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

Ruby mining near Bawpadan in Mogok

Bagan, Myanmar © P. Boegli, Flickr.com
TERMS AND THEIR SIGNIFICANCE

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

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
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.
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.
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.
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).
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 Cortés’ 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.

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.

<table>
<thead>
<tr>
<th>First submission</th>
<th>Second submission</th>
<th>Third submission</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 2015</td>
<td>September 2017</td>
<td>July 2018</td>
</tr>
</tbody>
</table>

- 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/
Gemtrack™ can be easily integrated in existing blockchain solutions.

**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.

See also: [https://www.ssef.ch/library/](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