

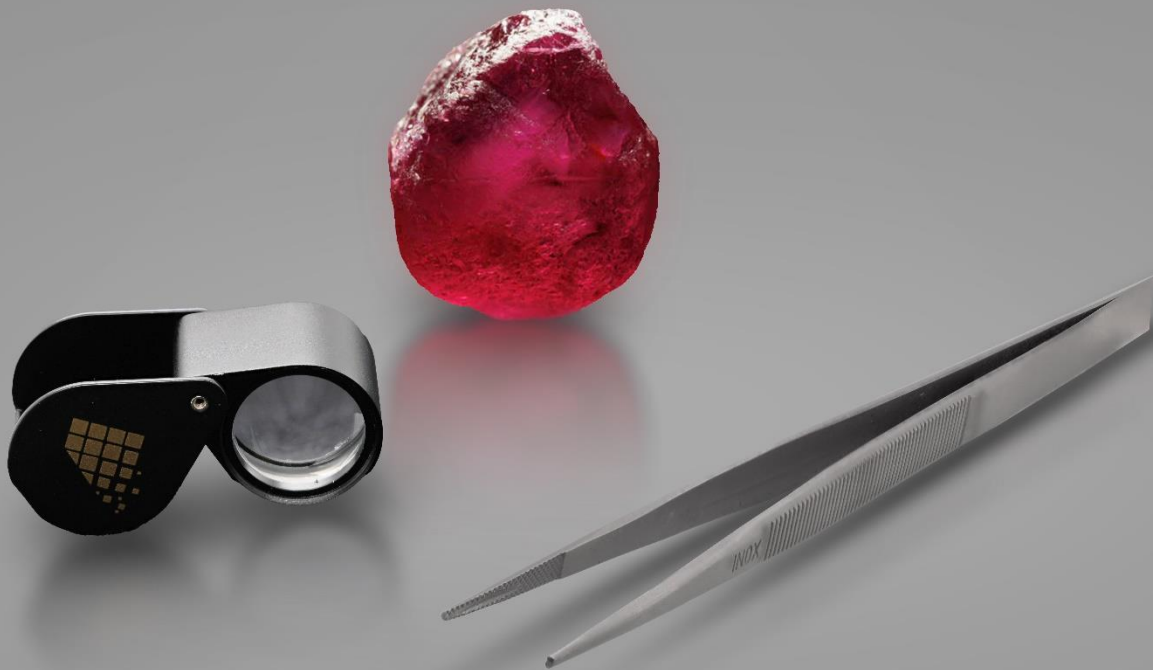
Bellerophon Gemlab

“ESTRELA DE FURA”

Elysium Award Report ^(a)

^(a) Bellerophon Gemlab Group, 16 Place Vendome, 75001 Paris, France.

M.P.H. Curti, 14th of February 2023



Estrela de Fura

Rough Ruby 101 carats

Bellerophon Gemlab

« Les grands voyages ont ceci de merveilleux que leur enchantement commence avant le départ même. On ouvre les atlas, on rêve sur les cartes. On répète [...]. »

-Joseph Kessel, La vallée des rubis.

INTRODUCTION

The "Estrela de Fura" is one of the most important rubies discovered in the history of mankind, of our generation, and probably of many generations after. This 101 carat single crystal rough ruby may well define the quintessence of magnificence and be considered the paragon of perfection achieved by nature over the last 600 million years.

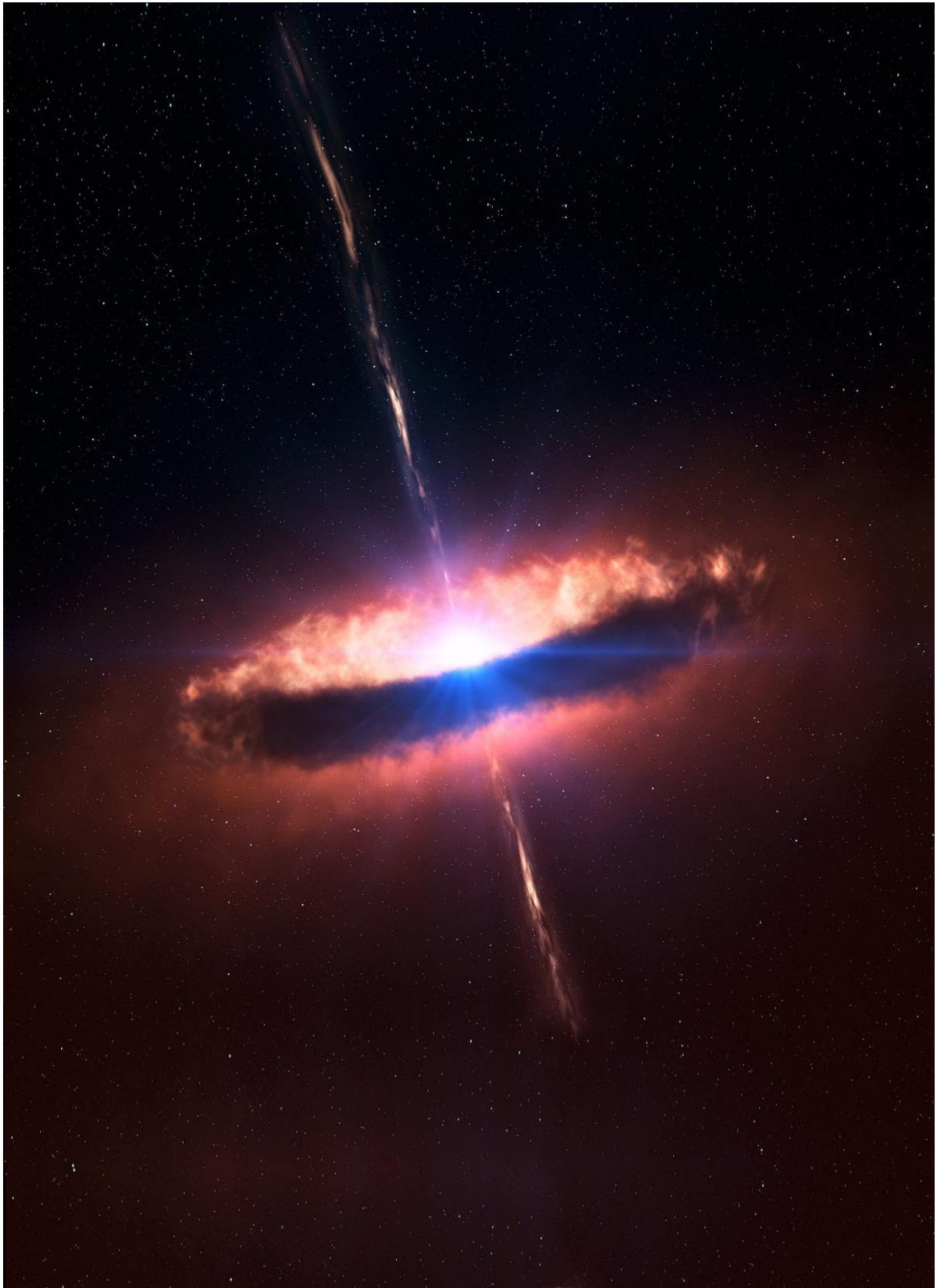
Rather than write about it, I would like to place the Estrela de Fura in your hand and let its magic work. Never dream of owning such a beauty, but think of it the other way round: it will own you, and most likely a pedigree of important people for thousands of years to come.

Without further ado, let me introduce you to the incredible odyssey and the extremely slim chances that the Estrela had to overcome to get to your hand.



Estrela de Fura in the hands of Elsa Marlin, Bellerophon Gemlab Gemmologist, catching the morning sunlight.

Billions of years ago, in galaxies far away.



Supernova explosion

CHILD OF SUPERNOVA

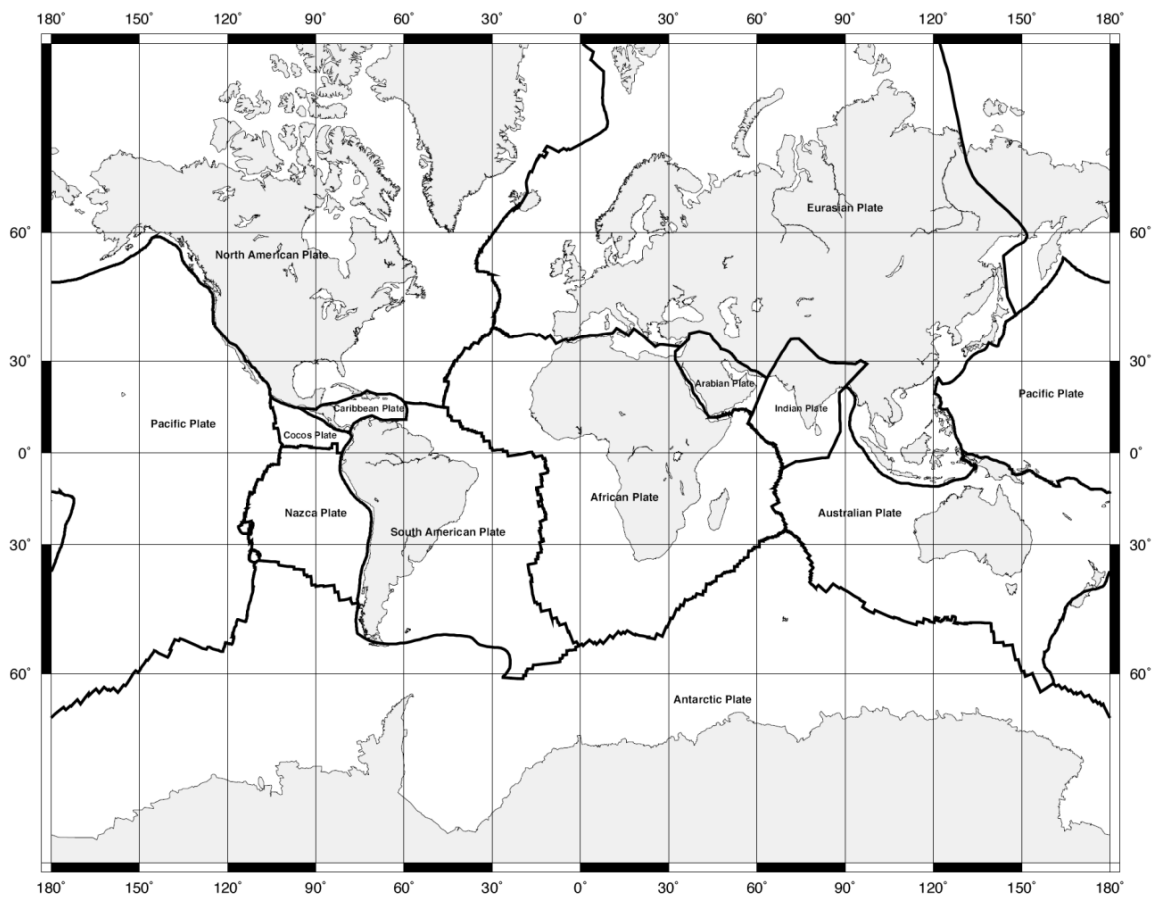
The fundamental constituents of this ruby date back to the beginning of time. To arrive at their present state, they have undergone many processes of compression, assembly and separation. This is not an easy process. From the extreme pressure and temperature needed to fuse light elements in the cores of massive stars to the huge bursts of energy released in supernova explosions needed to fuse them back into heavier elements. As the universe stirs and new stars and planets form from old gas and dust, these elements eventually reach the Earth in a dance that has been going on for millennia.

Their journey spans billions of years, unfathomable distances and improbable odds. The atoms that make up this ruby were created in some of the most intense explosions in the cosmos. As a gemmologist, I am fascinated by the science and romance of this story - the creation of a new, lasting and precious object from an ancient remnant of a once luminous star.



TECTONIC GROWTH

A planetary puzzle has been unfolding for millions of years beneath our feet. These are the 'tectonic plates', a moving puzzle of interconnected slabs of upper mantle and crust that collide and diverge, generating earthquakes, fuelling volcanoes, opening ocean basins and raising mountain ranges.



Map of the main tectonic plates today.

The Earth formed when a rocky core accreted dust and debris from the formation of our sun, including the stardust needed to create our ruby. Today, the planet has eight main plates. These plates shape the surface of our planet, but it is also much deeper: the movement of the plates is the surface expression of the Earth's interior.

The Earth did not always have plate tectonics. For millions of years after our planet melted, its surface was bathed in an ocean of molten magma. Once the planet cooled enough for a crust to form, the surface looked more like modern-day Venus, with the crust and upper mantle - collectively called the lithosphere - forming a single, unbroken plate. Millions of years later, the Earth's lithosphere broke up into plates and developed dense roots that burrowed into the mantle, and the pieces began to recycle via subduction zones.

Let's fast forward to about 600 million years ago. Enough of our much-needed stardust accumulated in a super continent called Gondwana. This landmass comprised most of the present southern hemisphere, including Antarctica, South America, Africa, Madagascar, Sri Lanka, India, Australia and New Zealand.



Gondwana, about 250 million years ago.

This accumulated stardust began to form the Estrela de Fura when it encountered the right environment beneath the surface of the land mass we now call Mozambique. Like a master chef, nature's cooking must be perfect to produce such an exquisite piece. The recipe for such a piece must be tailored to the atom. Mother Nature needed the right atoms, in the right quantities, with no others to spoil the recipe.

At the time of formation, the surface of our own pale blue planet, in a quiet part of the Milky Way, was not even home to dinosaurs.

The geological formation known as the "Mozambique Belt" created the perfect geological environment for the Estrela de Fura to develop. At a depth of around 30 kilometres, with a temperature of up to 600°C and a pressure of around 11,000 bar, the magic began. Supercritical fluids: a mixture of carbon dioxide and water, supersaturated with stardust, began to transport each atom to the nucleation point of the Estrela de Fura.

One atom at a time in a hexagonal symphony the ruby grew, we don't know if it grew at once or in a successive accumulation of geological events over thousands of years. What we do know is that the belly of the Estrela de Fura, located deep under the earth, must have been very stable for millennia in terms of pressure, temperature and geological activity to allow the formation of a ruby of this size, colour and clarity.



Nucleation point and growth direction of the Estrela de Fura, x90 magnification.

COLOURFUL BIRTH

Now fully formed around 550 million years ago, Estrela de Fura is slightly larger in size and weight than the rough we found and in a perfect hexagonal tabular shape, it still lies in its matrix of mostly amphibolite surrounded by smaller rubies.

It will remain dormant for a few more million years, first in the depths of the earth and then slowly transported to the surface by mountain formations. Now cooled and at rest in the heart of a mountain, a few million years ago, probably at the time when the first dinosaurs walked the earth, successive rains completely eroded the mountain that sheltered Estrela de Fura.

It was there, at that precise moment when a drop of rain removed the last piece of rock separating the magnificent ruby from its matrix, that the first ray of light travelling 8 minutes from our nearest star, which we call the Sun, reached the Estrela de Fura directly, giving it for the very first time its mesmerizing glowing colour.

Drop by drop, the mountain disappeared, swept away by the prehistoric rivers. With it, the Estrela de Fura, now completely free of its matrix and surrounded by powerful water currents, collided, rolled and crashed against the heavy rocks of this riverbed. Surviving this mile-long ordeal imposed by nature was far from guaranteed, only the luckiest and most flawless of the jewels manage to remain.



Dramatic photo of the Estrela the Fura resting in the washed gravel bed of the Fura mine in Mozambique.

It remained but not whole, its perfect hexagonal shape was rounded by these traumatic events, any fault in the crystal that might create a weakness was tested by the neighbouring rocks. Nature's selections, even for precious and beautiful stones, are brutal, but Estrela de Fura belongs to one of the hardest families of minerals the universe has ever produced. Its chemical composition and the way it is assembled are matched by only one other family on earth. This allows this paragon of beauty to stand the test of time.

Somewhere along this prehistoric river, in a sharp curve, our ruby lay, as the rivers dried up and the sediments carried by water, wind and/or ice covered it deeper every year, patiently waiting millions of years to be found...

THE FURA JOURNEY

Fura was founded in 2017 as a mining start-up by Dev Shetty, Founder and CEO, with an ambition to create a trusted supplier of colour gemstones. Though colour gemstones are desirable for centuries, the sector was never developed due to lack of investment and absence of large-scale mining players. Within the first four years of incorporation, FURA acquired all its key mining assets, Coscuez Emerald mine in Colombia in 2018, seven ruby mining licences in Montepuez, Mozambique in 2019 and Great Northern Mining and Capricorn Sapphire mines in Queensland, Australia in 2020.

FURA Gems is today a leading global mining company of colour gemstones. Although a young mining company, they take pride in having built the first truly pioneering, nimble, creative and ethical enterprise to cover the entire spectrum of precious colour gemstones. Uniquely positioned as the first and only producer of the big-three colour gemstone categories, emeralds, rubies and sapphires, through its mining subsidiaries on three continents.

They are dedicated to transparency, reliability and honouring their responsibilities towards all their partners, including the many vibrant communities around mines, manufacturers, designers, retailers and consumers across the globe and the natural environment that is the seed and root of all good fortune.

FURA's Mozambique ruby mine is in Montepuez district in the province of Cabo Delgado, approximately 200 kilometres from international airport of Pemba. FURA holds 100% share in eleven ruby licences covering 58,091.57 hectares of land, signalling its steadfast commitment to sustainable supply over the years.

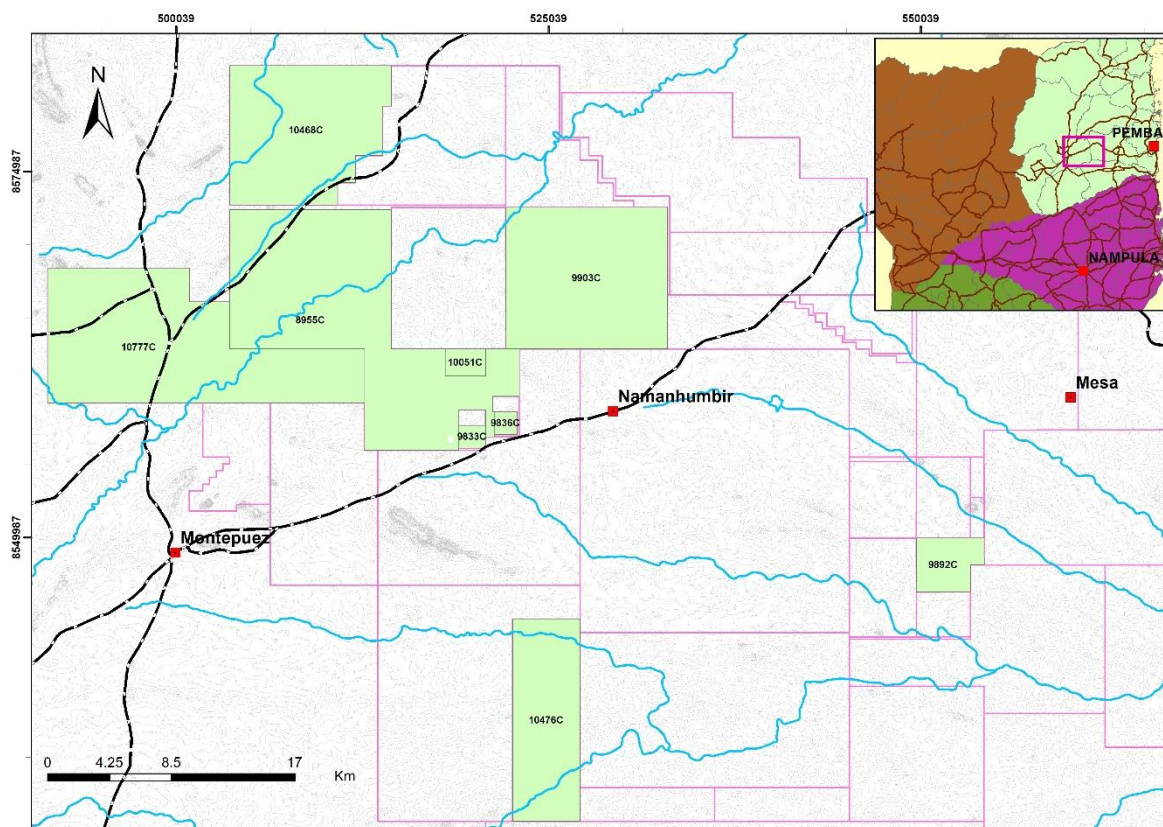


Open pit at the Fura ruby mine in Mozambique.

Rubies were found in Mozambique as early as in the 14th century. Yet, it was only after the country gained independence from Portugal rule in 1975 and the ensuing civil war that ruby mining started in the 1990s in the Niassa province. Niassa, being a protected sanctuary, was prohibited from any sort of mining activity by the Mozambique government.

However, with discovery of second deposit near Montepuez district, rubies from Mozambique started surfacing in the market in 2010-11, encouraging full-scale ethical ruby mining in the region.

On May 25, 2022, on a sunny day in the "Jamwai East Pit" in the Cabo Delgado province of Mozambique, a Fura excavator picked up a patch of earth 5 metres deep that contained our assembled stardust. On 21 July of the same year, one month later, the first human laid eyes on the Estrela de Fura...



Fura's portfolio of Mozambique assets.

Measuring 3cm by 2cm and weighing an astonishing 101 carats, with a highly saturated pure red reminiscent of the purest colour of pigeon's blood and a transparency that allows light to bounce and play through the ruby, the Estrela de Fura is a discovery unprecedented since the "royal ruby" or also known as the "Nga Mauk ruby", discovered in the Middle Ages and described by English ambassadors and traders in the 19th century. The only ruby in the written history of mankind that could have rivalled the Estrela de Fura was described as worth half its kingdom by its last owner King Thibaw of Burma. The story of the "royal ruby" is told by Joseph Kessel in his book "The Valley of the Rubies" as follows:

"And then came the big day.

Usually, when his expert hands examined the bayonet of his basket, Nga Mauk would automatically reject without a second glance the excessively large fragments of mineral, because their very size meant that they could not contain anything valuable. On that memorable day, however, when he came across a piece of this nature, the 'sense of stone' with which his fingers were equipped made Nga Mauk hesitate. He took the huge piece out of the basket and examined it by the light of his lamp. And his heart stopped. He was holding a gigantic rough. He had discovered the greatest ruby of all time.

Not for a moment did Nga Mauk think of taking this miracle of nature away for him. Only the Golden Feet - that was the title of the Burmese rulers - were worthy of it. But Nga Mauk could not bear the thought that the credit for his find, that the glory would go to someone else. He resolved to carry the colossal ruby to the king in person. [...]

The rough ruby was entrusted to the most skilful stone cutters in the kingdom. Once cut, [...] the ruby, made of the purest pigeon's blood, and which henceforth bore the name of Royal Ruby, had the volume of a hen's egg. The last three Burmese kings showed it with pride to ambassadors accredited to their court and to distinguished travellers. Colonel Slade, a distinguished British officer, described it in his notes. And at major ceremonies, the Nga Mauk ruby sparkled as a pendant on one of the ears of the king's favourite elephant.

When Mandalay was taken by the British in 1885, the royal ruby disappeared without a trace. Many stories are told. King Thibaw is said to have taken it with him, buried in his long hair. A guard or a servant stole it and sent it to India, where it still sleeps in the fabulous cassette of a prince. Or some English soldier... But what is certain is that no one has ever seen the fantastic ruby of Nga Mauk again, which was used as an earring for the royal elephants."

It is not impossible nor unheard of at the time that the royal ruby may have been broken and separated in smaller pieces. Even if great value is lost with such process, it enables a fair separation of ill gain treasure amongst thieves and more importantly much less dangerous attention during the reselling.



The painting depicts King Thibaw showing the Royal Ruby to gem merchant and author Edwin Streeter.

Photo credit to Bill Larson & Pala International.

EXAUSTIVE INVESTIGATION

By Bellerophon Gemlab

MESMERIZING ON THE FIRST LOOK

At the first contact between my eyes, my hands and the Estrela the Fura, I knew, after seeing over 400 gems a day for the past 7 years, that this rough was the most magnificent ruby our generation of gemmologists had ever laid eyes on.

The Estrela de Fura rough with the "c" axis facing the camera.



Even in the face of such beauty, my wonder was scientific. Armed with our empirical minds, lasers of all kinds and equipment far beyond the standard gemological state of the art, our team of gemologists, 3D engineers, chemists and earth scientists could not wait a moment to decipher nature's code for such a wonder of the universe.

Our first set of tests were: its weight, its density, followed by a manual measurement and a 3D scan of the surface. We then moved on to its refractive index from all angles, carefully recorded on what would become our 3D map of Estrela de Fura. The heavy artillery was deployed; starting with Raman spectroscopy using a 785 nanometre laser, vibrating the entire structure of the aluminium, we ascertained that it belongs to the corundum family. A photoluminescence spectroscopy measurement followed, using a 532 nanometre laser, we excited all the chromium atoms that replaced an aluminium atom in the structure, which provided a second confirmation of the species and variety of the gemstone as well as key information about its current internal pressure.



Théodore Rozet, managing partner of Bellerophon Gemlab, studies ruby under the microscope.



Credit photo Garaude SAS

Najah Sanoon, Francois Garaude and Ananda Weedyage examining the ruby next to the Bellerophon digital microscope.

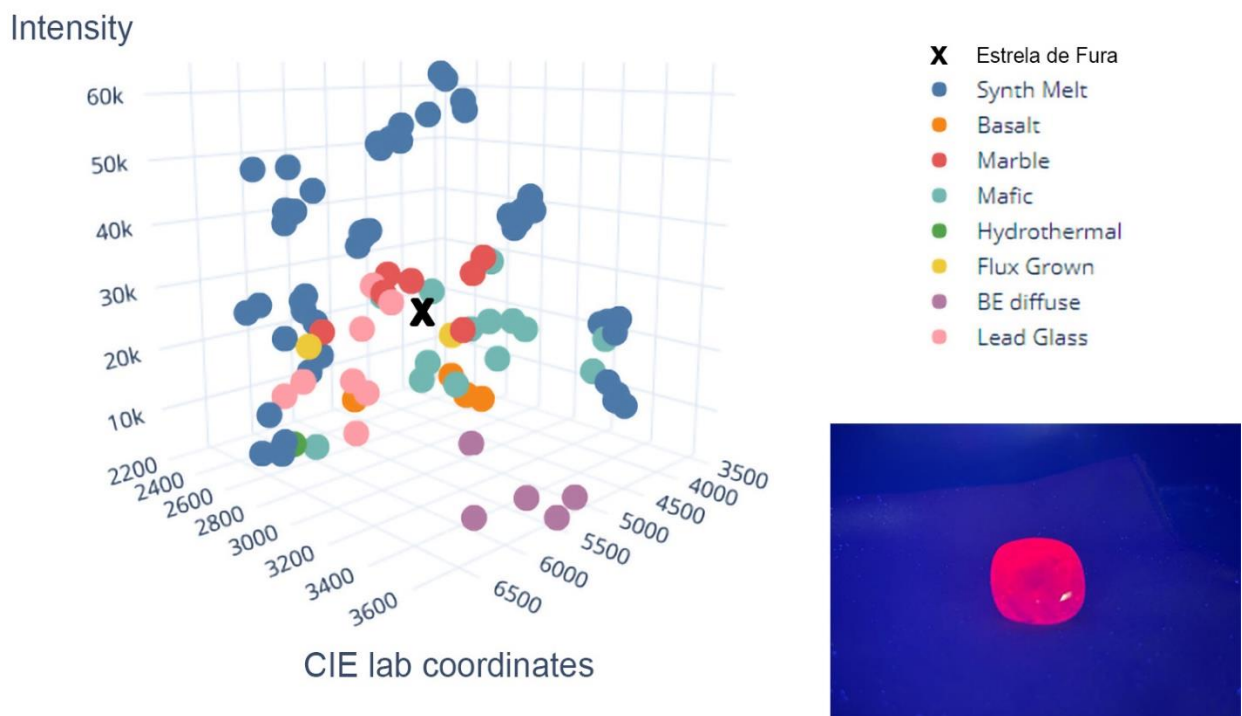


Credit photo Garaude SAS

Kun Chirapat, master gem cutter, carefully inspects the rough ruby.

After X-ray fluorescence (EDXRF) to quantify most of the foreign atoms present in its composition, we continue with a multitude of polarised and non-polarised spectroscopies in the visible ultraviolet and near infrared (UV-vis-NIR). UV-vis-NIR provides us with a wealth of knowledge, from the valence of many atoms and combinations of atoms that give ruby its colour, to their positions in the structure. More importantly, the visible part of the spectra provided a very good estimate of the future colour of the cut stone depending on the chosen optical axis.

The addition of Fourier Transform Infrared Spectroscopy (FTIR) gave us a better understanding of the foreign elements linked to the O-H group, as well as some foreign crystals and hydroxides. We then proceeded to identify all the foreign crystals that our laser could reach using Raman micro spectroscopy, as well as correlating the amorphization of zircon with the approximate age of ruby formation. We completed our analysis with spectrophotometry at 365 and 253 nanometres, which allowed us to obtain an accurate measurement of the ruby's fluorescence in the long and short wave ultraviolet.



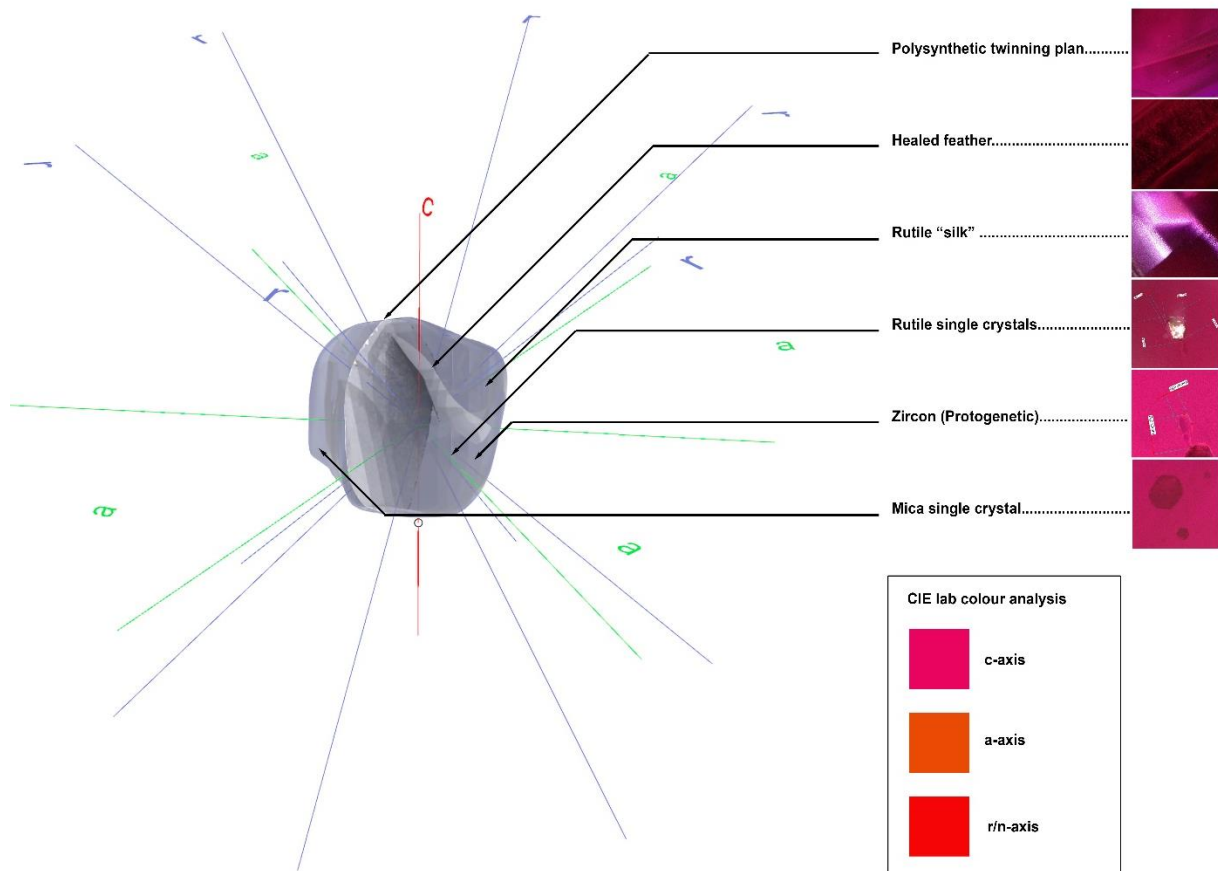
Fluorescence intensity of Estrela de Fura compared to other rubies.

Our most important tool is still to be used here: The VHX-6000 digital microscope can dive inside the stone in all directions, accurately measure all crystals as well as scan the shape of most inclusions in 3D. Adding to the 3D map of the Estrella its optical axis, using a conoscope and a polariscope.

Our digital reconstruction of the Estrella de Fura, close to perfection, now includes: the exact rough shape, its optical axis, the "silk" or exsolve rutile particles, every important feature and inclusion. Equipped with this newly created digital tool, we can now test any combination of cuts, from any angle and give a very good estimate of the final part, its weight and even a reconstructed photo of what the cut simulation might look like. Our virtual cut battery included factors such as the maximum weight we can keep, the best colour, the best transparency and the maximum light return we can get.

THE ESTRELA DE FURA DIGITAL VERSION

Weight: 101.737
Density: 3.969 g/cm³



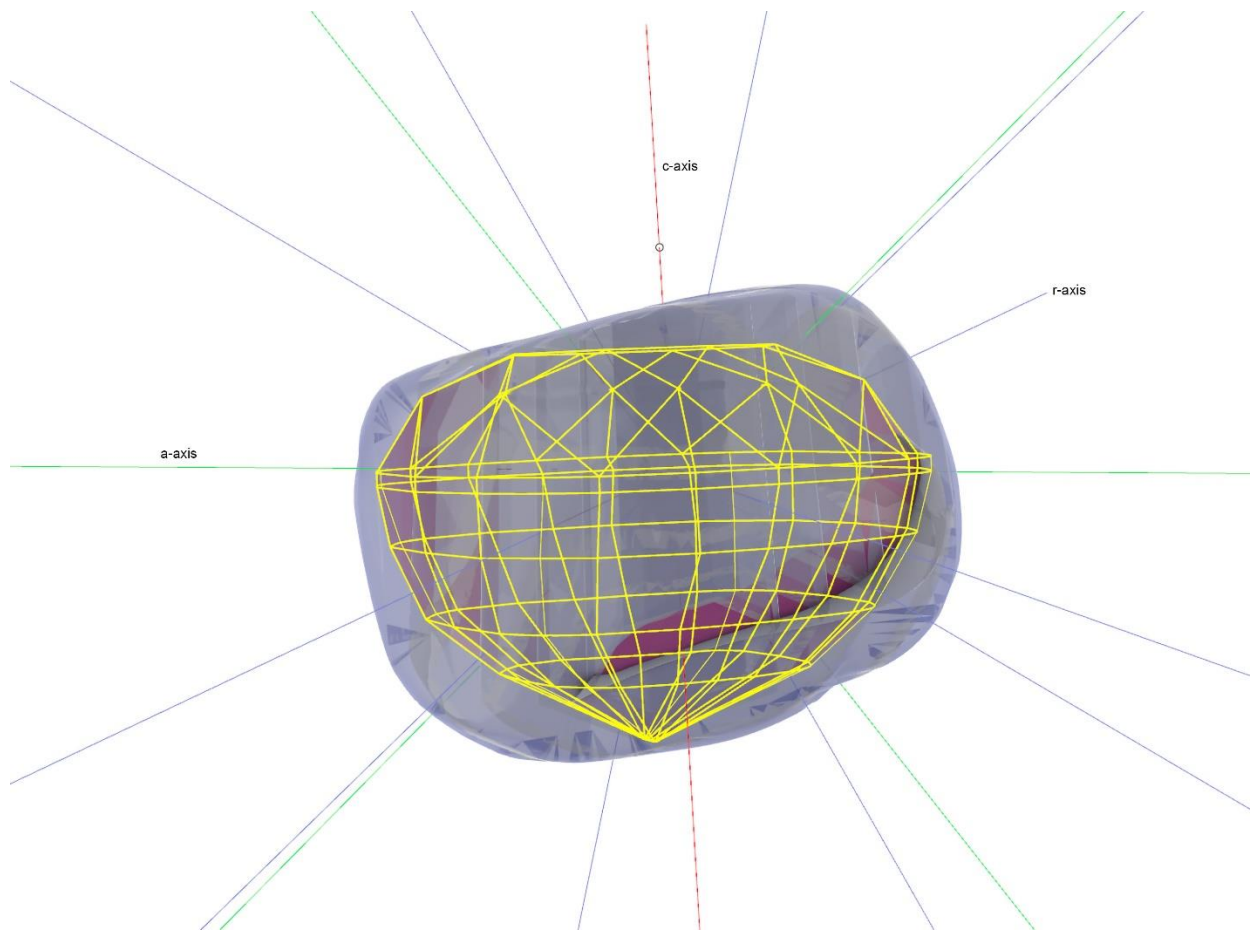
Factors taken into consideration were the angles of reflection of the "silk" on the future tables, the best face up colour derived from the position of the optical axis of the chosen crystal, the size, depth and location of all inclusions in the future stone. Without compromise, it was unanimously decided to give the Estrela la Fura what it deserved: The best of everything, the best possible colour, the best achievable transparency, a light reflection that makes the ruby glow like embers and of course keeping as much weight as possible.

This is the first time that a ruby has been cut with the help of such a panel of experts. As far as is known, never before has a ruby been digitized from all angles: physically, optically, and with its gemmological properties integrated. A new generation of gemmologists and gem cutters is born.



François Garaude, CEO and founder of Garaude SAS, carefully inspects the Estrela de Fura.

ESTRELA DE FURA CUTTING SIMULATION #1



MAKING OF THE ESTRELA

From rough to cut



101.737 ct



70.328 ct



55.222 ct

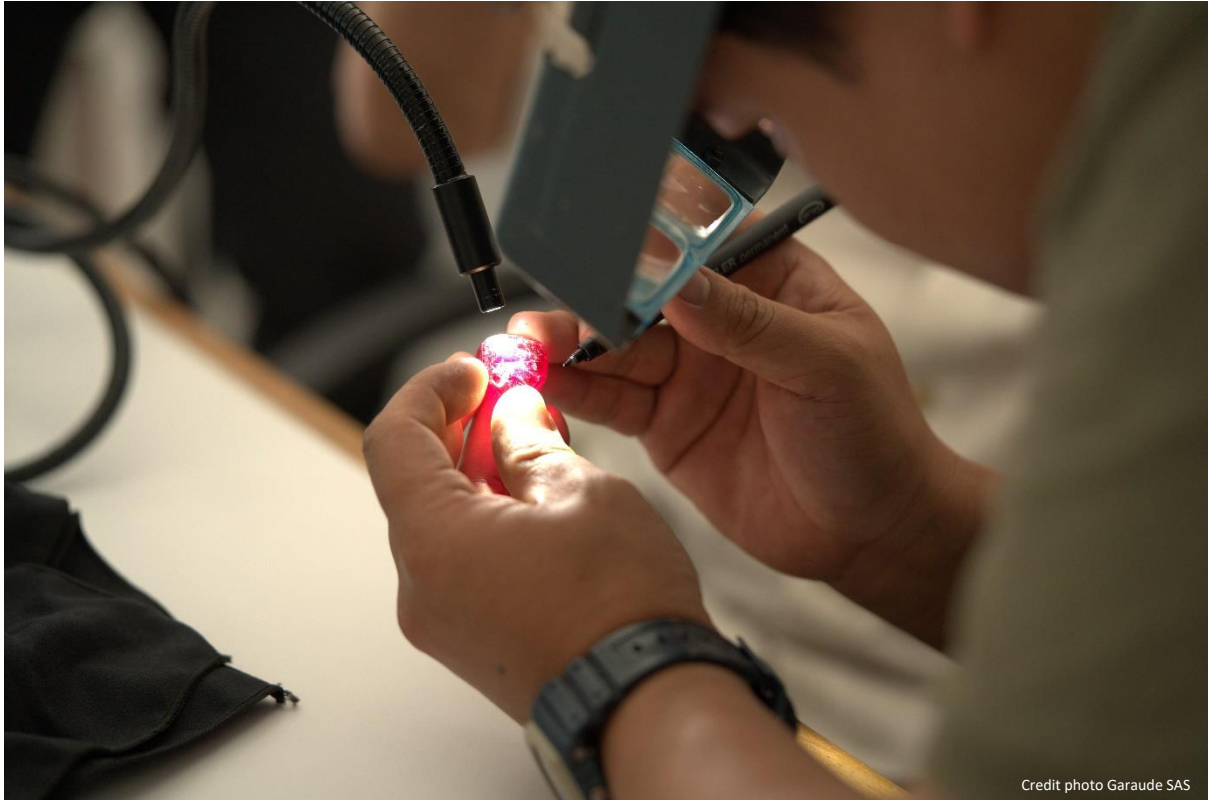


Bellerophon Gemlab

To cut one of the largest rubies in existence, knowledge alone is not enough. It takes skill, technique, icy veins and two Iron Hands. Fortunately, master gem cutter Chirapat from Garaude SAS has all of these. In a dance that lasted weeks, the master gem cutter had to have every move he made, from grinding to polishing to faceting, checked by computer engineers, gem dealers with price expertise, gemmologists and batteries of analysis. For every change brings new information, opens up new possibilities and closes down others. The plans had to be modified, adjusted and carefully adapted to the new reality that the Estrella de Fura revealed with each layer of skin it shed.

Chirapat combined our detailed plans, made largely with his input, along with his years of experience as a ruby cutter. His senses allowed him to pierce through the ruby as no one else had. Not to see what it is, but to visualise what it could be. The skill required to cut rubies of this calibre is not learned from books, but is passed down from generation to generation and practiced over decades of training. Few people have cut valuable rubies, even fewer have succeeded in doing so.

Master gemstone cutter Chirapat marking the ruby.



Reflecting life in this beautiful ruby was no easy task. Seven major steps were taken in the process, each bringing its own fascinations, challenges and reflections. It really must be emphasised that finding the most magnificent rough our generation has found so far was only the beginning. The final and most important test that Estrela de Fura had to pass was yet to come: its cutting process. Too often I have seen valuable rubies cut poorly, whether the fault lies with the decision making process, the cutter or the rough itself, the fact remains clear to all the experts on the team: We will not compromise on the Estrela de Fura.

There are very few places where angular structures can be found in nature, the laws of physics follow efficiency, and most of the time, this efficiency translates into the shape of a sphere. Minerals, on the other hand, are the most perfect angular shapes that early humans could come across. Gems, shells and other ornaments have been polished and shaped since the dawn of mankind, our deep fascination with these treasures remains a mystery. Gemstone faceting, as we understand it today, has its roots somewhere in 15th century Europe. Presumably, the origin of this tedious work was to correct defects in certain crystals and make them closely resemble their perfectly angular mineral counterparts. However, we soon realised that once made, the jewellery came to life through the play of light that occurred. Thus began a whole new quest: maximising the beauty of gemstones through the art of cutting.



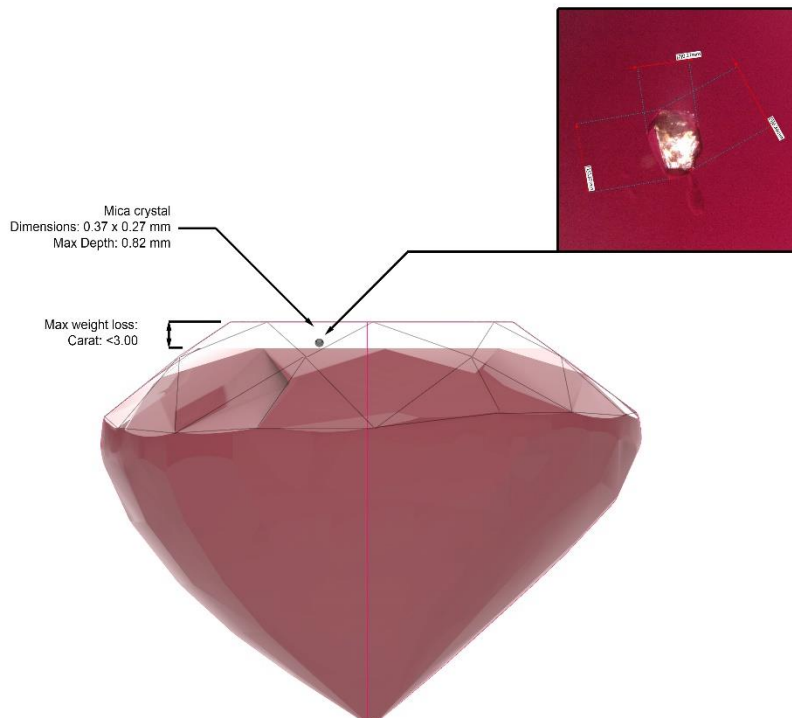
Estrela de Fura seven's major steps during its cutting process.

The most important challenge we faced was the final step. With the Estrela de Fura now weighing an astonishing 57.640 carats fully cut, all doubts about its quality were removed. At this point we all knew that this ruby was a paragon of beauty, all fears and speculation about what we might find inside had evaporated a few steps ago. Nevertheless, we still had one important decision to make: A highly reflective mica crystal 0.37 millimetres long is hidden 0.82 millimetres below the top right corner of the table. To remove it, the table will have to be opened wider and all the crown facets readjusted. Calculating the exact depth, size and chemical composition of the flaw was an easy task in view of the changes in the reflectivity of light within the stone that these changes will cause. However, the most important decision was the actual weight loss: including all safety factors, we estimated a total cost of 3 carats maximum.

The decision is not insignificant, is this tiny white spot of less than a third of a millimetre worth the millions of dollars that this operation will cost? The price of such an operation being totally out of my reach, the gem value experts agreed to remove it. Again, no compromise will be made for the beauty of the Estrela de Fura.

ESTRELA DE FURA

Cut step #7





Master Gemstone Cutter Chirapat

Polishing the crown facets of the Estrela de Fura.

Francois Garaude inspecting the last step
of the Estrela de Fura's cutting.

REBIRTH OF A STAR

The Estrela de Fura

Like a butterfly emerging from its chrysalis, the Estrela de Fura emerged again as a bright star. No amount of calculation, equipment or knowledge could prepare us for the shock of the final ruby glory. Everyone in the room was trying to catch a glimpse of the velvet-red sparks emitted by the magnificent freshly cut stone. Like a hot ember in his hands, Chirapat delicately left the ruby in the middle of the table in the afternoon light for all to see.

Dev Shetty, CEO and founder of Fura Gems Inc, being the first of many future major holders of the Fura Estrela, was privileged to pick it up from the table. A broad smile instantly appeared on his face as Dev realised that the calculated risk of cutting the ruby was worth all the sweat he had endured since the beginning of his project...

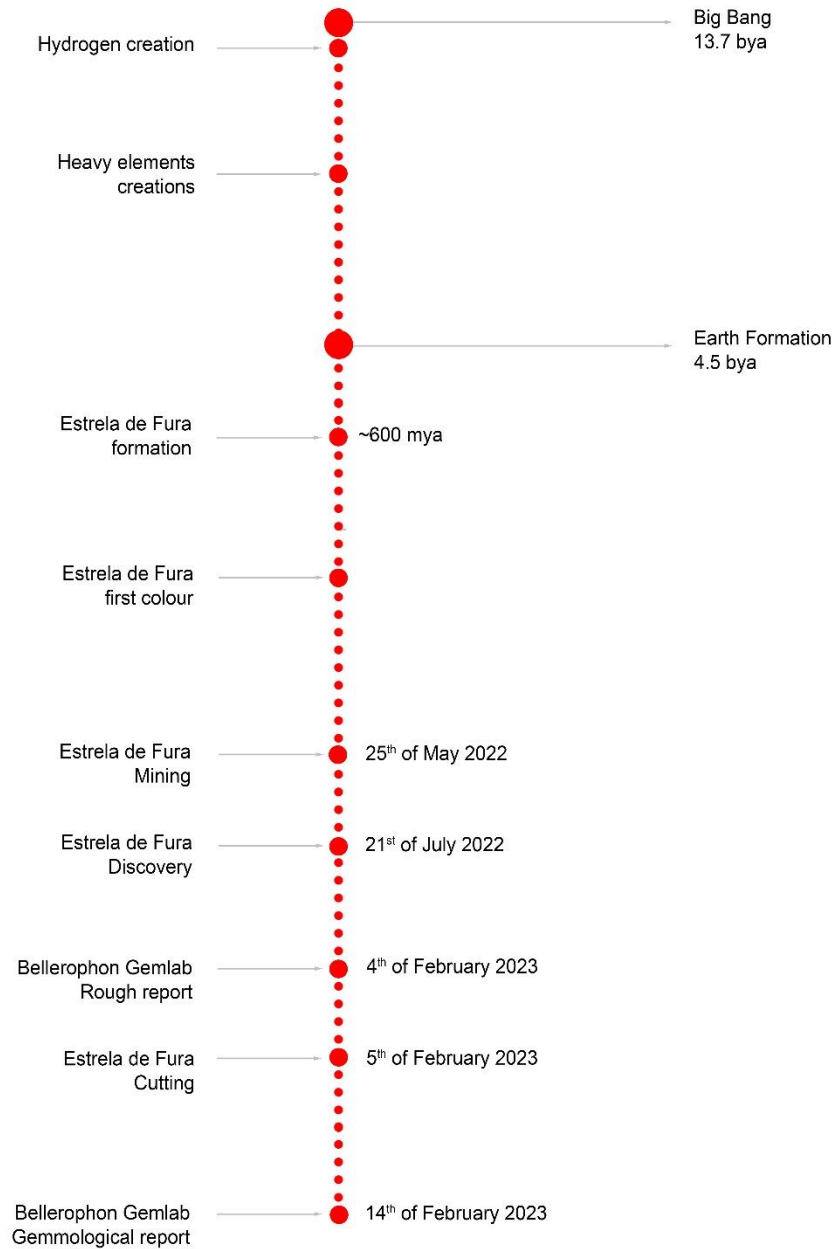
Dev Shetty in awe with the Estrela de Fura final shape in hand.





ESTRELA DE FURA

Timeline



ACKNOWLEDGEMENT

By Martial Curti

First and foremost, I would like to thanks Dev Shetty, CEO and founder of Fura Gems Inc and Francois Garaude, CEO and Founder of Garaude SAS to have chosen Bellerophon Gemlab to assist during this incredible odyssey. Special thanks to Bellerophon Gemlab team; including Theodore Rozet, Elsa Marlin, Giada Musilli, Piotr Hinnemann and Hugo Ellia, as well as Anthony Salvatori for his invaluable knowledge of 3D engineering.

I am also extremely grateful to the Fura's team; Najah Sanoon and Ananda Weedyage. Special and warm thanks to Garaude SAS team; especially Felix Elsky, Hughe Leroux and Chirapat.

To Sukhadia team I would like to express my gratitude for their insights. A special mention must also go to Chiku Sukhadia, Kaimesh Sukhadia and their master gemstone cutter Charlie.

I would also like to express my gratitude to Arjuna Irsutti for his incredible talents in gemstone photography.

Finally, many thanks to all the peoples not mentioned in this list but who contributed in so many ways.

M.P.H. Curti

CEO and Founder of Bellerophon Gemlab group

