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GEM TESTING LABORATORY

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'Tairus' Created Gems: "Part I - Beryl"

In the Volume 49 of Lab Information Circular, November 2007, we reported "Synthetic Beryl of Paraiba colour" produced by Tairus Co. Ltd. in order to take the advantage of the popularity of 'Paraiba' tourmalines. Thereafter, we procured sets of various coloured beryls and corundum from the same manufacturer for our research and reference purpose. The study of these sets has been divided into two parts; this issue describes the study of beryl set, while the study of corundum set will be published in the next issue.

The Beryl set consisted of five colour varieties (figure 1), namely, green (emerald), light blue (aquamarine), electric greenish blue (paraiba type), purple pink and orange red. All specimens were facetted as square step and measured 6 X 6 mm.

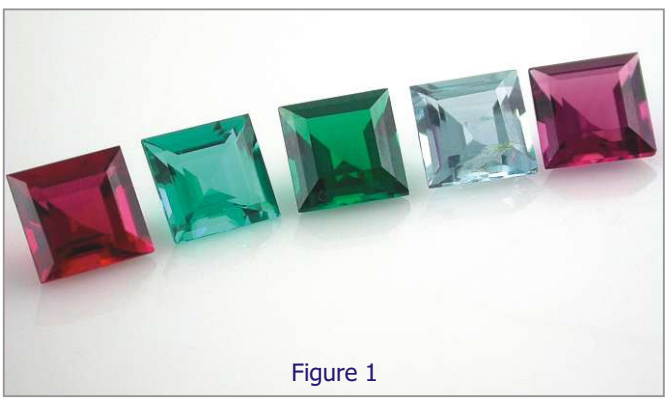


Figure 1

Standard gemmological tests and advanced analysis on FTIR and EDXRF were performed on all the samples for records even when all samples were readily identifiable as the product of hydrothermal process. All samples displayed strong 'chevron' growth which was even seen with an unaided eye..

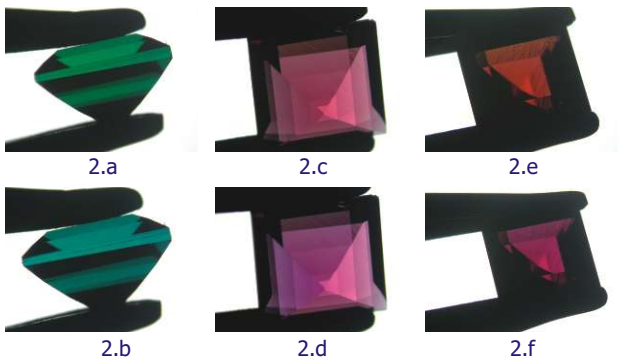
Gemmological Properties

The gemmological properties have described in table 1 and discussed below.

Refractive Index : The lowest R.I value varied from 1.583 to 1.590 while the higher from 1.590 to 1.600 with birefringence of 0.007 to 0.010. The values varied as per the colour variety as given in the Table 1.

Specific Gravity : The SG values ranged from 2.69 for emerald colour while 2.76 for 'paraiba' colour, which is unusually high for a beryl of synthetic origin.

Pleochroism : Dichroism varied from weak in aquamarine to very strong in darker coloured varieties like purple pink or orange red (see figure 2).



2.a 2.c 2.e

2.b 2.d 2.f

Figure 2 Pleochroic colours of Tairus created Beryls

Absorption Spectrum : The spectrum varied as per the colour variety; emerald showed a typical chromium spectrum while 'paraiba' colour displayed a strong band at around 430 nm. Purple pink and orange red varieties exhibited strong bands at 460 to 490 and 550 to 600 nm.

UV fluorescence : All samples were inert to long wave as well as short wave UV light.

Chelsea Filter Reaction : Emerald revealed a red glow while all other varieties were either inert or did not displayed any reaction.

Internal Features : The inclusion study in most of the cases distinguishes a natural stone from the synthetic counterparts as was also in this case. The range of inclusions observed in this particular set of stones includes:

1. **'Chevron' growth features:** The features (figure 3.a) typically associated with synthetic hydrothermal stones were visible even with naked eyes in these stones. In 'paraiba' and 'orange red' varieties 'hound's tooth' (figure 3.e) effect was also observed in the direction perpendicular to the chevron growth.
2. **Rows of fine dotted inclusions:** Fine rows of dotted inclusions (figure 3.b) were also observed in emerald following the direction of chevron. This gave appearance of fine / broken needles.

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Table: Properties of 'Tairus' created Beryl as studied at the GTL, Jaipur

Property	Emerald (bluish green)	Aquamarine (light blue)	'Paraiba' (greenish blue)	Purple Pink	Orange Red
RI	1.590 1.598	1.582 1.590	1.590 1.600	1.585 1.592	1.583 1.591
Birefringence	0.008	0.008	0.010	0.007	0.008
SG	2.69	2.70	2.76	2.70	2.69
UV Fluorescence	Inert	Inert	Inert	Inert	Inert
CF Reaction	Red	Inert (weak greenish)	No reaction	No reaction	No reaction
Pleochroism	Moderate; yellowish green (along optic axis) and bluish green (⊥to optic axis). see figure 2.a and 2.b	Weak; shades of blue	Moderate; greenish blue (along optic axis) and blue (⊥to optic axis)	Strong; orange pink (along optic axis) and purplish pink (⊥ to optic axis). see figure 2.c and 2.d	Strong: orange red (along optic axis) and purplish red (⊥to optic axis). see figure 2.e and 2.f
Absorption Spectrum	Typical chromium as seen in natural and other synthetic emeralds	None	Strong band at around 430 nm	Strong bands at 550 600 nm and 460 490 nm	Strong bands at 550 600 nm and 460 490 nm
Inclusions	Strong 'chevron' growth, liquid fingerprints, rows of dotted inclusions	Strong 'chevron' growth, two-phase inclusions, 'spicule' like inclusion	Strong 'chevron' growth, hound' tooth pattern	Strong 'chevron' growth	Strong 'chevron' growth, hound's tooth pattern
EDXRF Analysis	Al, Si, Ca, Cr, Fe, Ni	Al, Si, Ca, Fe	Al, Si, Ca, Fe, Cu	Al, Si, Ca, Ti, Mn, Fe, Ni	Al, Si, Cr, Mn, Fe

3. Liquid fingerprints: Emerald also displayed fine liquid fingerprints (figure 3.b) which were also oriented along the direction of 'chevron' growth.

4. Two-phase inclusions: Aquamarine specimen had a cluster of two-phase inclusions with irregular boundaries (figure 3.c); one individual triangular/ conical phase inclusion (figure 3.d) was also present giving impression of a 'spicule'. However, 'head' of the spicule like inclusion was not visible.

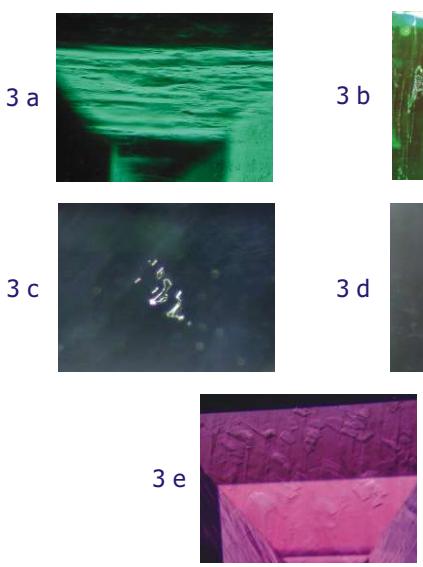


Figure 3: Inclusions in 'Tairus' created Beryls

EDXRF Analysis: Quantitative elemental analysis performed on all five samples revealed the presence of Al and Si as the major elements as expected for Beryl. Various trace elements detected include Cr, Fe, Cu, Mn, Ti, Ca, and Ni. The manufacturer claims that the orange red and purple pink colours are produced by adding Co impurity; however, in our analysis no distinct peak for Co was detected.

FTIR Analysis: FTIR absorption spectra exhibited a general absorption till 2200 cm^{-1}, an absorption band ranging from 3400 to 4000 cm^{-1} and a sharp but small peak at around 5266 cm^{-1} accompanied by two smaller peaks on the either sides. This pattern of peaks in the region 5500 to 5000 cm^{-1} is often encountered in synthetic hydrothermal emeralds. Some natural emeralds have also displayed a similar feature and hence not conclusive enough to differentiate these two. However, the shape of the peaks gives an indication regarding the origin.

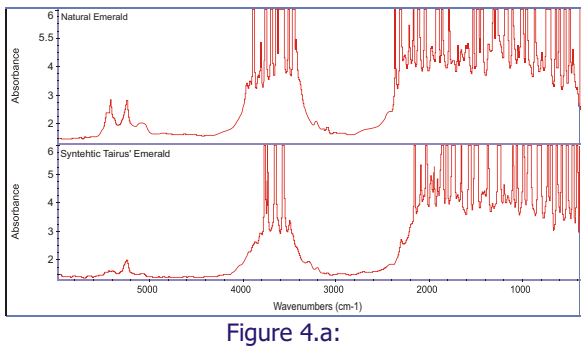


Figure 4.a:
FTIR spectra of natural (top) and synthetic (bottom) emerald

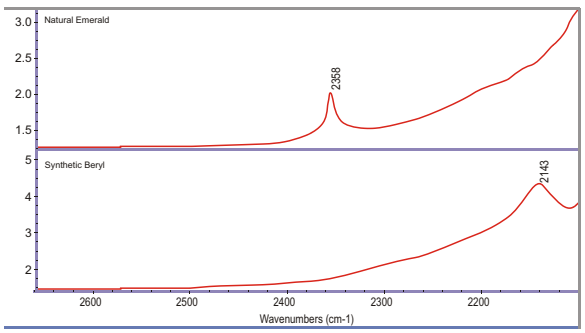


Figure 4.b: FTIR spectra of natural (top) and synthetic (bottom) beryl in the region around 2300 cm-1.

The distinguishing features were observed in the region around 2300 and 4100 cm^{-1}. Natural emerald displayed strong peaks at around 2358 / 2340 cm^{-1}, while this was either missing or present as weak peak. Synthetic emerald displayed a hump at around 4055 cm^{-1}, which was missing in natural counterparts, but also affected by the noise present in the spectra. These features are also described by Koivula et al., "Gemological Investigation of a New Type of Russian Hydrothermal Synthetic Emerald", spring 1996, Gems & Gemology, pp 32-39.

This study represents the gemmological properties of 'Tairus' created hydrothermal beryls, which were purchased as gem set for research and reference purpose. Their standard gemmological properties, such as RI and SG overlap with those of natural counterparts. Microscopic features, such as, 'chevron' growth can readily identify this material as synthetic which is visible even with unaided eyes, however, there might be cases when the internal features may not identify the material; in such cases, FTIR and EDXRF analysis may be needed to conclude the stones as synthetic. Now, more care has to be taken when dealing with beryls, as synthetic counterparts for various colours are much easily available.

Mustaqeem Khan resigns from GTL……

Mr. Mustaqeem Khan has resigned from GTL after serving it for more than eight years. He joined GTL in April 2000 after completing MDGI from GTL. He then joined as Research Gemmologist and was involved in research and creation of database on FTIR. Later, he was designated as Asst. Gemmologist where he was involved in all various activities of GTL including certification, educational, research and other day to day activities. During the last five years, he has been Asst. Director and acting as in-charge after Mrs. Fernandes left GTL. His contributions in the GTL activities were of great importance and will be missed. GTL wishes him all the very best for his future endeavours.

GTL…Annual Awards Function….2008

22nd April 2008, Gem Testing Laboratory, Jaipur has celebrated its annual awards function at Mohanlal Sukhadia Hall, Rajasthan Chamber Bhawan at 3.45 P.M.

The Chief Guest for the ceremony was Dr. D.K. Verma, Commissioner Central Excise & Service Tax, who kindly consented to present the certificates and deliver the valedictory address.

Other distinguished guests from the local Gem and Jewellery industry were present; some of them were Shri Vijay Kumar Chordia (Convener, Technical and Education Committee, Jaipur), Shri Mehul Durlabji (Co-Convener, GTL), Shri Vimal Chand Surana, Shri B.N. Gupta etc.

Following candidates stood out best in their respective batches in the year 2007 - 2008:

1st Overall

1. Kim Gupta	-	Batch 40
2. Preeti Gupta	-	Batch 41
3. Burke Tomar	-	Batch 42

1st in Practicals

1. Rashi Agarwal	-	Batch 40
2. Niranjan K. Sreenivas	-	Batch 41
3. Dheeraj Verma	-	Batch 42

The two trade awards: **Durlabhji Education Trust** Award for the Best student of the Year (Overall) went to Preeti Gupta

Bhuramal Rajmal Surana Award for Best Student of the Year in Practicals won by Dheeraj Verma.

Congratulations to all students and we wish them all the very best in all their future endeavours. We hope they will make a valuable contribution to the Gem & Jewellery Trade.

Interesting inclusions: *"Banana"* and *"Turtle"* in Spinel!!!

Recently, we examined a blue coloured spinel of natural origin shown by Mrs. Shyamala Fernandes. The stone was readily concluded as natural spinel by its optic character, RI, spectrum and inclusions. It consisted of numerous crystalline inclusions; some were scattered while some were present as clusters. On careful examination, we observed two different types of inclusions which were unique in themselves.

Inclusion 1: A 'Banana'

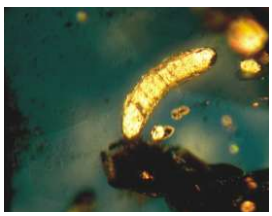


Figure 5 A 'Banana"

This was basically an elongated hexagonal birefringent crystal with curved faces. Note the six sided faces (of prism) terminated by pyramidal faces. Such patterns are commonly observed in apatites, which is also one of the common mineral inclusions found in spinel. Also note the lines/ planes oriented perpendicular to the length of the crystal; this indicates the basal cleavage of apatite. However, due to lack of Raman analysis, we could determine the exact nature of the mineral.

Inclusion 2: 'Turtle'

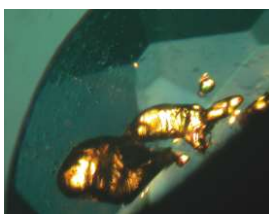


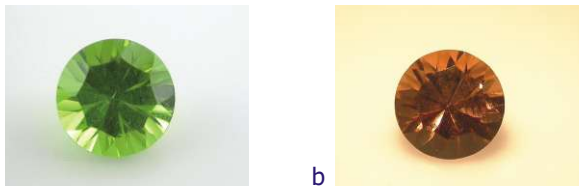
Figure 6 'Turtle'

This particular spinel consisted of clusters of birefringent crystals and coincidentally one of the clusters gave appearance of a 'turtle'. One can almost make out the 'body' with dome / shell, 'head' coming out of the shell and the 'paw'. Also note the spectral colours (as the image has been taken under crossed polars) and some lines/ planes oriented perpendicular to the length of the body. Again the overall pattern of these inclusions indicated apatite.

The microscopic study is the most fascinating part of gem identification or gemmology but this was really amazing to see such patterns of mineral inclusions; we are grateful to Mrs. Fernandes for sharing such a pleasure with us.

Colour Changing Glass "Alexite"

In the recent past, few colour-changing glasses have been encountered at GTL for identification. The colour of these glasses appeared green (figure 7.a) in fluorescent light while brownish red (figure 7.b) in incandescent light. The colour change of these glass specimens are similar to glasses that are marketed as "Alexite" by the RMC group. This particular reported colour of 'Alexite' is being marketed as "Autumn", while blue coloured material that turns to violet as "Lavender".



a b

Figure 7

Gemmological properties were consistent with those of a glass. Absorption spectrum exhibited spectrum typically associated with 'rare earth' elements, consisting of series of lines across the visible range. EDXRF analysis revealed the presence of high concentration of 'Praseodymium' and 'Neodymium' along with Zn, Ca, K, and Si.

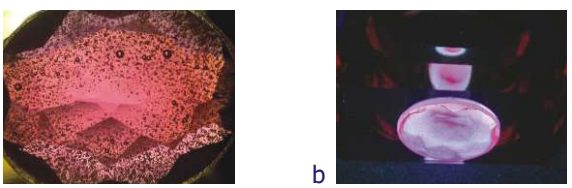
Synthetic Citrine Ring...

Figure 8

An orangy yellow specimen carved as a ring was submitted for identification at GTL. This carved ring was studded with a purple red oval facetted stone.

The ring was immediately identified as Citrine on the basis of "Bull's eye" optic figure. The specimen did not exhibited signs of colour zoning; which indicated synthetic origin. Under magnification, it was virtually inclusion free with an exception of tiny flaky inclusion; this was not sufficient to conclude the specimen as synthetic. The identification of this citrine was made using FTIR, where a complete absorption of wavelengths up till 4000 cm^{-1} was seen.

Further, the red specimen exhibited refractive index of 1.760- 1.770, confirming ruby. On magnification, plane/ cloud of large gas bubbles were easily seen (figure 9.a) presented only on the back surface of the ruby. These gas bubbles were the result of the glue used to fix this piece of ruby in the citrine ring. However, on careful examination, one gas bubble appeared to present within the stone indicating synthetic origin. On cautious rotation of specimen in various directions, weak curved lines were seen confirming the identification.



a b

Figure 9

Often, UV fluorescence helps to differentiate natural corundum from synthetic counterpart. Hence, we checked for SWUV for this ruby specimen, but no distinct separation could be made as the glue beneath exhibited a strong chalky blue fluorescence.

Created and Edited by : Gagan Choudhary, *Asst. Director (Tech. & Training)*

Contact for further details : Meenu Brijesh Vyas, *Asst. Director (Tech. & Training)*

Radhamani Amma, *Asst. (Coordination & Info.)*

Priti Singh, *Gemmologist*

Rajasthan Chamber Bhawan
M.I. Road, Jaipur, India
Phone : 91-141-2568221, 2573565
Fax : 91-141-2567921
Email : gtl@gjepcindia.com