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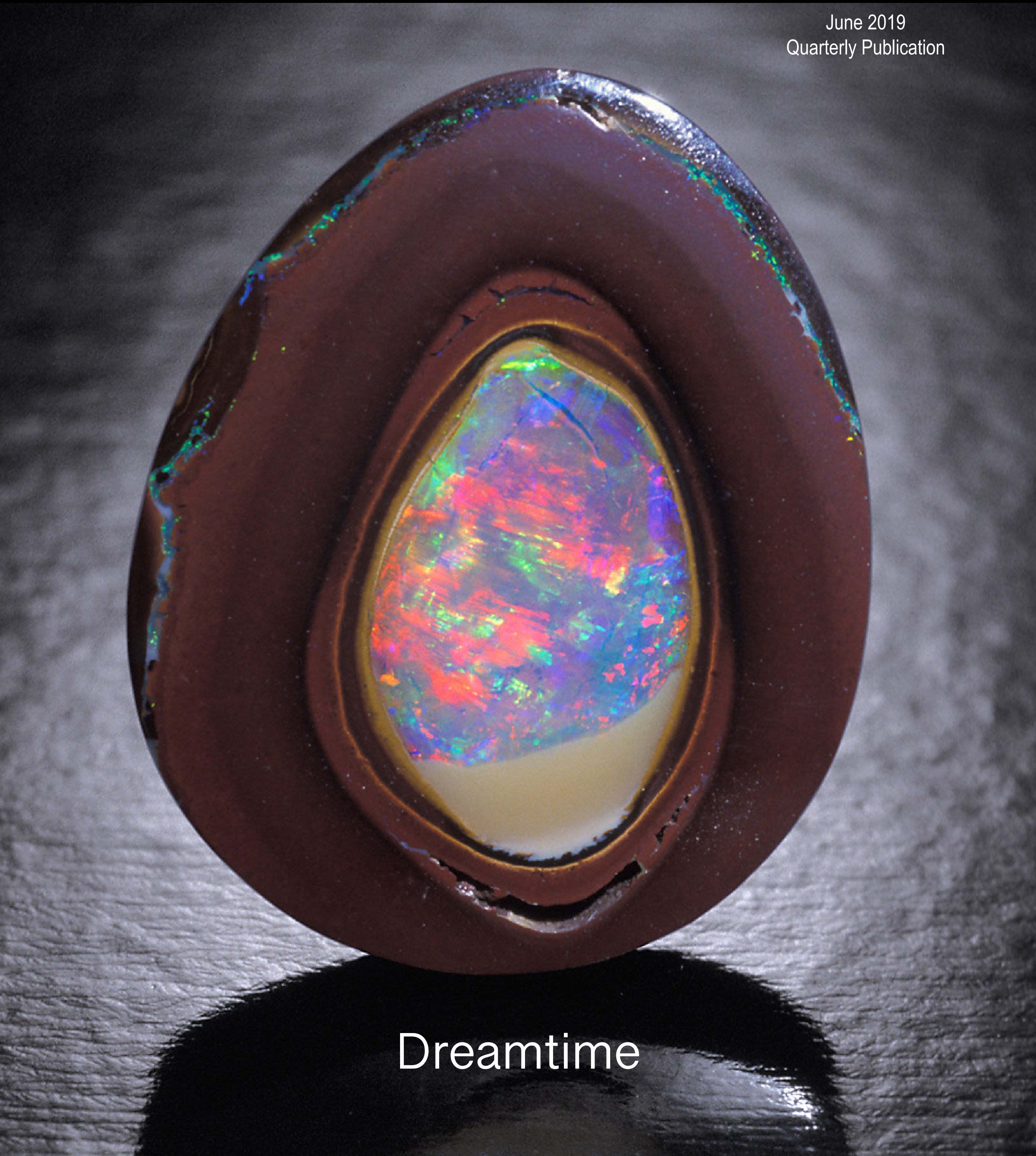

Dreamtime

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Crystallography 101 - A Seven-Sided Emerald Crystal?

Introduction

I had recently seen, on websites specializing in synthetic gemstones, an interesting rough synthetic emerald that looked very much like a natural emerald crystal (elongated with a ‘hexagonal’ habit). Due to the fact that this type of synthetic could reach the rough-emerald market, this article has been written to make gem dealers and rough stone buyers aware of this material and to relay the technical data and my observations so that they can differentiate this material from its natural counterpart.

Sample

A 3.51 carat emerald-green elongated crystal with a ‘roughly’ hexagonal base (Figure. 1).

Figure 1: The synthetic emerald crystal being analyzed

Equipment

Visible-near infrared (Vis-NIR) spectrometry using an Ocean Optic USB 4000 spectrometer equipped with a homemade setting with an integration sphere. The software rendering was set in absorbance.

Fourier transform Infrared (FTIR) spectrometry using a Bruker Alpha spectrometer with a low noise DLaTGS detector, equipped with a diffuse (or specular) reflectance type (DRIFT) signal capture module running at 4 cm^{-1} resolution.

Energy Dispersive X-Ray Fluorescence (EDXRF) spectrometry collected with a homemade spectrometer involving a silver-anode X-Ray tube running under 10 to 40 kV and 5 to 200 µA and a silicon CCD detector. This setting was chosen to detect elements that were heavier than sulfur with an exposition time that was suitable for a good signal/noise ratio in the Region Of Interest (ROI).

Specific gravity was determined with a homemade set-up involving a Dendritics Gemscale.

Reactions to ultraviolet radiation (shortwave and longwave) were evaluated in a dark box lit with 6W UV tubes.

Results and Related Comments

Superficially, the crystal looked like a natural emerald crystal. Under the polariscope, the stone proved to be uniaxial with light restoration every 90° rotation when observed perpendicular to the length and without light restoration when observed down to the elongation axis (C-axis). The measured specific gravity of 2.68 matched that of emerald. Reaction to ultraviolet radiation was inert under both SWUV (254 nm) and LWUV (365 nm) wavelengths. The refraction indices (taken on a crystal face) matched those expected for natural or hydrothermally grown synthetic emerald. Pleochroism (Figure 2) was typical of certain vanadium or low chromium content emeralds.

Looking more closely at the crystal, it was evident that the crystal had been cut and polished. Indeed, seven major

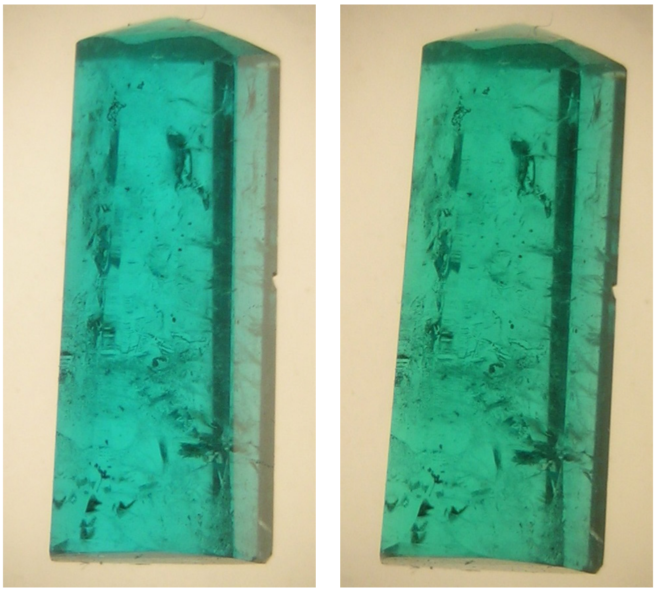

Figure 2: Blue-green / Yellow-green dichroism on the sample best seen perpendicular to the length of the crystal as in natural crystals.

crystal faces plus a smaller one were seen (instead of 6 Figure 3). Moreover, no growing defaults were seen on the faces indicating that they had been polished. At the top and the bottom of the crystal, some extra more or less rounded faces were also seen (Figure 3 far right). Although a cut and polished crystal is not proof of a synthetic or natural stone, one does wonder about the motivations that led to this cutting craftsmanship. Other unnatural looking faces were seen at the top and the bottom of face 5.

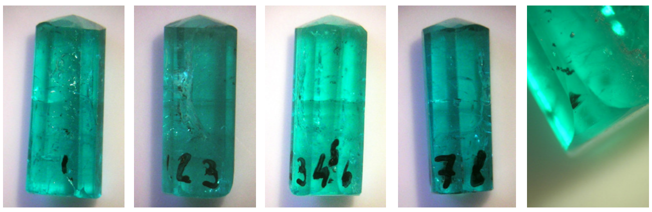

Figure 3: An unnatural number of faces were seen: seven faces (1,2,3,4,6,7,8) plus a small one (5) (3rd image from the left).

Under magnification, some natural looking inclusions (liquid veil and fractures) were seen, with some of the fractures oriented perpendicular to the C-axis (Figure 4).

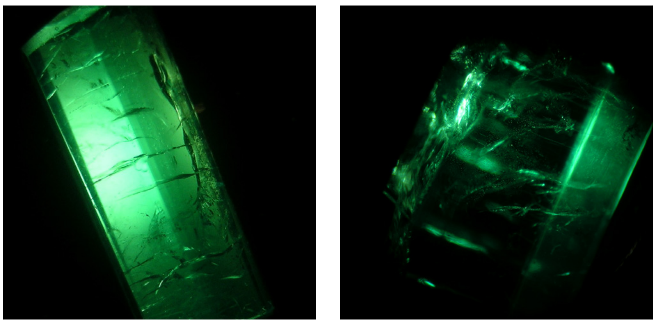

Figure 4: Fracture and liquid veils oriented perpendicular to the elongation axis (C-axis) giving a natural look to the crystal.

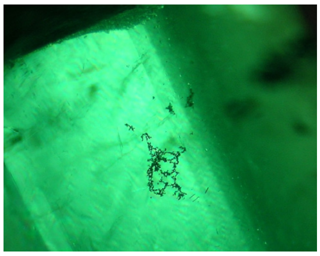

Figure 5: A black dendritic inclusion (platinum or copper?)

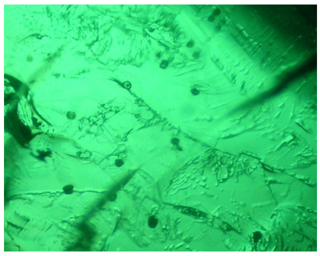

Figure 6a: Black dot inclusions

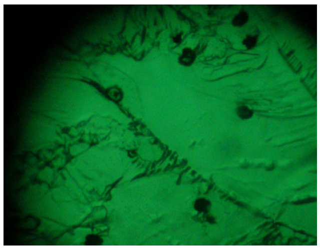

Figure 6b: Black dot inclusions with some encircled

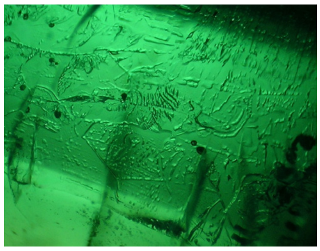

Figure 6c: Low relief pseudo-geometric inclusions

Other interesting inclusions included a black dendritic inclusion close the surface (Figure 5), tiny black discs (Figure 6 a,b,c) and low relief pseudo-geometric shaped inclusions (Figure 6 a,c) .

When observed between crossed polarizing filters, 'rainbow' coloured fringes (interference) perpendicular to the C-axis were seen (Figure 7 left). A 'swirled' texture was also seen along a plane close to the surface of a face (Figure 7 right). Both of these observations are strongly indicative of synthetic hydrothermally grown material [1].

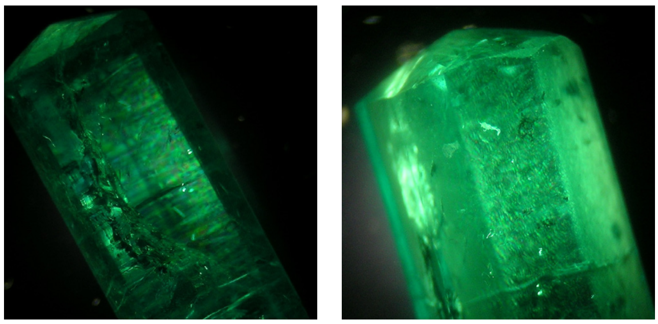

Figure 7: Between crossed polarizers an iridescent fringe can be seen perpendicular to the C axis (Left). A face shows a swirled-like texture along a plane parallel to the crystal face (Right).

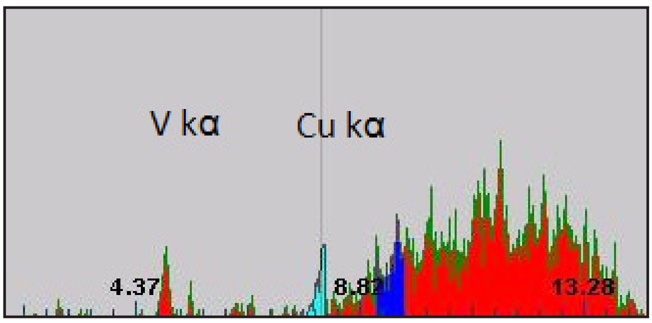

Figure 8: EDXRF spectrum showing vanadium (4.95 KeV) & copper (8.05 KeV) content & signal noise (~8.5 to 14.0 KeV)

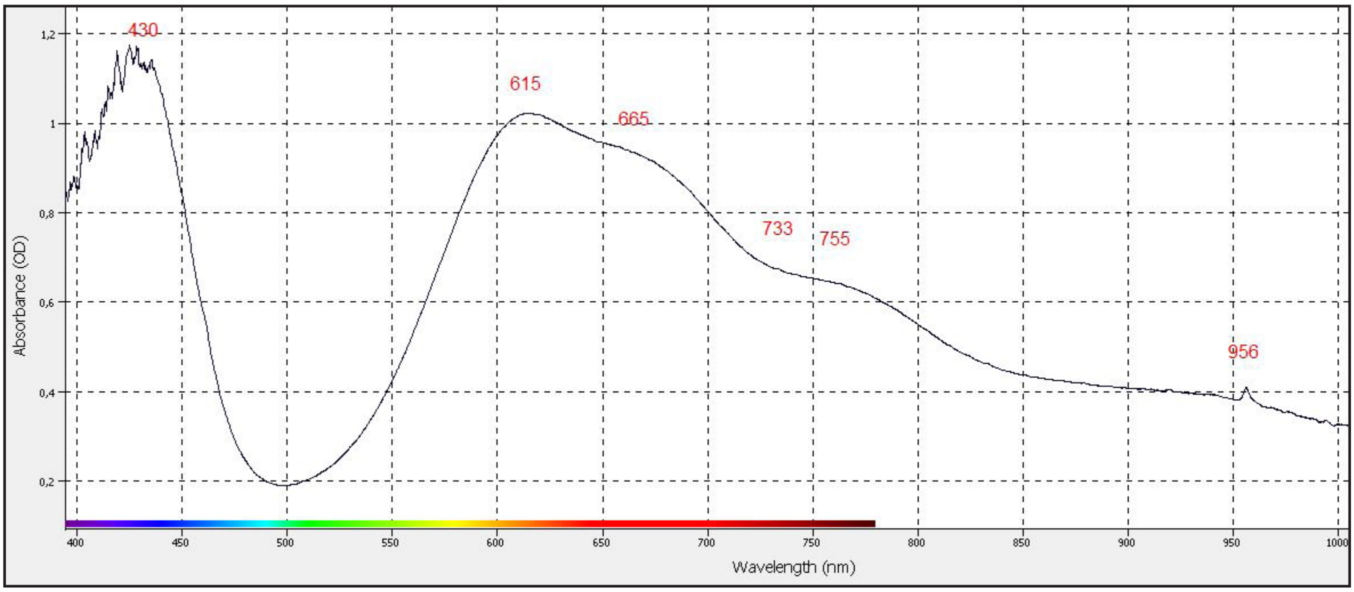

Figure 9: Vis-NIR unpolarized spectrum of the crystal. Absorption patterns indicated that vanadium (615, 665 bands) and copper (755 band) were involved in the final color but not chromium.

Using laboratory spectroscopic tools, copper was detected in the EDXRF spectrum (Figure 8). In this case, this element is the signature of the synthetic origin. Vanadium was also detected but not chromium.

The absorption spectrum in the visible near-infrared domain (Figure 9) showed the typical shape for a vanadium emerald, no expected chromium peak and a band corresponding to copper. When a polarized spectrum for the 'e' and 'o' rays was collected, bands related to vanadium and copper were noted (Figure 10).

When searching in our gem-material database (specular reflectance FTIR identification database) a perfect match was found with beryl. In transmission FTIR, the spectrum indicated synthetic beryl (Figure 11).

Conclusion

The crystal has formally been identified as a Hydrothermal Synthetic Vanadium bearing Emerald.

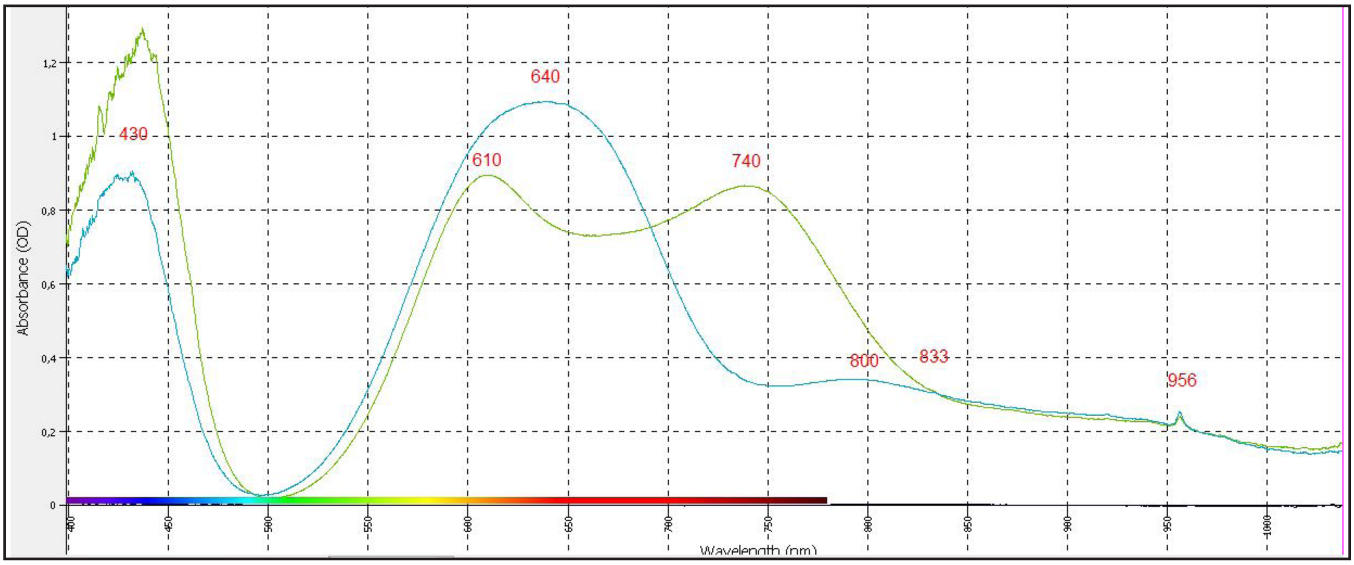

Figure 10: Vis-NIR polarized spectrum of the crystal. When the electric field of the light (E) is perpendicular to the C axis it corresponds to the yellow-green trace on the figure and when E is parallel to the C axis it is represented by the blue-green trace. Absorptions at 430, 610, 640 nm come from V^{3+} in octahedral sites (substitution of Al^{3+}). Absorption at 740 comes from Cu^{2+} in tetrahedral sites (substitution of Be^{2+}). Large band at 800 nm is assumed to come from Cu^{2+} too. The 956 nm peak comes from water. The small peak detected at 833 nm is of an unknown origin.

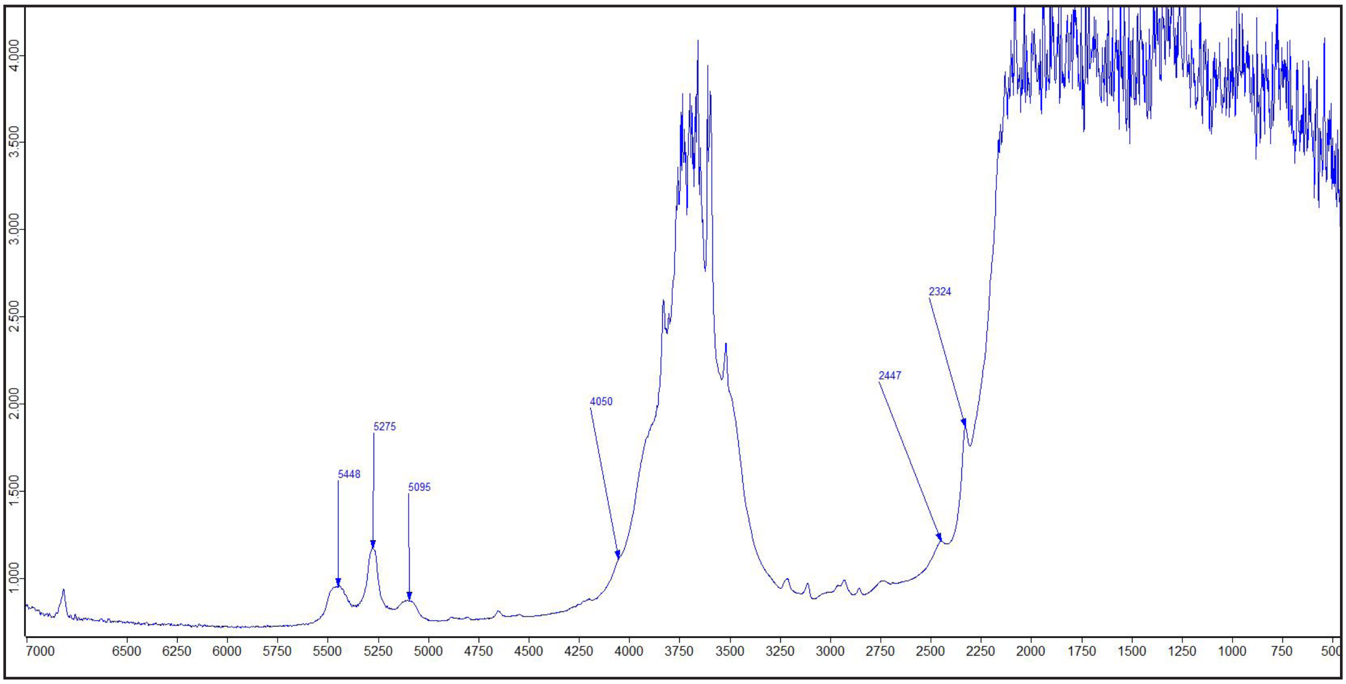

Figure 11: FTIR spectrum of the crystal. Shape of three peaks at 5448, 5275, 5095 cm^{-1} (water type I & II) in conjunction with 4050 cm^{-1} shoulder, 2447 and 2324 cm^{-1} peaks with the lack of obvious CO_2 peak indicate the synthetic nature of this hydrothermally grown material.

Although the identification will be straightforward in a gem lab, this material will be quite difficult to identify with standard gemological tools.

There are however certain characteristics that if present, will help to identify this material as synthetic. These include the lack of regularity in the overall crystal shape (rounded face junction, face number, etc.), a lack of growth structure on the faces (indicating that they have been cut and polished), the pseudo-geometric low relief inclusions, the dendritic black inclusion close to the surface of a crystal face, its reaction under the polariscope (with rainbow colored fringes perpendicular to the C-axis) and the ‘swirled’ texture along a plane.

Bibliography

Arlabosse J.M., 2008, ‘Tairus’ synthetic beryls obtained by hydrothermal process (in french), GSP GemLab – www.gemsolidphase.com - http://www.gemsolidphase.com/publications.php?Pub=All#enc

Gubelin E.J., Koivula J.I., 1986 Photoatlas of Inclusions in Gemstones Vol.1 532p

Gubelin E.J., Koivula J.I., 2008 Photoatlas of Inclusions in Gemstones Vol.3 672p

Kane R.E., Liddicoat T, 1985, The Biron Hydrothermal Synthetic Emerald, Gems & Gemology, Fall pp. 156-170

Schmetzer K., Schwarz D, Bernhardt H-J., Hager T. 2006 A new type of Tairus hydrothermally-grown synthetic emerald, coloured by vanadium and copper, Journal of Gemmology Vol.30 No1-2 pp. 59-74

Footnotes

[1] Gubelin & Koivula 1986, 2008, Schmetzer et al. 2006

Editors Note

If you are going to simulate a rough crystal by cutting and polishing it, having a good understanding of crystallography is imperative. Beryl belongs to the hexagonal crystal system and is noted for its six-sided, not seven-sided prisms!

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