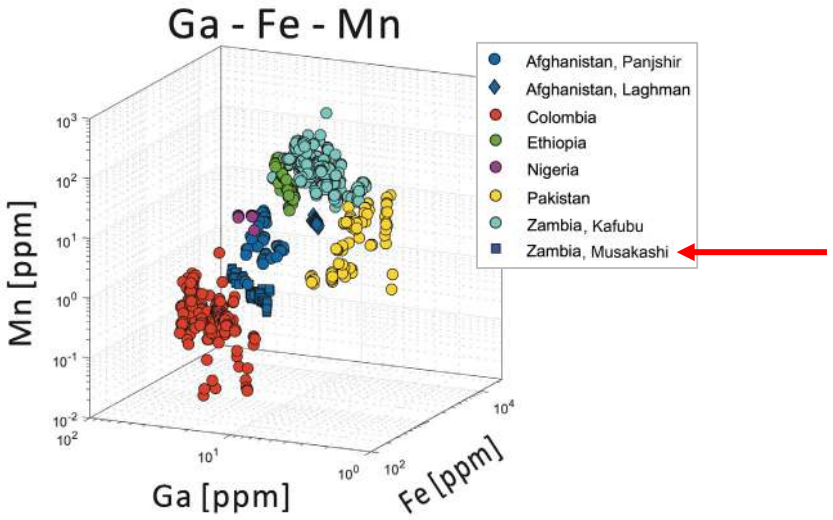
EMERALDS FROM MUSAKASHI (ZAMBIA)

In many aspects very similar to Colombian emeralds.

MACHINE LEARING (AI) for Origin Determination

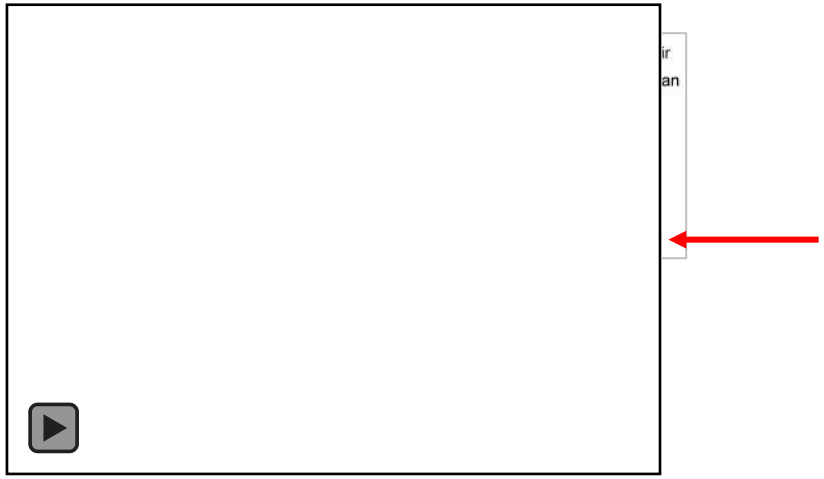
Data visualisation for emerald origin determination at SSEF





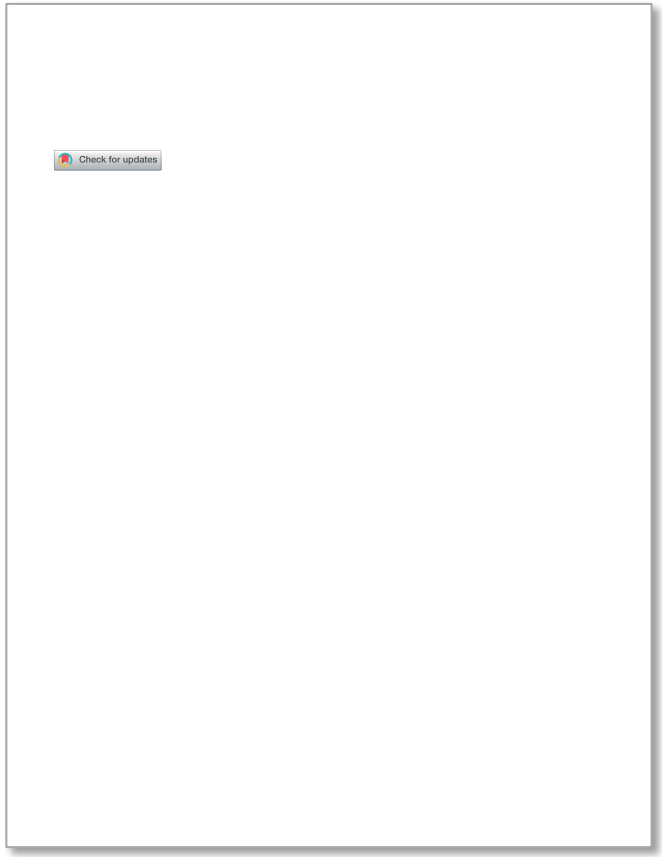
Trace element analysis using GemTOF mass spectrometry.

Statistical processing using **machine learning algorithm** (non-linear unsupervised tSNE).



MACHINE LEARNING (AI)

Published by SSEF in 2021 in the JAAS Journal of the Royal Society of Chemistry, UK



EMERALD TREATMENT

Emeralds often contain fissures. These fissures may be filled with a (colourless) substance such as oil, wax, and natural or artificial resin.

Fissure filling detection, quantification and identification is usually done by:

Microscope

Filler detection and quantification

FTIR

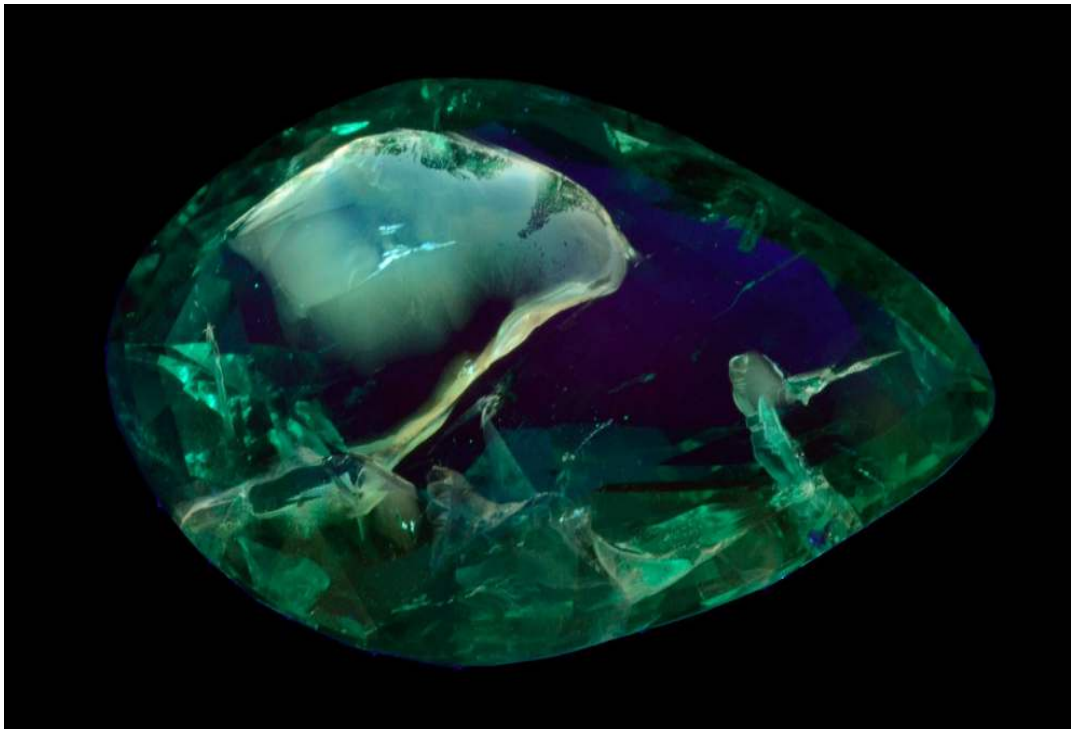
Filler detection and identification (volume)

Raman

Filler identification fissure by fissure (spot analysis).

EMERALD TREATMENT

UV lamp can also be very helpful for filler detection and quantification.

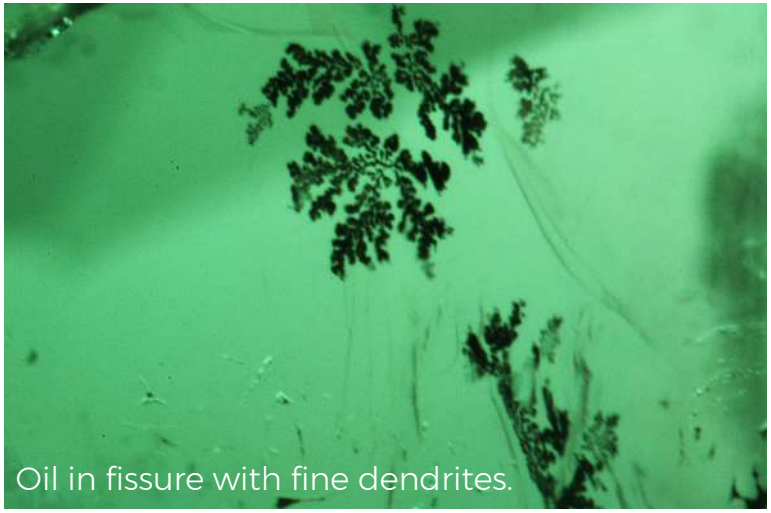


Fluorescent reaction of fissures in an emerald filled with substance (e.g. oil) when exposed to **long wave ultraviolet light** source.

Unfortunately not all fillers react!
So, no reaction does not mean that an emerald is not fissure filled!

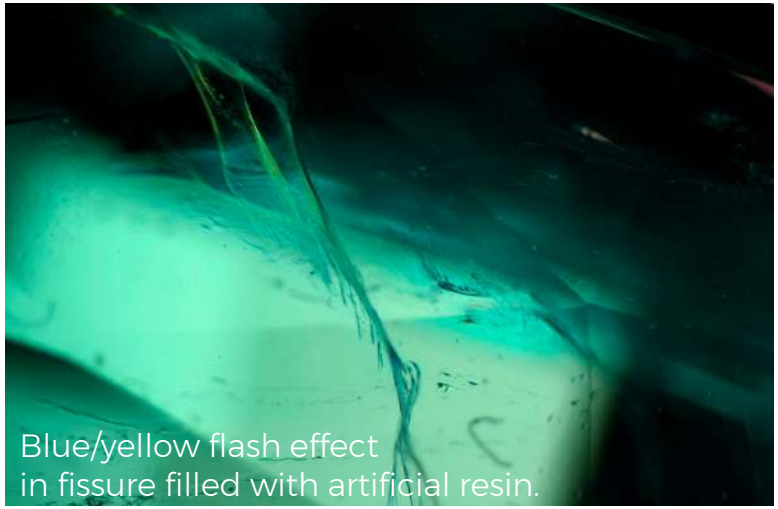
CHARACTERISTIC MICROSCOPIC FEATURES

Oil

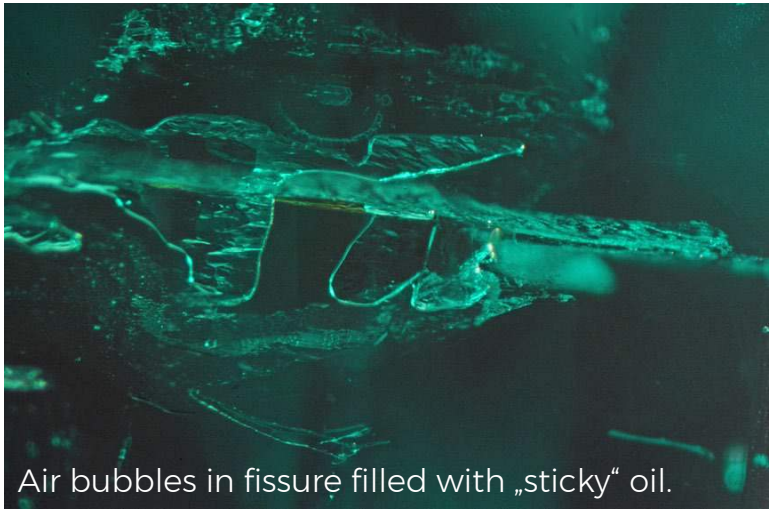


Oil in fissure with fine dendrites.

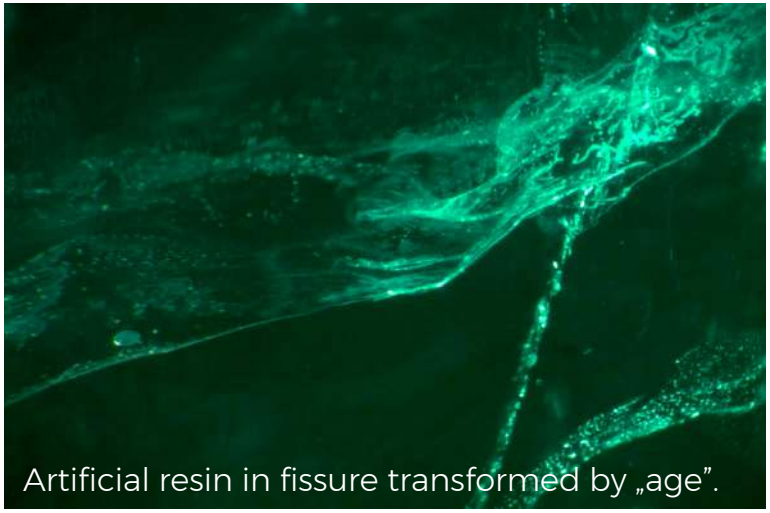
Artificial resin



Blue/yellow flash effect
in fissure filled with artificial resin.



Air bubbles in fissure filled with „sticky“ oil.



Artificial resin in fissure transformed by „age”.

EMERALD TREATMENT

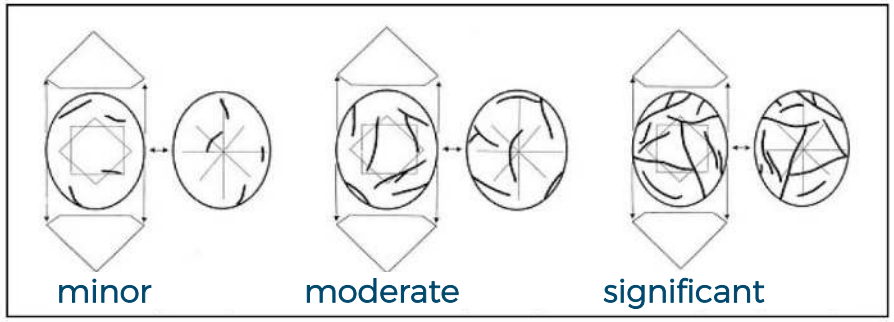
Filler quantification is mainly based on microscopic observation, and also supported by UV fluorescence observation and FTIR spectra (visibility of filler peaks)!

At SSEF, the substance is **always** indicated:

- Oil
- Wax
- Natural Resin (e.g. canada balm)
- Artificial resin
- Filler (if substance cannot be identified)

Table 1: Emerald, quantification and identification of filler in fissures see: www.lmhc-gemmology.org

Status:	No fissures present in stone	No or insignificant filler in fissures[3]	Quantification and identification of filler in fissures		
Report Alpha numeric:			F1	F2	F3
Report Text:	None[2]	**No / Insignificant** fissure filling	**Minor** amount of oil / resin in fissures	**Moderate** amount of oil / resin in fissures	**Significant** amount of oil / resin in fissures
		or	or	or	or
		No / Insignificant indications of clarity enhancement / modification	Indications of **minor** clarity enhancement / modification	Indications of **moderate** clarity enhancement / modification	Indications of **significant** clarity enhancement / modification



EMERALD RESEARCH

Cedarwood oil mixed with Artificial resin (Opticon™)

From Bachelor thesis of Micha Baur, University Basel, 2021

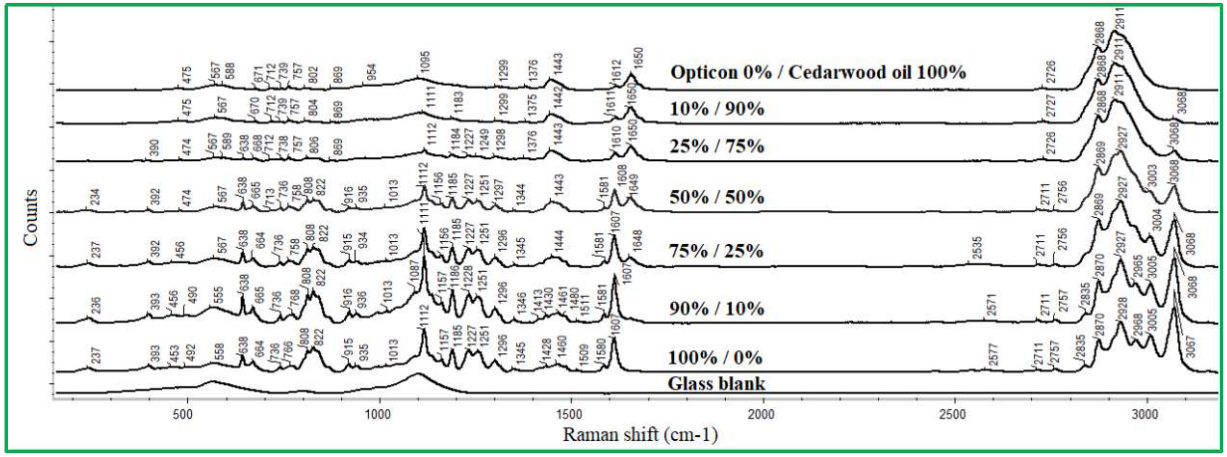
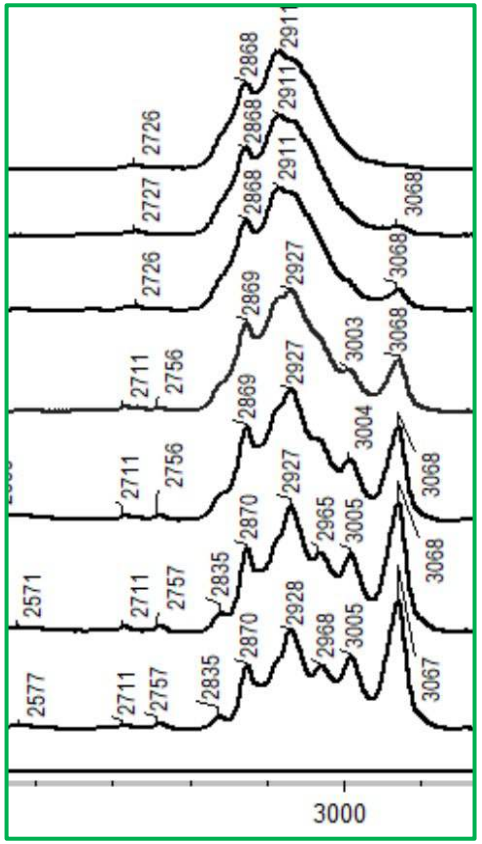


Figure 37: Raman spectra of the mixture of Opticon 224 with natural cedarwood oil at different ratios.



EMERALD RESEARCH

“Ageing” behavoir of filler substances

From Bachelor thesis of Micha Baur, University Basel, 2021

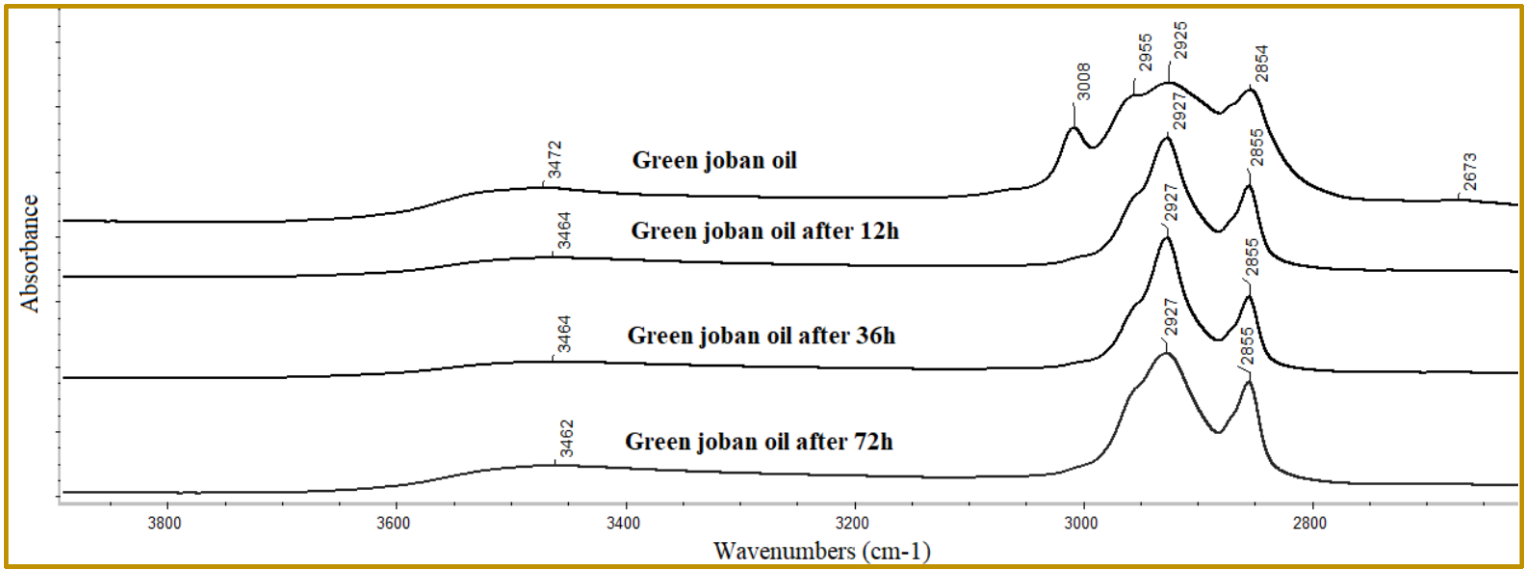


Figure 13: FTIR spectra of green joban oil before heating, and after 12h, 36h and 72h of total heating time.

Emerald issue

tested at SSEF 2019
Minor oil
Many fissures visible!

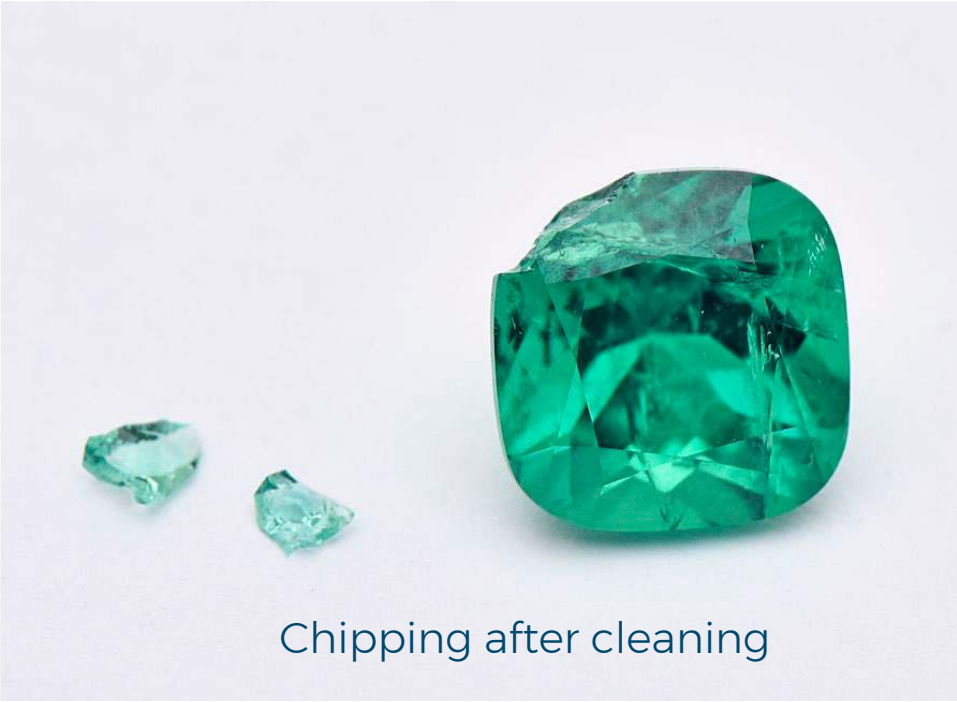
tested at SSEF 2022
Moderate artificial resin
Fissures now hardly visible!

Emerald issue

This Colombian emerald (9 ct) was tested 6 times by SSEF!

It was deliberately filled two times with artificial resin after testing at SSEF and each time sold with the SSEF report indicating the situation before refilling (minor oil)!

Emerald issue



Cleaning of emerald in acids, may result in **damage/chipping** during cleaning or later during handling (e.g. by laboratory, jewellery workshop, or client).

Consequence: Stone needs **considerable re-cutting** !

Emerald issue

SSEF Report

Gemstone Report No. XXXXXX

Weight: 4.254 ct
Shape & cut: antique cushion, brilliant / fancy cut
Measurements: 10.37 x 9.41 x 6.14 mm
Colour: green of medium strong saturation
Identification: EMERALD (variety of natural beryl)
Comments: The analysed properties confirm the authenticity of this transparent emerald.
No indications of clarity modification in fissures at the time of testing. (see attached additional information letter)
Origin: Colombia

SWISS GEMMOLOGICAL INSTITUTE – SSEF
Basel,
M. Rytz, MSc
Dr. W. Zhou, FGA

Additional information letter

Basel, 9 May 2022

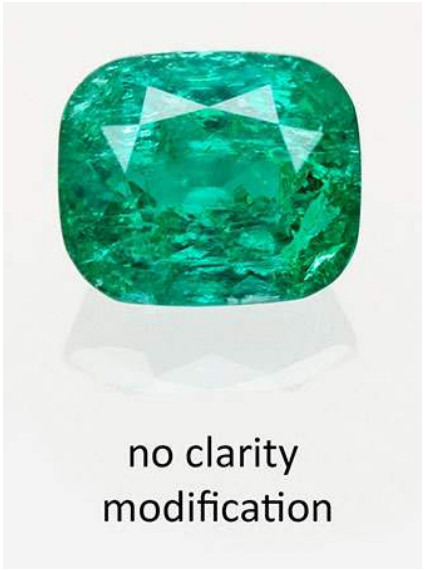
Additional information letter

Concerning:
Emerald described in SSEF Gemstone Report No. XXXXXXX

Emeralds often contain fissures due to how they formed geologically and subsequent mining processes. It has long been a tradition in the trade to fill such fissures with a colourless substance in order to reduce their visibility.

At the time of testing, the emerald described in this SSEF report exhibited **fissures which are distinctly visible by eye**.

If the emerald shows none or only slightly
possible that the fissures of this emerald
In this case, we recommend you resubmi
treatment status of the stone.



Comments: The analysed properties confirm the authenticity of this transparent emerald.

No indications of clarity modification in fissures at the time of testing. **(see attached additional information letter)**

Origin: Colombia

Concerning:
Emerald described in SSEF Gemstone Report No. XXXXXXX

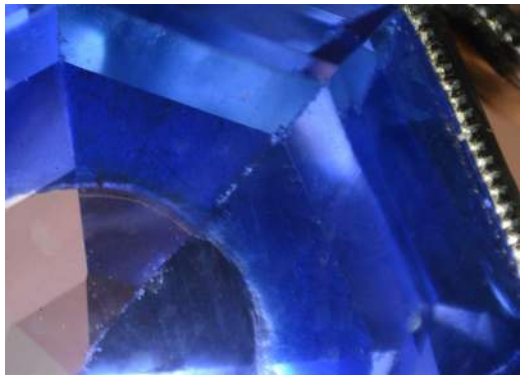
Emeralds often contain fissures due to how they formed geologically and subsequent mining processes. It has long been a tradition in the trade to fill such fissures with a colourless substance in order to reduce their visibility.

At the time of testing, the emerald described in this SSEF report exhibited **fissures which are distinctly visible by eye**.

If the emerald shows none or only slightly visible fissures when you look at the stone, then it is possible that the fissures of this emerald have been filled (treated) after testing at SSEF.
In this case, we recommend you resubmit the emerald to SSEF so that we can check the current treatment status of the stone.

New: **Additional information letter**
for “cleaned” emeralds with distinctly eye-visible fissures !

Sapphire case



Historic tiara with sapphires of rather low colour saturation.
Clever solution by goldsmith, blue enamel backing to enhance the colour!

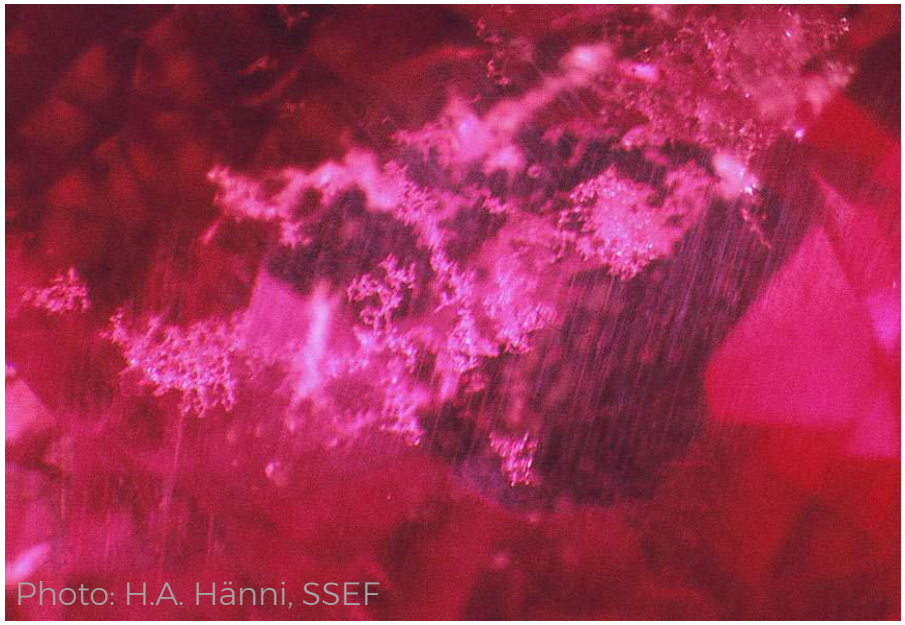
Ruby case

Natural ruby of 22.04 ct
from Mozambique
(named the “Rhino Ruby”)

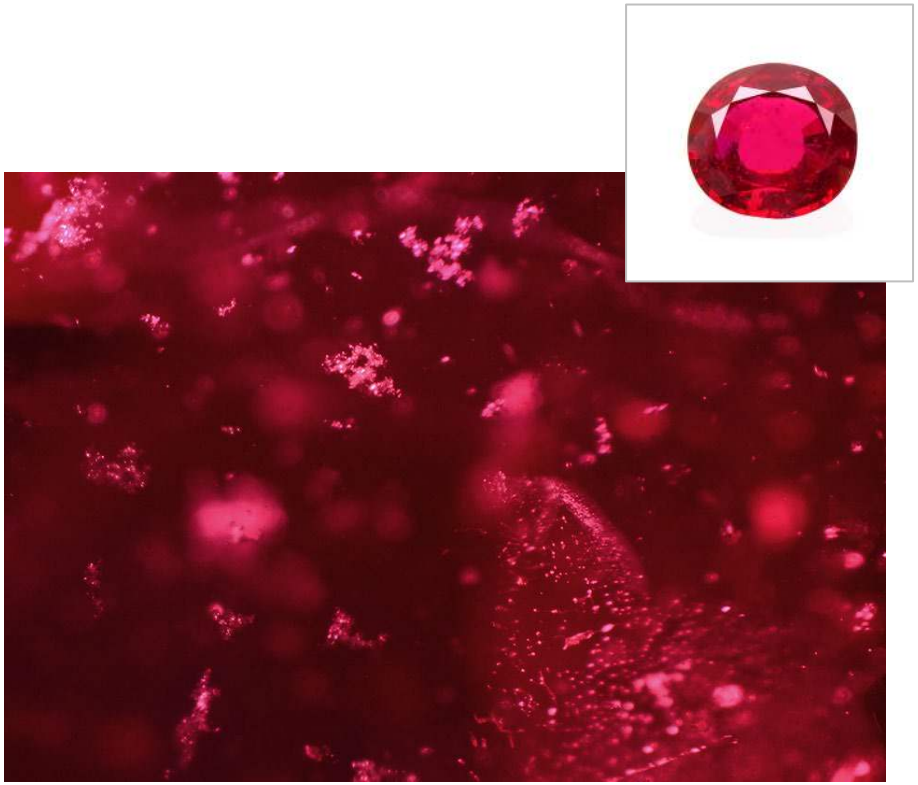
Synthetic ruby (flux-melt)
of 4.27 ct

An important part of the work of a gemological laboratory still today is to separate ruby of natural origin (formation by geological process) from ruby of synthetic origin.

Ruby case

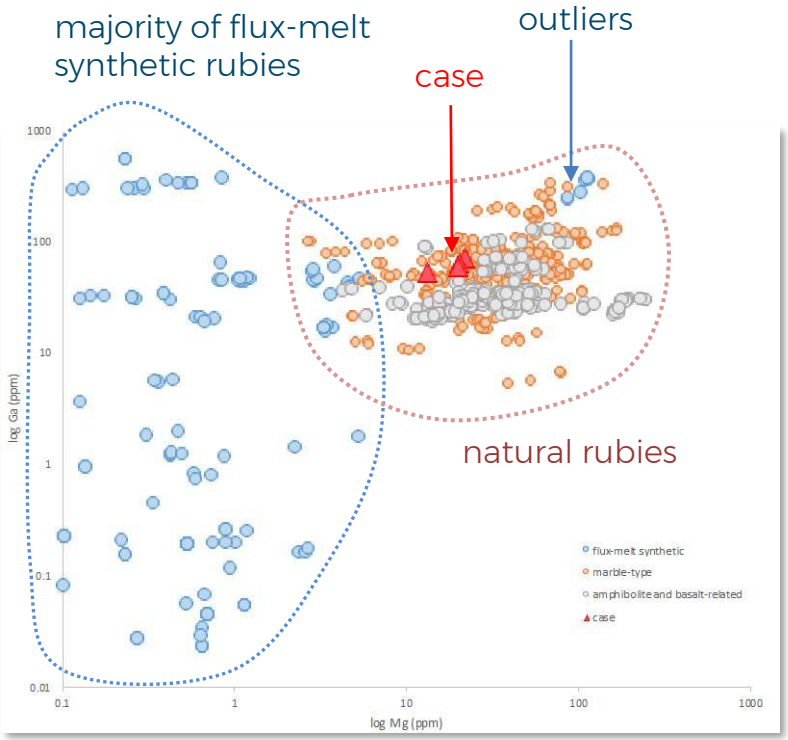


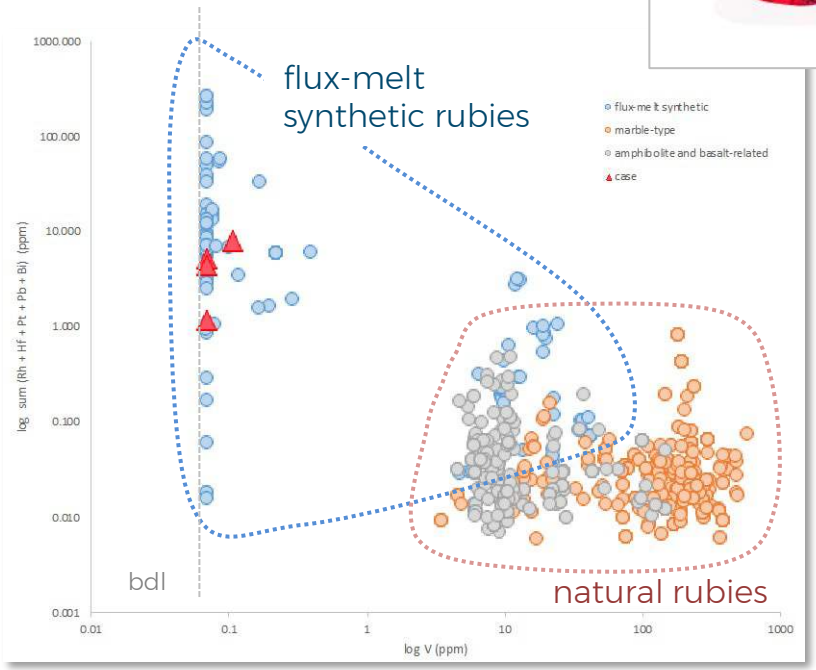
Natural ruby
from Vatomandry (Madagascar)
with numerous zircon clusters.



Synthetic ruby (flux-melt)
of 4.27 ct with similar clusters,
however not zircons!
(see also Atichat et al. GIT 2012)

Ruby case





Using different plots of trace elements to unambiguously identify this stone as a synthetic ruby (flux-melt).

Colour stability of Corundum remains an issue

Vivid pinkish red spinel of exceptional size and quality.

New: Colour stability test on rubies

Since about 2 years, there are rumours in the trade about rubies that are irradiated in Sri Lanka to enhance their colour (so-called “hospital treatment”).

Mainly applied to Mozambique rubies of purplish red colour, the irradiation activates a yellow/orange colour centre, so the rubies get a better red colour.

New additional test at SSEF for the colour stability of rubies

Date : 01/03/2022

Category : Research

In light of information gathered over the past few months, we have now added rubies to this colour stability testing protocol, specifically but not limited to rubies originating from Mozambique....

READ MORE

see: www.ssef.ch/news

So far only many hundreds of rubies tested, and only in one case (irradiated research stone) a slight colour instability could be observed.

Affaire à suivre....

New Cobalt Spinel from Mahenge area, Tanzania

Co-spinel from a new source near Mahenge in Tanzania.

Vivid pinkish red spinel of exceptional size and quality.

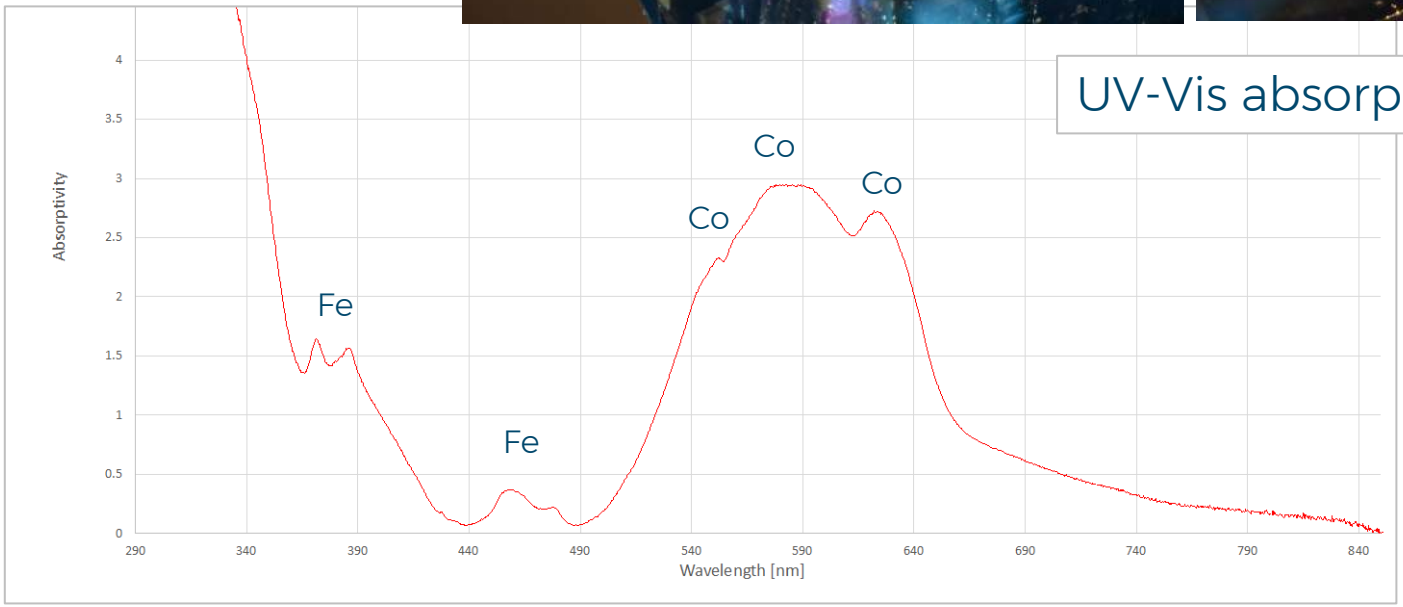
At Epangko, mining site of pinkish red spinel, field trip to Mahenge with Dr Walter Balmer in 2009.

New Cobalt Spinel from Mahenge area, Tanzania

New Cobalt Spinel from Mahenge area, Tanzania

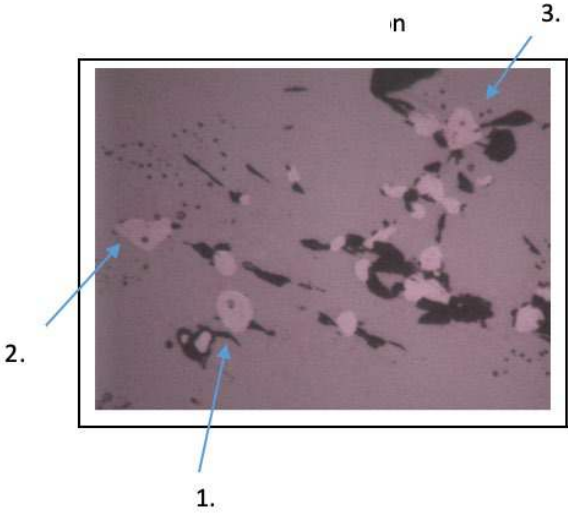
Photos: A. Leuenberger, Aline GmbH

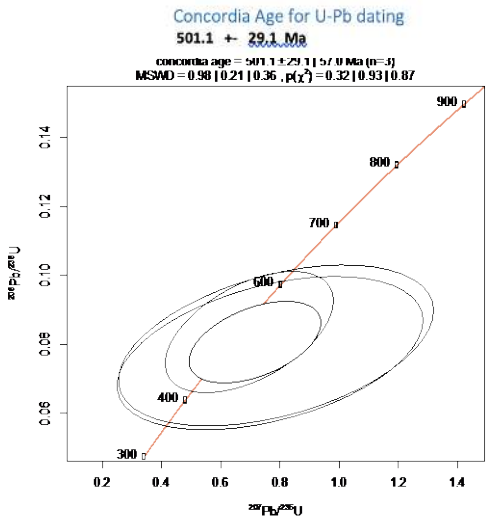
New Cobalt Spinel from Mahenge area, Tanzania



UV-Vis absorption spectrum

New Cobalt Spinel from Mahenge area, Tanzania





Measurement		[7Li]+	[9Be]+	[49Ti]+	[51V]+	[52Cr]+	[55Mn]+	[56Fe]+	[59Co]+	[60Ni]+	[66Zn]+	[69Ga]+
min	Tanzania	119.96	13.82	13.33	29.86	4.56	228.74	7242	24.37	31.11	1007	81.60
max	Tanzania	310.08	34.99	54.50	78.05	36.36	293.81	11810	48.22	58.57	11535	329.71
art mean	Tanzania	236.91	20.95	34.56	41.83	9.47	254.70	8532	32.24	39.40	3249	162.19
std dev	Tanzania	47.86	5.27	7.36	12.36	6.75	16.60	1078	7.08	7.18	2580	71.28
min	SriLanka	12.32	3.97	-1.00	11.65	0.30	26.51	5523	17.33	2.86	33.64	108.60
max	SriLanka	185.82	101.79	81.62	86.09	20.85	619.93	23562	109.86	359.18	3531	200.30
art mean	SriLanka	95.58	46.26	20.09	34.06	6.84	272.43	15312	54.23	110.53	1229	151.61
std dev	SriLanka	57.71	32.35	28.44	24.18	8.22	223.87	6039	29.80	129.29	1100	35.11
min	Vietnam	42.70	9.82	-1.00	2.10	0.96	49.14	3758	10.82	3.63	252.7	79.56
max	Vietnam	859.87	72.79	8.10	25.61	76.66	289.15	21984	71.94	43.98	4141	628.37
art mean	Vietnam	294.51	20.17	2.04	8.15	13.38	120.39	14032	39.95	25.08	1547	193.10
std dev	Vietnam	229.83	18.84	2.30	7.63	25.70	78.66	6030	17.84	13.10	1415	171.81

Paraiba or not?

Cu-bearing
Nigeria

Cu/Fe ratio: 18

Fe-Cu bearing
Nigeria >

Cu/Fe ratio: 0.16

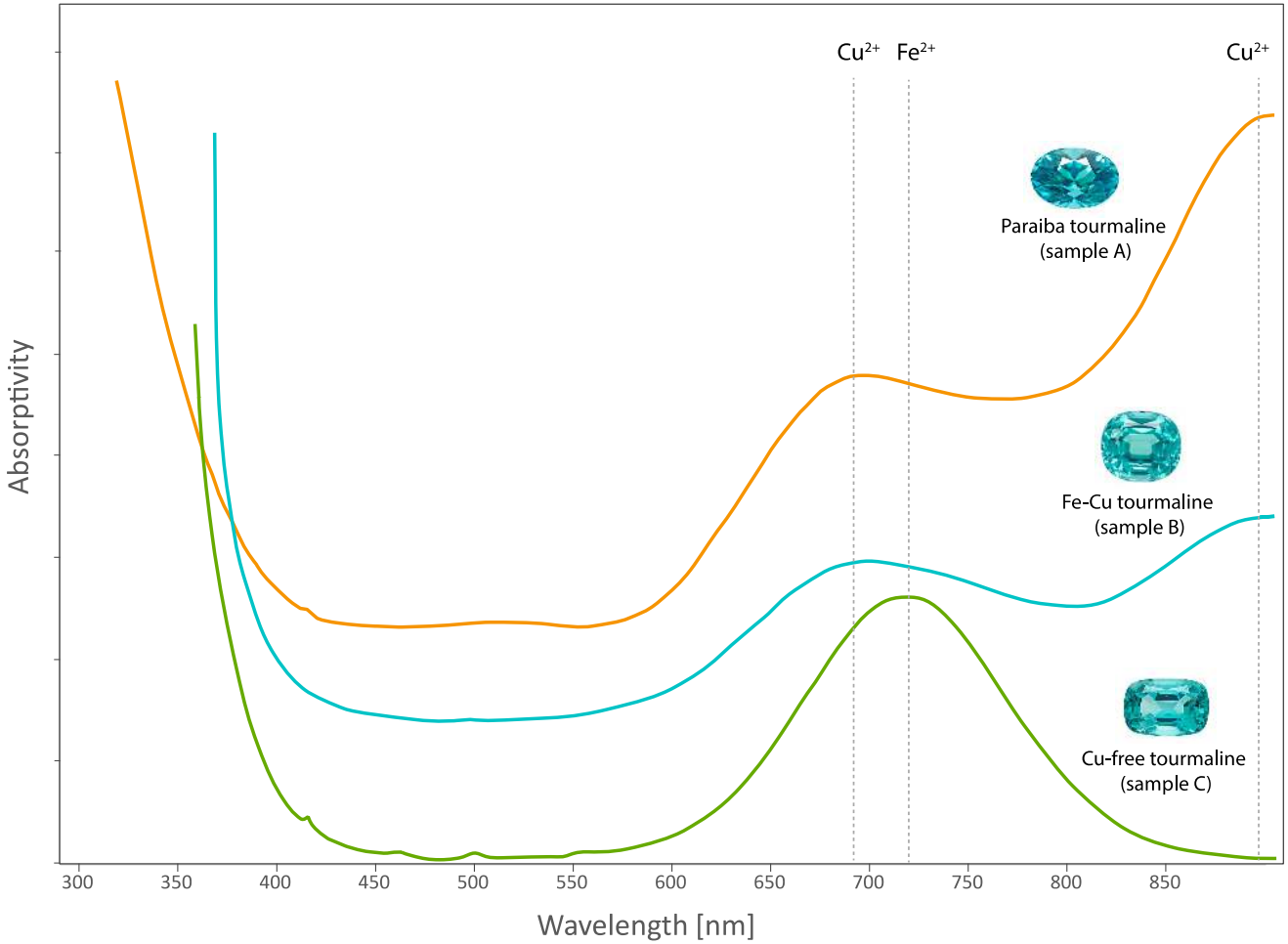
Fe-bearing
Namibia

Cu/Fe ratio: 0.000025

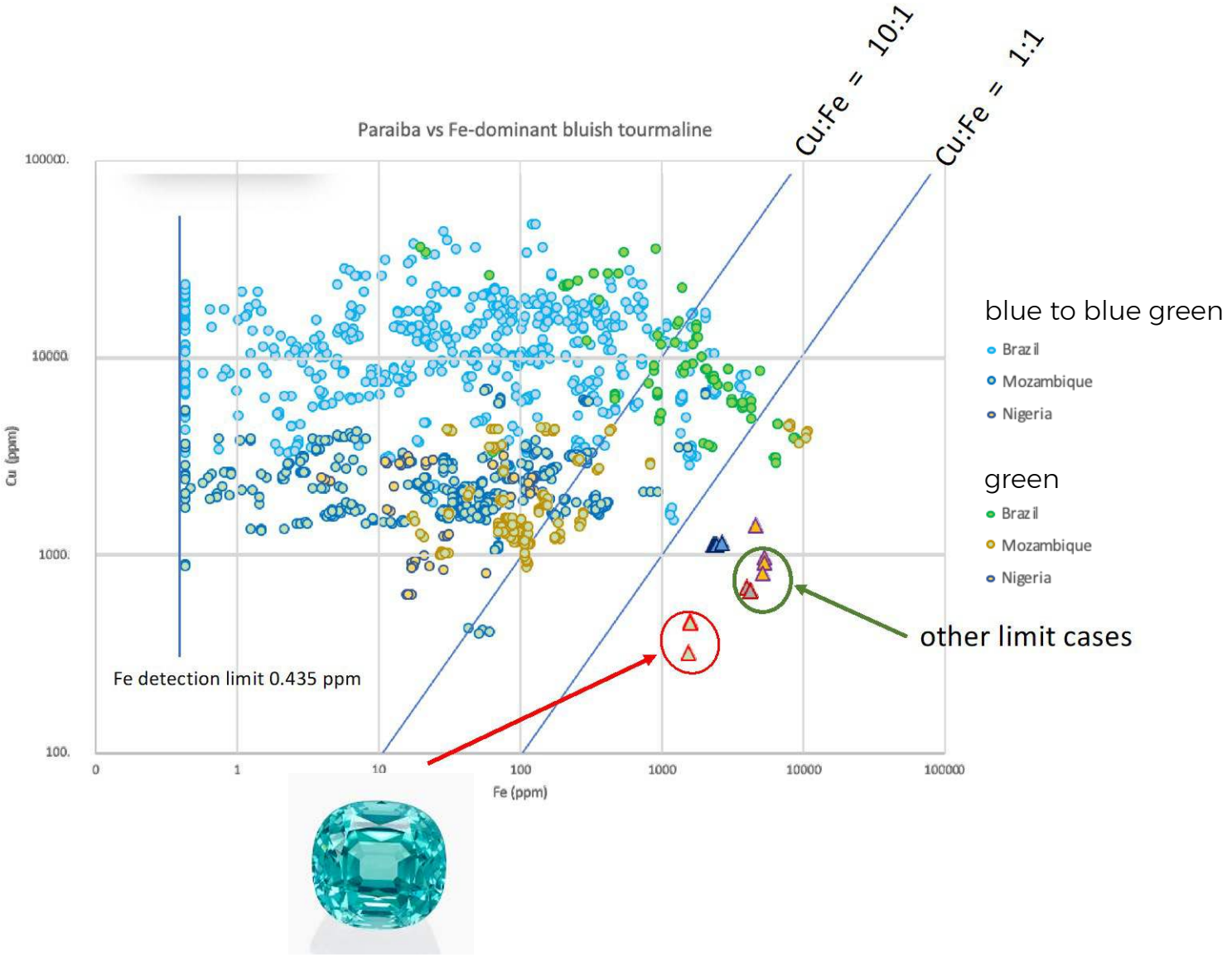
Paraiba or not?

Table 1: Comparison of trace element composition

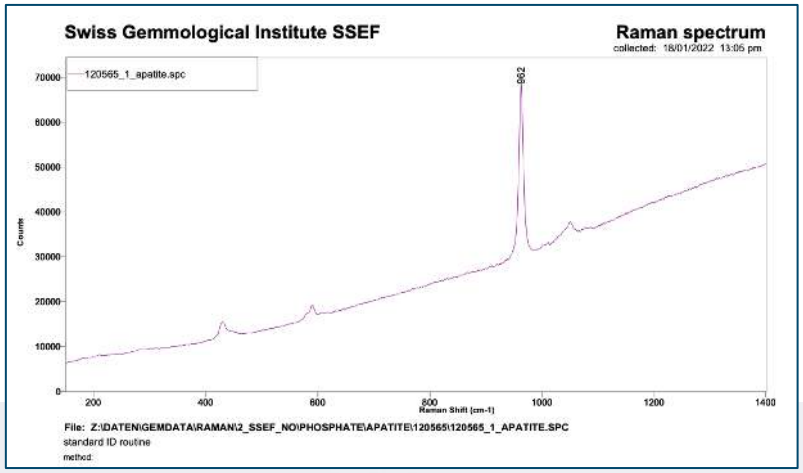
	sample A (Cu) average (4)	std dev.	sample B (Fe-Cu) average (4)	std dev.	sample C (Fe) average (4)	std dev.
Fe (ppm)	113	15	4181	107	6194	444
Cu (ppm)	2037	69	670	12	0.16	0.04
Cu / Fe ratio	**18**		**0.16**		**0.000025**	



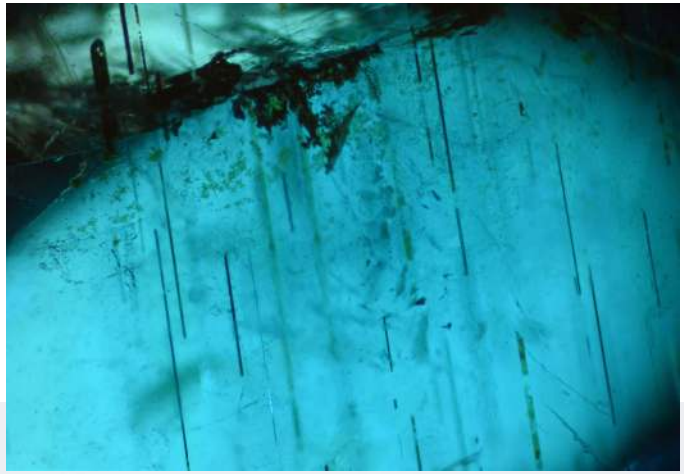
Paraiba or not?



Paraiba or not?



Raman spectrum of one of these apatite samples.



Hollow channels parallel optic axis.

Blue (heated) apatite, submitted to SSEF as Brazilian Paraiba tourmalines!

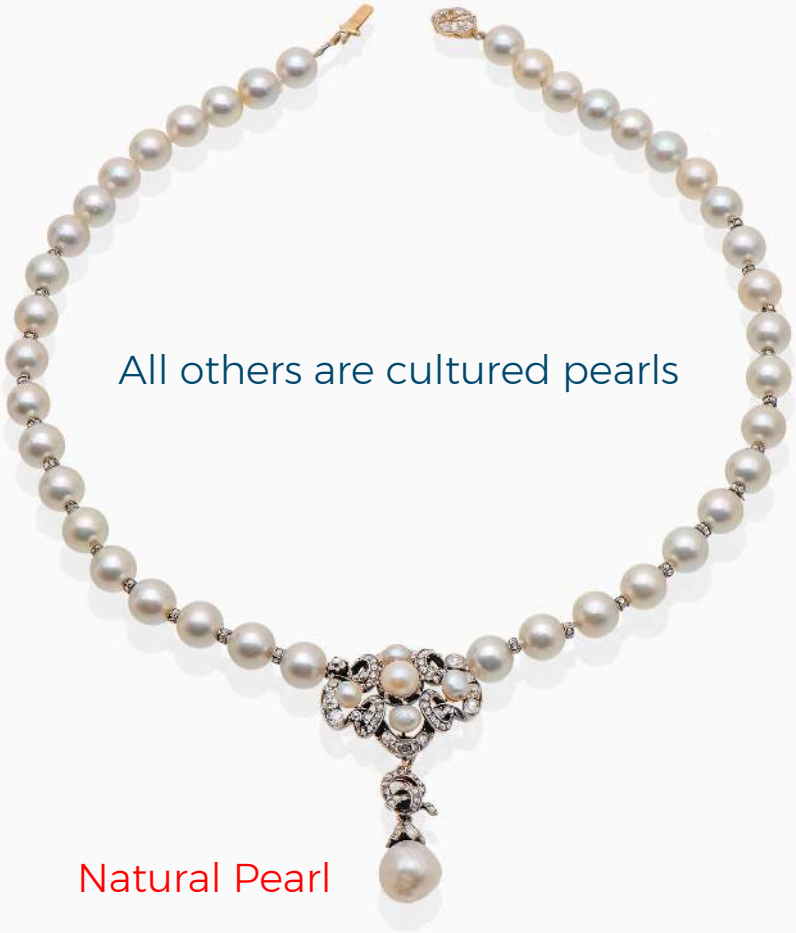
Exceptional Pearl Jewellery

Antique pearl jewellery from Boucheron. The pearl necklace can be transformed into a tiara.

Exceptional Pearl Jewellery

Royal pearl tiara of the House of Savoy, sold at Sotheby's Geneva in May 2021 for 1.47 mio CHF. It can be transformed into a necklace.

Pearl Surprise



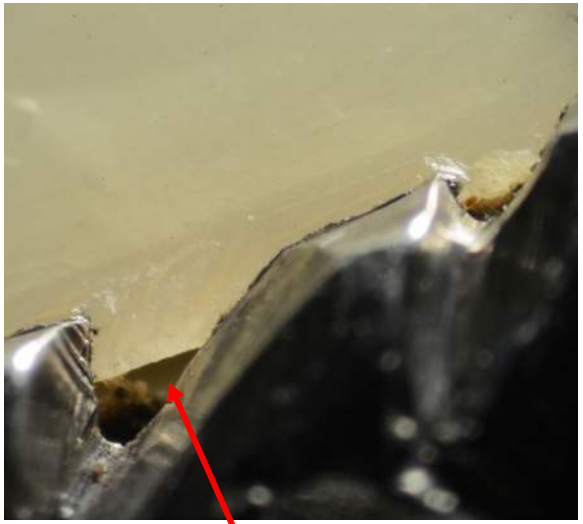
All others are cultured pearls

Natural Pearl

Pearl Surprise

"Pearl" pendant, made of three curved shell pieces (blisters).

Detail at metal setting revealing the construction of this "pearl".



Hole below the shell blister

^{14}C Dating of Pearls of Historic Provenance

Historic Pearl Necklace from Spain

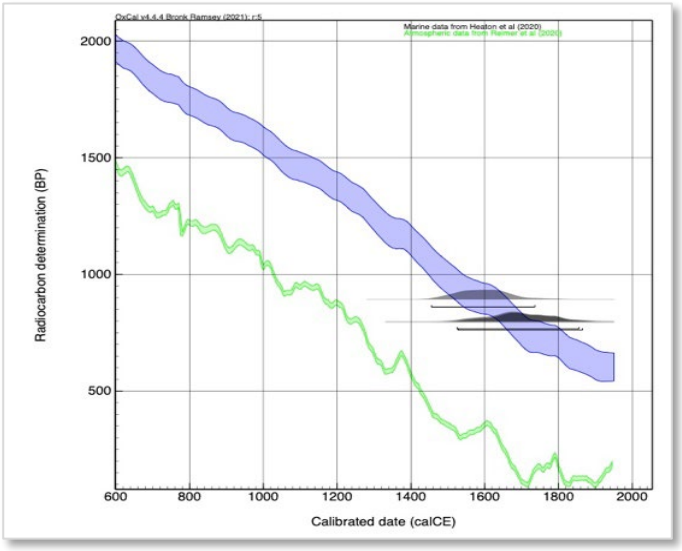
Three pearls were randomly selected to carry out ^{14}C dating and DNA fingerprinting.

Radiocarbon dating confirmed a historic age (16th to 17th century) of these three pearls.

DNA analysis on the same samples revealed a pearl of *Pinctada radiata*, whilst the other two belong to *Pinctada persica*, both species having their habitat in the Persian Gulf.

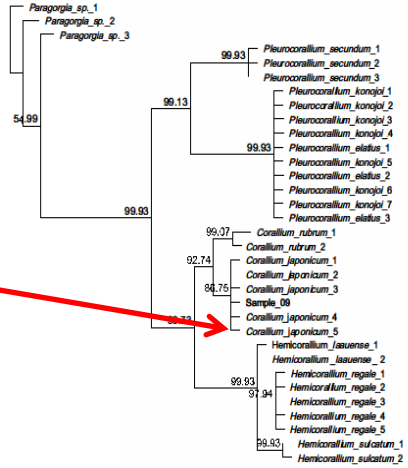
To our knowledge, this is the first time that *Pinctada persica* has been described in pearl jewellery.

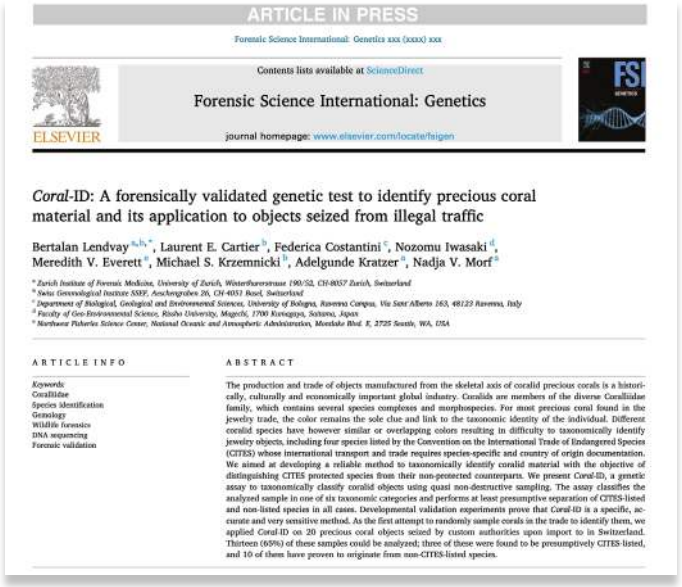
Pinctada radiata & Pinctada persica



DNA of CORAL

Coral-ID: a forensically validated genetic test developed by the Institute of Forensic Medicine (Uni ZRH) in collaboration with SSEF





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Coral-ID: A forensically validated genetic test to identify precious coral material and its application to objects seized from illegal traffic

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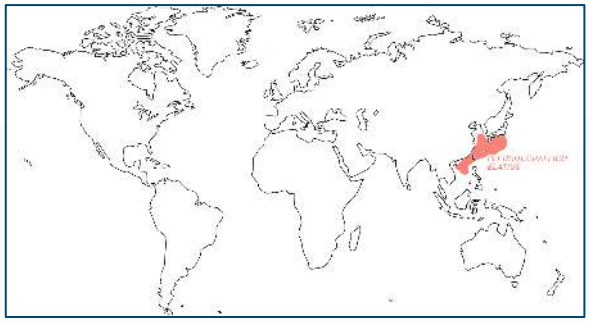
ABSTRACT

The production and trade of objects manufactured from the skeletal axis of coralid precious corals is a historically, culturally and economically important global industry. Coralids are members of the diverse Coralliidae family, which contains several species complexes and morphospecies. For most precious coral found in the jewelry trade, the color remains the sole clue and link to the taxonomic identity of the individual. Different coralid species have however similar or overlapping colors resulting in difficulty to taxonomically identify jewelry objects, including four species listed by the Convention on the International Trade of Endangered Species (CITES) whose international transport and trade requires species-specific and country of origin documentation. We aimed at developing a reliable method to taxonomically identify coralid material with the objective of distinguishing CITES protected species from their non-protected counterparts. We present *Coral*-ID, a genetic assay to taxonomically classify coralid objects using quasi non-destructive sampling. The assay classifies the analyzed sample in one of six taxonomic categories and performs at least presumptive separation of CITES-listed and non-listed species in all cases. Developmental validation experiments prove that *Coral*-ID is a specific, accurate and very sensitive method. As the first attempt to randomly sample corals in the trade to identify them, we applied *Coral*-ID on 20 precious coral objects seized by custom authorities upon import to in Switzerland. Thirteen (65%) of these samples could be analyzed; three of these were found to be presumptively CITES-listed, and 10 of them have proven to originate from non-CITES-listed species.

DNA Fingerprinting of Coral

Coral necklace designed by
Suzanne Belperron (1900-1983)



Pleurocorallium elatius

Coral Imitation made of Glass

	wt%
Na_2O	12.31
SiO_2	65.92
K_2O	1.77
CaO	5.93
Fe_2O_3	0.43
ZnO	9.42
As_2O_5	0.62

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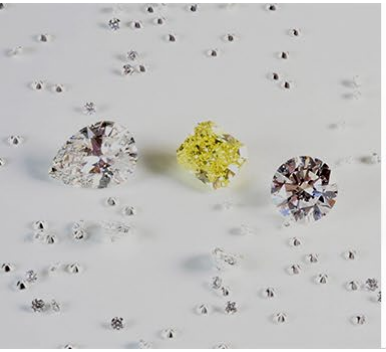


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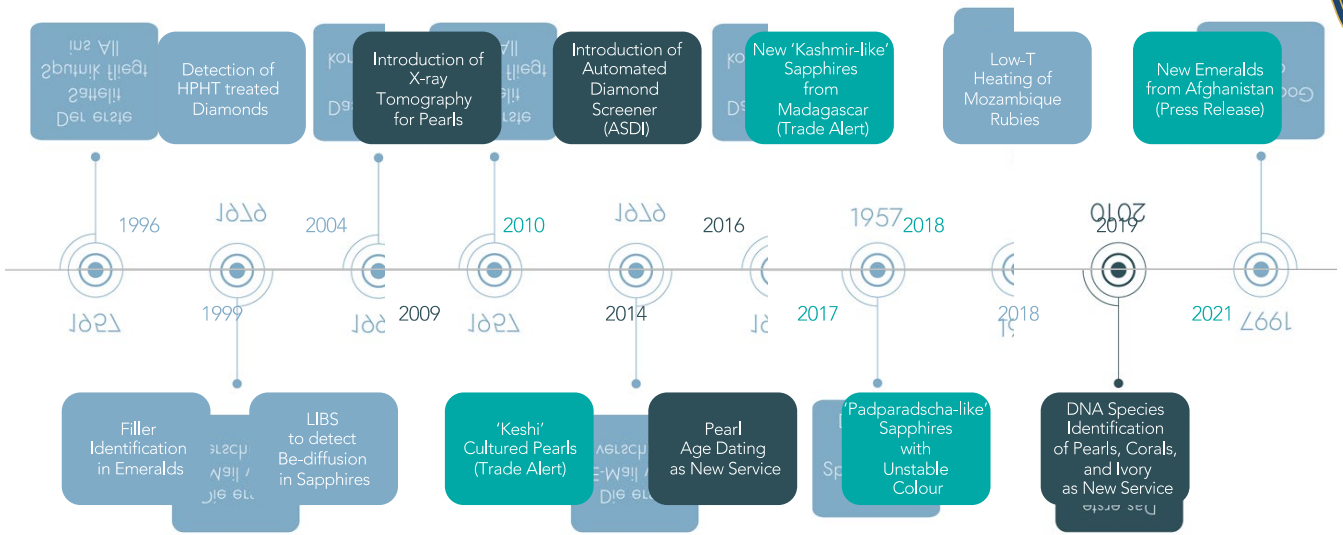

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