



EMERALD PATERNITY TEST

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Gübelin Gem Lab  
Lucerne Hong Kong New York

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PROVENANCE  
PROOF

We are proud to introduce to the gemstone industry the Emerald Paternity Test, a technology to prove the provenance of emeralds back to the exact mine. This novel technology uses DNA-based nanoparticles, applied directly at the mine on the rough crystals. Built to survive the usual procedures, which an emerald is subjected to before reaching the end consumer, the nanoparticles can be retrieved and decoded at any stage along the supply chain. This technology gives miners, governments, trade organisations, jewellery brands and final customers a tool to prove the very source of emeralds, instilling confidence and creating trust.

Gübelin Gem Lab



## UNKNOWN PATHS

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*Today, the gemstone industry is unable to fulfill the expectations of consumers regarding transparency of provenance.*

Buyers of gemstones and jewellery expect transparency about the provenance of their purchase. They want to understand where the products come from, how the raw materials have been sourced, and what practices, principles and values the companies and individuals at the mine apply and stand for. This expectation is starkly contrasting with today's reality. The conditions under which coloured gemstones are sourced are

highly intransparent. At best, mining companies provide some kind of self-declaration of the provenance of their gems, but have no way to provide an independent proof. By determining the gemmological properties typical for a specific geological environment, gem labs can determine the country of origin, but fail to discriminate between different entities mining the same geological unit. In recent years, the trend towards full transpar-

ency has also reached the gem and jewellery industry. Trade organisations and industry outfits formulate ambitious goals to shed light into an exceptionally fragmented and intransparent supply chain. The proof of provenance technology presented here finally enables miners and other stakeholders to work towards a more transparent and trustworthy industry.



DNA-based nanoparticles tightly adhering to the surface of a rough emerald crystal

Length of bar is 500 nanometres = 0.0005 millimetres

500 nanometres

## INVISIBLE TAGGING

*Combining the advances of nanotechnology and DNA engineering, we developed a technology applicable to gemstones, enabling us to trace back emeralds to the exact place of mining – a true paternity test for emeralds.*

Recent advances in both nanotechnology and the customisation of DNA has enabled a wealth of new applications, such as invisible tagging of various materials. Nanoparticles are used in many industries – e.g. food, cosmetics, petroleum – against counterfeiting and for other purposes. We have customised DNA-based, nano-sized particles to suit the specific needs of the gemstone industry. The particles have a diameter of about 100 nanometres or 0.0001 millimetres. For comparison, a human hair has the diameter of 100 of these nanoparticles. With such an incredibly small size, our nanoparticles are invisible even to the best optical microscope and induces no

optical effect whatsoever. They can only be visualised by means of Scanning Electron Microscopy (SEM).

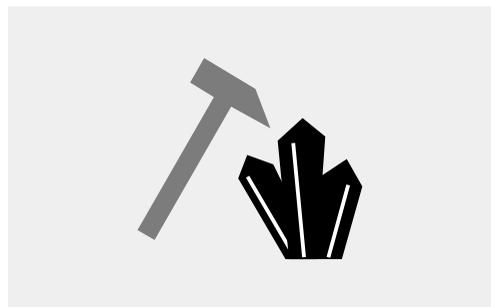
Information on the mining location (e.g. country, mining area, mine, shaft), the miner (e.g. company name, mining cooperative) and the mining time (year, quarter) is encrypted and stored in the DNA, and encapsulated in a sphere of amorphous silica to resist the influence of cutting, polishing and repeated treatment. By means of a carrier liquid, these particles are applied on the rough emerald crystals, penetrating even the tiniest fissures, and tightly adhering to their

walls. We have tested these particles and could verify that they survive the harsh procedures emeralds are typically subjected to by miners, cutters and dealers<sup>1</sup>. The nanoparticles can be retrieved, the information contained in the DNA read out and decoded at any later stage during the lifetime of the emerald, disclosing the paternity of the emerald. The Emerald Paternity Test can be performed with minimal additional effort and little influence on the standard process, allowing a truly independent test of the exact provenance of an emerald.

<sup>1</sup> With limitations, depending on the applied procedures and the type of filling material.

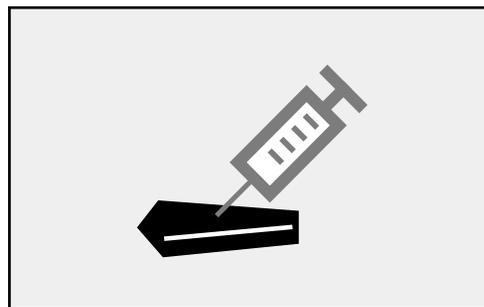
## STEP BY STEP

*Just one additional step (No. 2) needs to be introduced in the standard workflow to enable a later paternity test (No. 6).  
All other steps along the supply chain remain unchanged, as they are standard practice today already.*



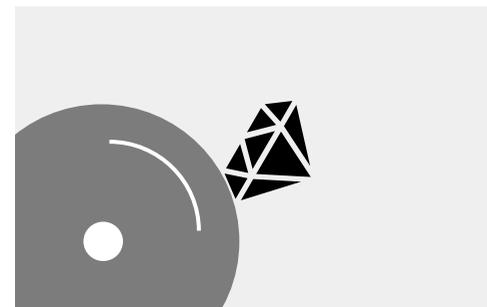
1

The process starts in the mine, where the emerald gets unearthed. Ideally, the rough crystals are tagged with the nanoparticles before any cleaning or sorting is undertaken.



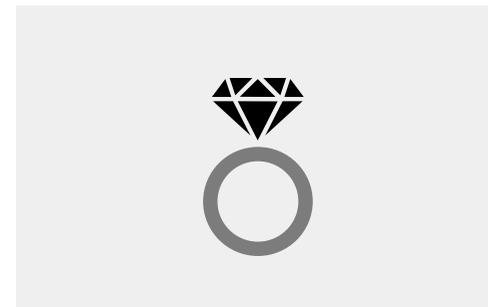
2

The nanoparticles are inserted into the rough crystals by a simple process during which the particles penetrate all fissures and adhere closely to their surfaces. The applied ethanol-based liquid evaporates completely within a few minutes. The insertion of the DNA tags does not affect the appearance, quality, or properties of the emeralds. The tagging process is already complete after this step.



3

Withstanding the usual processes that emeralds are subjected to during the cutting and polishing as well as the re-oiling process, a sufficiently big number of DNA tags remain in the fissures for a later paternity test.



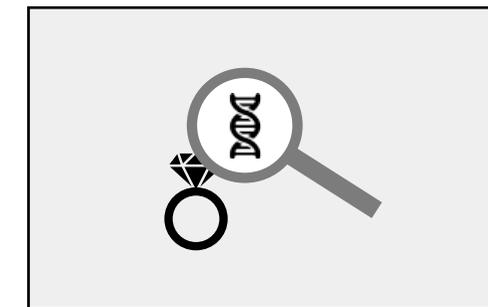
4

The mounting of emeralds in a piece of jewellery does not affect the nanoparticles.



5

During the sale of the final piece in a retail shop, the provenance proof label and potential paternity test inspire trust and bring to the customer additional confidence in the jewel.



6

Whenever required, the stone can be submitted to an authorised lab<sup>1</sup> to conduct the paternity test. This test comprises the retrieval of nanoparticles, their analysis and subsequent decoding. After decoding, the client gets transparency about the exact place where the emerald was unearthed.

<sup>1</sup> Currently (spring 2017) the paternity test is performed exclusively by the Gübelin Gem Lab.

## TRANSPARENCY CREATING TRUST

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*The Emerald Paternity Test is a true game-changer for the coloured gemstone industry.  
It enables all stakeholders to work towards the realisation of their goals of transparency.*

So far, companies in the jewellery industry embracing ambitious transparency goals faced limitations when it came to the exact origin of the gemstones they used in their products. They had to rely on a mixture of trust and self-declaration by mining companies, lacking an independent proof of provenance. With the availability of the Emerald Paternity Test, such a proof is now available for all stakeholders within the gemstone industry.

The Emerald Paternity Test is the first of a series of technologies and services dedicated to bringing more transparency into the gemstone industry, united under the Provenance Proof label.

The right of using the technology is subject to a Code of Conduct, defining the use and application of the technology. We recommend to have the application of the nanoparticles overseen by an independent auditor<sup>1</sup>, to ensure that the technology is used correctly on

the foreseen type of material. Clients working in compliance with the defined rules are authorized to use the Provenance Proof label on their products.

<sup>1</sup> Contact the Gübelin Gem Lab for names of companies offering such services.



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## ADDING VALUE FOR ALL STAKEHOLDERS

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*The Emerald Paternity Test is available to the entire industry, small and large mining entities, governments, jewellery brands and organisations overseeing the extractive industries.*



### **Mining companies**

The first and most obvious users of the paternity test technology are mining companies and cooperatives of all sizes. Being at the source, they unearth the rough gemstones and initiate the journey of the gemstone along the supply chain.



### **Industry organisations, NGOs**

Industry and trade associations, NGOs and other outfits overseeing the gemstone industry and the extractive sector in general can – directly or indirectly – use this technology to facilitate and check the implementation of policies and standards in the industry.



### **Governments**

Governmental bodies can use the technology to promote and monitor their domestic production, control exports and distinguish their gems from other origins.



### **Jewellery brands**

Jewellery houses, jewellery manufacturers and retailers can prove to their customers their commitment to the values of transparency and sustainability, which they embrace, setting them apart from their competitors.



### **Individual**

The end consumer gets an insight into the social, environmental, ethical and health standards which are pursued at the birthplace of the gemstone used in the final jewellery piece. This transparency finally gives the peace of mind, which responsible consumers expect today when buying luxury goods.

## INSPIRED BY KNOWLEDGE

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*At the cross-section between scientific research and the industry, the Gübelin Gem Lab has the scientific knowledge and the industry insight needed to develop solutions to solve the challenges of the gemstone industry.*

Continuous investments in scientific research are crucial to overcome today's limitations and challenges, to create a better tomorrow. The Gübelin Gem Lab has gained the knowledge and secured the intellectual property, which is now made available in the Emerald Paternity Test. We are perfectly positioned to provide this service to the industry. Being part of the privately owned Swiss family business Gübelin founded in 1854, our firm has a long history of testing the most exceptional gemstones worldwide. Traditionally, we are an independent entity providing the

gemstone trade with unbiased and neutral opinion on the identity, authenticity and origin of their goods, purely on the basis of scientific analyses and procedures. Our new

services offered under the Provenance Proof label are the logical continuation of our history of fostering trust in the gemstone industry.

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