GIA GEM TRADE LAB NOTES

Editors
Thomas Moses ◆ Ilene Reinitz
Shane F. McClure
GIA Gem Trade Laboratory

Contributing Editors
GIA Gem Trade Laboratory, East Coast
G. Robert Crowningshield
GIA Gem Trade Laboratory, West Coast
Karin Hurwit ◆ Mary L. Johnson
Cheryl Y. Wentzell

AQUAMARINE, Unheated Carving

Aquamarine is usually heat treated at a low temperature to change its inherent green-to-blue color to one that is predominantly blue (see Lab Notes, Spring 1997, p. 58, and references therein). On rare occasions, however, we receive predominantly green aquamarine for testing. Such occasions always spur us to question whether the material is unheated, a substantial gemological challenge because there are few differences in the properties of natural-color and heat-treated aquamarine.

The carving shown in figure 1, seen last fall in the East Coast Gem Trade Laboratory, is a gemologically interesting (and visually attractive, with its fish-and-sea motif) example of untreated aquamarine. Although the curved surface made it impossible to obtain a clear refractive index, we saw a uniaxial optic figure with the polariscope. The carving showed vitreous luster, and testing in an inconspicuous spot revealed a hardness greater than 7 on the Mohs scale. It was inert to both long- and short-wave ultraviolet radiation. With magnification, we saw sparse crystals and fractures, as well as intact two-phase inclusions. These properties suggested that the object was aquamarine, and the color and inclusions pointed to unheated material, but further testing was required to confirm this identification.

Figure 1. The predominantly green color and diagnostic absorption spectrum of this aquamarine carving, which measures approximately 16.0 × 11.0 × 9.0 cm, indicates that the material was not heat treated, unlike most aquamarine seen in the trade.

Using a desk-model spectroscope, we saw an unexpected, rather strong, narrow absorption band at 537 nm, in addition to the strong line at 427 nm that is normally present in aquamarine and the weaker one at 456 nm that is often visible. A check of the literature changed this observation from a source of concern to one of confirmation. In the several editions of Webster's *Gems* (e.g., 4th ed., Butterworth, London, 1983, p. 119), it is reported that this 537 nm line is seen only in untreated aquamarines and in yellow and colorless beryls. Because we observed the spectrum through a large thickness of material, this usually weak absorption line showed up quite strongly.

GRC and TM

Editor's note: The initials at the end of each item identify the editor(s) or contributing editor(s) who provided that item.

Gems & Gemology, *Vol. 33, No. 4, pp. 292–296*

”1997 Gemological Institute of America

BERYL, Treated Color

Last fall, the East Coast lab was asked to identify the 16.40 ct violetish blue cushion-shaped stone shown in figure 2, which was being sold as a tanzanite simulant. The stone had the color appearance of tanzanite, for which there are several simulants, but ultimately we proved it to be a new twist on an old treatment of a different gem mineral. A uniaxial optic figure was seen easily, with the axis making an angle of about 30° to a line from the culet through the center of the table. We measured refractive indices of 1.575 and 1.580, and we obtained a specific gravity of 2.74 using the DiaMension noncontact measuring system. These three properties indicate the mineral beryl, which is known to occur in many colors.

Most colors of beryl are referred to by their own gem variety name, such as emerald (saturated green), aquamarine (pale to medium dark bluish green to blue), and morganite (pink). Dark blue beryl was found in the Maxixe mine of Minas Gerais, Brazil, in 1917. However, interest in the material waned when it was discovered that the color faded with exposure to light. Decades later, in the late 1960s, it was found that irradiation with X-rays, gamma rays, or neutrons could produce a strong dark blue color in some near-colorless or pale yellow, pink, or blue beryls. Consequently, gemological interest in this color of beryl was revived (see K. Nassau and D. L. Wood, "Examination of Maxixe-type Blue and Green Beryl," *Gems & Gemology*, Spring 1973, pp. 130–133, and references therein). At that time, treated-color dark blue beryl was offered in the trade as aquamarine, or more rarely as sapphire (Winter 1972/73 Lab Notes, p. 111). Nassau, Prescott, and Wood compared some of the original Maxixe material (which had been kept in the dark over the decades) with some of the new, treated material and some natural-color aquamarine. They identified three properties unique to all dark blue beryl ("The Deep Blue Maxixe-Type Color Center in Beryl," *American Mineralogist*, Vol. 61, 1976, pp. 100–107).

Figure 2. This 16.40 ct highly saturated treated-color violetish blue beryl was being sold as a tanzanite simulant. Unfortunately, this color in beryl is unstable to light and heat.

The stone we examined at the East Coast lab clearly exhibited two of the three properties described in the 1976 article: (1) strong pleochroism, with blue seen along the ordinary ray (looking parallel to the optic axis) and light brown along the extraordinary ray (looking perpendicular to the optic axis); and (2) six sharp, closely spaced lines in the visible spectrum, as viewed with a desk-model spectroscope, across the orange and red wavelengths from 575 to 690 nm. In contrast, aquamarine shows a blue pleochroic color along the extraordinary ray, and one or more "iron" lines in the blue region of the spectrum.

The third distinctive property of dark blue beryl is that stones cut from either the original natural material or treated-color dark blue beryl fade readily on exposure to mild heat or strong light. Nassau and co-authors found that one week of exposure to a 100 watt light bulb at a distance of 6 inches (15 cm) diminished the blue color by at least 50%, and that heating to 235°C removed any remaining blue color. The color can be restored by irradiation. Although we did not test our stone for this third property, we did add a comment on the report stating that this color in beryl is not stable. *IR and TM*

DIAMOND

Acting as a Heat Sink

In addition to being an important gem material, diamond has many industrial applications, and occasionally we see manifestations of diamond's physical properties in the Gem Trade Laboratory. One property that is used to distinguish diamond from most of its imitations is that of thermal conductivity: Heat is rapidly transferred from one side of a diamond to the other, and diamond is more efficient at transferring heat than any other material. Because of this property, blocks of either synthetic or natural diamond are used as "heat sinks" in some electronic circuit boards, transferring heat away from components that generate it, thereby cooling down the hot component and its local area. Faceted diamonds also conduct heat rapidly; otherwise, jewelers would have to take far more precautions when working on diamond-set jewelry. In general, however, this property is taken for granted in the gem trade.

A 2.40 ct round brilliant that came into the West Coast laboratory this summer served as a reminder that diamonds should never be taken for granted. The diamond was stored in GTL's standard transparent plastic box with its pavilion sunk into dark gray plastic foam. When the preliminary grader went to examine the diamond, he saw that the box had warped around the table of the diamond (figure 3). The box label, which was made from a piece of thermally activated paper (similar to thermal facsimile-printer paper), had discolored locally in the area near the stone. The inside surface of the lid showed a perfect impression of the diamond's table and adjacent facets (figure 4). The diamond itself had typical proportions and color, and was not "hot"

Figure 3. This 2.40 ct round brilliant diamond melted the lid of the plastic box in which it was held and discolored a piece of thermal paper nearby, shown here at the bottom.

Figure 4. The inside surface of the plastic lid shown in figure 3 carried an impression of the 5.56 mm table of the diamond that had transferred heat to it.

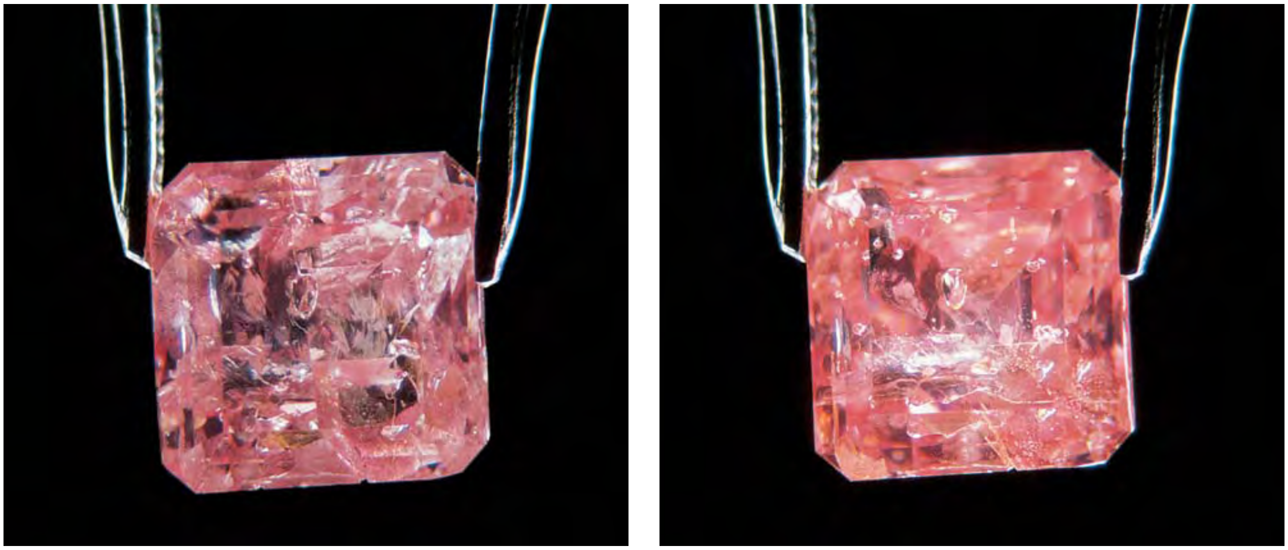
to the touch; nor did it demonstrate any radioactivity when tested with a handheld Geiger counter. So another explanation was required for the "meltdown."

We believe that the following scenario accounts for the deformation of the plastic box: Evidently, the box had been on top of the grader's stack of work items, directly in the beam of a high-intensity Tensor desk lamp, at a close distance. The dark plastic foam absorbed radiation from the Tensor lamp and grew hot. The diamond transferred this heat to the lid of the box, which melted locally; however, the stone itself was not damaged by this event. *MLJ*

Fracture-Filled Pink Diamond

A 1.39 ct square-emerald-cut diamond that we saw numerous times over the last year (both before and after several fracture-filling treatments) gave us a new perspective on the difference in color as well as clarity that such treatment can produce. Before filling, this emerald-cut stone showed a saturated pink color that was somewhat obscured by the abundant fractures, which created a white appearance across a large portion of the crown (figure 5, left). The pink graining and 415 nm line seen with a desk-model spectroscope unit proved that the color was natural, and in this state (before treatment) the stone

Figure 5. The many white fractures in this 1.39 ct Fancy Intense Pink emerald-cut diamond (left) detract from the color. After the diamond was subjected to several episodes of fracture filling, most of the fractures appeared to be transparent and the stone revealed a highly saturated pink color in the face-up color-grading position (right). However, now that the diamond has been treated, the Gem Trade Laboratory can no longer issue a color grade for it.



received a grade of Fancy Intense Pink.

Because there were many fractures of different thicknesses, some of which were interconnected, it took several treatments to produce the desired effect. Although the clarity of the diamond after treatment was not significantly improved, the color appearance was much better (figure 5, right). The fracture-filling procedure made most of the fractures appear transparent rather than white, allowing the inherent color to show more fully when the stone was viewed in the face-up position. (As we have stated many times in the past, however, the GIA Gem Trade Laboratory does not offer grading services for clarity-enhanced diamonds, so no new color grade was issued.)

The durability of diamonds that have undergone fracture-filling treatment is a continuing concern to many in the trade, and this diamond also provided one example in that regard. Like many other pink diamonds, this one showed strong anomalous birefringence with high-order colors, an indication of high levels of strain within the original crystal. As mentioned previously, the treatment process was repeated several times to achieve the final result. Although the fracture-filling process involves heat and some changes in pressure (as discussed in R. C. Kammerling et al., "An Update on Filled Diamonds: Identification and Durability," *Gems & Gemology*, Fall 1994, pp. 142–177), this particular diamond survived the treatment intact.

IR

Mysteriously Fractured Diamonds

Occasionally, clients ask us whether fractures can appear in diamonds spontaneously, without any apparent cause. Typically, they report that a diamond of documented clarity is stored under ordinary conditions in a safe with other diamonds, and sometime later it is observed to be substantially fractured. The 2.93 ct crystal and the 0.73 ct polished round brilliant shown in figure 6 were loaned to the East Coast laboratory by a client who made this very claim. Both diamonds showed large eye-visible fractures and cleavages. The cut stone had no polishing drag lines emanating from the fractures where they reached the surface, which indicates that the fracturing occurred subsequent to the last polishing. Further examination with magnification did not reveal any kind of surface trauma, as often occurs if the diamond is subjected to some kind of blow. These observations support the client's claim that the fracturing was recent, but they do not eliminate the possibility that the stone was damaged from exposure to stress during setting or another circumstance.

The case of the crystal is even more perplexing, since it had not undergone any manufacturing and probably had never been exposed to any jewelry-setting procedure. On the basis of the available information, we can only surmise that both diamonds were highly strained and that the fracturing was spontaneous. Examination of both stones between crossed polarizing filters showed moderate strain but no high-order interference colors. It is possible that some of the strain was relieved when the fracturing occurred. Although we are not certain exactly what happened to these diamonds, this is the first time we have been able to examine two stones that appear to have fractured spontaneously. We have not yet been able to document such an occurrence firsthand, but we have found one reference in the literature supporting this possibility (see Yu Orlov, *Mineralogy of the Diamond*, John Wiley & Sons, New York, 1977, p. 140). Perhaps one of our readers has had a similar experience and can provide further insight into this conundrum. *TM and GRC*

Figure 6. The owner of these two diamonds, a 2.93 ct crystal and a 0.73 ct round brilliant cut diamonds, hoped that GTL could explain why the stones had apparently fractured spontaneously during routine storage.

GARNET,
A Very Dark Pyrope-Almandite Identified by Raman Spectroscopy

A ring mounted with a large, very dark red oval cabochon was submitted to the West Coast lab for identification. We were able to determine some gem properties on the mounted stone, that is, that it was singly refractive, with a spot R.I. of 1.75, and was inert to both long- and short-wave UV radiation. Because this information was not sufficient to identify the piece, we advised the client that the stone would have to be unmounted.

The loose cabochon measured 21.12 × 16.22 × 11.33 mm and weighed 38.92 ct. Although quite dark, the material was transparent; nevertheless, most of the light entering the stone was absorbed by it, and the absorption spectrum revealed by the spectroscope showed only a narrow transmission region in the red. The specific gravity was 3.76 (measured hydrostatically). When the cabochon was immersed in methylene iodide and viewed with direct transmitted light and magnification., straight parallel bands were visible through the side of the piece.

At this point, we had two possible candidates for the identity of this material: a very dark garnet or a high-refractive-index glass. Five minutes with GIA's new Renishaw Raman spectrometer answered our identification question: the Raman spectrum—with peaks at 360, 560, and 919 cm^{-1} —matched that of pyrope-almandite garnet (and not glass), as confirmed by comparison with reference samples in our collection as well as with two compendia of spectra (a library file that comes with the Raman spectrometer, and "Utilité de la Microsonde Raman pour l'Identification non Destructive des Gemmes," by M. Pinet et al., *Revue de Gemmologie*, June 1992, pp. 12–60). The color and R.I. of this garnet were also consistent with pyrope-almandite.

To confirm the Raman results, we also analyzed the cabochon using energy-dispersive X-ray fluorescence (EDXRF), which showed elements consistent with pyrope-almandite (and no heavy elements such as lead, bismuth, or gold which might be found in a glass with such a high R.I.). Nor did the infrared spectrum match any of the spectra of glasses that we had on file. We therefore concluded that the cabochon was pyrope-almandite garnet.

MLJ, SFM, and JIK

SYNTHETIC SAPPHIRE, Sunglasses

The sunglasses shown in figure 7 represent one of the more unusual uses for a gem material that we have ever seen. Created for British rock star Elton John, the glasses were submitted to the East Coast laboratory by the manufacturer of the lens material for a report to identify the material and document the item.

The blue color and the refractive indices of 1.76 and 1.77 indicated sapphire. Examination between crossed polarizing filters showed a uniaxial flash figure (as described in Wm. R. Phillips, *Mineral Optics: Principles and Techniques*, W. H. Freeman and Co., San Francisco, 1971), which indicates that the optic axis lies in the plane of the lens. Such an orientation allows for easy observation of dichroism—in this case, blue and blue-green—over polarized light (without a dichroscope). The lenses were inert to long-wave UV radiation, and fluoresced a weak, chalky green to short-wave UV. These latter two properties proved that the material was synthetic sapphire.

Figure 7. The lenses in these unusual sunglasses were fashioned from synthetic sapphire. They measure 32.77 mm in diameter and 3.50 and 3.90 mm thick.

The client shared with us some details on the growth of the synthetic sapphire and manufacture of these lenses. The proprietary growth method is carefully controlled to minimize the stress across the growing crystal, producing large areas of synthetic corundum that are free from any inclusions and show no color variations or growth lines (curved striae). To choose a specific area optically suitable for lenses, the manufacturer examined a section of the rough material while it was immersed in oil to reduce light scattering at the as-grown surface. Next, two slabs were sawn from adjacent areas of the rough and with the same optical orientation. They weighed a total of 194 grams (970 ct). A core drill and carborundum slurry were used to cut circles (lens blanks) from the slabs, and parallel faces were ground on the blanks with a steel lapidary wheel that was charged with the slurry. These parallel-sided rounds were then polished with diamond abrasives of successively finer grade (smaller particles) over a period of about a month. The final polish was done at an aerospace company, by a specialist in the machining of hard materials, to achieve high optical quality.

From the dimensions of 32.77 mm in diameter and 3.50 and 3.90 mm thickness for the two lenses, we estimated finished weights of 59.05 and 65.80 ct, respectively. The handmade frames are sterling silver, and have been engraved with the first name of the silversmith, Behrle Hubbuch III. Because of the way these lenses are oriented, they function well as polarizing sunglasses. However, the combined weight of the lens material and the frame might limit the length of time that they could be worn comfortably. *IR*

PHOTO CREDITS

Nick DelRe is responsible for figures 1 and 6. Maha DeMaggio took figures 2–4 and 7. Vincent Cracco photographed the stone in figure 5.