

Gemmologie de laboratoire

A REMARKABLE "OTTU" SAPPHIRE IN THE LABORATORY

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Abstract

A REMARKABLE "OTTU" SAPPHIRE AT THE LABORATORY - The analysis of the 7.91-carats 'Ottu' sapphire developed in this article could be considered a classic gemmology exercise for all enthusiasts. The concentration of blue colour in a thin layer of the sample gives the appearance of a doublet. However, this particular type of sapphire, which is well-known to Sri Lankan lapidaries, is not a composite but a single gemstone. This remarkable stone provides an opportunity to revisit the origin of the word 'Ottu', traces and interpretations of which can be found in Dravidian languages. It has been demonstrated through meticulous observation that the presence of blue calcite inclusions has been identified in conjunction with colourless calcite, thus indicating an unconventional crystallisation process. Microscopic observations and other spectral analyses indicate a probable origin in Sri Lanka, where these 'Ottu' sapphires are traditionally encountered in the market.

Résumé

L'analyse de ce saphir "Ottu" de 7,91 carats, développée dans cet article, pourrait s'apparenter à un exercice de gemmologie classique pour tous les amateurs. La concentration de couleur bleue dans une fine couche rend son apparence similaire à celle d'un doublet. Cependant, ce type de saphir, bien connu des lapidaires sri lankais, n'est pas un collage mais bel et bien une seule et même gemme. Cette pierre remarquable est l'occasion de revenir sur l'origine du mot "Ottu" dont on trouve des traces et interprétations diverses dans les langues dravidiennes. Son observation poussée a révélé la présence d'inclusions de calcites bleues accolées à des calcites incolores suggérant une cristallisation peu commune. Les observations microscopiques et autres analyses spectrales indiquent une origine probable du Sri Lanka, où sont traditionnellement vendus ces saphirs "Ottu".

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Figure 1 : Ring set with diamonds and the rectangular cushion gem submitted for analyses. Photos courtesy: Sotheby's Geneva.

Figure 1 : Bague sertie avec diamants et avec la gemme coussin rectangle soumise pour analyses. Photos gracieusement fournies par Sotheby's Genève.

In June 2025, a bicolour faceted gemstone was submitted for expertise to the GGTL Laboratories Switzerland. This gemstone, weighing 7.91 carats, was originally set on a ring (Figure 1). It is a slightly asymmetrical rectangular cushion measuring approximately 11.5 x 9.5 x 7.0 mm. This stone, believed to be a sapphire, was removed from its setting to determine whether or not it was a doublet, given its intriguing appearance.

When viewed through the table, the stone appears to be a relatively uniform and relatively dark blue (Figure 2, left). However, when viewed parallel to the table, the colour appears to be concentrated in a thin blue layer covering the crown and part of the girdle. The rest of the stone, i.e. the entire pavilion, appears colourless to slightly yellowish (Figure 2, right).

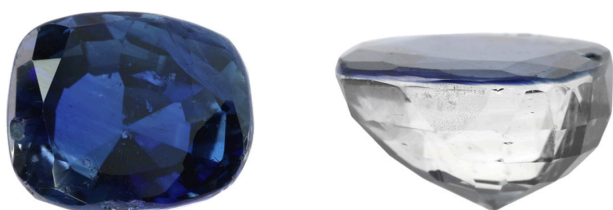


Figure 2: Front and side view of the bicoloured gemstone. Pictures: C. Alliol-Mouton.

Figure 2 : Vue de face et de profil de la gemme bicolore. Photographies : C. Alliol-Mouton.

At first glance, several identifications are possible for this stone, including doublet. This hypothesis could apply because the colour appears to be located only on the crown, reminiscent of composite gems such as natural colourless corundum doublets on synthetic colourless corundum with a thin layer of colouring agent between the two (or, more rarely, natural sapphire on synthetic colourless corundum). To identify whether a gem is a doublet, it is necessary to pay attention to the separation plane (Hughes, 2017). The other possible hypothesis is that a layer of blue colour was deliberately placed under the table by the lapidary so that the gem would appear entirely blue when viewed from the front and once set (Figure 1). This type of sapphire is known to occur in Sri Lankan samples (Hughes, 1997; Manutchehr-Danai, 2005) with very pronounced zoning or domains giving the illusion that the entire stone is coloured. These sapphires are commonly referred to as 'Ottu'.

TERMINOLOGY: SPECIFIC CHARACTERISTICS OF "OTTU" SAPPHIRES

The term 'Ottu' is used today in Sri Lanka to describe sapphires with very localised and contrasting colour zones or areas (usually blue and colourless; Manutchehr-Danai, 2005). This term seems to be used interchangeably as a noun and an adjective.

There are many definitions of ‘*Ottu*’ in gemmological literature, some of which may seem questionable or at least imprecise. According to Faleel (2024), “*Ottu*” are varieties of geuda sapphires. It seems that the term ‘*Ottu*’ can also be used generally to refer to all corundums that have irregular colouring. Thus, references to ‘*Ruby Ottu*’ exist to describe rubies with blue spots on the surface (Soysa & Fernando, 1992). But also ‘*Ural Ottu*’, which would correspond to colourless sapphires (leucosapphires) with a slight bluish colouration on one surface (Soysa & Fernando, 1992). Finally, there are special classifications for ‘*Blue Ottu*’ with the terms ‘*Inner Ottu*’, when the colour patches are inside the rough (Figures 3a and b), and conversely, ‘*Outer Ottu*’, when the colour is close to the surface of the crystal (Figures 3c, d and e; Soysa & Fernando, 1992).

These stones can sometimes be mistaken for doublets by gemologists who do not necessarily possess a sufficiently effective binocular microscope.

Their apparently homogenous hue is due in the experience and skill of the lapidary. Thanks to the subtle arrangement of zones – or domains – by the lapidary and the play of light created by the cut, the colour appears evenly distributed when the gem is viewed from the table. When it comes to coloured zoning, it is generally placed under the table; and when it comes to a non-flat domain, it is placed towards the tip of the pavilion, with a slightly less convincing result when the stone is viewed (mounted) from the side. In order to cut such stones, rough stones are required in which the colour is concentrated either in zones along the faces of the bipyramid ($w\{111\}$ and $n\{223\}$ for Sri Lanka), with the centre remaining colourless, or in areas (in volume) whose position allows them to be placed at the tip of the pavilion of the finished stone (Hughes, 1997; Dharmaratne, 1999). Another author, Choudhary (2006), also describes this colouring in a stone with very marked colour zoning in the culet (see again Figures 3a and b).

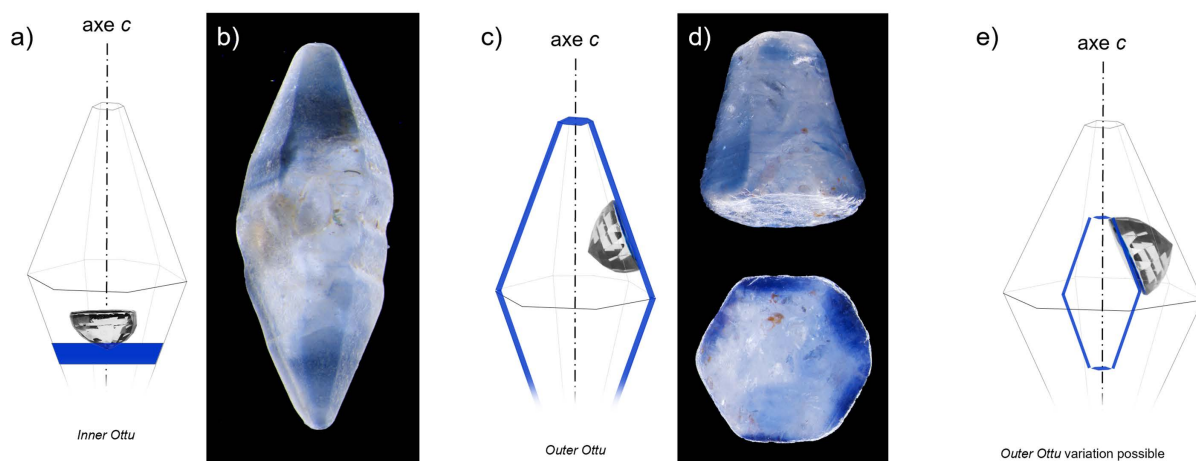


Figure 3: Schematic representations of possible colour zoning in the bipyramid (a, c, and e) with two Sri Lankan examples of rough sapphires exhibiting this zoning (b and d). Each diagram shows a hypothetical placement of the stone cut from the rough. The placement of the cut stone in diagram e) remains purely theoretical, as it presupposes a significant loss of mass during cutting. Diagram: after F. Notari ; pictures: F. Blumentritt.

Figure 3 : Représentations schématiques des possibilités de zonation de couleur dans la bipyramide (a, c, et e) avec deux exemples de saphirs bruts du Sri Lanka présentant ces zonations (b et d). Sur chaque schéma, un placement hypothétique de la pierre taillée dans le brut est indiqué. Le placement de la pierre taillée sur le schéma e) reste purement théorique puisque cela présuppose une perte de masse conséquente lors de la taille. Schémas : d’après F. Notari ; photographies : F. Blumentritt.

This type of rough requires the facets of the pavilion to have optimal angles, close to total reflection of the facets (critical angle of corundum for a refractive index $n=1.76$: 34.62°), in order to correctly reproduce the apparent blue colour. This phenomenon has also been observed on cabochon-cut stones, with a thin blue lamella at the base of the cabochon and a colourless-yellowish dome (Krzemnicki, 2019). Another example of this blue colour zoning on a rough stone can be found in the field report by Pardieu *et al.* (2012) from GIA Bangkok. Figure 98 shows a photo of a rough sapphire from Sri Lanka with a thin layer of blue colour parallel to the face of the bipyramid on a crystal whose interior mass is colourless. In this article, it is called that rough stones suitable for cutting '*Ottu*' are found in the Kataragama region of Sri Lanka. *Ottu* stones can be very culasse stones, as weight is often preferred in Sri Lanka over colour intensity (Hughes, 2017).

ETYMOLOGY OF THE TERM "*OTTU*"

Today, it is generally accepted that the term '*Ottu*' is a contemporary Tamil word meaning 'to take risks' (to risk; Hughes, 1997) or to take a chance, due to the size skills required and great care to place the zoning or domain in the finished stone in order to obtain an attractive apparent colour (Hughes, 1997). That said, '*ottu*' in Tamil has several meanings depending on the reference. For example, in the Tamil-English dictionary of the University of Madras (Tamil Lexicon, 1924-1936), there are fifteen meanings for the word alone (*ottu*, *oṭṭu*, *ōttu*, *ōṭṭu*), out of a total of 134 including the use of '*ottu*' as a prefix or suffix. None of these meanings is really satisfactory for describing these sapphires. The origin of the term '*ottu*' therefore remains uncertain, but it could come from an ancient southern Dravidian language, Kannada (Krishnamurti, 2003).

Today, modern Kannada is spoken in the state of Karnataka in southern India, but also in parts of Andhra Pradesh, Tamil Nadu and Maharashtra. In Kannada, an interesting suggestion for the meaning of "*ottu*" would be the term '*otu*' with a single 't', from the verb "*ōtu*" (ಒತ್ತು) which means 'to keep one above the other or one next, to the other in a row; to arrange in a pile; to stack' (Krishna, 2019). In the same article, Krishna also proposes 16 meanings attributed to the ill-defined name '*ottu*' (ಒತ್ತು) in Kannada, the definition 'an assemblage of things'.

These definitions could be consistent with the nature of these sapphires and suggest a possible etymology.

METHODS

Energy dispersive X-ray fluorescence (EDXRF) chemical analyses were performed on a ThermoFisher Scientific ARL Quant'X system equipped with an X-ray tube with a rhodium anti-cathode for excitation and a 1000 μm thick silicon detector cooled by the Peltier effect. The spectra were acquired in partial vacuum rotation for 300 seconds with a voltage of 4 to 30 keV.

Fourier transform infrared (FTIR) spectrometry analysis was performed using a Thermo Fisher Scientific iS50 spectrometer equipped with a tungsten-halogen source, a La-DTGS-XT-KBr detector ($12500\text{-}350\text{ cm}^{-1}$) and an XT-KBr separator. The resolution was set at 4 cm^{-1} and the spectrum at an accumulation of 400 scans of 1 s each. The accessory used was a Spectratech Collector II, initially designed for diffuse reflectance. Backgrounds were collected with 20 scans.

The UV-Vis-NIR (Ultraviolet-Visible-Near Infrared) absorption spectra were collected using a four-channel slaved spectrometer, model UVN-XeH-4CCh, designed by GGTL Laboratories. The detectors are CCD arrays

Figure 4 : Detail of the girdle (feuillets in French) showing the boundary of the upper facets of the pavilion. The blue zone contains thin blue layers and a healed fracture or “fingerprints”, Micrograph : F. Notari.

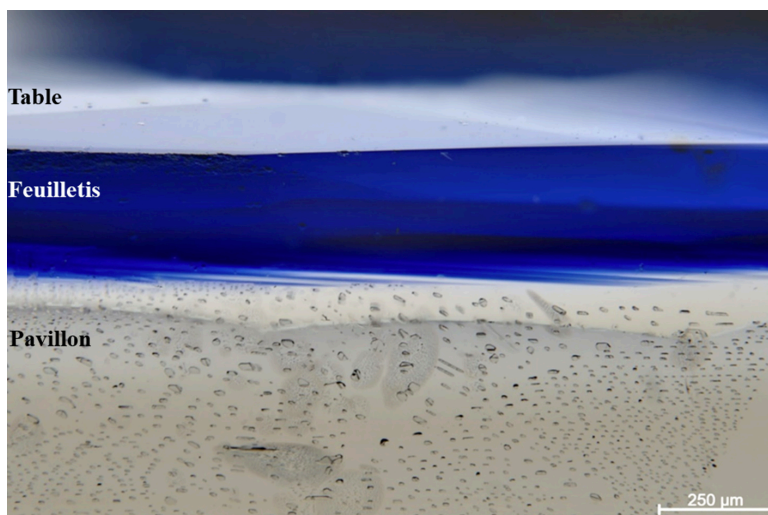
Figure 4 : Détail du feuillets montrant la limite des facettes supérieures du pavillon. La zone bleue comporte de fines lamelles bleues et une fracture cicatrisée ou « empreinte digitale ». Micrographie : F. Notari.

maintained at 5 °C by the Peltier effect. The system allows stones to be analysed at an average resolution of ≈ 0.35 nm in a spectral range from 234 to 1055 nm. For measurements, the sample is placed in an integrating sphere and exposed simultaneously to xenon and halogen sources (UV to PIR) with average integration times of 70 to 110 ms. The spectra were recorded with an accumulation of 100 scans without a polariser. -UV luminescence analyses (spectra and imaging) of this sample were performed using a D-tect V1.9 system from GGTL Laboratories equipped with a 3W focused UV LED source with a nominal wavelength of 365 nm, a single-channel GEM10 spectrometer with a resolution of ≈ 1.3 nm in a spectral range of 310-1100 nm, and a CCD array detector maintained at 5 °C by a Peltier effect.

- The observations were made using a Leica M165 microscope equipped with a modified Schott GGTL illumination system, allowing for darkfield and brightfield observation.

The photomicrographs were taken with a Leica M205 binocular microscope with a z-stack function and a Leica DMC5400 camera, with an integrated Leica analyser and a removable Schott polariser.

- Inclusion identifications were performed on a Thermo Scientific DXR3 micro-Raman equipped with a 532 nm laser (max. 10 mW) in a window.



from 100 to 3570 cm^{-1} (the instrument's spectral range is from 50 to 6400 cm^{-1}). The inclusions are analysed using one of five Olympus objectives (x5, x10, x20, x50 or x100). The diameter of the analysis spot is estimated at approximately 5 μm for the standard x10 objective. The spectra were acquired with an accumulation of 100 scans of 1s.

RESULTS

Before any other consideration, the bicolour gemstone submitted to the laboratory was formally identified as sapphire by infrared spectrometry specular reflectance, both on the table and in the pavilion.

Microscopic observations and inclusions

Under the microscope, the gem shows some slight scratches, evidence of the normal wear and tear of a stone that has been set and worn regularly. Examination of the foliation reveals no cuts or glue lines between the blue and colourless parts. Under high magnification, the boundary between the blue and colourless zones is not clear and flat, but rather shows a more complex interlocking pattern. In addition, subtle and fine zones penetrate into the colourless area (Figure 4). This stone is therefore not a doublet but an ‘Ottu’ sapphire.

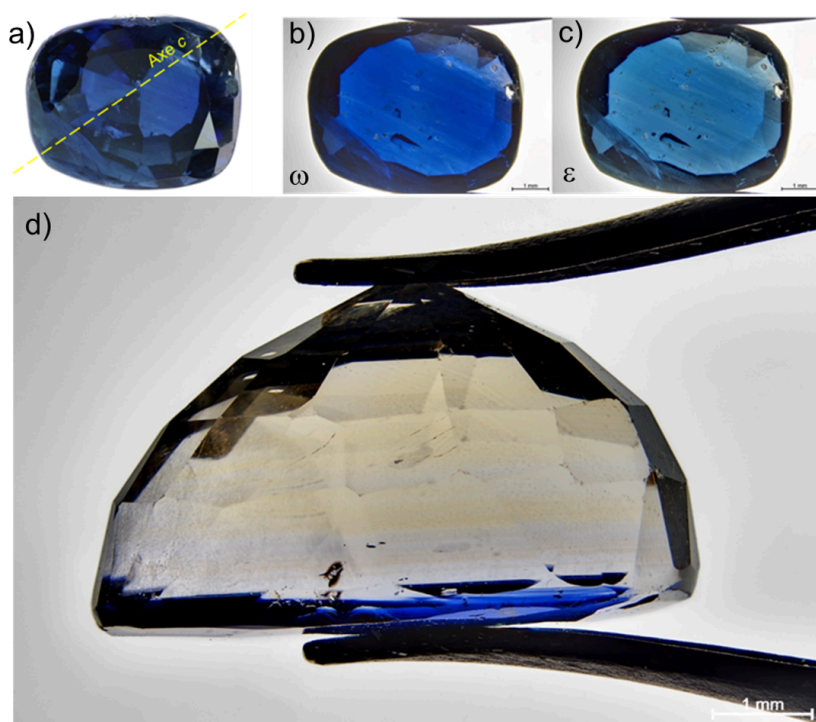


Figure 5: a) apical view, c axis (in yellow) is parallel to the observation plane. Micrographs under polarised light immersed in ethanol: colour due to b) the ordinary ray ω and c) to the extraordinary ray ε . d) Photo of the gemstone immersed in ethanol, viewed from the side and in transmitted light. The blue colouration is concentrated in the table and the beginning of the crown. The pavilion is composed of successive colourless, yellow and brown areas. Micrographs: F. Notari.

Figure 5: a) vue apicale, l'axe c (en jaune) est parallèle au plan d'observation. Micrographies en lumière polarisée en immersion dans l'éthanol : teinte due b) au rayon ordinaire ω et c) au rayon extraordinaire ε . d) photo de la gemme en immersion dans l'éthanol, vue de profil et en lumière transmise. La coloration bleue se concentre dans la table et le début de la couronne. La culasse est composée de zones successivement incolores, jaunes et brunes. Micrographies : F. Notari.

When immersed, observation of the blue zoning through the table shows that the hue is not evenly distributed but reveals bands of varying darkness (Figure 5a). Similarly, a difference in hue is observed in polarised light depending on the orientation parallel to the ray ω (ordinary; Figure 5b) or ε (extraordinary; Figure 5c). It also appears that the pavilion, which at first glance appears colourless, is traversed by pale yellow and brown zoning (Figure 5d).

The positioning of the optical axis (c; shown in Figure 5a) tends to demonstrate that this stone was cut from a rough according to the diagram in Figure 3c, i.e. with the table corresponding to an external face of the bipyramid.

Several solid inclusions were also observed, some of which were located exactly at the interface between the blue and colourless domains, getting on approximately half of each. The boundary between the blue and colourless domains divides them more or less symmetrically.

Among these solid inclusions, prismatic crystals were observed and identified by Raman spectroscopy as zircons. Some exhibit more or less discoid fractures caused by their expansion during metamictisation (Figure 6).

Other crystalline inclusions with a more rounded appearance were identified as calcite by Raman spectroscopy. When observed under polarised light, some of these calcite inclusions appeared to retain a blue hue regardless of the orientation of the polarisation plane (Figure 7). These calcite inclusions would therefore appear to be intrinsically blue. As this colouring only affects certain calcite inclusions, it is surprising to observe visibly coloured calcite crystals close to colourless calcite crystals (Figure 8). This suggests that this observation corresponds to an epitaxial attachment of a few blue calcite crystals that had already formed and were brought to the sapphire growth site by fluids. Indeed, the most commonly described cause of blue hue in calcite is due to hole centres from mechanical

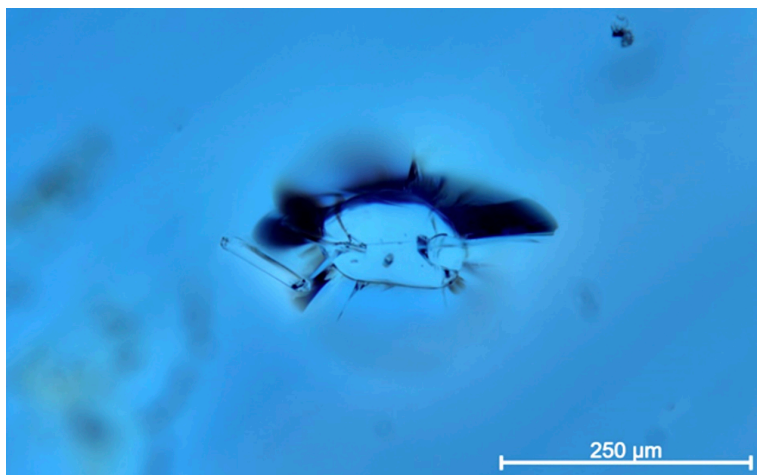


Figure 6: In the centre is a corroded zircon crystal (identified by Raman spectroscopy). Around the crystal is a hemidiscoidal fracture caused by pressure due to the metamictisation of the zircon. The small elongated crystal on the left is an automorphic zircon (visually recognisable and identified by Raman spectroscopy). Micrograph: F. Notari

Figure 6 : Au centre, un cristal de zircon corrodé (identifié par spectroscopie Raman). Autour du cristal, une fracture héli-discoïdale l'entoure, induite par la pression due à la métamictisation du zircon. Le petit cristal allongé sur la gauche est un zircon automorphe (reconnaisable visuellement et identifié par spectroscopie Raman). Micrographie : F. Notari.

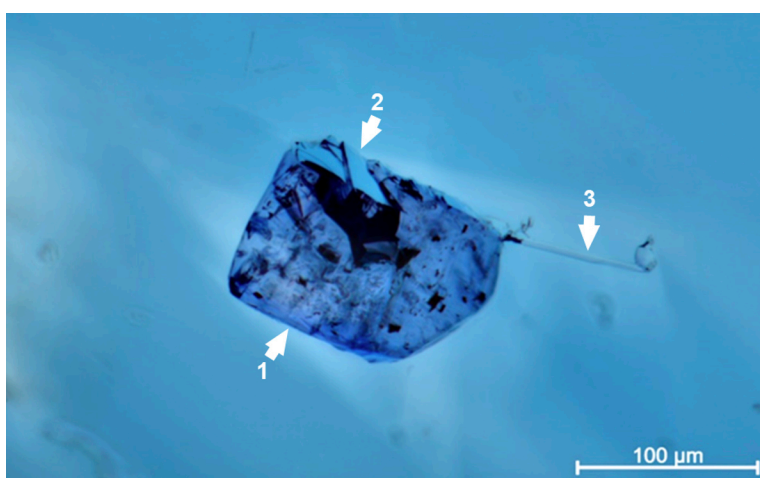


Figure 7: Blue calcite crystal (arrow 1) attached to a diaspore crystal (arrow 2; both identified by Raman spectroscopy). On the right, an elongated cavity with bulges at both ends (arrow 3). Micrograph: F. Notari.

Figure 7 : Cristal de calcite bleue (flèche 1) accolé à un cristal de diaspore (flèche 2; tous deux identifiés par spectroscopie Raman). Sur la droite, une cavité allongée possédant des renflements à ses deux extrémités (flèche 3). Micrographie : F. Notari.

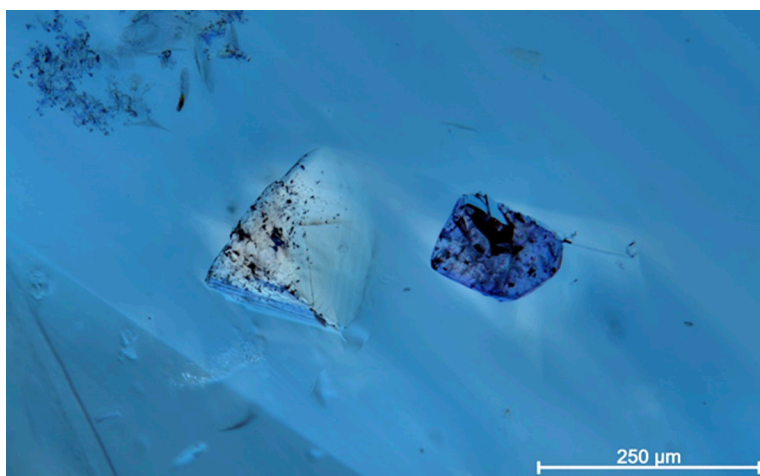
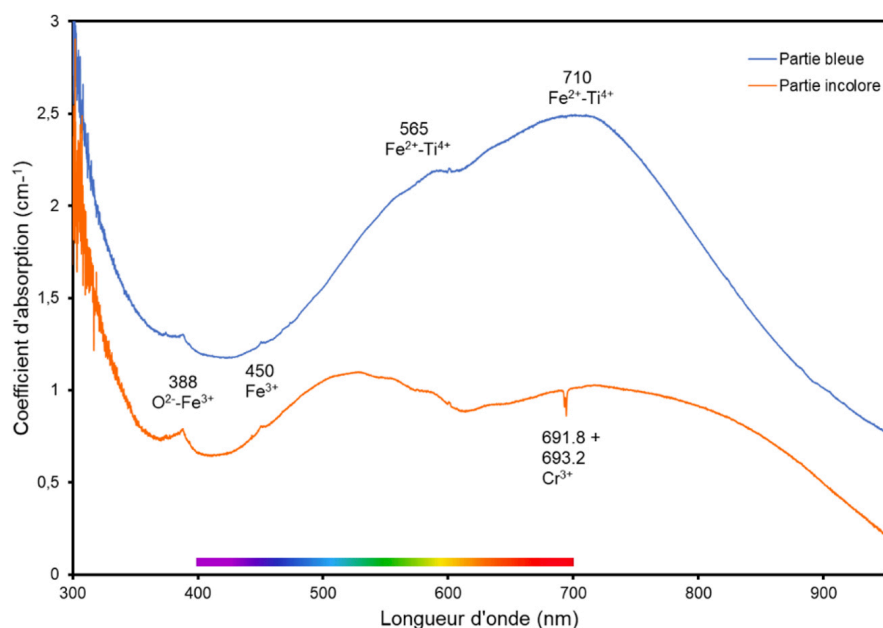


Figure 8: Two calcite crystals located at approximately the same level at the edge of the blue zoning. The crystal on the left appears colourless, while the one on the right shows a distinct blue tint. A halo of discolouration with a complex morphology is present around both crystals. Micrograph F. Notari.

Figure 8 : Deux cristaux de calcite situés à peu près sur le même niveau à la limite de la zonation bleue. Le cristal de gauche paraît incolore, alors que celui de droite montre une teinte bleue évidente. Un halo de décoloration de morphologie complexe est présent autour des deux cristaux. Micrographie : F. Notari.

Figure 9: UV-Visible-NIR absorption spectra of the blue (blue trace) and colourless (orange trace) parts of the sapphire. The spectra are not oriented.

Figure 9 : Spectres d'absorption UV-Visible-PIR des parties bleue (tracé bleu) et incolore (tracé orange) du saphir. Les spectres ne sont pas orientés.



constraints concomitant (or followed) by irradiation (Wirsema, 1960; Kolbe, 1961; Calderon *et al.*, 1983). This irradiation is thought to be the source of the CO_3^{2-} colour centres that cause the blue colour in calcite (Kolbe *et al.*, 1961), similar to the blue colouring of Maxixe-type beryls (Nassau *et al.*, 1976).

However, one article (Garcia-Guinea *et al.*, 2014) suggests that the colouration is induced by trace chromogenic elements. The exact causes of blue calcite colouration still seem debatable.

On one of these blue calcites, an automorphic inclusion was identified as a diaspore inclusion by Raman spectroscopy (see Figure 7 again). The presence of this unaltered alumina hydroxyl can be interpreted as an indication that the gem is unheated (Krzemnicki *et al.*, 2023).

This sapphire also exhibits naturally healed fractures with visually intact negative cavities, similar to those observed in sapphires from any geographical origin (see Figure 4 again). Other negative cavities were observed, notably adjacent to calcite inclusions.

One of them has a relatively atypical shape with significant directional elongation and could easily be mistaken for an acicular mineral inclusion (Figure 7). Without drawing any conclusions, a cavity with identical morphology was observed in a Padparadscha sapphire from Sri Lanka.

Globally, all inclusions observed in this gem appear intact and show no changes that could be attributed to heat treatment.

UV-Visible-Near Infrared

The UV-visible absorption spectra obtained for the blue and colourless zones show the typical absorptions of blue sapphires (Figure 9): a pair transition (Fe^{3+} - Fe^{3+}) at ≈ 377 nm and at ≈ 450 nm (very weak); a charge transfer (O^{2-} - Fe^{3+}) at ≈ 388 nm; charge transfer involving Fe and Ti at ≈ 565 nm and ≈ 710 nm; and an inter-valent charge transfer (Fe^{2+} - Fe^{3+}) at ≈ 880 nm (Dubinsky *et al.*, 2020).

The absence of Fe^{2+} - Fe^{3+} interstitial charge transfer at ≈ 880 nm in the near infrared indicates that this is sapphire of stricto sensu metamorphic geological origin.

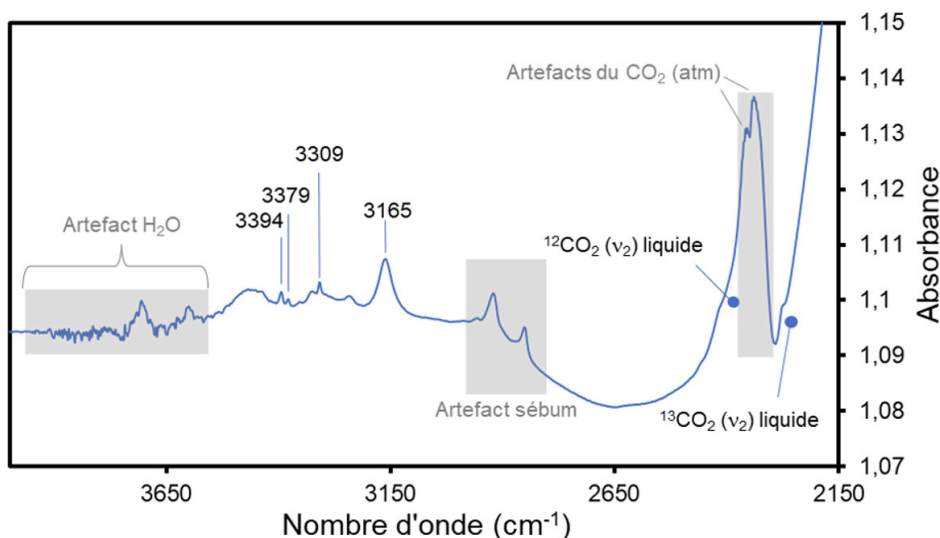


Figure 10: Infrared absorption spectrum in the hydroxyl group vibration range. The spectrum is not oriented.

Figure 10 :
Spectre d'absorption infra-rouge dans le domaine des vibrations des groupements hydroxyles. Le spectre n'est pas orienté.

The instrumentation used to obtain these absorption spectra (integrating sphere) involves the presence of artefacts linked to the luminescence of the sample. Thus, signals due to luminescence are observed on the spectrum of the colourless part, identified by oscillations between ≈ 520 and 600 nm and two very fine signals at 691.8 nm and 693.2 nm. The oscillations between ≈ 520 and 600 nm are attributable to relatively broad luminescence bands, which are discussed in the Luminescence section below. The very narrow luminescence signals at 691.8 nm and 693.2 nm correspond to the R^1 and R^2 transitions of Cr^{3+} . The absorption spectrum of the blue part does not show these chromium signals, but the oscillations due to the broad luminescence bands from centres in the colourless part are still distinguishable. This difference is possibly attributable to almost total reabsorption of the chromium luminescence by the blue zoning (absorption band at 710 nm). This effect is discussed in more detail in the luminescence section.

Infrared

In infrared spectrometry, in absorbance mode, a narrow band at 3309 cm^{-1} is measured. It is not accompanied by the band at 3232 cm^{-1} , which is a robust indicator of heat treatment in sapphires of stricto sensu metamorphic origin,

which indicates that the stone is unheated. The doublet at 3379 cm^{-1} and 3394 cm^{-1} is part of a triplet (the third band being at $\approx 3339\text{ cm}^{-1}$), and of the 3309 cm^{-1} system (Notari, 2016). On the other hand, a wider band at 3165 cm^{-1} is attributed to the so-called Mg^{2+} hole centre. As this centre cannot withstand temperatures above 650°C (unpublished study), its presence is a second indication of the absence of heat treatment. Finally, the significant band of liquid CO_2 ($^{12}CO_2$ & $^{13}CO_2$), topped by the artefact of atmospheric CO_2 , can be considered here as a third indication of the absence of treatment (Figure 10).

Chemistry

Two semi-quantitative analyses were performed on the blue part (table) and the colourless part (pavilion). Taking into account the gallium and iron contents measured on the blue part, the ratio between the two elements is consistent with that obtained in metamorphic blue sapphires (Palke *et al.*, 2019). The concentrations of all elements in this blue part may also correspond to those measured in samples from Sri Lanka with relatively low average titanium and iron concentrations compared to gallium (see again Palke *et al.*, 2019).

Élément	Concentration normalisée (ppm) Partie bleue	Concentration normalisée (ppm) Partie incolore
Al ₂ O ₃	999 730 ± 90	999 840 ± 90
Si	n.d.	n.d.
Ca	n.d.	11,39 ± 0,07
Ti	157,1 ± 0,2	15,85 ± 0,07
V	1,89 ± 0,08	2,52 ± 0,05
Cr	0,30 ± 0,03	0,22 ± 0,03
Fe	87,3 ± 0,1	113,6 ± 0,1
Ni	n.d.	0,38 ± 0,02
Ga	24,66 ± 0,04	14,88 ± 0,04
Zr	n.d.	n.d.

Table 1: Semi-quantitative EDXRF analyses measured on the table (blue zonation) and on the culet (colourless zonation) of the sample.

Tableau 1 : Analyses EDXRF semi-quantitatives effectuées sur la table (bleue) de l'échantillon et sur la culasse (incolore).

Comparing the two measurements, the one taken on the table indicates titanium levels ten times higher than those in the pavilion. This observation is consistent with the colouring of the two parts where titanium is involved in the blue colouring of the table. However, the pavilion contains a slightly higher iron content than the table. This concentration of iron (Fe³⁺?) in the pavilion could explain – in part – the slight yellow colouration observed during immersion (Figure 5). It is more surprising to see the gallium content change significantly between the two parts. This difference could suggest a clear change in the chemical environment during crystallisation and not just an addition of chromogenic elements (Fe and Ti).

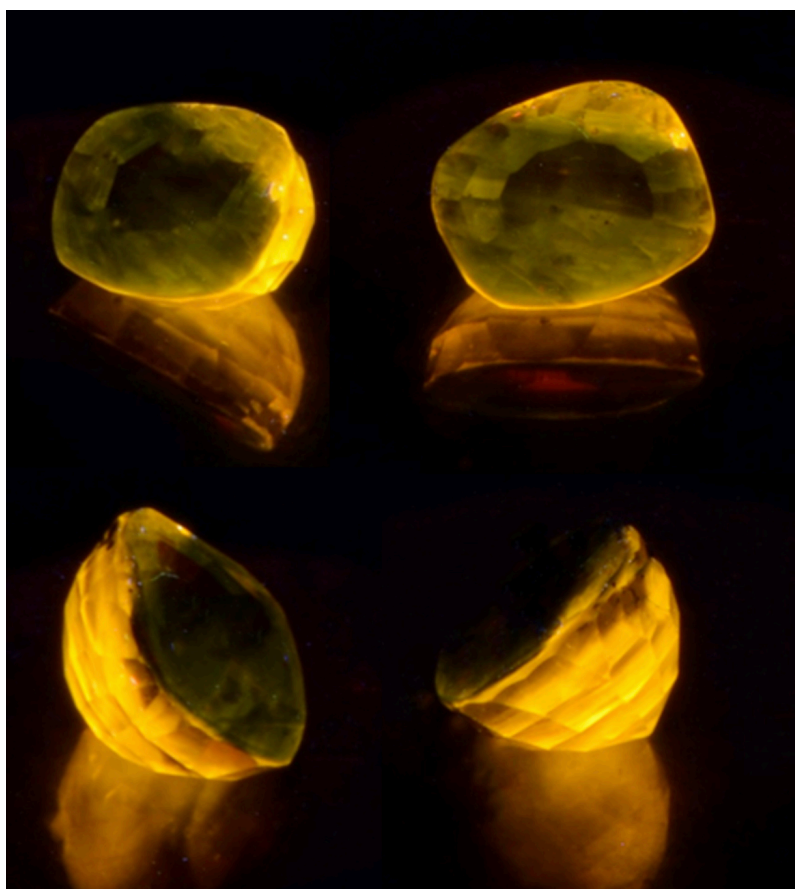
Figure 11: Pictures of the "Ottu" sapphire showing the orangey-yellow luminescence of the pavilion under 365 nm UV excitation. Pictures: C. Alliol-Mouton.

Figure 11 : Photos du saphir "Ottu" montrant la luminescence jaune orangé du pavillon sous excitation UV (365 nm). Photographies : C. Alliol-Mouton.

Luminescence

Under long UV excitation (365 nm), the pavilion exhibits a slightly heterogeneous orange-yellow luminescence. The blue zoning appears inert, which is consistent with the absorption of the Fe-Ti colour centre, which reabsorbs most of the luminescence emitted from the pavilion. Through transparency, the orange colour of the culet shines through the table of the stone (Figure 11).

On the luminescence spectrum (Figure 12), the emission of Cr³⁺ at around 694 nm is visible, which corresponds to the two bands R² and R¹ at 693.2 nm and 691.8 nm respectively, not separated here because the instrument's spectrometer has a resolution of 1.3 nm. Two broad bands at around 570 nm and 600 nm are present, which have already been observed in yellow sapphires of metamorphic origin. This luminescence is attributed to the hole centres linked to the presence of Mg²⁺ (Ramirez *et al.*, 2007)



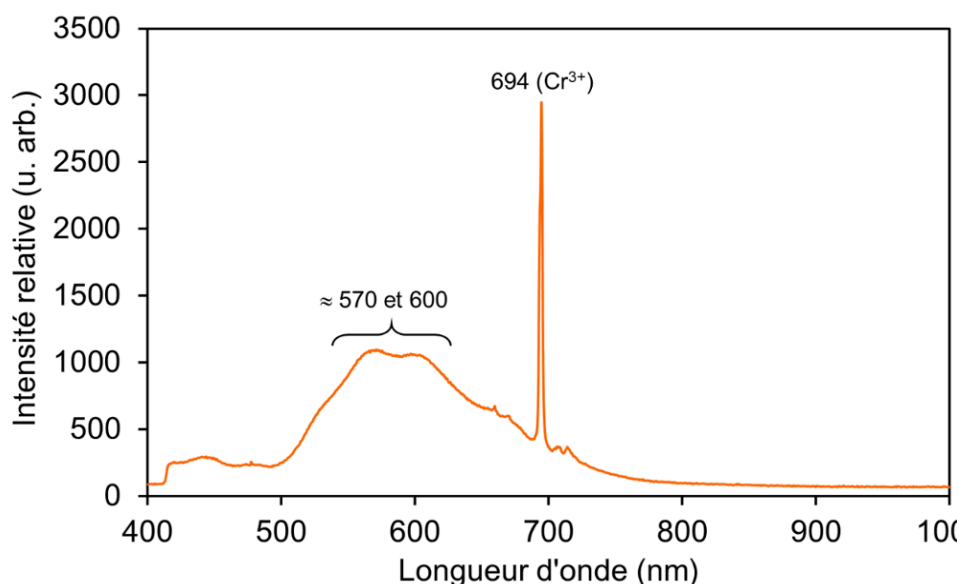


Figure 12: Emission spectrum mainly emitted from the colourless part of sample.

Figure 12 : Spectre d'émission émis principalement de la partie incolore du saphir.

or possibly other divalent cations (Vigier *et al.*, 2024). This intense orange luminescence under long UV (365 nm) is typical of colourless and yellow sapphires from Sri Lanka (Hughes, 2017; Kilbo Pehrson, 2017).

CONCLUSION

The observations of this 'Ottu' sapphire demonstrate the skill of the gem cutter, who succeeded in cutting a 7.91 carat gem and creating the illusion of a uniform blue colour by placing a thin blue zone under the table. All that remains is to use an appropriate setting so that the boundary between the blue and colourless zones remains discreet. All of these criteria are met in the ring shown in Figure 1, which combines significant mass and uniform colour with subtlety.

Microscopic observation and chemical analysis of the two zones suggest that the crystallisation of this 'Ottu' sapphire is the result of a complex process. The presence of blue calcite close to colourless calcite suggests that some of it was brought in by crystallisation fluids and integrated into the corundum by epitaxial attachment. The difference in gallium

concentration between the blue and colourless parts supports this hypothesis of a significant change in the crystallisation fluid.

Finally, microscopic observations and infrared analyses show that this stone has not been heat treated. All observations and spectral analyses converge to suggest that this 'Ottu' sapphire originates from Sri Lanka, the best-known source of this type of sapphire.

ACKNOWLEDGEMENTS

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*The original French version of this article is available on the GGTL Laboratories website.
Address: <https://ggtl-lab.org/en/other-publications>*

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