

GEMMOLOGICAL PROFILE



GÜBELIN



FOR A
MOZAMBICAN RUBY
OF
1.83 CT

COMPLEMENTING

GEMMOLOGICAL REPORT
NO. 16110123

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 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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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 its colour and brilliance by cutting and polishing.

The gemmologist's eye looks beyond the sparkling outer appearance of the stones, attempting to understand how they have formed. Minute crystals, fluid inclusions and subtle growth features trapped in their interior are witnesses of their formation ages ago and in tens or even hundreds of kilometres depths in the earth. This inner life allows us to detect their identity, authenticity and even their geographic origin.

This Gemmological Profile complements the Gübelin Gem Lab Gemmological Report No.

16110123, contained in the inside cover page of this booklet. In this Profile, we present our insights and findings for the 1.83 ct Mozambican ruby, disclosing some of its microscopic, chemical and structural characteristics and providing 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 November 22, 2016, the Gübelin Gem Lab in Lucerne has been entrusted with testing the 1.83 ct gemstone presented here. The careful assessment and detailed analytical studies performed on this gemstone revealed the results provided in the Gemmological Report No. 16110123 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^{ACA}.

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 Gemstone Professional classes provided by Gübelin Academy. For more detailed information visit www.gubelinacademy.com



*Ruby has justly been
named the king, the leader,
the gem of gems*



DESCRIPTION

WEIGHT

Geologic conditions under which rubies form are highly specific and rare. They grow in great depths in the earth, 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 ^{ACA}, and faceted rubies of good overall quality exceeding one carat in size are rare. Weighing 1.83 ct, the ruby presented here is a small 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.

**Large perfect rubies
are unheard of**

SHAPE AND 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 ^{ACA}.

These considerations were also applied on the present crystal. It was fashioned into an oval shape, using a cutting style that combines features of both the brilliant cut and the step cut. The dimensions of the gemstone are 7.18 mm in length, 6.16 mm in width and 4.68 mm in depth.

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

COLOUR AND 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 ^{ACA}. 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 an overtone 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 very pleasant, characterised by an intense, saturated and homogeneous red colour, free of any overtone.

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.

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.

IDENTITY & AUTHENTICITY

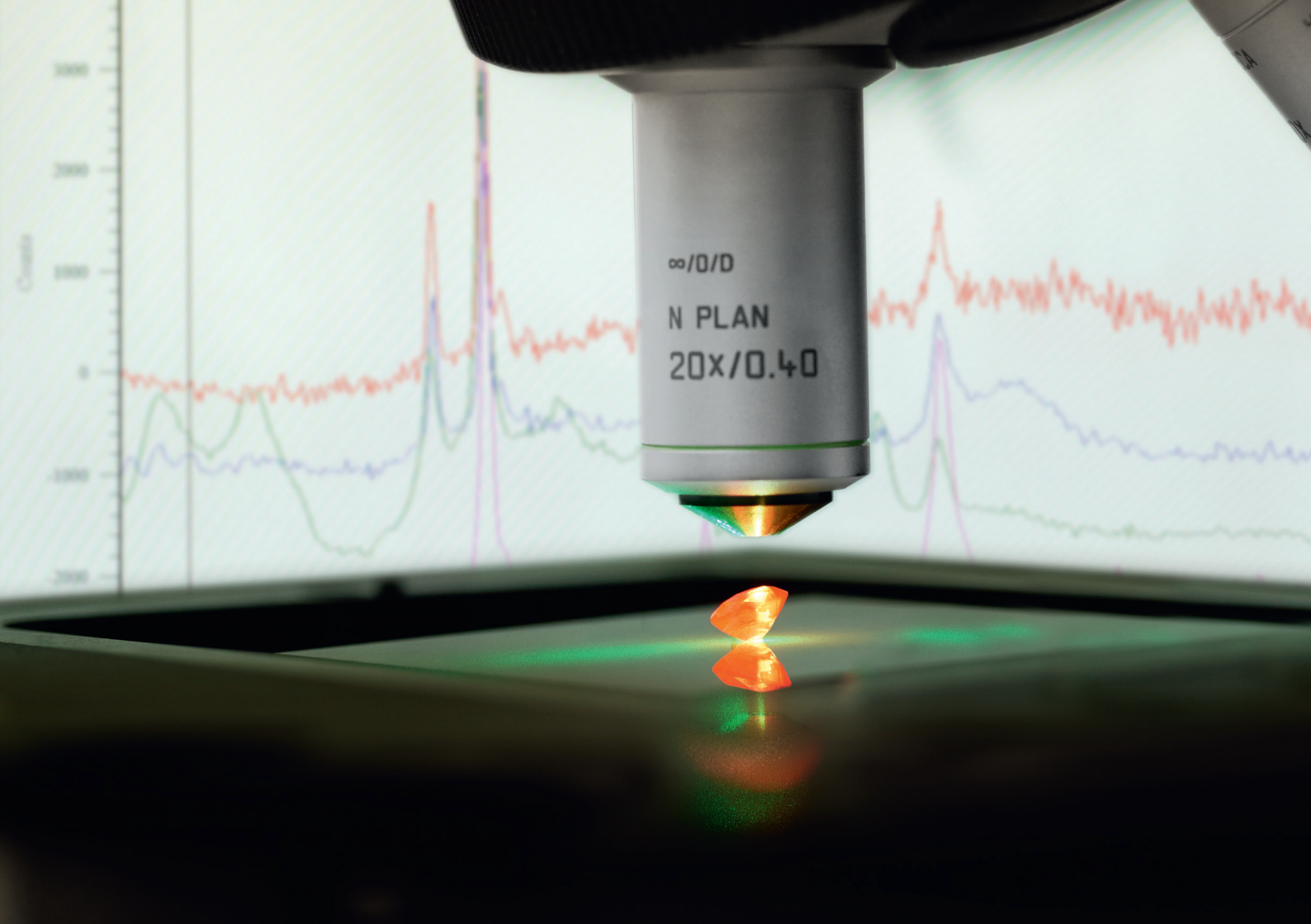
One most fundamental information any gem lab report has to provide is on the identity of the stone. Ruby is defined as crystalline aluminium oxide, Al_2O_3 , called corundum, with traces of the chemical element chromium and sometimes vanadium. In gems, such trace elements are most commonly the agents 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 gets turned into a ruby of an attractive red colour ^{ACA}. 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 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 1.83 ct gemstone has proven to be of the red variety of natural corundum, called ruby.

OVERALL QUALITY ASSESSMENT

The 1.83 ct ruby described in Gübelin Gem Lab Gemmological Report No. 16110123 is of high visual quality.



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N PLAN

20X/0.40

Counts

3000
2000
1000
0
-1000
-2000

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 1.83 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 millenium for the mineralogical wealth emerging from the pegmatite fields around Alto Ligonha, producing morganite, aqua-

marine 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 at the top of the list of ruby producing countries. The success of the Mozambican ruby is fueled by several factors. One major reason is the sheer beauty and quality of the material. The best ruby crystals lay 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



Oxbow river, Mozambique

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 company that operates the area on the basis of a 25 year lease. 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 1.83 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 27,000 stones, it is probably the world's most complete collection of gemstones collected 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, al-

lows 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 www.gubelingemlab.com/scholarship.





AFGHANISTAN

TAJIKISTAN

PAKISTAN

NEPAL

BURMA

VIETNAM

THAILAND

CAMBODIA

SRI LANKA

KENYA

TANZANIA

MALAWI

MOZAMBIQUE

MADAGASCAR

Major ruby deposits

G E O L O G Y & A G E

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 Proterozoicum - 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 metamorphosis. 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 700 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.

**This Mozambican ruby
grew some 600 million
years ago, about
20 kilometres deep in
the earth's crust**

T R E A T M E N T

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^{ACA}.

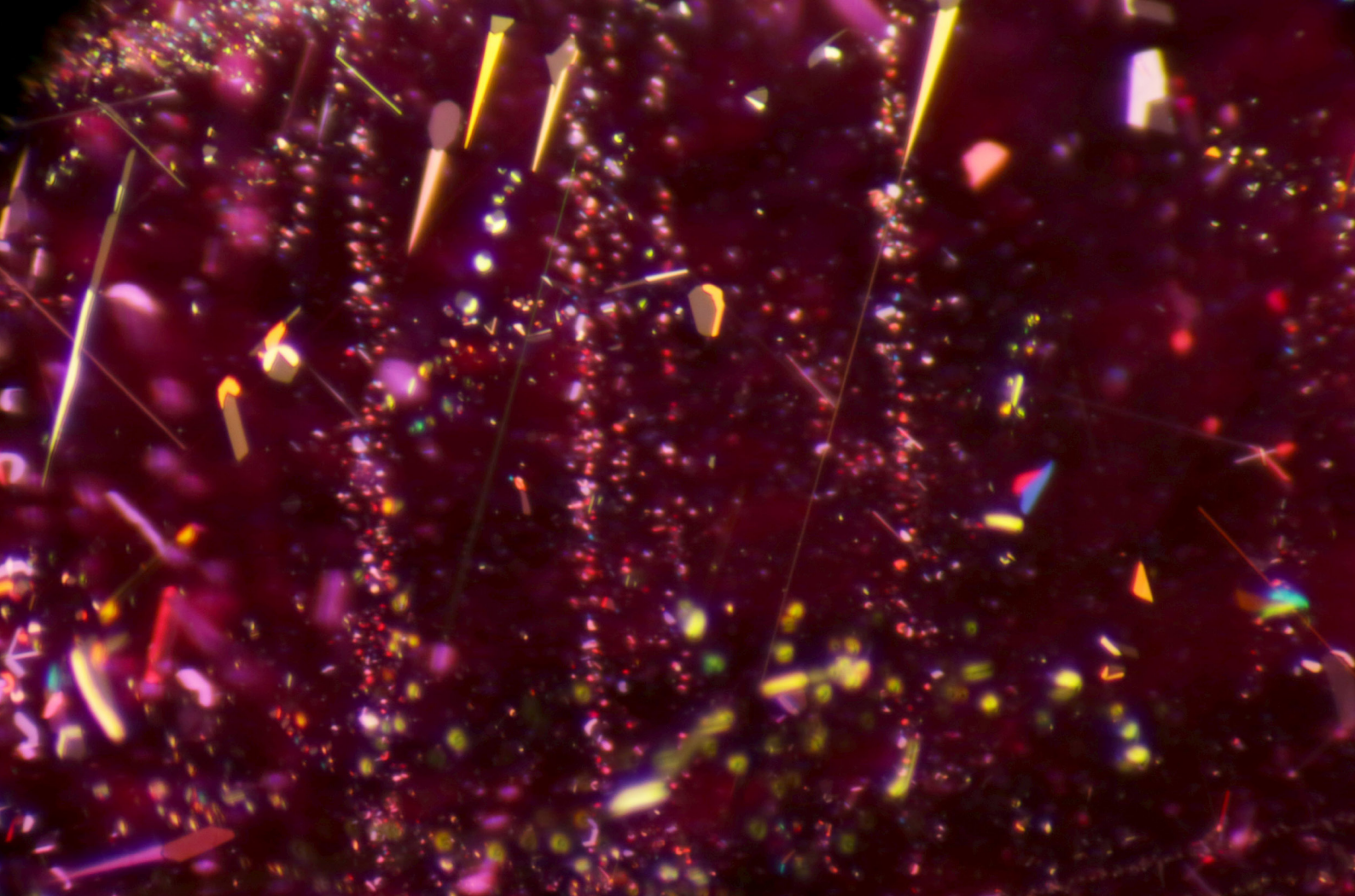
Generally, heat treatment offers a way of turning rubies of less desired quality into highly attractive gems. Treatment is thus an important way of overcoming the enduring undersupply of aesthetically appealing gemstones. However, each treatment must be properly and accurately disclosed, as the presence 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 significantly improvement of the transparency and even the stability of the stone through a process of fracture filling.

The ruby presented here has been subjected to heat treatment, resulting in subtle alterations of some internal characteristics. This type of heat treatment is commonplace to enhance the appearance of rubies and a practice well known and accepted by the trade.



Traditional blow-pipe heat treatment



Mineral platelets and needles of various shapes are frequently observed in rubies from Mozambique

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 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 1.83 ct ruby, the scientists in 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.

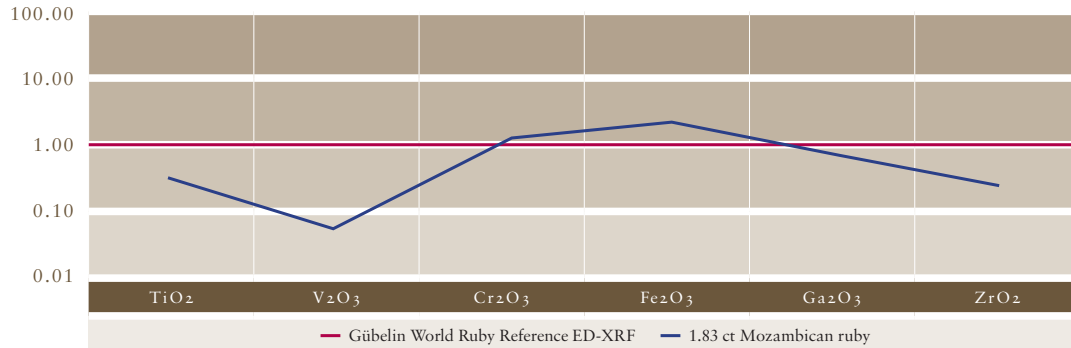


Rutile needles, platelets and particles oriented in three directions as seen in this 1.83 ct Mozambican ruby.

Some of the internal features recorded in this ruby include iridescent needles and some whitish hexagonal or irregular shaped platelets. These inclusions are regularly observed in Mozambican and other East African rubies and are potentially helpful indicators to determine their authenticity and origin². Further to these characteristic inclusions, few whitish healed fissures are other internal features present in this 1.83 ct ruby.

In addition to microscopic features, a number of technologically advanced analytical methods are deployed to contribute to a secure determination of a gemstone's authenticity and 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.

² For more information about the inclusions in gemstones contact the Gübelin Academy or consult 'Photoatlas of Inclusions in Gemstones' (see chapter 'Addendum')



Trace element pattern for the 1.83 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.

CHEMICAL FEATURES

Sophisticated analytical techniques³ measure the concentration of chemical elements in gems. Aside from the main and trace 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.

³ For more information about the applied analytical methods see gubelingemlab.com

The trace element concentrations of this 1.83 ct ruby vary slightly to the Gübelin World Ruby Reference⁴, as shown in the trace element diagram. The individual and truly unique chemical fingerprint measured in this 1.83 ct gemstone displays the characteristic deviations we expect for a ruby from Mozambique.

⁴ 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.

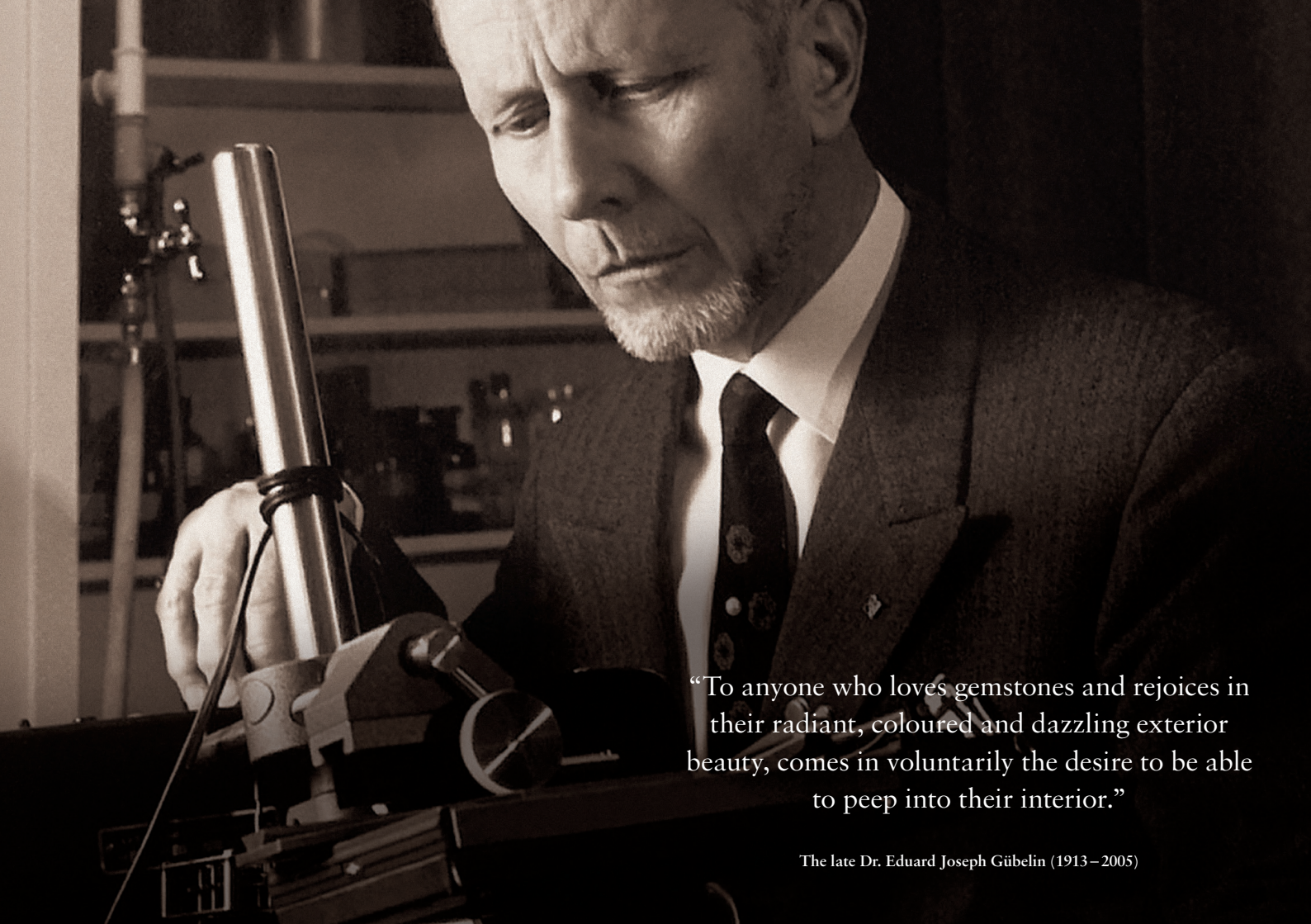
SPECTROSCOPIC FEATURES

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 sub-microscopically small particles induced by man-made heat treatment. The present 1.83 ct ruby shows spectroscopic features typical for rubies that have been subjected to heat treatment.



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



“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 Joseph Gübelin (1913–2005)

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 maintaining the integrity and reliable service that our clients have come to expect from the Gübelin Gem Lab.

A D D E N D U M

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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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