GEM TRADE LAB NOTES

DIAMOND, Light Yellow Treated Color

Clients sometimes ask the GIA Gem Trade Laboratory why Origin-of-Color reports are needed for light yellow or brown diamonds—that is, those without sufficient depth of color to fall in the fancy-color range. A 0.91-ct, light yellow round brilliant that came into the West Coast lab this fall clearly showed that one can never be too careful even with such light-colored stones.

This diamond was a moderate blue transmitter, showed a weak green "haze" with no green graining, and had a moderate localized mottled strain pattern. It fluoresced very strong blue to long-wave ultraviolet radiation and strong yellow to short-wave UV; it phosphoresced weakly to both wavelengths. In the desk-model spectroscope, it showed a moderate Cape spectrum, with weak 498- and 504-nm lines, but no 595-nm line was visible. This spectroscopic information (498 with 504 line, but no 595-nm line), combined with the green haze without graining, provoked our suspicions. UV-visible spectrophotometric measurement detected peaks at 451, 477, 496, and 503.2 nm; a possible 546-nm peak; plus a very faint peak at 595 nm. Mid-infrared spectra showed that the diamond was a type IaB>A (high nitrogen). These spectra also showed peaks at 5163 and 4932 cm^{-1}. These H1b and H1c peaks are considered conclusive proof that a type-Ia yellow-to-brown diamond has been irradiated and annealed.

Although color grades are not assigned to treated diamonds, the color of this stone would be in the T–V range. In our experience, it is most unusual to encounter such a light tone, treated-color diamond. Perhaps it represents a failed attempt to improve the diamond's color without leaving a detectable treatment signature.

MLJ, Dino DeGhionno, Patricia Maddison, and IR

Carved EMERALD Fetish

The carved fetish shown in figure 1 was represented to staff members at the East Coast lab as the emerald centerpiece of a pre-Columbian necklace. Although we could not verify the stone's origin, or even when the necklace was fabricated, the primitive carving and crude drilling certainly suggest an early carving technique. However, unlike some other carved gem materials featured in past Lab Notes, the material from which this 39-ct fetish was carved was easily identified as emerald by its "textbook" properties.

Figure 1. This natural emerald carving, measuring 28.25 × 14.05 × 11.15 mm (39 ct), was represented to be part of a pre-Columbian necklace made up of the pieces shown in figure 2.

Specifically, the refractive index was approximately 1.57 (by the spot method). The absorption spectrum, with its chromium lines visible in the hand spectroscope, was diagnostic of emerald. The classic three-phase inclusions also pointed to the carving being natural emerald.

The material was of exceptional quality for a carving, and it showed no evidence of clarity enhancement (e.g., oiling), although microscopy revealed some surface-reaching fissures. This supports the case for the fetish being a genuine pre-Columbian artifact, as it is unlikely that such fine material would escape faceting today.

Although pre-Columbian gold jewelry is not our area of expertise, we could not help but admire the gold figures that accompanied the fetish. Of particular interest were the three shown in the necklace arrangement in figure 2. From their heft, we

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

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Figure 2. Note the fine craftsmanship of the reportedly pre-Columbian pieces (including the emerald carving featured in figure 1) shown here as they might have been worn on a necklace.

believe that they are solid, and they appeared to have been cast by the lost-wax technique. The figure above the emerald fetish in the center of the necklace was hollow, but it was most likely also cast by the lost-wax technique. This method was used with a high degree of technical proficiency in the pre-Columbian era. According to Warwick Bray, professor of Latin American Archeology at the Institute of Archeology, London (as was reported in *Gem and Jewellery News*, Vol. 3, No. 3, 1994, on p. 43), "The cast ornaments (Panamanian and pre-Columbian) were generally of a gold/copper alloy, which was easier to cast than pure gold and which could be surface treated with vegetable acids to produce a finer gold colour on the surface—what we call depletion gilding today." This gold/copper alloy, known as *tumbaga*, was alloyed in various proportions. *TM*

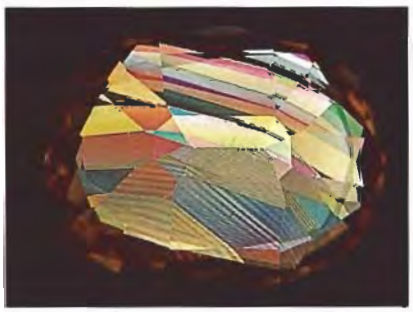
FELDSPAR, Separating Alkali from Plagioclase Species

Faceted yellow feldspars have been coming into the market from a number of localities, including Australia, California, Madagascar, and Oregon. A 5.52-ct faceted stone submitted to the West Coast lab had been represented as sanidine, the potassium sodium feldspar that forms in a high-temperature environment. Although standard gemological tests revealed that the stone was a feldspar, refractive index values of 1.559–1.568 were sufficient to confirm that it was labradorite, not sanidine.

Working with this feldspar reminded us of a comparatively easy test using crossed polarizers that not all gemologists may know about. Although it will not identify the species, it will distinguish some plagioclase feldspars (albite, andesine, anorthite, bytownite, labradorite, and oligoclase) from alkali feldspars (microcline, orthoclase, and sanidine).

When examined with the microscope between crossed polarizing filters, this stone—for example—showed the fantastic, multicolored stripes (figure 3) characteristic of polysynthetic (many-layered) twinning. Polysynthetic twins grow according to twin laws that are only possible in feldspars with triclinic symmetry: microcline and the plagioclases, not sanidine or orthoclase. (Microclines in general are even more twinned than plagioclases and tend to look "plaid" through crossed polarizers.) The stripes in some faceted plagioclases, including the example shown here, are obvious enough to be seen with little or no magnification between crossed polarizers, which makes this a useful field test. Pressed for a quick decision, a gemologist could even look for twinning planes while holding a stone between two pairs of polarized sunglasses placed in the "crossed" position. *MLJ*

Figure 3. The bright stripes seen in this 5.52-ct labradorite feldspar when viewed between crossed polarizers are due to polysynthetic twinning (parallel twin planes). Such twinning is present in plagioclase feldspars, and separates them from the alkali species microcline, orthoclase, and sanidine.



GROSSULAR-ANDRADITE GARNET from Mali, West Africa

In September, a client brought a piece of yellow-green rough to the East Coast laboratory for identification. The client stated that the stone had been mined in the Republic of Mali, in western Africa, but he had

Figure 4. This 16.30 × 15.45 × 12.40 mm piece of rough, a grossular-andradite garnet, is reportedly from Mali.

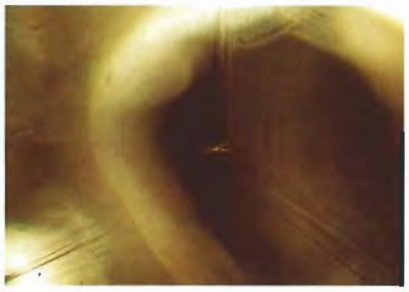


Figure 5. Dodecahedral growth faces (seen here in polarized light) and a small wispy horsetail inclusion are evident in the stone in figure 4 at 50× magnification.

received conflicting opinions regarding its identity (chrysoberyl versus tsavorite garnet).

The transparent material (figure 4) measured approximately 16 × 15 × 12 mm and weighed 25.35 ct. Since it was unmounted and had a fairly flat surface, we were able to determine its optical properties by standard gemological testing. It had a single refractive index of 1.77, but showed strong anomalous birefringence when viewed in the microscope between crossed polarizers. When we examined the piece with a microscope, we saw an unusual pattern resembling dodecahedral growth faces, which was even more pronounced under polarized light; we also found a small, wispy "horsetail" inclusion (figure 5). The spectroscope showed a broad absorption band at 440 nm and a 600-nm line, as well as a possible feature at 500 nm. The specific gravity of 3.65 was determined by hydrostatic weighing. These properties do not fall within the range of properties that characterize either grossular or andradite garnet (e.g., the R.I. is too high for grossular and too low for andradite). Since these findings were not sufficient to identify the material, the stone was sent to the West Coast laboratory for further testing.

X-ray powder diffraction analysis gave a typical garnet pattern. The unit-cell spacing from this pattern and the specific gravity matched the values charted in Deer, Howie, and Zussman's *Introduction to Rock Forming Minerals* (Longman Group, London, 1974) for a garnet intermediate between grossular and andradite, with probable composition 68%–75% grossular, 32%–25% andradite. We confirmed this using EDXRF, which revealed small amounts of Mn, Ti, and V in addition to the major elements Si, Al, Ca (from the grossular component), and Fe (from the andradite). A UV-visible spectrum showed Fe^{3+} peaks at 434, 575.5, and 872 nm. There was no evidence of chromium from either test. Therefore, we concluded that it was a grossular-andradite garnet.

KH, MLJ, and Emmanuel Fritsch

JADEITE JADE

Bleached and Impregnated, with Distinctive Surface Features

We continue to encounter bleached and impregnated jadeite ("B jade") on both coasts, which has enabled us to support and expand the observations in "Identification of Bleached and Polymer-Impregnated Jadeite" (Fritsch et al., *Gems & Gemology*, Fall 1992, pp. 176–187). Consistent and conclusive identification still requires infrared spectroscopy. In some cases, however, careful examination of the surface with a binocular microscope and a variety of lighting techniques may provide useful clues. One such case was a fine-quality bangle bracelet (figure 6) tested at the East Coast laboratory.

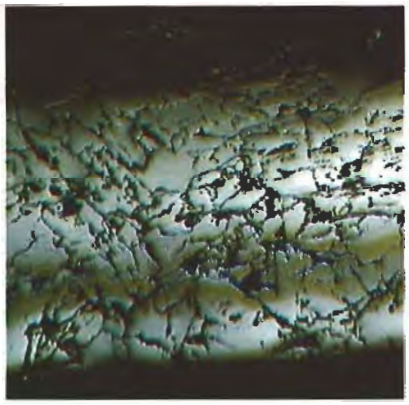
The change in surface texture produced by the treatment was described briefly in the above reference and in greater detail by Ou-Yang Chiu Mei in *Jewellery News Asia*, December 1993, pp. 96–100. The acid treatment removes the usually brown impurities that outline individual crystals of jadeite and detract from the jade's overall appearance. At this stage, the grain boundaries are obvious and, due to the crystal habit of jadeite, may form a honeycomb pattern. Following the "bleaching" step, the jadeite is impregnated with a neutral-color polymer or wax. This substance fills the voids left by removal of the impurities and makes the item appear more uniformly colored and more transparent. In addition, the grain boundaries are less visible after impregnation, although they may still be seen with the microscope. In her article, Mrs. Ou-Yang states that "For more severely treated jadeite, the structure looks like a beehive . . . the changed feature is the fingerprint for identifying type-B." The bleaching process weakens the jade, and both Mrs. Ou-Yang and Mr. Tay Thy Sun (*JewelSiam*, November–December, 1992, pp. 98–100) point out that although impregnation reduces the visibility of the bleaching treatment, it does not restore the original toughness.

We have experimented with different lighting techniques to detect this honeycomb structure after impregnation. Although it may be visible in some pieces with strong transmitted fiber-optic light, we saw it best with reflected light in this bracelet and a cabochon examined recently (figure 7).

In addition, with diffuse reflected light, we detected filled cavities, reminiscent of those seen in treated rubies, in the bracelet. However, these did not have the appearance of a surface residue, which has been noted before in both treated and natural jade; rather, they were actually "finished," or smoothed over, so they were flush with the polished surface. The wax normally used to finish a piece of jade flows and then resolidifies when tested with a "hot point."

Figure 6. Characteristic surface features indicated, and IR spectroscopy proved, that this jadeite bangle bracelet had been bleached and polymer impregnated.

Figure 7. At 40× magnification under diffused reflected light, the surface of this jadeite cabochon shows the unusual texture—actually, the outline of many individual jadeite grains—seen in some "B jade."



However, the material in these filled areas burned slightly when the thermal reaction tester was brought close to their surfaces, a reaction typical of a polymer. To observe the reaction best and to minimize potential damage to the item, we performed this test under magnification.

Corroborative testing with infrared spectroscopy showed strong absorption between 2800 and 3000 cm^{-1}, which is diagnostic of polymer treatment. We tested the bracelet in several areas to see if the filled cavities showed greater infrared absorption than the rest of the bracelet. However, we recorded very strong absorption in all the areas selected. Note, too, that the bracelet floated in methylene iodide, indicating a specific gravity range of about 3.20–3.25, as would be expected for most "B jade" (and lower than the average 3.34 for untreated jadeite).

This bracelet also gave us the chance to use two unconventional tests mentioned in the Fritsch et al. 1992 article. When the bracelet was gently tapped with steel forceps, the sound emitted was clearly muffled or dull, unlike the higher-pitched "ring" that untreated jade would emit. This supports an observation made by some dealers. Also, a drop of hydrochloric acid (HCl) remained intact on the surface; with untreated jade, "sweating" is observed around the droplet on the nearby surface of the stone after only a short time

(*Gems & Gemology*, Fall 1992, p. 180). *TM and IR*

Spotted MALACHITE, Imitation and Natural

Many ornamental materials are recognized by their coloration patterns. One obvious example is malachite, which usually has opaque green parallel bands of the same hue but of variable tone or saturation. Two pieces of jewelry, set with material having this characteristic appearance, were submitted to the West Coast lab for identification.

The necklace contained a number of bezel-set 11 × 9 mm stones, with prominent banding that ranged from medium to pale green (figure 8). The material had a spot refractive index of 1.55 and effervesced slightly to a weak HCl solution. It showed conchoidal fracture and fluoresced a weak green to long-wave UV radiation, with a fainter green fluorescence to short-wave UV. Because the material was mounted, we could not determine specific gravity. However, on the basis of the presence of small

Figure 8. Banding can be seen in this 9 × 11 mm segment of a necklace. The swirled appearance of one of the bands helped identify the material as a malachite imitation. Magnified 10×.

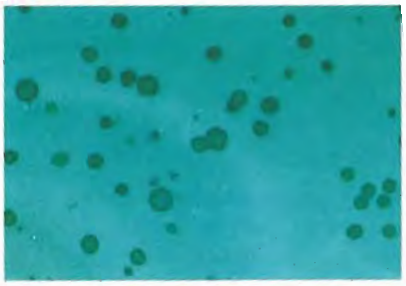


Figure 9. These "spots" on an 18.0 × 3.8 mm segment of a multiple-piece bracelet are similar to those seen on a natural malachite in the GIA collection. Magnified 10×.

bubbles, the "swirly" appearance of one of the bands (again, see figure 8), and the only slight effervescence, we suspected that it was a manufactured substance.

With the client's permission to perform destructive tests if necessary, we applied the thermal reaction tester in an inconspicuous spot: The material turned chalky white, melted easily, and flowed away from the test point. We thus confirmed that it was a malachite imitation.

The second, similar-appearing material was an 18.0 × 3.8 mm polished trapezoid that was set in a bracelet with obsidian, sodalite, imitation sugilite, and imitation turquoise. Given its "swirled" background color banding, the dark green spots on the lighter banded background, and the apparent conchoidal fracture, a first glance would indicate that this could also be a malachite imitation. However, refractometer testing indicated a strong birefringence "blink," and the material effervesced strongly to the weak HCl solution. The darker green spots (figure 9) had a somewhat higher relief (i.e., were more resistant to polishing) than the lighter green background. One dark corner of the background material was slightly translucent, while the rest was opaque. Furthermore, the material was inert to both long-wave and short-wave UV. These test results pointed to malachite as the identity.

We compared this stone to a natural malachite cabochon from the GIA GTL reference collection that also had small green spots with elevated relief on the surfaces of some striped bands. Unlike the response of the imitation malachite described above, the TRT produced a small brown spot where it touched the reference cabochon. When, again with the client's permission, we tested his material with the TRT, a similar dark brown spot was produced. This further confirmed that the unknown material was indeed natural malachite, which had probably been sliced parallel to the plane of the malachite banding.

MLJ, John I. Koivula, and Cheryl Y. Wentzell

Figure 10. This 12-mm "mabe" has been fashioned from a cultured abalone blister pearl.

Figure 11. Regular mother-of-pearl shell was used to back the "mabe" in figure 10.

PEARLS

Abalone "Mabe" Pearl

"Mabes" made with blister pearls cultured in the abalone shell (*Haliotis rufescens*) from North America were introduced to the participants of the Pearls '94 International Pearl Conference held in Hawaii last May. Thanks to a generous donation to the GIA reference collection, our West Coast laboratory staff subsequently had the opportunity to examine a sample (figure 10).

All of the abalone "mabes" seen thus far have had round button shapes, averaging approximately 9 to 14 mm in diameter. The demarcation line between the abalone blister and the backing was easily seen in our sample because the blister had been backed with ordinary mother-of-pearl shell (figure 11) rather than abalone shell. However, the blisters showed all the qualities that are characteristic of abalone pearls: attractive color combinations in green, blue, pink, and lavender; extremely high, almost metallic luster; and fairly transparent nacre. With high magnification, we noted that the nacre layer showed a fine cellular structure (figure 12). The characteristic appearance of the blister-pearl portion, as well as its strong yellow fluorescence to long-wave UV radiation, proved that it had indeed been obtained from an abalone.

KH

Non-Nacreous Cultured "Pearl"

The Summer 1990 Lab Notes section discussed cultured calcareous concre-

Figure 12. The cellular structure of the abalone portion of the "mabe" in figure 10 can be seen at 80× magnification.

Figure 13. This cultured concretion (11.8 mm × 12.7 mm in diameter) was found in a parcel of cultured South Sea pearls.

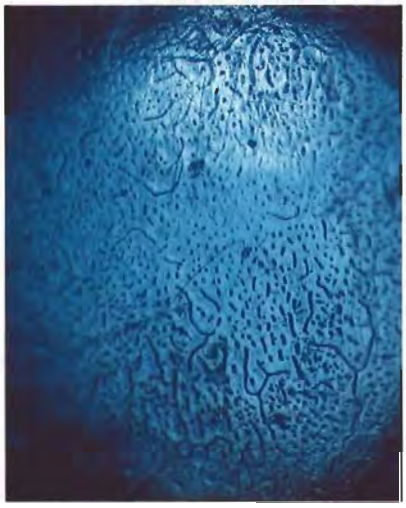


Figure 14. Note the dimples and fine fissures on the surface of the non-nacreous cultured "pearl" shown in figure 13. Magnified 30×.

Figure 15. When the cultured "pearl" shown in figures 13 and 14 was magnified 40×, the unusual lattice-like subsurface structure became apparent.

tions that had been found while harvesting cultured black pearls in the South Seas. Another of these non-nacreous cultured "pearls" arrived at the West Coast laboratory for identification last summer. With a subvitreous luster and no orient, the approximately 11.8 × 12.7 mm "pearl" resembled a shiny black marble (figure 13). When examined with magnification and reflected light, the surface appeared to have shallow dimples and displayed a network of very fine, hairline fissures (figure 14) that corresponded to the subsurface structure of the "pearl." Higher magnification with strong, fiber-optic illumination revealed this structure to be a tightly knit, lighter-colored, lattice-like network covering the entire sphere (figure 15). This structure was more concentrated in some areas, forming faintly eye-visible bands around the circumference of the "pearl." Accompanying the latticework were gray translucent areas that had a distorted honeycomb or cellular structure. These alternated with transparent areas to create an overall patchiness when magnified. The structure near the surface was similar to that of cultured calcareous concretions described in the previously mentioned Summer 1990 Lab Notes section (p. 153).

Because this non-nacreous "pearl" had an appearance different from that of any natural concretion we had seen before, we used X-radiography to reveal its internal structure. The X-radiograph confirmed its cultured origin, evidenced by an obvious bead nucleus surrounded by a thick outer layer.

The owner reported that this "pearl" came from a South Sea black-lipped oyster (*Pinctada margaritifera*), harvested near Rikitea in the Gambier Islands of French Polynesia. If so, it appears to be an unusual product of the usual culturing process, one in which the mantle-tissue graft lacked the critical epithelial cells necessary to produce the nacreous layer. *Cheryl Y. Wentzell*

SAPPHIRE of Unusual Color

Occasionally we see color-change sapphires with the green-to-blue (daylight) and red-to-brown (incandescent light) colors of alexandrite. A 1.83-ct square step cut seen in the East Coast lab was surprising in that it was clearly corundum and had a reddish brown body color similar to that seen in some alexandrite in incandescent light, yet it exhibited no color change. The unusual color appearance was due in part to the presence of pronounced pink and green-blue bands, which were best seen in diffuse transmitted light (figure 16). Part of the color sensation was also influenced by the stone's dichroism. The visible spectrum, viewed through a desk-model prism spectroscope, showed a strong broad band at 450 nm along with general absorption from about 680 to 700 nm. The most notable gemological property was the refractive index of 1.775–1.784. Although rather high, this still falls below the upper limits of 1.785 and 1.794 for natural brown sapphire cited by M. Fleischer et al., in *Microscopic Determination of the Nonopaque Minerals*—U.S. Geological Survey Bulletin 1627 (U.S. Government Printing Office, 1984).

Figure 16. The pink and blue-green banding seen with diffused transmitted light in this 1.83-ct sapphire is partially responsible for the reddish brown body color of the stone. Magnified 15×.

Although sapphires in this color range are seldom encountered at the Gem Trade Lab, we are told by members of the trade that they are not particularly rare, just of little interest commercially.

TM

SYNTHETIC SAPPHIRE, Another Striae Resolution Technique

To get the most from our microscopic examination of gems, we use a variety of lighting techniques: darkfield, brightfield, diffused, oblique-angle fiber-optic, and shadowing, among others. These may be further enhanced by examining the stone while it is immersed (see, e.g., the Winter 1993 Gem Trade Lab Notes, p. 282). Filters can also be useful in resolving growth structures. For example, a white diffusion filter may help resolve curved color banding in blue synthetic sapphires, and a blue diffusion filter may resolve curved color banding in yellow to orange synthetic sapphires (see, e.g., the Summer 1992 Gem Trade Lab Notes, p. 128).

The West Coast lab was asked to identify a transparent pink, 15.58-ct oval modified brilliant. Gemological properties were consistent with corundum, both natural and synthetic. Microscopic examination revealed only minute pinpoint inclusions of an undetermined nature. The method that finally revealed the growth structures that proved its synthetic origin was the Plato test, performed using immersion in conjunction with crossed polarizers.

Figure 17. Examination with short-wave UV radiation at 15× magnification reveals curved growth features in this 15.58-ct pink synthetic sapphire.

As part of our documentation of the stone, we also viewed it under both long- and short-wave ultraviolet radiation. While the even, very strong red fluorescence to long-wave UV was not unexpected, we were surprised to see that the typical strong bluish white reaction to short-wave UV was uneven. To characterize this unevenness better, we examined the stone using magnification in conjunction with short-wave UV illumination (carefully filtering the light coming from the stone to block short-wave UV reflections and thus avoid eye damage). This revealed that the fluorescent reaction was confined to clearly defined curved color bands (figure 17). Preliminary examination of other pink synthetic sapphires from our reference collection has shown the technique to hold promise, as curved growth was also seen in some of these under short-wave UV radiation.

It should be noted that there are precedents for using ultraviolet radiation in the resolution of diagnostic growth features in synthetic gem materials. R. Hughes, in his book *Corundum* (Butterworth's, London, 1990), mentions using low magnification (2× to 6×) and short-wave UV illumination to see growth details in colorless synthetic sapphires. He also cautions that eye protection, such as a short-wave-UV blocking filter, is essential when observing stones under these conditions. The technique also helps characterize growth sectors in synthetic diamonds (see J. Shigley et al., "The Gemological Properties of Russian Gem-Quality Synthetic Yellow Diamonds," *Gems & Gemology*, Winter 1993, pp. 228–248).

RCK, Dino DeGhionno, and Patricia Maddison

PHOTO CREDITS

Shane F. McClure provided figures 1, 2, and 7. Photomicrographs in figures 3, 5, 8, 9, 12, 14, 15, and 17 are by John I. Koivula. Figures 4, 11, and 13 were taken by Maha DeMaggio. Nicholas DelRe supplied the pictures used in figures 6, and 16. Figure 10 is © GIA and Tino Hammid.