



GEMMOLOGICAL PROFILE



FOR A
MOZAMBICAN RUBY
OF
0.00 CT

COMPLEMENTING
GEMMOLOGICAL REPORT
No. SPECIMEN 1

ABOUT THIS DOCUMENT

This Gemmological Profile is complementing a Gemmological Report issued by the Gübelin Gem Lab. The Gemmological Profile has been issued upon request of a client, on the basis of data collected for the described stone at the time of the analysis as stated on the Gübelin Gem Lab Gemmological Report. The Gemmological Profile is only valid if presented together with the original Gübelin Gem Lab Gemmological Report.

Gemmological Profiles provide a more detailed description of a gemstone than the concentrated wording used in Gübelin Gem Lab Gemmological Reports. While Gemmological Reports primarily address the professional traders, Gemmological Profiles attempt to cater to the needs of the jeweller and the layperson, who might be interested in getting explanations and background information about gems in general and their gemstone in specific. Gemmological Profiles are issued on request and are available for a broad range of gemstone qualities. Hence, the existence of a Gemmological Profile does not imply any level of quality or rarity of the gemstone it describes. The language used in Gemmological Profiles is more extensive and informal. Statements about certain quality traits of the stone in the Gemmological Profile might be more detailed and go beyond the sober scientific language deployed in the Gemmological Report. In contrast to the Gemmological Report, whose content is based exclusively on data that Gübelin staff has collected directly from the stone, the Gemmological Profile considers and contains also external, possibly uncorroborated data and information.

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See also gubelingemlab.com.

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INTRODUCTION

Gemstones are true products of nature, grown millions of years ago in the earth's crust, brought up to the surface by geological processes and eventually found by man who brings out their colour and brilliance by cutting and polishing.

The gemmologist's eye looks beyond the sparkling outer appearance of the stone, attempting to understand how it has formed. Minute crystals, fluid inclusions and subtle growth features trapped in its interior are witnesses to its formation ages ago, at depths of tens or even hundreds of kilometres into the earth. This inner life may help us detect a stone's identity, authenticity and even its geographic place of origin.

This Gemmological Profile complements the Gübelin Gem Lab Gemmological Report No. SPECIMEN 1. In this Profile, we share with you our

insights and findings for the 0.00 ct Mozambican ruby, disclosing some of its microscopic, chemical and structural characteristics, and providing you with valuable information about its genesis and origin.

We intend to share with you the story that your gemstone tells us on its very individual history and personality.

On March 25, 2023, the Gübelin Gem Lab in Lucerne had been entrusted with testing the 0.00 ct gemstone presented here. The careful assessment and detailed analytical studies performed on this gemstone revealed the results provided in the Gemmological Report No. SPECIMEN 1 and are described in more detail in this Gemmological Profile.

HISTORY & SYMBOLISM OF RUBY

Above all others, ruby has historically been prized as the most precious and powerful gemstone in the world. Two names in Sanskrit hint at the stone's noble, indeed royal, charisma: 'Ratnaraj', 'king of the precious stones' and 'Ratnanayaka', 'leader of precious stones'^{ACA}.

The fiery life within the ruby was recognised in early Western tradition, as part of the nomenclature for all glowing red stones, but also as a property in its own right. A fourth century source noted the ruby's ability to shine in the dark, and through the material of clothing. This internal fire from within the gem engendered the later belief that the life of the ruby was linked to that of the person who owned it, giving the gem a prophetic quality. Ruby was used as a talisman that warns its bearer of danger by turning to a darker shade of red. A more contemporary association

is that of enduring love. Ruby is still thought by some to be curative for all matters of the heart, both physical and emotional.

Unrivalled in colour, life and vitality for thousands of years from East to West, ruby has justly been named the king, the leader, the gem of gems.

ACA This abbreviation refers to specific contents of the Coloured Gem Professional classes provided by Gübelin Academy. For detailed information see gubelinacademy.com





DESCRIPTION

Identity & authenticity

One most fundamental information any gem lab report has to provide is the identity of the stone. Ruby is defined as crystalline aluminium oxide, Al_2O_3 , called corundum, with traces of the chemical element chromium and sometimes vanadium. In gems, such trace elements are most commonly the agents responsible for adding colour. Despite their small contribution to the overall chemical composition of the gemstone, trace elements play a key role in determining whether a mineral is just a standard stone or a rare and coveted gemstone. Merely by replacing a few aluminium ions in the atomic structure of corundum with chromium ions, common, colourless corundum is turned into a ruby of an attractive red colour. With a hardness of 9 on the Mohs scale, corundum is one of the world's hardest minerals. This property, paired with

toughness and durability, makes ruby and sapphire quite forgiving gemstones, keeping their beauty for many generations.

Different types of minerals and other materials might be used to fake ruby, i.e. act as so-called simulants. Clearly, the value of a simulant is a fraction only of the true ruby. As ruby can also be grown synthetically, the authenticity needs to be addressed; is the ruby indeed of natural provenance, i.e. grown millions of years ago in the depth of the earth, or is it a synthetic ruby, i.e. a man-made crystal? Synthetic rubies are known for more than a hundred years and possess chemical and physical properties almost identical to natural rubies. But the production and hence the supply of synthetic rubies is virtually unlimited, which reduces their value dramatically compared to a pristine, naturally

grown ruby. The 0.00 ct gemstone has proven to be of the red variety of natural corundum, called ruby.

Weight

Geologic conditions under which rubies form are highly specific and rare. They grow in great depths in the earth crust, under extreme conditions of high pressures and temperatures. In this harsh regime, with a fierce competition for space, crystals grow at very small sizes only, rarely exceeding a few millimetres in diameter. The process of cutting and polishing further reduces the size of the crystal, and faceted rubies of good overall quality exceeding one carat in size are rare. Weighing 0.00 ct, the ruby presented here is a large specimen. It can generally be stated that increasing size in ruby seems to be inevitably linked to decreasing quality. For this reason, large perfect rubies are unheard of.

Shape & cut

The final shape and cut of the gemstone is the result of a highly complex decision taken by the cutter and

mainly defined by the shape and the quality of the rough crystal. The cutter tries to find a balance between maximising the colour, brilliance and transparency, while retaining as much weight of the crystal as possible.

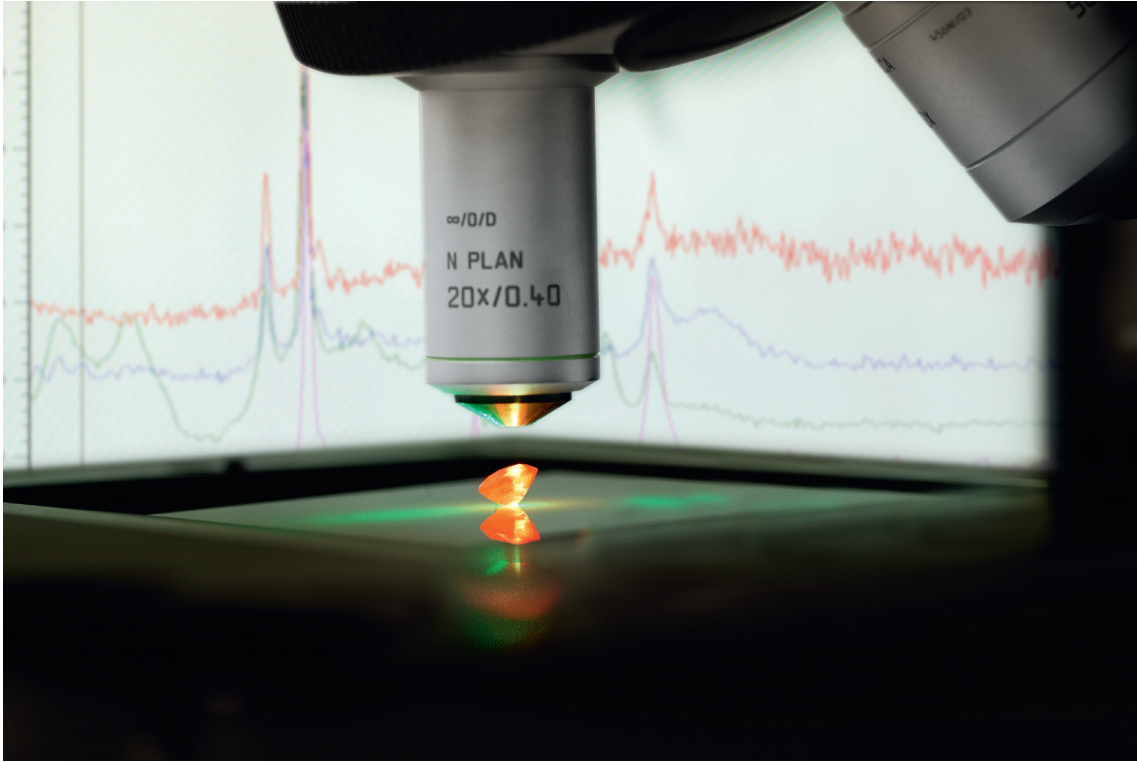
These considerations were also skilfully applied on the present crystal. It was fashioned into a cushion shape, using a cutting style that combines features of both the brilliant cut and the step cut. The dimensions of the gemstone are 12.25 mm in length, 2.26 mm in width and 2.00 mm in depth.

The cutting and polishing applied on this stone result in an attractive appearance of this ruby.

Colour & transparency

The single most important criterion of a gemstone's quality is its colour. In the case of rubies, the most coveted colour is a bright and pure red of high saturation. This, however, is a rare gift granted to just a small share of all rubies. Most





rubies show a colour slightly off the ideal colour; it might be a bit too dark, show a secondary hue of purple or orange, or might be undersaturated. The latter results in a pink rather than an intense red colour.

The colour of the present gem is exceptional, characterised by an intense saturated and homogeneous red colour, free of any secondary hue.

As a rule of thumb, the transparency of gemstones usually follows the same logic as in diamonds: the cleaner – i.e. showing no or few internal features only – the better. Although tiny, usually microscopically small inclusions are a common and welcome feature in coloured gemstones, ideally they do not affect the transparency of the stone.

The present stone shows an exceptionally high transparency and clarity.

Frequently observed in Mozambique rubies are mineral platelets of various shapes, such as hexagonal, triangular or irregular shape. Occasionally they are organized in loose bands. Together with these platelets, rutile needles of different lengths are frequently present, often in a seemingly random arrangement. Generally these needles look more delicate; they are often slightly flattened or plate-like at one extremity.

This gemstone displays a very good transparency, with only a few minute inclusions, that do not affect the transparency of the ruby. Remarkably for a ruby, the stone shows virtually no eye-visible fissures.

Fluorescence – the inner glow

Some rubies seem to glow from within the stone. That fiery red inner glow is caused by an effect called fluorescence, facilitated by a small amount of chromium in the atomic structure of ruby. Chromium atoms have the capability to absorb parts of

higher energy light and emit a very specific red light in return, yielding a crimson glow that illuminates the stone and enhances its red body colour.

The ruby described herein displays a medium red fluorescence when exposed to ultraviolet light, enhancing the red body colour and adding to its appearance.

Overall quality assessment & Gübelin rating points

The 0.00 ct ruby described in Gübelin Gem Lab Gemmological Report No. SPECIMEN 1 is of high visual quality. It reaches 90.00 points in the Gübelin Gemstone Rating, a comprehensive system that assesses the most relevant quality and rarity parameters. With 90.00 points, the 0.00 ct ruby is considered an outstanding gemstone¹.

¹ The Gübelin Gemstone Rating system assesses the quality, rarity and salience of a specific gemstone and translates these attributes into a simple number: the Gübelin Points. These rating points are only granted to stones reaching more than 75 points. The theoretical highest rating is 100 points. Gübelin Gemstone Rating system gives meaningful orientation and comparability for the main types of high-value coloured gemstones. See <https://www.gubelingemlab.com/en/gemlab/gemstone-rating> for details.





Oxbow river, Mozambique

ORIGIN

Throughout history, gemstones – in particular rubies, sapphires and emeralds – have been associated with specific countries and mining localities by virtue of their outstanding beauty and quality. However, the outward splendour of a gemstone is not all that contributes to the prominence of a particular source. The history and notoriety – often tumultuous – with which many exceptional gemstones are associated, combined with a relatively steady production over decades or even centuries, have contributed greatly to the reputation of a few specific gem deposits. The country of origin of the present 0.00 ct ruby has been determined to be Mozambique, a name that has entered the league of important gem producing countries just a few years ago. Gifted with an abundance of gemstones, Mozambique became well known in the first years of the new millennium for the mineralogical wealth emerging from the pegmatite fields around Alto Ligonha, produc-

ing morganite, aquamarine and paraiba-type tourmaline. Rubies from Mozambique were reported already in the 1990s from the Niassa province. But only in 2009, when gem quality rubies from near Montepuez in the Cabo Delgado province appeared on the market in Thailand, it triggered a sequence of events catapulting Mozambique to the top of the list of ruby producing countries.

The success of the Mozambican ruby is fuelled by several factors. One major reason is the sheer beauty and quality of the material. The best ruby crystals display an intense, saturated red colour, a high transparency and a strong lustre. The quality of colour and transparency of the best stones is so high, that no treatment is required. The bulk of the production, however, lack transparency due to inclusions and fissures, but are suitable for heat treatment, which makes the production economically

sustainable. Aside of the intrinsic aesthetic and gemmological quality of these rubies, the Mozambican rubies are assumed to remain at the top for further reasons. The market is hoping for a steady supply of gem-quality rubies over the next years. This optimism is fuelled by encouraging forecasts from the prospective geologists and the scale and long-term commitment of the companies that operate the area. After many decades of a chronic and severe undersupply of the worldwide market with high-end rubies, Mozambican rubies might help satisfying the appetite for the king of gems.

Determination of origin

The geographic origin of this 0.00 ct ruby has been determined by comparing its gemmological properties with those of rubies from the reference collection of the Gübelin Gem Lab. With more than 28,000 stones, it is probably the world's most complete collection of gemstones gathered from all commercially relevant mines worldwide. The collection has been started in the 1930s and is maintained up to this day. It hence also encompasses mines which are exhausted or closed decades ago. This unique reference collection, combined with the most sophisticated analytical techniques, allows the scientists of the Gübelin

Gem Lab to determine the origin of almost all rubies, solely based on the observations and data they collect on the stone. If the pattern of properties gathered from the unknown stone matches the one from the reference stones, i.e. of secured provenance, an origin can be determined. However, this is sometimes not a straightforward process, as the properties of rubies from different deposits might overlap. Although today they might lie thousands of kilometres apart, their geologic setting might be similar, or the host rocks were even adjacent to each other millions of years ago when the gem grew. Hence, despite skilful assessment and evaluation of carefully collected analytical data, the determination of the origin is not feasible for any stone. The trustworthiness of the final opinion is – among other factors – defined and limited by the completeness and quality of the lab's knowledge database and reference collection. This is why the Gübelin Gem Lab continuously invests a significant share of its revenues in research and development, both in-house as well as in joint projects with universities and other external scientific research institutions¹.

¹ The annual 'Dr. Eduard Gübelin Research Scholarship' is another key engagement of Gübelin to contribute to the advancement of gemmological knowledge. For more information visit gubelingemlab.com/scholarship.



GEOLOGY & AGE

Mozambican rubies have been formed some 600 million years ago, at a time, where the earth's face looked dramatically different from what we see today. At that time - a period referred to by geologists as Proterozoic - Mozambique was part of the so-called supercontinent Gondwana, comprising the continents Africa, South America, India, Australia and Antarctica. The growth of rubies was facilitated by a major tectonic event called regional metamorphism. This geologic event encompasses collision and thickening of the continental crust, accompanied by volcanic activities and the formation of entire mountain ranges.

This event is referred to as the Pan-African orogenesis, and is responsible not only for the formation of Mozambican rubies, but for most of the rubies and sapphires from East Africa (including Madagascar) and Sri Lanka. At that time, rubies formed in great depths of at least 20 kilometres and at temperatures of more than 600 degrees Celsius. Over the millions of years that passed by since then, the rocks containing these rubies were slowly uplifted and eroded away and are now accessible near the earth's surface.



TREATMENT



Traditional blow-pipe heat treatment

Heating has been applied for centuries, and even millennia, to improve both the colour and clarity in corundum. References in Pliny show a diverse knowledge of various mineral treatments in the Roman period, and explicit literary references to the heat treatment of ruby are found in early mediaeval Arabian and Renaissance European texts.

Generally, heat treatment offers a way of turning rubies of less desired quality into highly attractive gems. Treatment is thus an important way of overcoming the enduring undersupply of aesthetically appealing gemstones. However, each treatment must be properly and accurately disclosed, as the presence and the type of treatment influences the value of a ruby significantly.

By far the largest share of the gem-quality ruby from Mozambique is subjected to some type of heating, with or without a flux material. Lower quality rubies typically undergo a specific type of treatment referred to as lead-glass treatment, resulting in a significant improvement of the transparency and even the stability of the stone through a process of fracture filling.

The ruby presented here shows indications of heating, as well as a minor amount of residues in fissures. Such residues are caused by a heating process at elevated temperatures that likely involved a flux agent for an enhanced alteration of the transparency. This type of heat treatment is often used for this type of ruby to enhance its colour, colour homogeneity and clarity and is a well known practice in the trade.

WITHIN RUBY

Careful study of the internal features and properties gives valuable insights into the identity, authenticity and sometimes the origin of a gemstone. All these characteristics are the result of the individual history of this specific gemstone, providing a patchy and fragmented – but very personal – diary from its growth in the inner parts of the earth, its uplift to the surface, to the mining process and finally the processing by man.

The growth of the crystal is controlled by the geological setting in which the mineral formed, the pressure and temperature conditions and the specific chemical environment prevailing at that time. To unravel these secrets from this 0.00 ct ruby, the scientists at the Gübelin Gem Lab have scrutinised its microscopic features, analysed its detailed chemical composition and its physical-structural properties.

Microscopic features

In combination with the magnifying aid of a microscope, the experienced human eye provides an extremely sensitive, powerful and versatile analytical tool. The determination and description of the microscopic characteristics found in a gem - ranging from tiny crystals, fluid inclusions and particles, to growth features and minute fissures - provide a comprehensive qualitative survey indispensable for any gemmological conclusion.

Some of the internal features recorded in this ruby include fine and dense mineral particles oriented in a repeated angular and parallel banding and mineral platelets of various shapes. These inclusions are regularly observed in Mozambican and other East African rubies and are potentially helpful indicators to determine their authenticity and origin¹.

Further to these characteristic inclusions, fissures and fine dust particles are other internal features present in this 0.00 ct ruby.

¹ For more information about the inclusions in gemstones contact the Gübelin Academy or consult 'Photoatlas of Inclusions in Gemstones' (see chapter 'Addendum').



Some of the internal features recorded in this ruby include thin platelets, short needles and particles oriented in a repeated angular and parallel banding.

Chemical features

In addition to microscopic features, a number of technologically advanced analytical methods are deployed to allow for a secure determination of a gemstone's authenticity and - with limitations - its origin. These more sophisticated methods can be grouped into spectroscopic and chemical methods. Both types give hints to the type of rock in which the gem formed and might also reflect alterations imposed by a possible treatment process.

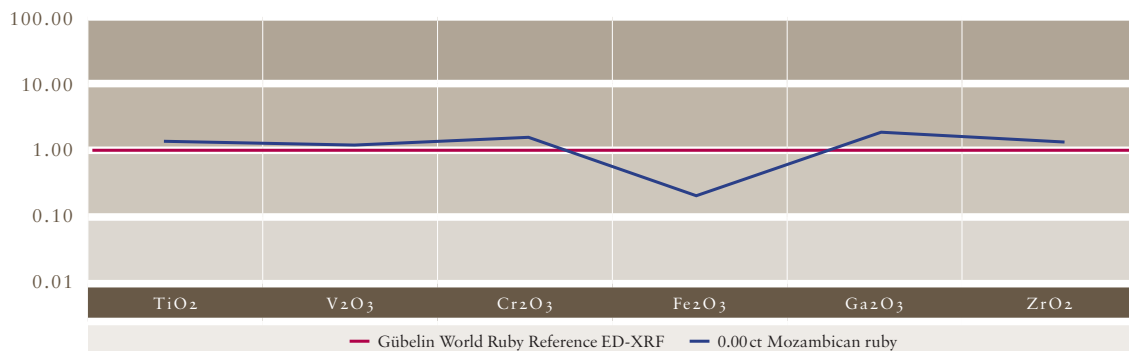
Sophisticated analytical techniques¹ measure the concentration of chemical elements in gems. Aside from the main and minor elements, gemstones also contain other elements present in even smaller concentrations of a few parts per million. These trace elements typically do not have any significant influence on the appearance of the gemstone, but they shed light on the environment in which it grew thousands, millions or even billions of years ago. The type and amount of these elements in a gemstone are often indicative of a specific location and are used by gem labs to determine its country of origin.

The trace element concentrations of this 0.00 ct ruby vary slightly to the Gübelin World Ruby Reference², as shown in the trace element diagram. The individual and truly unique chemical finger

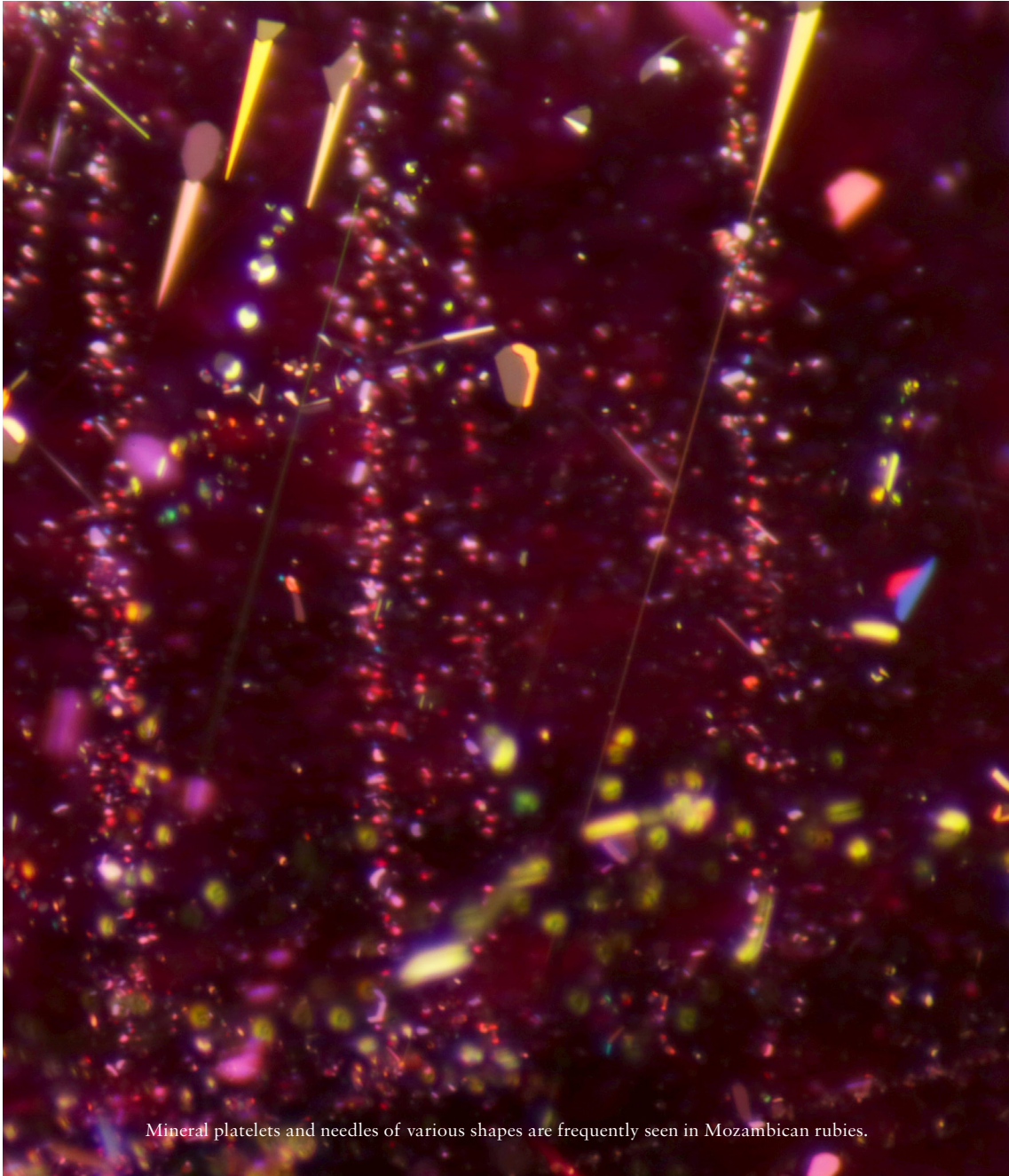
print measured in this 0.00 ct gemstone displays the characteristic deviations we expect for a ruby from Mozambique.

¹ For more information about the applied analytical methods visit gubelingemlab.com.

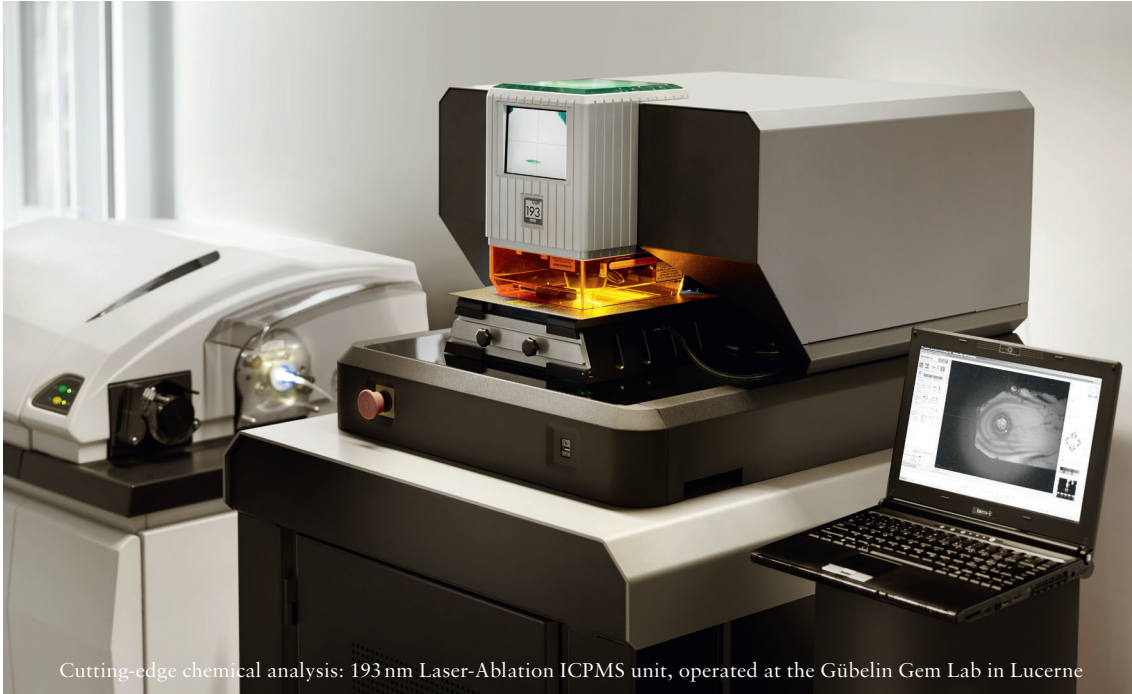
² The Gübelin World Ruby Reference is an empirical trace elemental composition of an assumed ruby with the averaged and weighted concentration of potentially indicative elements, comprising all commercially relevant deposits worldwide.



Trace element pattern for the 0.00 ct Mozambican ruby, gathered by energy dispersive X-ray fluorescence (ED-XRF) spectrometry. The blue line shows the deviations of a selection of trace element concentrations in comparison to the normalised Gübelin World Ruby Reference, shown in red.



Mineral platelets and needles of various shapes are frequently seen in Mozambican rubies.



Cutting-edge chemical analysis: 193 nm Laser-Ablation ICPMS unit, operated at the Gübelin Gem Lab in Lucerne

Spectroscopic features

Different methods of spectrometry are applied to help determining possible treatments and the origin of a gemstone. These analytical techniques apply electromagnetic radiation that interacts with the gemstone, providing information about its chemical and structural constituents (i.e. elements, molecules, crystallographic properties) through the characteristic absorbance of visible, infrared and/or ultraviolet light.

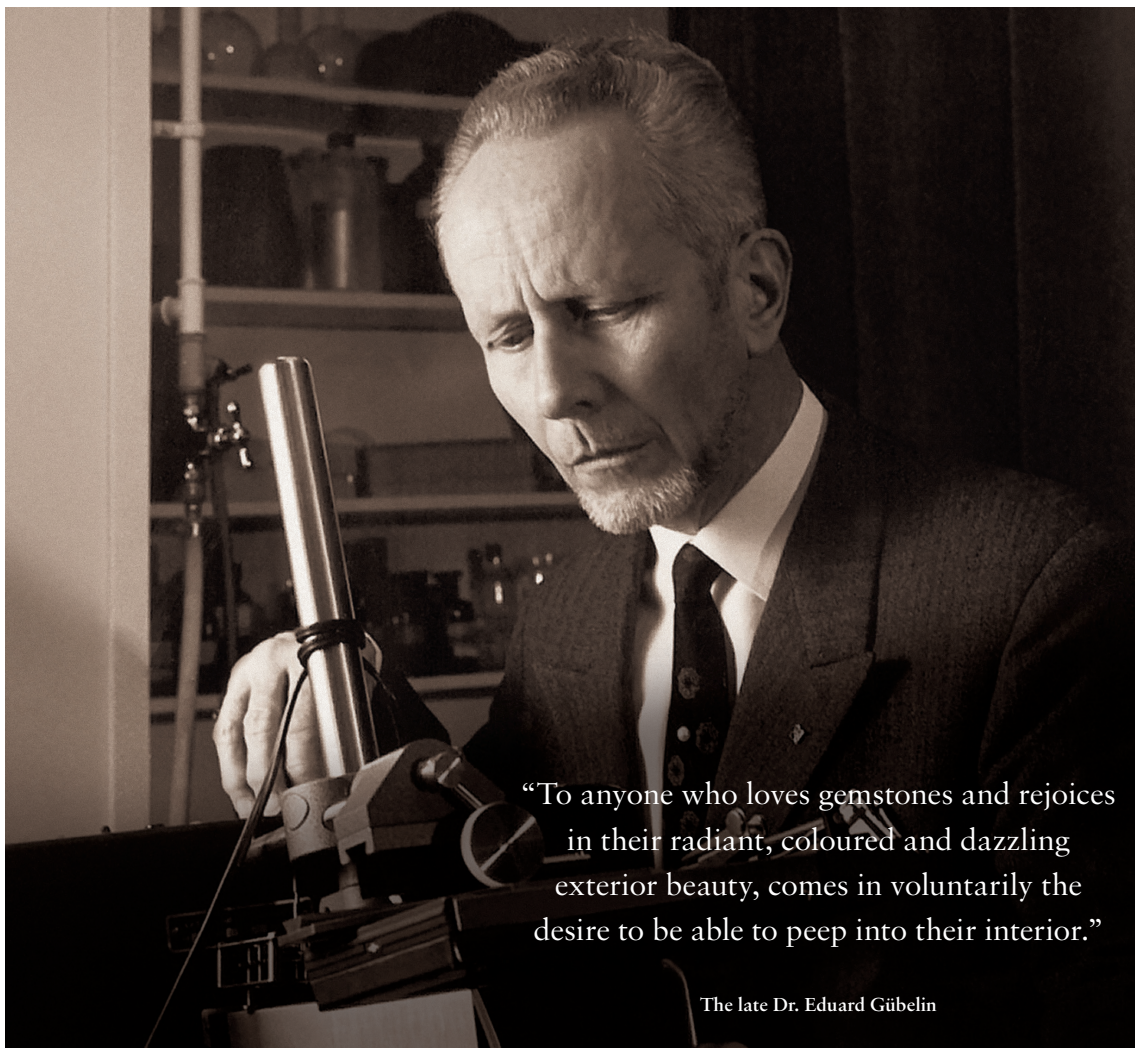
For rubies, infrared-spectroscopy is an essential technology to detect the presence and possible alterations of submicroscopic small particles induced by man-made heat treatment.

The present 0.00 ct ruby shows spectroscopic features typical for rubies that have been subjected to heat treatment.

ABOUT GÜBELIN GEM LAB

The roots of the Gübelin Gem Lab go back to the 1920s. The laboratory's standard of excellence and tireless devotion to the science of gemmology, pioneered by the late Dr. Eduard Gübelin, soon came to be rewarded with international esteem and recognition. Today, the team of the Gübelin Gem Lab is composed of highly trained and experienced professionals who share a passion for the treasures released by the earth and entrusted

to our hands by our clients. We combine state-of-the-art analytical techniques, expertise and extensive practical skills when it comes to interpreting gemmological and geological data and rendering a professional opinion on diamonds, coloured stones and pearls. We are committed to maintain the integrity and reliable service that our clients have come to expect from the Gübelin Gem Lab.



“To anyone who loves gemstones and rejoices in their radiant, coloured and dazzling exterior beauty, comes in voluntarily the desire to be able to peep into their interior.”

The late Dr. Eduard Gübelin

ADDENDUM

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Gübelin Academy

Gübelin Academy was established in 2013 to offer unique, fast-track training into the wonderful world of coloured gems. Designed for professionals as well as enthusiasts and connoisseurs, courses cover the basics as well as the advanced history, gemmology and psychology behind the most precious and colourful commodities in the world.

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