Origin determination and traceability:

An overview for gemstones

Presentation by

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TERMS AND THEIR SIGNIFICANCE

The terms Origin and Origin Determination cover many aspects:

- Formation (natural vs synthetic or cultured)
- Geological
- Geographical
- Historical
- Emotional
- Species-related (e.g. CITES)
- Political (boycott) / Sustainability / responsible sourcing

Bagan, Myanmar © P. Boegli, Flickr.com

Ruby mining near Bawpadan in Mogok

TERMS AND THEIR SIGNIFICANCE

Traceability:

- Tracing (from market to origin)
- Tracking (from origin to market)

Tsavorite garnet from Kenya & Tanzania.
For sale in India.

Challenges, especially for coloured gemstones:

- Mostly informal artisanal mining
- Mostly small short-lived deposits
- Quality main criteria over origin
- Stock management
- Gems are not a commodity
  (huge amount of historically mined gems)
- Overlapping analytical data for gems
  from different origins

Photos © L. Cartier, SSEF

GEMMOLOGICAL LABORATORY

A gemmological laboratory analyses loose and mounted gems with scientific methods and issues reports giving expert opinions to answer the following questions:

Identification: What gemstone ?

Authenticity: natural formation or synthetic production ?

Treatment: treated or not, what kind of treatment ?

Origin: which country/deposit ? (scientifically only possible for certain coloured gemstones)

Quality: international standardised grading (commonly only for natural diamonds)

ORIGIN DETERMINATION

A multi-step scientific deduction process:

- Inclusion features
- Analysed physical and structural properties
- Trace element composition
- In certain cases radiometric age dating

First level
Deduction of the geological setting (e.g. marble, amphibolite rock, basaltic rock) in which the gemstone has formed.

Second level
Based on this, deduction of the best fitting geographic gem producing country/area.

ORIGIN DETERMINATION

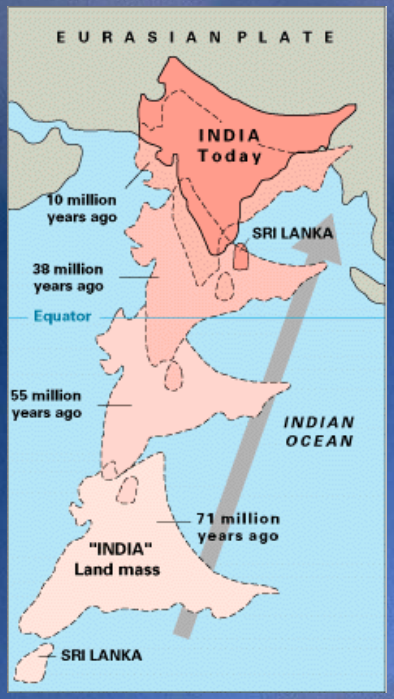
Finally, a geographic origin determination is always an **expert opinion**, and as such different labs may also come to different results, very similar to fields such as paintings, or antiquities.

But still it is an independent assessment and may be crucial to support or exclude origin claims made in documents or by a client.

ORIGIN DETERMINATION

Minerals and Gemstones mostly form in areas where large-scale geological processes shaped the surface of the Earth.

ORIGIN DETERMINATION



The collision of the Indian plate with the Eurasian continental plate has produced some of the most important sources for coloured gems, such as the sapphires from Kashmir and the sapphires and rubies from Burma, and many more.

KASHMIR SAPPHIRE

Zanskar © Corto Maltese, Flickr.com

1880	sapphire deposit discovered in the Zanskar mountain range in Kashmir (India)
1882-1887	main mining activity
1888-today	only sporadic activity, but no evident production of gem-quality material

KASHMIR SAPPHIRE

The Richelieu sapphires, sold at Sotheby's Geneva for US$ 8.35 mio.

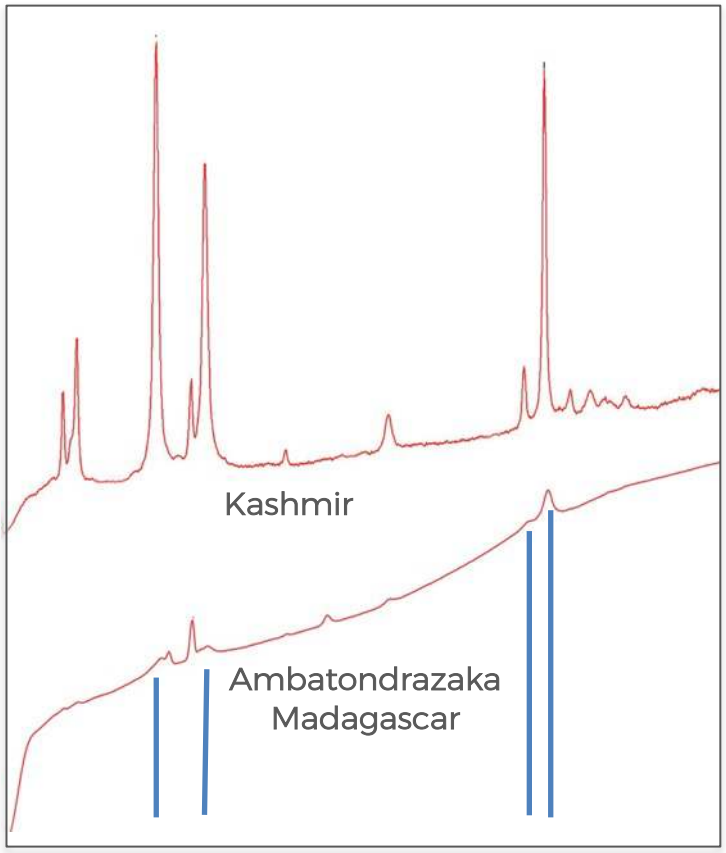
KASHMIR SAPPHIRE

Pargasite (amphibole)
in sapphire from Kashmir

KASHMIR SAPPHIRE

‚Kashmir-like' sapphires of excellent quality from new deposit near Ambatondrazaka, Madagascar.

Raman spectra of zircon inclusions

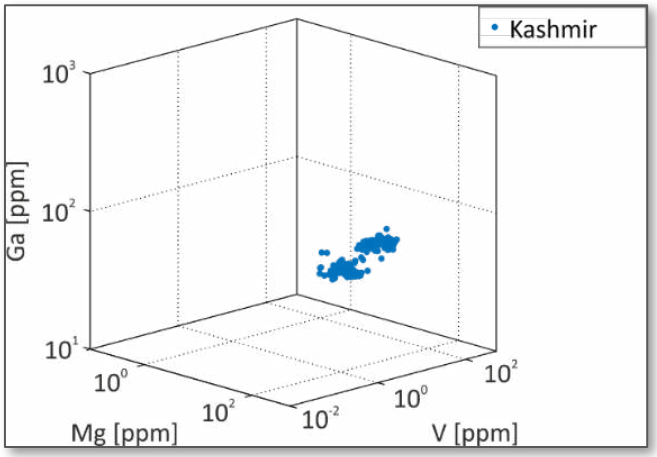


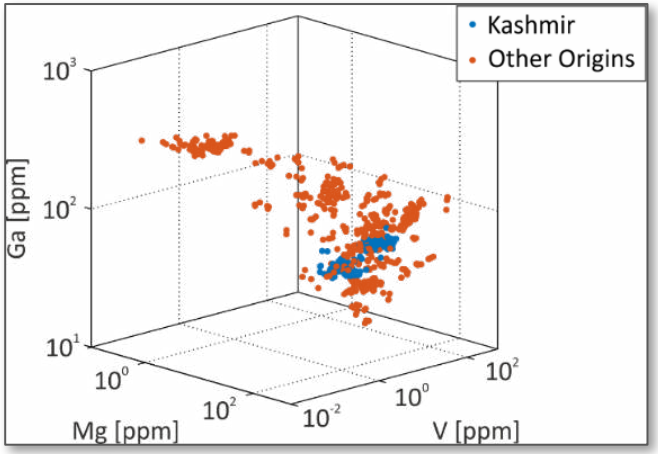
non-metamict zircon inclusions

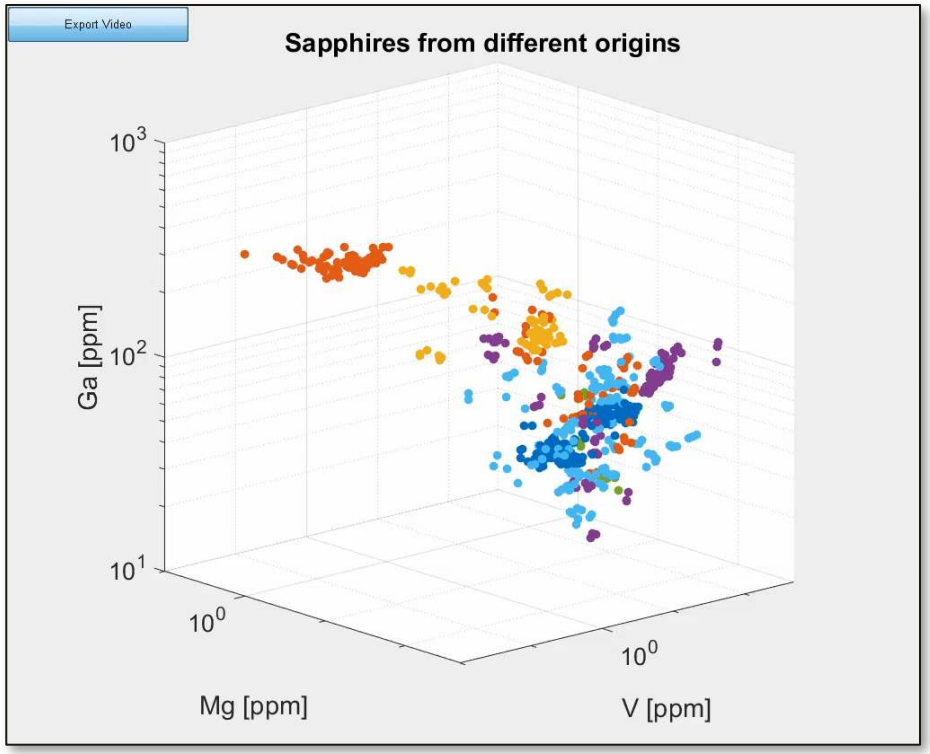
metamict zircon inclusions

KASHMIR SAPPHIRE

Trace element analyses using
laser ablation ICP TOF MS







REAL CASE IN THE SSEF LABORATORY

Natural vs Synthetic Origin

Separation of ruby of natural origin (formation by geological process) from ruby of synthetic origin (produced in a factory, e.g. in Switzerland).

Natural ruby of 22.04 ct from Mozambique
(named the “Rhino Ruby”)
ca. 500 million years old

Synthetic ruby of 6.54 ct
Probably 1-30 years old !

REAL CASE IN THE SSEF LABORATORY

Historic Provenance

Documenting scientifically gemstones of historic or iconic significance.

Sapphire of Catherine the Great (331 ct), Empress of the Russian Empire from 1762 to her death in 1796.

Later part of the Harry Winston *'Court of Jewels'* collection (see *Harry Winston, the ultimate Jeweler* by Krashes and Winston, 1984, page 27).

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INSTITUT SUISSE DE GEMMOLOGIE

Gemstone Report No.

Weight:	331.049 ct
Shape & cut:	oval, modified brilliant / step cut
Measurements:	45.98 x 33.75 x 21.64 mm
Colour:	blue of medium strong saturation
Identification:	**SAPPHIRE** (variety of natural corundum)
Comments:	The analysed properties confirm the authenticity of this transparent sapphire. No indications of heating. Origin: Ceylon (Sri Lanka)

SWISS GEMMOLOGICAL INSTITUTE – SSEF

Basel, 3 October 2018 dh

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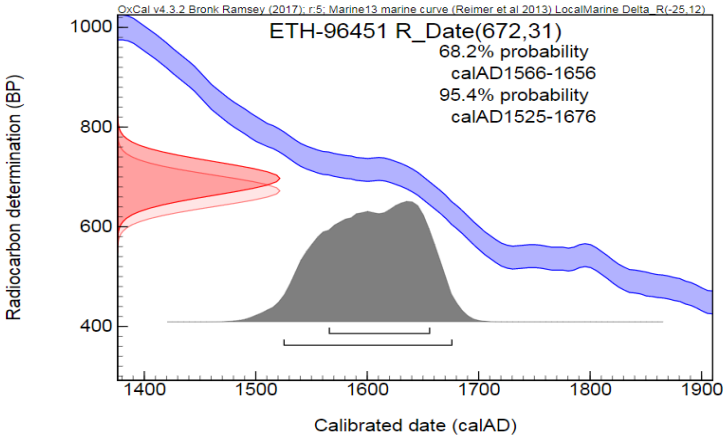
REAL CASE IN THE SSEF LABORATORY

Historic Provenance

Supporting evidence by using radiocarbon age dating of a historic pearl.

Documented since mid 19th century, originally belonging to Ana María de Sevilla (1828-1861); probably fished during Hernán Cortéz' conquest of the Aztec empire in the 16th century.

Our **radiocarbon age dating** result (16th – 17th century) perfectly matches the historic provenance of this pearl.

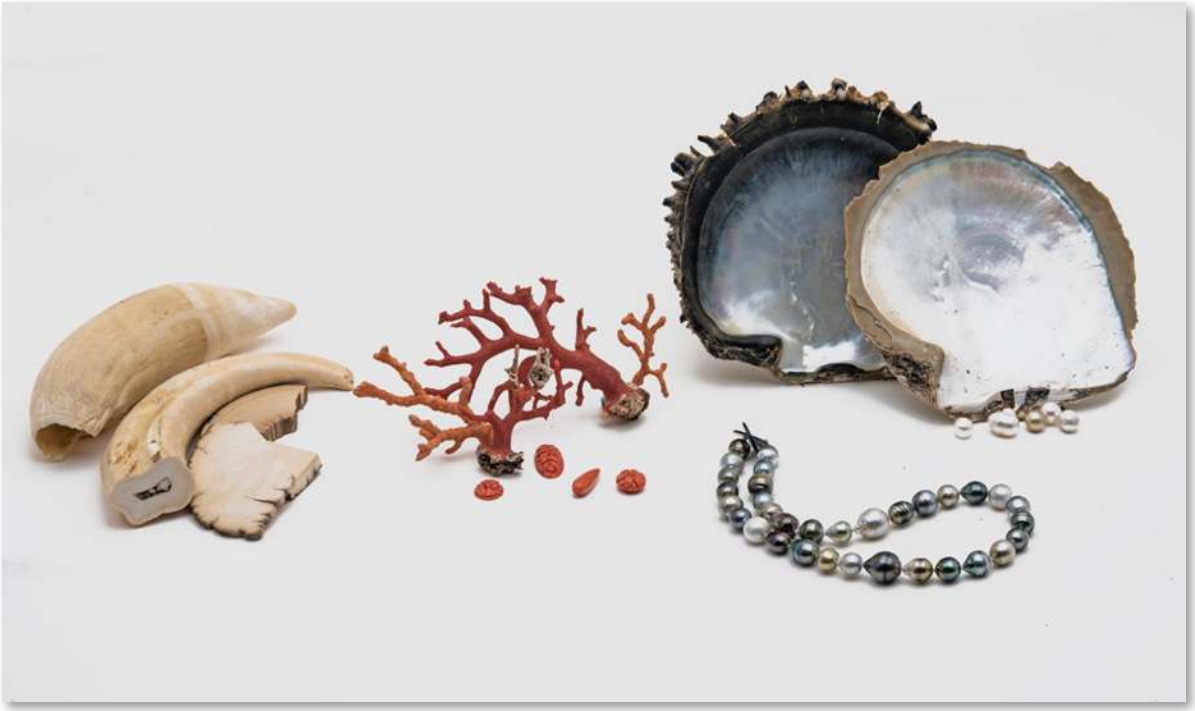


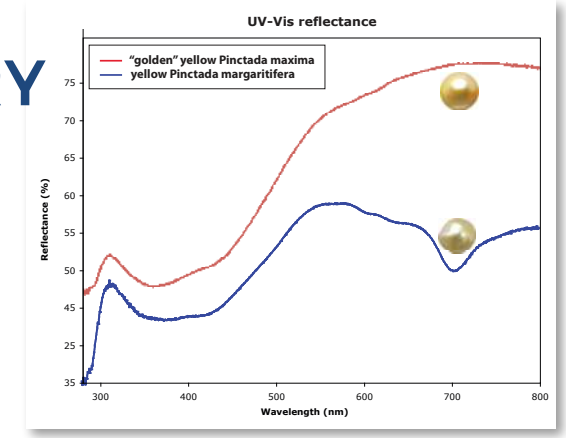
at auction this May in Geneva
Christie's Magnificent Jewels Lot 264

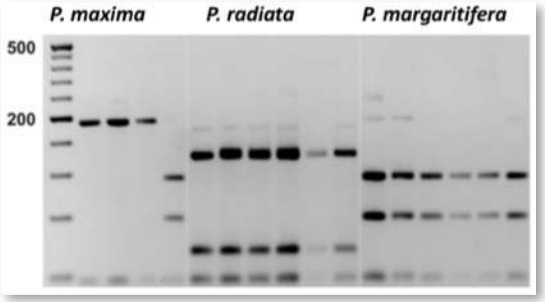
REAL CASE IN THE SSEF LABORATORY

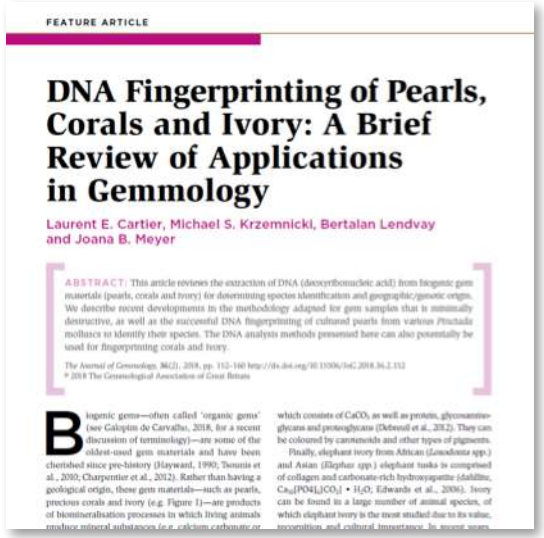
Determining biological species
by using spectroscopic methods and DNA fingerprinting.

SSEF will soon offer DNA fingerprinting and species identification as a service for pearls, corals, and ivory in collaboration with the IRM University Zurich.








FEATURE ARTICLE

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

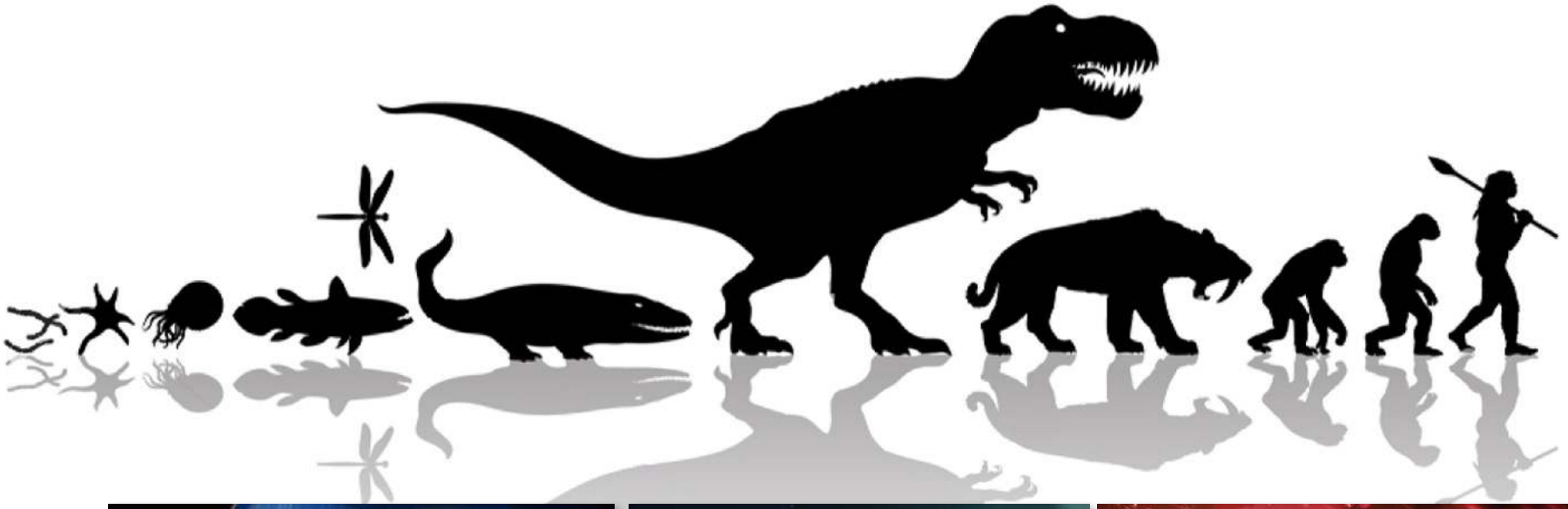
Laurent E. Cartier, Michael S. Krzemnicki, Bertalan Lendvay and Joana B. Meyer

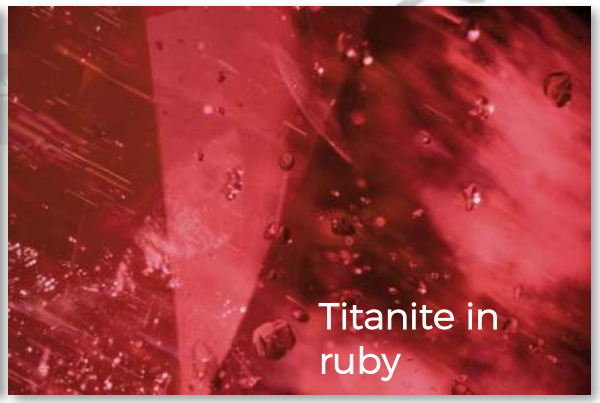
ABSTRACT: This article reviews the extraction of DNA (deoxyribonucleic acid) from biogenic gem materials (pearls, corals and ivory) for determining species identification and geographic/genetic origin. We describe recent developments in the methodology adapted for gem samples that is minimally destructive,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

See also https://www.ssef.ch/library/

REAL CASE IN THE SSEF LABORATORY

Geological age dating
of gemstone formation possible in specific cases by using tiny, surface-reaching inclusion minerals.

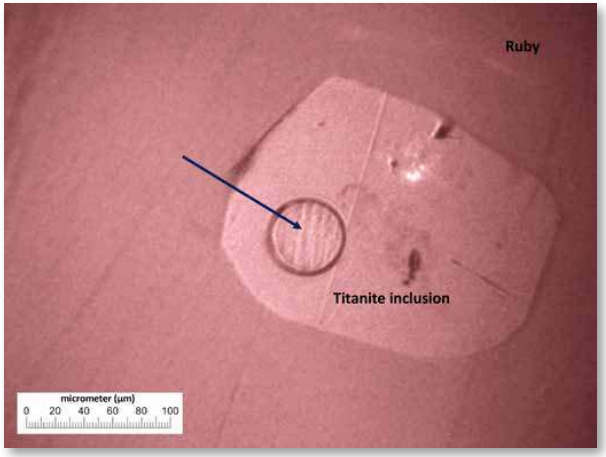




REAL CASE IN THE SSEF LABORATORY

Geological age dating

May support geographic origin determination, as it connects a gemstone to gem deposit formation and plate tectonics.



This ruby of 12 ct from an iconic Harry Winston necklace is approximately 35-40 million years old. The radiometric age dating result is well fitting with the formation of the Himalaya mountain range and the formation of gem deposits in Mogok, Myanmar. See also SSEF Facette 2019 https://www.ssef.ch/ssef-facette/

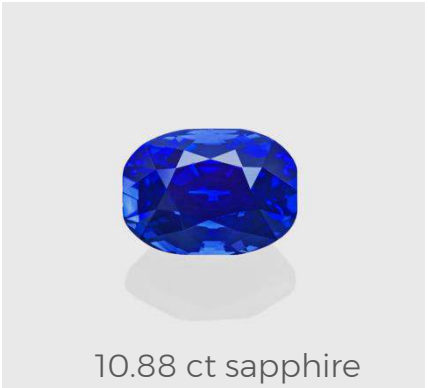
REAL CASE IN THE SSEF LABORATORY

Documenting (tracking) the treatment status of a gemstone
when tested several times in the laboratory, even when submitted by different clients and without indication that the gemstone was already tested before by SSEF.

First submission June 2015	Second submission September 2017	Third submission July 2018
		
cleaned	Filled with artificial resin	Partly cleaned again

REAL CASE IN THE SSEF LABORATORY

Documenting (tracking) of a gemstone in the lab
when tested several times, even when recut between submissions and without disclosure that the gemstone was already tested before by SSEF.

First submission February 2012	Second submission March 2015	Third submission June 2018	Fourth submission March 2019
			 10.88 ct sapphire

TRACKING SERVICE BY SSEF: GEMTRACK™

New service by SSEF which links a **cut stone** to a specific **rough stone** using gemmological techniques.

Given the growing demand for provenance and traceability in our industry, the SSEF provides a truly independent gemmological documentation of any gem on its journey from rough to cut and even into jewellery.

TRACKING SERVICE BY SSEF: GEMTRACK™

Procedure:

1) Step: Rough stone is tested by SSEF

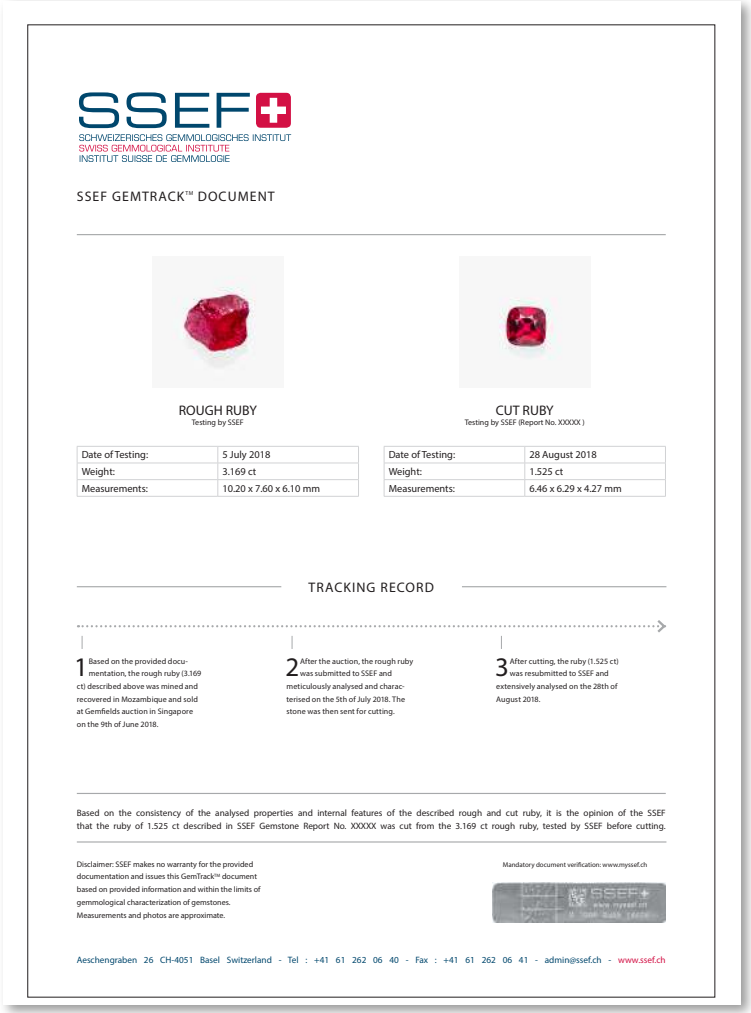
Stone is cut by client and resubmitted to SSEF

2) Step: Cut stone is compared to data of rough GemTrack™ document added to SSEF Report documenting the journey from rough to cut.

If (new) client sets stone in jewellery

3) Step: Recheck of the mounted stone GemTrack™ document added to SSEF Report documenting the journey from rough to jewellery.

See also https://www.ssef.ch/gemtrack/



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SSEF GEMTRACK™ DOCUMENT

ROUGH RUBY
Testing by SSEF

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

CUT RUBY
Testing by SSEF (Report No. XXXXX)

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

TRACKING RECORD

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

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

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

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

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

Mandatory document verification: www.myssef.ch

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TRACKING SERVICE BY SSEF: GEMTRACK™

Gemtrack™ can be easily integrated in existing blockchain solutions.

FEATURE ARTICLE

Blockchain, Chain of Custody and Trace Elements: An Overview of Tracking and Traceability Opportunities in the Gem Industry

Laurent E. Cartier, Saleem H. Ali and Michael S. Krzemnicki

ABSTRACT: Recent developments have brought due diligence, along with tracking and traceability, to the forefront of discussions and requirements in the diamond, coloured stone and pearl industries. This is a result of consumer demands for detailed information on the provenance of gems, banking requirements aiming to reduce risk, industry and company initiatives seeking to bring greater transparency, and growing government legislation on mineral supply chains. To address this trend, certification mechanisms and technologies (such as blockchain) are being developed to solve inherent traceability challenges. As applied to gems, such standards and associated technology could benefit from the support of existing gemmological approaches (e.g. geographical origin determination) to enhance traceability and transparency measures. Recent initiatives are not just limited to corporate social responsibility reporting and due diligence requirements, but they also embrace supply chain management (including quality control and process improvements)—for example, to correctly identify and disclose treated and synthetic materials throughout the jewellery industry—as well as address consumer demand for provenance information. This article provides an overview of current trends and developments in the tracking and traceability of gems, along with an explanation of the terms used in this context.

The Journal of Gemmology, **36**(3), 2018, pp. 212–227, http://doi.org/10.15506/JoG.2018.36.3.212

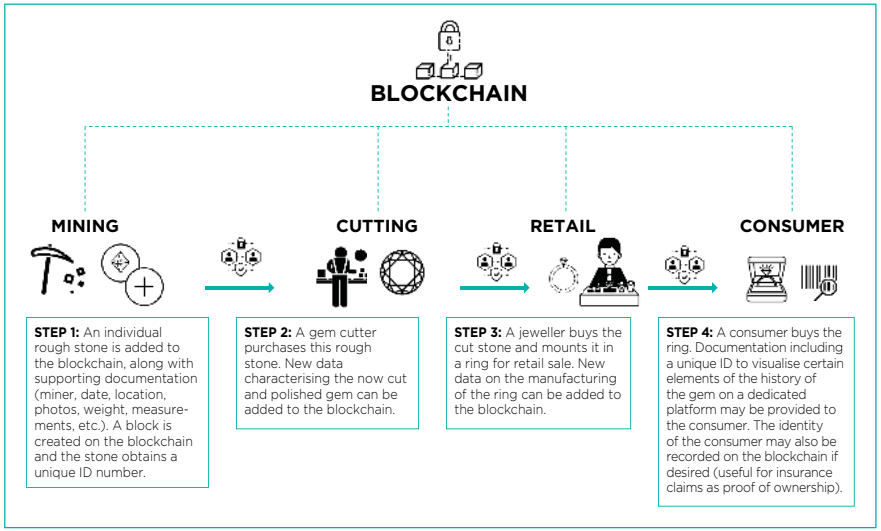

Figure 4: This generalised example of a blockchain serves to illustrate how information can be documented on a single gem's journey from mining to cutting and onward to retail and eventually the end consumer. After the stone is mined, the trade and transfer of ownership are validated at each step by both parties involved and recorded immutably to the blockchain. Illustration by L. E. Cartier.

See also: https://www.ssef.ch/library/

CONCLUSIONS

- Origin determination is a scientific deduction process to assess the geographic origin (commonly country/mining area) of a cut gemstone.

- Origin determination from a laboratory provides an independent assessment and may support or exclude origin claims made in documents or by a client.

- Tracing and tracking of gemstones submitted several times to the laboratory is possible.

- SSEF GemTrack™ is a tracking service from rough to cut (and mounted) gems, similar to services offered by other laboratories.

- Integration in blockchain solutions is possible in principle whenever a gemstone is tested in a gemmological laboratory.

THANK YOU FOR YOUR ATTENTION

www.ssef.ch/ssef-facette