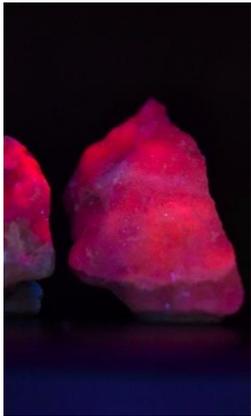
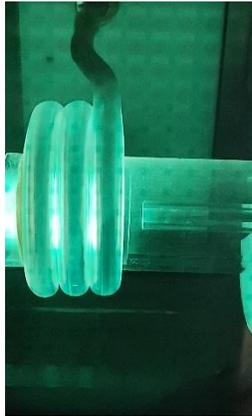


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IIGJ – RESEARCH & LABORATORIES CENTRE

DELHI ✨ **JAIPUR**





SODALITE-HACKMANITE: A PHOTOCHROMIC GEM

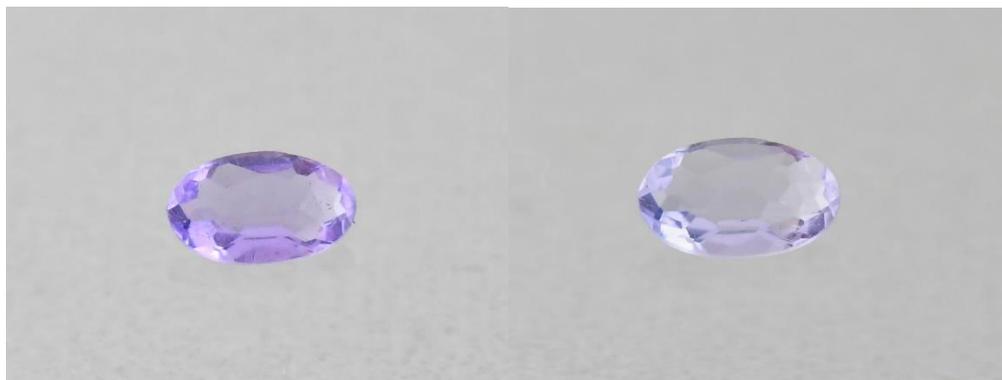
Hackmanite is a rare sulphur-rich variety of sodalite exhibiting an unusual and special optical property, known as “tenebrescence” or “reversible photochromism”. This feature allows the gemstone or mineral to change its colour temporarily when exposed to different types of light or energy: hackmanite when mined appears pink to purple, but on exposure to sunlight it turns to greyish or pale colours; these pale colours when kept in dark for several hours or exposed to ultraviolet light attain their original colours. This process can be repeated for unlimited times. The reversible photochromism property makes hackmanite a rare and prized mineral for collectors. However, there has been a sudden surge in supply of hackmanite in Jaipur market in past few months, as evident from the frequency of submissions of hackmanite for certification at the IIGJ-Research & Laboratories Centre’s Jaipur laboratory (formerly, GJEPC-Gem Testing Laboratory).



1. Rough samples of hackmanite after exposure to UV light (left) and after fading (right). Note the intensification of purple-violet component after exposure to UV light. The sample in centre is least affected by the UV exposure but still display some degree of colour change.

APPEARANCE

Most of the hackmanites seen at the IIGJ-Research & Laboratories Centre were translucent (cloudy) to opaque – cabochon and bead grades. However, these grades were seen in appreciable sizes of up to ~10ct for polished specimens; rough specimens were even bigger, weighing several grams up to ~50 grams.



2. Such transparent facetable hackmanite is extremely rare and only small pieces are seen.





Transparent hackmanite is extremely rare and is found only in small sizes – transparent facet grade specimens seen at the laboratory ranged in sizes 0.13 – 0.50 ct.

PROPERTIES

Another striking property of hackmanite is the orange to yellow fluorescence under longwave UV light. This fluorescence reaction may not help in identification of hackmanite, as this reaction is often seen in other similar looking gems too, such as, scapolite, afghanite and tugtupite. This UV reaction along with refractive index of ~1.48 and specific gravity in the range 2.14 to 2.40 helps in separation of hackmanite from other similar-looking gemstones.

Identity can further be established by Raman and infrared spectroscopies. Due to the massive form and presence of different minerals, polished specimens commonly display mottled / cloudy appearance. Transparent gems may display crystalline inclusions and liquid fingerprints.



3. Orange fluorescence is another striking property of hackmanite. Here, specimens illustrated in figure 1 display strong orange fluorescence under longwave UV light.

OCCURRENCE AND SOURCES

Hackmanite though firstly discovered in Greenland, gem quality hackmanite deposits were first discovered in Quebec, Canada in 1991. Currently, major sources of hackmanite are Afghanistan and Myanmar (Burma), being Norway and Russia as other deposits. Most of the hackmanites arriving in Jaipur market are reportedly from Afghanistan deposits. Finding pure hackmanite is also rare and is commonly associated with other minerals such as calcite, sodalite, feldspar, richterite, lazurite, diopside, afghanite, etc. As a result, it is not uncommon to find different minerals in the same specimen at the time of testing.

PROPERTIES	
<i>Composition</i>	$\text{Na}_8\text{Al}_6\text{Si}_6\text{O}_{24}(\text{S},\text{Cl})_2$
<i>Refractive Index</i>	1.48
<i>Lustre</i>	Waxy and Sub-vitreous
<i>Specific Gravity</i>	2.14 to 2.40
<i>Hardness</i>	5.5 to 6 (Mohs Scale)

The gem trade is continuously looking for new materials and hackmanite is yet another mineral which may gain a lot of popularity amongst the consumers, especially for its unique property, “tenebrescence” or “reversible photochromism”. ✦ **Gagan Choudhary & R. Lalitha**





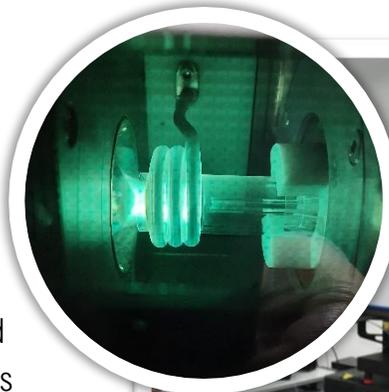
IIGJ-RLC INTRODUCES “ORIGIN CERTIFICATION” OF EMERALDS

From the bouquet of new services for the trade, IIGJ-Research & Laboratories Centre (IIGJ-RLC) had introduced its brand-new service of origin certification of emeralds, beginning 1st March 2022. The service was much awaited by the industry for past few years.

The origin certification at IIGJ-RLC is based on gemmological analyses by highly skilled and experienced team of gemmologists, spectroscopic analyses using UV-Vis-NIR, Laser Raman and FTIR, and chemical analyses using highly sophisticated, advanced, and state-of-the-art instrument, LA-ICPMS, which has the capability of detecting the presence of various elements up to ppb (parts per billion) levels. IIGJ-RLC is the first and only gemmological laboratory in the country to house LA-ICPMS for its routine certification, thereby, making the issued reports more authentic.

In past few years, the laboratory has been working on collecting the database on emeralds, after carefully sourcing and selecting authentic specimens from various commercially important sources. In addition to detailed inclusion study, which forms the basis of origin determination by most gemmological laboratories, comprehensive chemical fingerprinting, using LA-ICPMS, is routinely performed at IIGJ-RLC, before issuing a report on origin. Detailed chemical fingerprinting becomes more important when two emeralds are formed in similar geological environment but belong to different locations. For example, emeralds from Colombia and Afghanistan (Panjsher), both forming in similar geological environment, display similar inclusion scene, but have different chemical ratios. Chemical fingerprinting helps separating the two emerald sources.

Introduction of this new laboratory service in Jaipur, with world-class infrastructure will not only have advantage to the Jaipur's Gem & Jewellery Industry but the entire country. The laboratory has already arranged to serve the manufacturers, dealers and retailers in other parts of the country by empanelling experienced and affordable logistics partner. The laboratory is operational in Sitapura, Jaipur while samples can still be submitted at the regional office of the GJEPC, situated at 3rd Floor, Rajasthan Chamber Bhawan, M.I. Road, Jaipur or sent from any part of the country. ✦



4. LA-ICPMS installed at the IIGJ-RLC is extensively used for detailed chemical fingerprinting, before issuing reports on origin of emeralds.



AQUAMARINE OR BLUE BERYL?

In addition to aquamarine, the most popular blue coloured variety of beryl, IIGJ-Research & Laboratories Centre often receives for identification yet another blue-coloured beryl, referred to as “maxixe-type beryl”. However, majority of the gem trade is unaware about the existence of blue coloured beryl, other than aquamarine. This is evident from the number of queries we receive each time when issued report identifies the submitted sample as “natural beryl” and not “natural aquamarine”. Following are key differences between the two blue-coloured varieties of beryl:

Colour

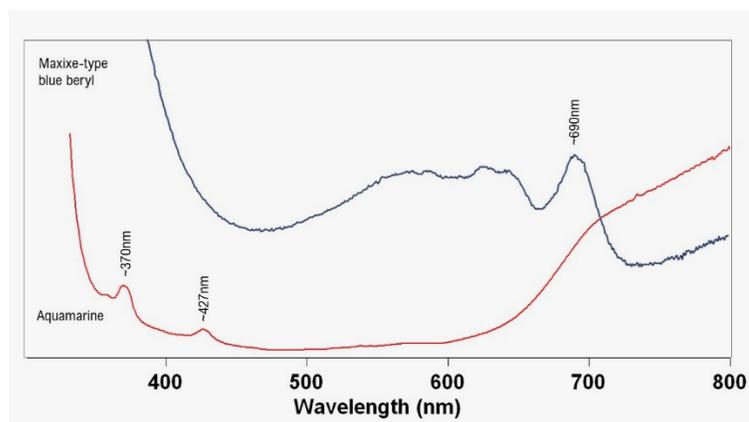
Aquamarine typically ranges from greenish blue to blue, of low to moderate saturation with low to medium tone, while maxixe-type blue beryl is usually more intense in blue with slight violet component, similar to many tanzanites and sapphires. However, some of them appeared very similar to the premium colour of aquamarine, described as “Santa Maria” colour – named after the classic aquamarine deposits of Brazil. Hence, these maxixe-type blue beryls are often presented as “Santa Maria” aquamarine in the trade.



5. Examples of classic aquamarine colour (left), saturated blue aquamarine (centre) and maxixe-type blue beryl (right). Saturated colours (centre and right) require detailed absorption spectroscopy for separation of aquamarine and maxixe-type blue beryls.

Cause of Colour

Aquamarine is coloured blue due to presence of iron ($\text{Fe}^{2+}/\text{Fe}^{3+}$) on different lattice positions and channels within the beryl structure, while maxixe-type blue beryl is coloured by colour centres or defects associated with carbonate impurities. These differences are detected by absorption spectroscopy; usually a desk-model spectroscope can make such separation, however, in case of samples with low saturations, such differences are revealed by UV-Vis-NIR spectrometer.



6. UV-Vis-NIR spectra of aquamarine and maxixe-type blue beryl.





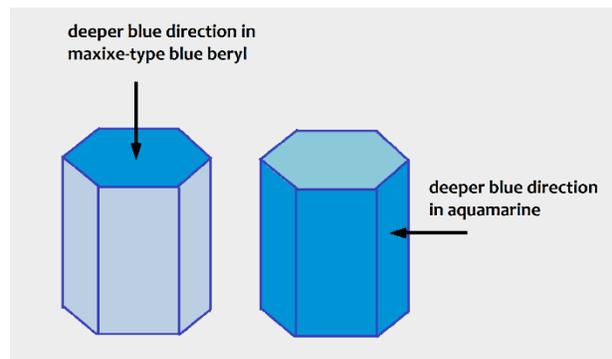
Aquamarine typically displays peaks at ~370 and 427nm along with a broad band centered at ~825nm, while maxixe-type blue beryl displays a series of peaks in the region 500-700nm, with a dominant feature at ~690nm.

Dichroism

Maxixe-type blue beryl displays dominant blue colour when viewed down into the 'c' axis or length of the crystal, while aquamarine displays the opposite. This becomes one of the quickest methods to separate the two beryl types, especially in rough form.

UV Fluorescence

When present, a chalky yellow to green fluorescence under ultraviolet light is a good indicator of maxixe-type beryl, which otherwise is absent in aquamarines. However, many resin-treated aquamarines display similar fluorescence, therefore, one needs to be careful while making separation of these beryl types using fluorescence. ✦ **Gagan Choudhary**



7. Dominant blue colour directions in aquamarine and maxixe-type blue beryl.

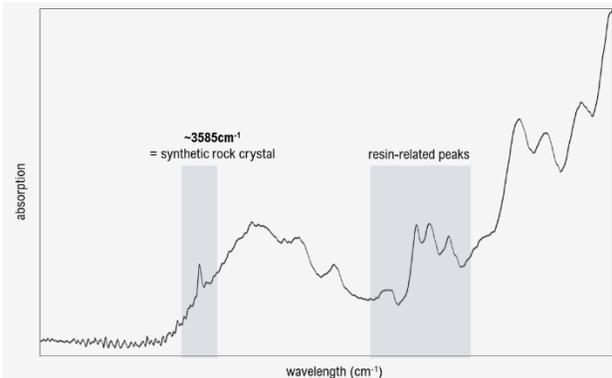
DYED SYNTHETIC ROCK CRYSTAL

In past few months, the IIGJ-RLC at Jaipur received few yellow-coloured beads – loose and strung for identification. All these beads displayed eye-visible colour concentrations against a colourless body. Detection of dyeing was straightforward, while the chequerboard pattern of colour concentrations was consistent with “quench-crackling”. Anisotropic reaction under polariscope and spot RI of 1.54 suggested the bead to be quartz (rock crystal); presence of fractures restricted the visibility of bull’s eye optic figure. Other than the surface reaching fissures with dye, no inclusions were present.

As a routine process, infrared spectra were collected for all such beads, which confirmed them as quartz. However, presence of strong feature at ~3585cm⁻¹ and absence of features at ~3595 and 3480cm⁻¹ confirmed these as synthetic rock crystals. In addition, strong resin-related peaks in the region 3200-2800cm⁻¹ were also present, which further confirmed the use of organic coloured dye in fissures.



8. This 4.05ct bead was identified as dyed synthetic rock crystal.



9. Infra-red spectrum of the 4.05ct bead confirmed its synthetic origin and presence of artificial organic dye.



Since this yellow colour is already available in large quantities and at cheap prices, purpose of dyeing synthetic rock crystal after quench-crackling is unclear. ✦ **Gagan Choudhary & R. Lalitha**



SPURRITE – ANOTHER UNUSUAL GEM

Recently, the IIGJ-RLC, Jaipur received a 16.31ct triangular cabochon, measuring 28.00 x 23.00 x 2.00 mm for routine identification. At first glimpse, the cabochon displayed parallel bands / zones, commonly associated with parting planes; this feature along with its violet colour suggested that the cabochon requires detailed analyses. The laboratory previously had encountered few violet to purple ornamental gemstones, such as sugilite, charoite, heterosite-purpurite, etc., but this sample appeared something unusual.

At higher magnifications, parallel bands / zones appeared to be planes containing some whitish and cloudy inclusions, suggesting that they are indeed parting or twinning planes. In addition, some unoriented white streaks were also present. Spot RI was measured at ~1.63 with observable birefringence blink, while hydrostatic SG was measured at ~3.01. No observable fluorescence was present under longwave- or shortwave UV and no spectrum was observed.

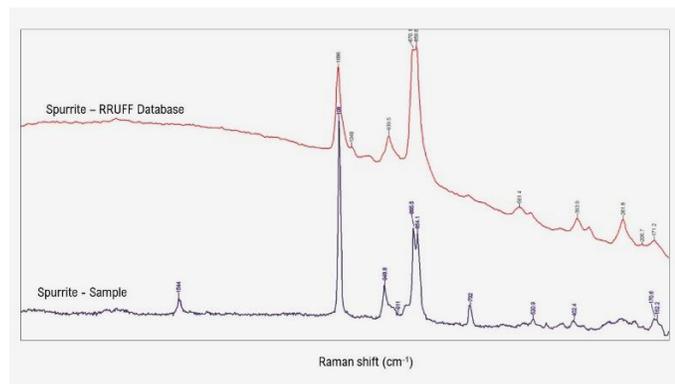
Raman analyses performed from multiple points revealed similar peaks at ~261, 370, 395, 520, 560, 702, 860, 870, 940 and 1085 cm^{-1} . This spectral pattern matched with that given for spurrite in the RRUFF database. EDXRF analysis revealed Ca and Si as major elements, while Al, Mg, S, P, Fe, As, K, as impurities. This chemical distribution was also consistent with spurrite.

Spurrite is a $\text{Ca}_5(\text{SiO}_4)_2\text{CO}_3$ mineral occurring in white, gray, purple and violet colours forming in contact metamorphism zones of carbonate rocks and magma. As a result, it is often associated with other carbonate and silica-rich minerals. The best-known source of spurrite is Mexico and Ireland but is also found in the USA (California), Scotland, Turkey, Israel, and Russia. However, the origin of sample described here is not known. ✦

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10. This 16.31ct cabochon submitted at the IIGJ-RLC Jaipur laboratory was identified as spurrite.



11. Raman spectra of tested sample matched with that of spurrite given in the RRUFF database.



QUARTZ, COLOURED BY MALACHITE

There are numerous gem materials, which are coloured by various types of minerals present in the form of grains, crystals or flakes within the host mineral or concentrated within their fissures and /or cavities. Recently, the IIGJ-RLC, at its Jaipur laboratory received a freeform polished specimen weighing 31.60ct, which displayed concentration of green colour within the fissures of pale, near colourless host – such features are commonly associated with dyed materials. Examination under the microscope further revealed the presence of liquid fingerprints giving a cloudy appearance to the sample; in addition, green colour was restricted to fissures.



12. This 31.60ct quartz specimen is coloured green by malachite within the fissures.

However, careful examination further indicated that the fissures displaying green concentrations were quite wide and appeared solid, which suggested that the material in the fissures was rather a natural mineral and not dye.

Raman spectra (with 532 nm laser) of the host and green material in fissures agreed with those of quartz and malachite present in laboratory's as well as RRUFF database.

This specimen could easily be misidentified as a 'dyed' specimen, and hence reminds us of importance of careful observations. ♦ **Gagan Choudhary**



'ZACHERY' TREATED TURQUOISE

A proprietary treatment developed in late 1980s uses inorganic substances to fill the pores of medium to high quality turquoise – the purpose and result remains improvement of colour, lustre, and durability. The treatment involves more advanced process of filling and because of the use of inorganic substance, treated turquoise by this process are more durable compared to those treated with polymers / resins i.e., 'stabilised'.



13. Polymer treated 'stabilised' turquoise (top) and 'Zachery-treated' turquoise (left). Note the difference in surface lustre of the two specimens – 'Zachery-treated' turquoise is much brighter and appear glassy.



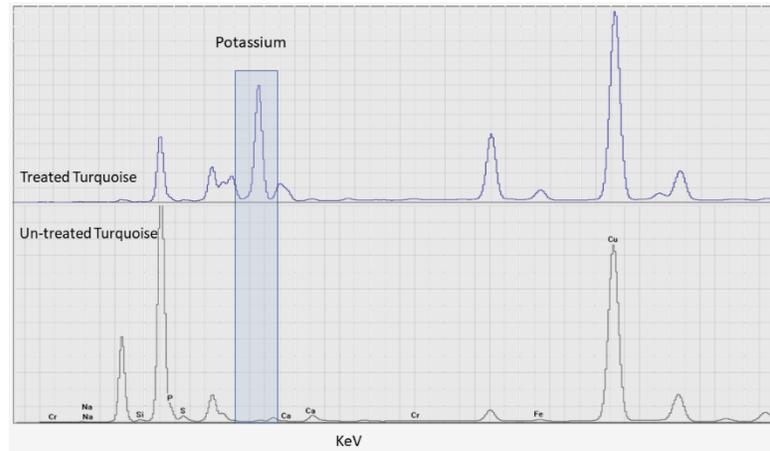


Due to its proprietary nature, exact details of the treatment and its process are not available, however, advanced spectroscopic analyses at molecular levels reveal the use of potassium-based compound, which also forms the basis of its detection.

For past many years, Zachery-treated turquoise was rarely seen at the laboratory, however, during the past few months, there has been an increase in encounters of such treated turquoise. The treated samples submitted for routine identification at the IIGJ-RLC Jaipur laboratory ranged in colour from sky blue to blue, without any matrix, and with a glassy appearance. Microscopic observations displayed white cloudy areas, typically seen in turquoise. No crevices or cavities with colourless or coloured polymer were observed.

Chemical analysis (in EDXRF) is a powerful tool in detection of the 'Zachery' treatment. Hence, as a routine, all turquoise samples submitted for identification undergo EDXRF analyses. All 'Zachery' treated stones displayed high concentration of potassium, while it was either absent or present only in minor quantities in non-Zachery treated counterparts.

Considering that all treated turquoise requires a clear disclosure, the IIGJ-RLC mentions the following comments on its identification reports for 'Zachery-treated' turquoise: "Impregnated with potassium containing compound also known as "Zachery treatment". ✦



14. 'Zachery-treated' turquoise (top trace) displays high concentration of potassium, which is absent in natural turquoise (bottom trace).

Gagan Choudhary & R. Lalitha

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