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'DYED' AND 'SMOKE' TREATED OPAL

Since the last 10-12 months, the Gem Testing Laboratory is routinely receiving opals for identification with unusual body colours such as blue, purple, pink, etc. displaying bright spectral colours on the surface, 'play of colour'. Further, few black opals have also been encountered, which is the most sought after and rarest of the opal varieties. This is because of the fact that dark body colour enhances the 'play of colour' effect, dramatically. While, the best qualities of natural black opal originate from Australia, little quantity is also reported from Honduras; some dark brown material is reported from Indonesia and even Ethiopia. The fancy colours mentioned above were proved to be 'dyed' while the black ones, 'smoke-treated'.

Figure 1: Dyed (left & centre column) and Smoke-treated opals (right column)

In addition to the colours described above, the past few years have seen a remarkable increase in supply of white to yellow opals in the trade, with strong 'play of colour' flashes at relatively much cheaper prices than the Australian counterpart. Due to extensive abundance of this material, gem laboratories already expected to see treated versions in a variety of colours.

The spot RI of the encountered opals was measured in between 1.41 and 1.45, while SG in the range of 1.68 - 1.76; these opals did not show signs of porosity while taking SG readings. This might be due to the treatment performed. These properties are consistent with those reported for white to yellow Ethiopian opals from Wollo (see e.g. B. Rondeau et al., "Play-of-color opal from Wegel Tena, Wollo Province, Ethiopia," Summer 2010 *Gems & Gemology*, pp. 90–105).

Visual observations with or without magnifications are the key to separate these dyed and smoke-treated opals from natural counterparts. The fancy body colours such as blue, purple, pink, orange etc. along with strong 'play of colour' patches are quite apparent and should readily raise the suspicion regarding the colour origin. However, in case of black opal, higher magnifications are required. Under magnification, these opals displayed a characteristic cellular 'play of colour' or a 'digit' pattern along with some cloudy interstitial areas; the features typically associated with opals from Wollo, Ethiopia. Careful observation of these opals under the microscope helps to detect the presence of treatments. Dyed as well as smoke-treated opals display concentrations of the impurities, namely dye and smoke (in the form of carbon). The best place to observe these features are the surface breaks or cavities. The dyed stone will display concentrations of colouring agent within the surface breaks, fractures or cavities while smoke treated opals will display some black to brown cloudy patches of carbon. Another feature to observe is the depth of body colour, where a dyed opal will not be evenly coloured throughout the stone, and the colour will be restricted mainly towards the surface.

Research has shown that the dyes used to produce these fancy colours in opal are soluble in acetone or any other alcohol (see e.g. Renfro N. & McClure S.F. A new dyed purple opal, http://www.gia.edu/research-resources/news-from-research), while, smoke treated were not affected by acetone. These however, produced some whitish to gray clouds after soaking in lime juice for around six hours.

Although, unusual body colours raise the suspicion regarding the presence of treatments and is more readily identifiable, but identification will become much more challenging when dyes are present in more usual colours such as orange or brown.

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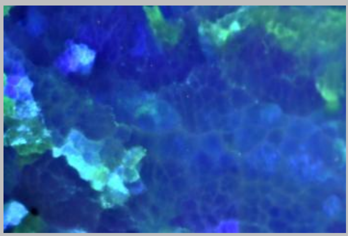
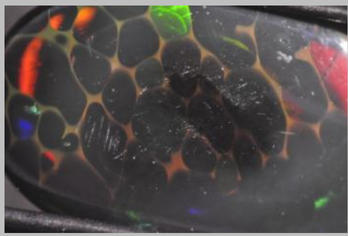
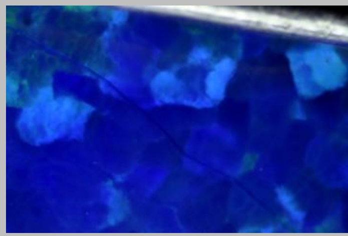
Box A: Features observed in 'dyed' and 'smoke-treated' opals



a. Cellular or digit pattern and cloudy areas are typically associated with opals from Wollo, Ethiopia.



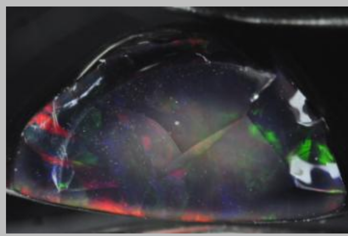
b. The interstitial areas within the digit pattern often appears cloudy in Ethiopian opals



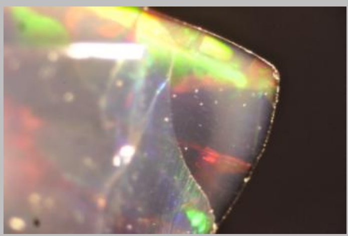
c. Colour concentration along surface reaching crack in dyed blue opal

d. This smoke-treated opal exhibiting brown spots, indicating concentration of carbon

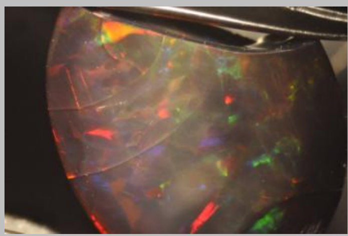
e. Smoke concentration in surface cavities



f. The central area appears light, while the outer rim dark, indicating the penetration of smoke



g. The penetration of smoke is sometimes marked with a sharp outline



h. A smoke-treated opal before immersing in lime juice

i. After immersing in lime juice for 6 hours, this smoke-treated opal displayed cloudy / milky patches

Synthetic Forsterite: synthetic tanzanite or an imitation

There has been a concern amongst the Tanzanite dealers in the recent past regarding the presence of "synthetic tanzanite" in the marketplace, especially in Jaipur, which is often presented as tanzanite. This is encountered not only as cut & polished but also as rough, as broken crystals, that too in large sizes weighing as much as 20 carats. The presence of this synthetic is well known to the dealers, but is misrepresented as "synthetic tanzanite", which is a misnomer. Factually, this material is a "synthetic forsterite" and has no relation with tanzanite, except the appearance, which makes it an imitation for tanzanite. This "synthetic" material is not only presented in Jaipur market but also the mining areas of Tanzania and its local market, in Arusha. Quite often, rough dealers purchase this 'synthetic forsterite' rough from the local dealers in Arusha as natural tanzanite, considering the fact that they are buying the rough at the source. The possibilities of salting a mine cannot be ruled out and as a result, the buyer ends up buying a fake material at the source.

Figure 2: Synthetic Forsterite (left) convincingly imitates Tanzanite (left)

Synthetic Tanzanite...

The term 'synthetic' is used for man-made materials having natural counterparts and possessing all properties - chemical, optical and physical, similar to natural counterparts. However, the properties of the material referred here are completely different from tanzanite and hence does not fit into the definition of 'synthetic tanzanite'. ***Hence, synthetic forsterite is not synthetic tanzanite, but an imitation of tanzanite.***

Fortunately till date, there are no reports of successful synthesis of tanzanite.

Forsterite is found naturally as an end member of olivine isomorphous series (Magnesium Silicate), better known as peridot, found in green, yellow green or brown green colours.

But, this tanzanite imitation is blue in colour with slightly greenish, pinkish or purplish secondary shades, making it a very good and deceptive imitation for tanzanites.

K. Nassau described synthetic forsterite in 1994 but then it did not become available in the market. The material started to appear in the trade by the end of last century and beginning of 2000 due to the increasing popularity of tanzanite. The material is synthesized by the 'Czochralski' or 'Crystal Pulling' process. Other colours of synthetic forsterite such as blue-green, colourless and olive green have also been reported, but these are not widely produced.

The below table illustrates that the properties of synthetic forsterite is quite different from tanzanite, and hence the material is not considered as "synthetic tanzanite" but an imitation of tanzanite. The gemmological properties of tanzanite and synthetic forsterite are quite distinct and readily assist in separating the two materials, especially for a reasonably equipped gemmologist, but it may still create problems for the traders who are usually equipped only with a hand loupe (10x).

The best and reliable method to separate tanzanite from synthetic forsterite is to look for doubling of facet edges from the opposite side. One has to observe the stone from the table or crown of the stone, concentrating on the facet edges of the pavilion side and vice-versa. In place of a single facet edge, when viewed from the opposite side, this will appear doubled in synthetic forsterite. This effect is due to the high birefringence of 0.035 in synthetic forsterite as compared to 0.008 of tanzanite.

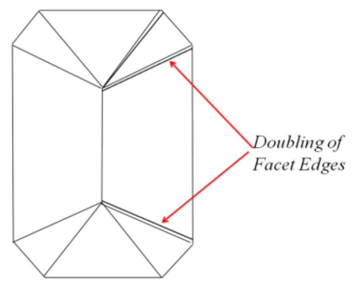


Figure 3: Doubling of back facet edges in synthetic forsterite

It is not only necessary to be aware and alert about the presence of synthetic, man-made and treated materials, but also to correctly define and name them to achieve better communication and disclosure policy.

Following table overviews the properties of tanzanite and synthetic forsterite

Properties	***Tanzanite***	***Synthetic Forsterite***
Chemical Composition	Calcium Aluminium Hydroxyl Silicate $Ca_2(Al.OH)Al_2(SiO_4)_3$	Magnesium Silicate Mg_2SiO_4
Hardness	6	7
Toughness	Fair	Good to excellent
Specific Gravity	3.35	3.23 - 3.25
Optic Character	Anisotropic, biaxial positive	Anisotropic, biaxial positive
Pleochroism	Distinct trichroism: blue, purple pink, brownish or yellowish green (in unheated); heated tanzanite display two colours, namely blue and purple pink	Distinct trichroism: blue, violet and purplish pink
Refractive Index	1.692 - 1.700	1.645 - 1.680
Birefringence	0.008	0.035
UltraViolet Fluorescence	Inert	LW: chalky orangy yellow SW: weak greenish yellow
Absorption spectrum	Broad absorption at around 595 nm and weak bands at 530 and 455 nm	Bands at around 520 and 580
Inclusions	Liquid fingerprints, phase, long tubes, etc.	Pinpoint scattered inclusions and gas bubbles

Quartz with acicular emerald inclusions

Quartz with randomly distributed tourmaline and/or rutile needles is widely available in the market. These gems are often described as “tourmalinated” or “rutilated” quartz, respectively. Recently, the Gem Testing Laboratory in Jaipur examined a quartz specimen that contained eye-visible emerald crystals (figure 4). Although intergrowths of emerald and quartz and a notable emerald-in-quartz specimen have been reported previously (e.g., *Gems & Gemology*, Lab Notes: Summer 2000, pp. 164–165; Fall 2008, p. 258), this specimen was quite different.

Figure 4: This quartz cabochon was unusual for its eye-visible inclusions of elongated emerald crystals

The light smoky - gray 45.85 ct marquise-shaped cabochon measured 37.60 x 18.26 x 11.57 mm. The prominent green inclusions displayed an acicular habit (figure 5). The green color and hexagonal

Figure 5: Acicular emerald crystals in quartz

profile (figure 6) strongly suggested emerald, but their acicular habit raised some doubts, as emeralds typically show a more columnar habit. Most of the crystals also displayed basal parting planes, reminiscent of the actinolite blades found in emeralds from the Ural Mountains of Russia. Some also displayed color zones following the prism faces, while others contained rain-like inclusions.

To conclusively identify the inclusions, we examined the sample under a desk-model spectroscope. It revealed a spectrum consistent with emerald, featuring a doublet in the red region and an absorption band in the yellow-green region. Further confirmation was obtained by FTIR, which displayed a typical emerald spectrum (figure 7). IR spectroscopy also confirmed the host material as quartz, which was supported by a spot RI of 1.54 and a hydrostatic SG of 2.65.

Textural relationships indicated that the emerald crystals formed before the host quartz (i.e., they are protogenetic). Emerald is known to occur within quartz, but this sample was quite unusual for the crystals’ acicular habit and their occurrence as inclusions, not merely in association with the quartz or as an intergrowth.

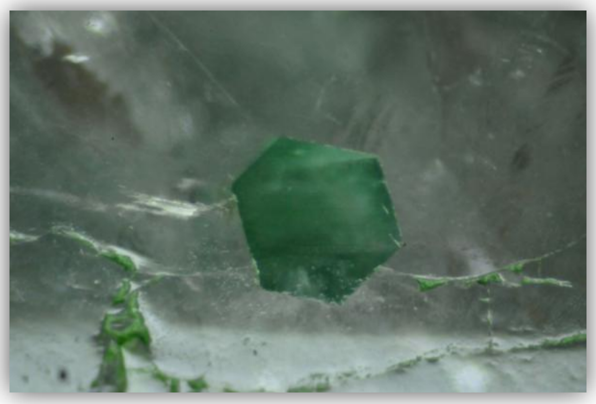


Figure 6: Emerald crystals showing hexagonal profile

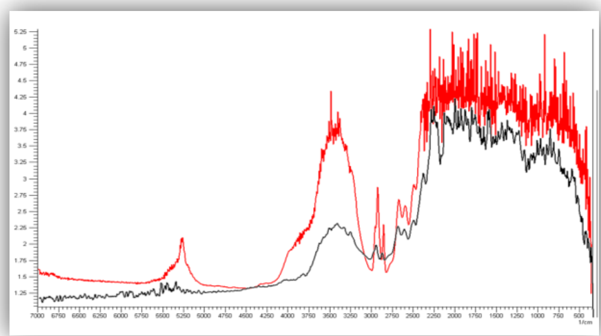


Figure 7: FTIR Spectra of quartz (black) and emerald (red)

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