

2004 LAB NOTES

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Faceted APOPHYLLITE With “Crop Circles”

Although apophyllite is found in beautiful transparent colorless to pale green tetragonal crystals of relatively good size, it is virtually unheard of as a faceted gemstone. On the one hand, its perfect basal {001} cleavage makes it difficult to cut. On the other, as a hydrated silicate $[(\text{KCa}_4\text{Si}_8\text{O}_{20}(\text{OH},\text{F})\cdot 8\text{H}_2\text{O})]$, apophyllite is also very susceptible to heat damage, so even the friction from grinding and polishing on a lap can generate enough heat to cause cracking. It was therefore of interest to document gemologically the 6.28 ct near-colorless oval modified brilliant cut $(13.11 \times 11.48 \times 9.31 \text{ mm})$ apophyllite

Figure 1. This 6.28 ct stone—from Poona, India—is the first faceted apophyllite we have encountered in the laboratory. Note the slight iridescence visible beneath the table facet.



shown in figure 1, the first faceted apophyllite we have seen in the laboratory. The gem, from Poona, India (a locality famous for apophyllite), was provided for examination by internationally known Scottish gemologist Alan Hodgkinson.

True to its nature, this faceted apophyllite had a relatively large cleavage open to the surface (again, see figure 1), which was clearly visible through the table facet. The cleavage was oriented in a plane slightly off parallel to the table, an alignment that was probably intentional. Had the planes of the table and the cleavage been parallel, it would have been virtually impossible to get a good polish on the table facet.

Gemological identification was relatively straightforward, with only standard instruments needed. When the stone was examined through the table facet, a uniaxial optic figure was clearly visible in polarized light. The refractive index was recorded as $n_o = 1.531$ and $n_e = 1.534$ in monochromatic near-sodium equivalent light, with a corresponding birefringence of 0.003. The stone was inert to both long- and short-wave ultraviolet radiation, and the hydrostatic specific gravity was 2.38.

As seen in figure 2, the most striking feature of this gem was the condition of its internal cleavage surfaces when viewed with magnification. Rather than being more or less “feathery” in appearance, as is common on fresh cleavage surfaces, this particular cleavage was relatively smooth. It

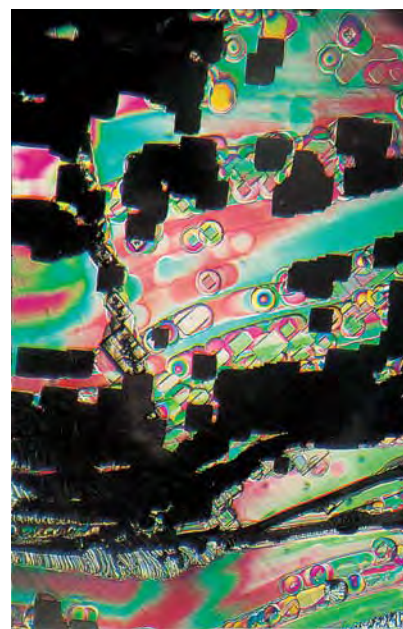


Figure 2. With 15× magnification, the apophyllite's perfect basal {001} cleavage shows a pleasing “crop circle” geometry colored by bright interference colors.

showed distinctive rectangular, circular, and square patterns, with some

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squares being contained in the centers of the circles. This was somewhat reminiscent of the infamous and relatively controversial “crop circles” that have been found in some farm fields. From the overall appearance of the inner walls of the cleavage, we suspect that the interesting geometric forms were the result of regrowth, rather than post-growth etching.

John I. Koivula and Maha Tannous

DIAMOND

Luminescent “Hopper” Diamond

The vast majority of the diamonds graded by the GIA Gem Laboratory are polished goods, so we enjoy the opportunity to examine natural diamond crystals that exhibit attractive colors or shapes, as well as other features. Such crystals are “gems” in their own right, and because of their intriguing beauty they often remain in their natural state, uncut. It was therefore with interest that we recently examined a 2.03 ct transparent, near-colorless diamond cube that showed significant hopper growth (that is, where the faces have grown more at the edges and corners than in the center) and etching, with the center of each of the cube faces depressed and the edges and corners extended (figure 3).

The crystal, which measured $5.90 \times 5.72 \times 5.67$ mm, was purchased in Antwerp by Chris Amo of CEO

Figure 3. Note the cavernous appearance seen on the faces of this 2.03 ct “hopper” diamond crystal.

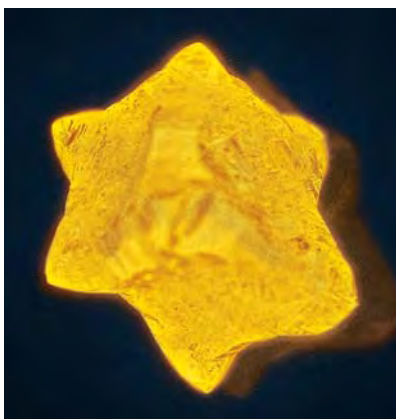


Figure 4. When viewed directly toward a corner, this 2.03 ct etched diamond cube showed an obvious stellate form that was further accentuated by the strong yellow fluorescence to long-wave UV.

Enterprises, Amherst, New York. He spotted it at a diamond cutting factory as it was being checked for UV luminescence. The crystal stood out immediately because of its bright yellow fluorescence to long-wave UV radiation, and the fact it looked like a glowing star when viewed in a direction toward a corner point (figure 4). After purchasing the crystal, which was in a parcel of rough diamonds reportedly from the Democratic Republic of the Congo, Mr. Amo sold it to gem and mineral collector William W. Pinch of Rochester, New York, who in turn provided it to the laboratory for examination.

Strain was visible in the diamond crystal when it was examined with magnification between crossed polarizers; the strain colors served to highlight the cubic etch figures and other surface contours (figure 5) visible on all the crystal's faces. Using the deep UV radiation of the Diamond Trading Company (DTC) DiamondView, we did not observe any growth zoning. Fourier-transform infrared (FTIR) spectrometry showed that the crystal was a type IaA, with significant amounts of both nitrogen and hydrogen.

It is not often that we see a crystal, such as this diamond from the Congo,



Figure 5. Viewed between crossed polarizers with 10× magnification, intense strain colors in the 2.03 ct diamond highlight the cubic etch pits and related surface contours.

that possesses all the attributes (beauty, durability, and rarity) required of a gem, as well as distinctive fluorescence and surface features.

John I. Koivula, Maha Tannous, and Christopher M. Breeding

“Magnetic” Natural Pink Diamond

One interesting feature of some synthetic diamonds is their attraction to a simple magnet. (Strictly speaking, diamonds do not possess any magnetism.) This apparent “magnetism” is due to the existence of metallic inclusions—usually the flux materials, such as Fe, Ni, or Co, used in the growth process. While magnetism is a very good indication that a diamond is synthetic, some rare exceptions do exist.

Recently, a 0.12 ct Fancy Intense purplish pink diamond (figure 6) submitted to the West Coast laboratory demonstrated apparent magnetism (figure 7). In addition to pink graining, magnification revealed several inclusions, among them “feathers” and



Figure 6. This 0.12 ct Fancy Intense purplish pink natural diamond demonstrated apparent magnetism.



Figure 7. Because of iron-containing residue in surface cavities, this diamond could be suspended when touched by a magnet.

dark features, a few of which reached the surface. Some of these features had a platy habit, while others were irregular in shape. The diamond also had several cavities on the girdle and pavilion facets that were filled with a dark material. It had a few cloud-like patches of pinpoint inclusions, but their appearance was different from the clouds we have seen in synthetic diamonds. When observed with a

desk-model spectroscope, the diamond showed only a 415 nm "Cape" line. It fluoresced blue to standard long-wave UV radiation, and yellow and blue to short-wave UV. When examined with the DTC Diamond-View fluorescence imaging system (figure 8), it did not show the cross-shaped zoning typically seen in most synthetic diamonds. Last, no bands that could be attributed to Ni or other flux metals were observed in the photoluminescence spectrum. On the basis of these results, we concluded that the diamond was natural.

Figure 8. In this fluorescence image recorded with the DTC DiamondView, the cross-shaped zoning pattern typical of most synthetic diamonds is absent. The residue-filled surface cavities can be seen along the girdle on the left side of the diamond.



Figure 9. This photomicrograph shows the residue-filled surface cavities along the girdle of the diamond. Chemical analysis by EDXRF revealed the presence of Fe and Ca in the residue. Magnified 60×.



When a magnet was brought close to the diamond, however, it attracted the dark material that was exposed in cavities along the girdle (figure 9). When we analyzed this dark material using energy-dispersive X-ray fluorescence (EDXRF) spectroscopy, we found Fe and Ca to be the major components. We studied the exposed dark material further using Raman spectroscopy and found features that could be attributed to hematite, limonite (rust), and diamond. We concluded that this dark material was residue from the manufacturing process. Metallic fragments within the residue caused the magnetic behavior of this sample, while oxidation of the iron fragments generated the hematite and limonite peaks observed in the Raman spectra. We attempted to analyze the dark inclusions in the diamond with Raman spectroscopy, but the spectra did not reveal any recognizable features. Raman analyses of some of these inclusions where they reached the surface produced spectra similar to the spectrum of the dark material in the cavities, but this also may be from residue covering those inclusions.

The magnetic response of this natural diamond was similar in intensity to what we have seen in synthetic diamonds with metallic inclusions. Cleaning the diamond with acid would presumably dissolve this residue, and thereby render the diamond "nonmagnetic." Attraction to a magnet remains a useful way to check for synthetic diamonds, but as with other gem testing methods, this should not be the sole identification criterion.

Andy H. Shen and James E. Shigley

Diamond with Many Microscopic Carbonate Inclusions

Mineral and fluid inclusions in diamond have been studied extensively, because of the unique information they offer about diamond formation and the geochemistry of the Earth's mantle. Carbonate, phosphate, and water inclusions of microscopic scale also have been reported in the coatings on many of those natural diamonds



Figure 10. This 2.38 ct Fancy Dark brown-greenish yellow diamond contains numerous microscopic carbonate inclusions.

that have a translucent outside “skin” and a transparent gem-quality core (see, e.g., O. Navon et al., “Mantle-derived fluids in diamond micro-inclusions,” *Nature*, Vol. 335, 1988, pp. 784–789). Ranging up to 1 mm thick, these coatings generally are removed by the cutting and polishing process, although coatings on some (usually

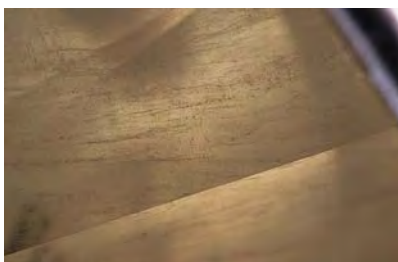
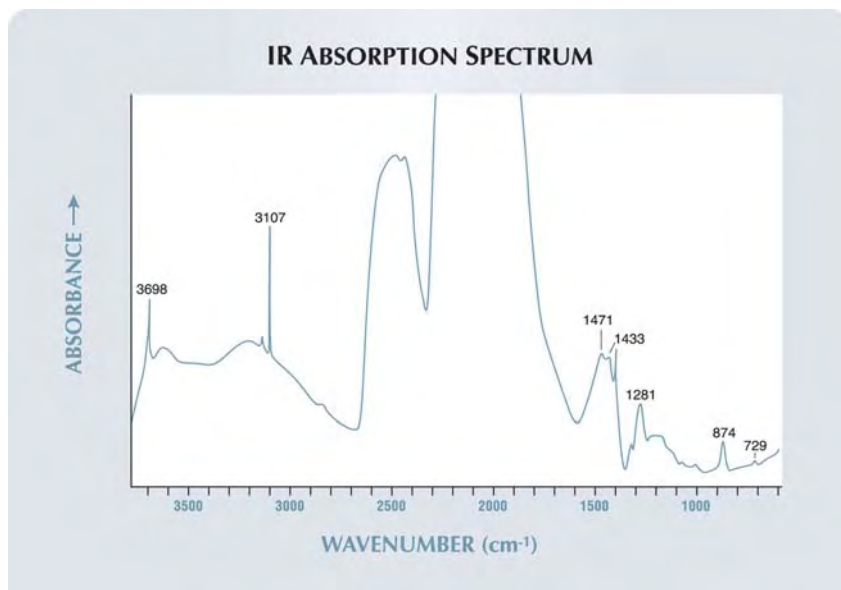


Figure 11. Micro-inclusions occur throughout the 2.38 ct diamond, and relatively large particles are aligned to form many nearly parallel bands. Width of the image is 3.2 mm.

very small) cuboid opaque diamonds could extend to the central part of the crystals. The East Coast laboratory recently examined a faceted diamond (figure 10) that had dense microscopic carbonate inclusions similar to those found in such coatings; however, the micro-inclusions occurred throughout the entire stone, with relatively large particles aligned in many nearly parallel bands (figure 11). These inclusions

Figure 12. The IR absorption spectrum of this unusual diamond revealed the presence of calcite and dolomite-ankerite (i.e., features at 1471–1433, 874, and 729 cm^{-1}). The absorption at 3698 cm^{-1} is rarely observed in diamond or its inclusions; its assignment is unclear.



also showed some interesting features in their composition.

The 2.38 ct round brilliant cut ($8.63 \times 8.66 \times 5.27$ mm) was color graded Fancy Dark brown-greenish yellow, and its clarity was at the bottom of the GIA clarity grading scale. Indeed, it was translucent due to the micro-inclusions. No transparent region was observed even with magnification. Infrared absorption spectroscopy showed that the diamond was a type IaA, with very low nitrogen but relatively high hydrogen concentrations (figure 12). Strong absorptions at 1471–1433 and 874 cm^{-1} , and a weak but sharp absorption at 729 cm^{-1} , from micro-inclusions of calcite and dolomite-ankerite were detected. These features are similar to those observed for micro-inclusions in diamond coatings. However, a strong and sharp peak at 3698 cm^{-1} also was observed, which is not present in coatings and rarely occurs in diamond. Another unusual feature of this diamond was that no water component was detected. Water is very common in diamond coatings, and the absence of water and the relatively large size of this diamond indicate that it crystallized in a stable carbonate-rich and water-poor environment.

Despite the low clarity, this diamond was of interest due to the numerous micro-carbonate inclusions and their uniform arrangement.

Wuyi Wang and TMM

Unusual Near-Colorless SYNTHETIC DIAMOND

Recently, a 0.32 ct near-colorless round brilliant was submitted to the West Coast laboratory for a Diamond Dossier report. Gemological examination of the inclusions and spectroscopic analysis suggested that this was not a typical diamond. Further testing with the DTC DiamondView instrument strongly indicated that the diamond was, in fact, a synthetic. Although GIA does not provide color or clarity grading services for synthetic diamonds, had this been a natural

stone it would have been equivalent to the VS range in clarity, with only a few small inclusions in the crown, and approximately I color.

It is extraordinary to encounter such a high-quality near-colorless synthetic diamond in the marketplace, because this material is extremely difficult to grow by conventional high pressure/high temperature processes. Considerable effort and expense must be undertaken to prevent nitrogen (which causes yellow in diamonds) from being incorporated during diamond growth. Furthermore, the processes required to limit nitrogen almost always result in abundant, readily visible inclusions.

Previous researchers have described experimental synthetic diamonds from De Beers and General Electric Co. that showed properties similar to this sample (see, e.g., J. E. Shigley et al., "Gemological properties of near-colorless synthetic diamonds," Spring 1997 *Gems & Gemology*, pp. 42–53). Because of the rarity of this type of near-colorless synthetic diamond, a full description of its properties is presented here.

Microscopic examination revealed opaque metallic-appearing inclusions, pinpoint inclusions, and a number of very thin, translucent, parallelogram-shaped platelets that appeared gray-blue to brown and transparent in transmitted light (figure 13). Similar inclusions were described by Shigley et al.; however, those platelets were triangular. When viewed between crossed polarizing filters, anomalous birefringence ("strain") was observed to be associated with the platelets; but the cross-hatched, or "tatami," strain typical of natural type IIa diamonds was absent. A cloud of very fine pinpoint inclusions, similar to those often seen in synthetic diamonds, was evenly distributed throughout the sample, although it was not dense enough to have a significant effect on clarity. The opaque inclusions in this synthetic diamond appeared as fine black rods, needles, or sub-rounded particles in transmitted light. Several of these reached the



Figure 13. This 0.32 ct near-colorless synthetic diamond, submitted to the lab for a grading report, revealed opaque metallic-appearing inclusions, "pinpoints," and numerous parallelogram-shaped platelets. Reflected light, magnified 35 $\times$.

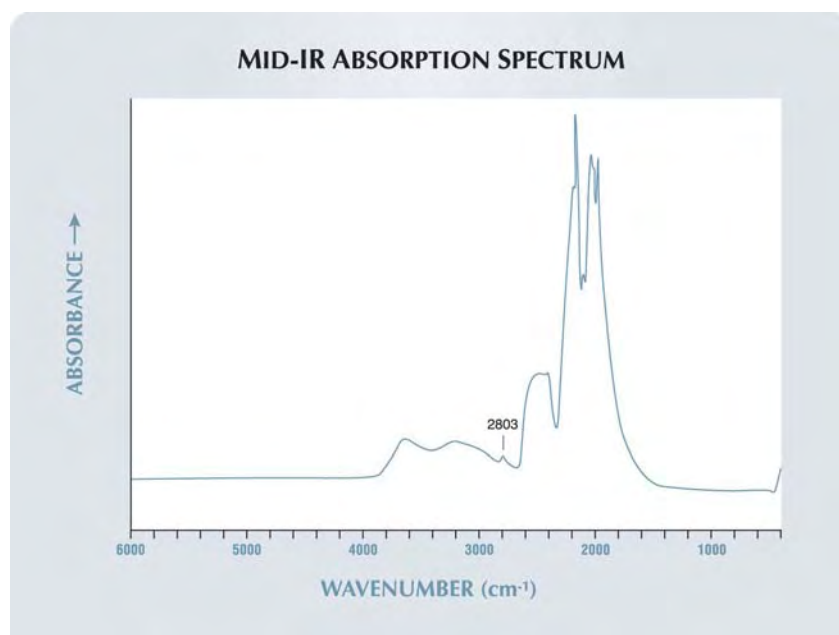
surface and appeared metallic and "gold" colored in reflected light. The opaque inclusions were not attracted

to a magnet, and Raman spectroscopy suggested that they consisted of non-diamond, carbon-rich material.

All known colorless and near-colorless synthetic diamonds are type IIa; that is, they are effectively nitrogen-free. While spectroscopic analysis usually indicates that natural type IIa diamonds do contain very small amounts of nitrogen, absorption and photoluminescence spectra showed no evidence of nitrogen in this sample. However, the mid-infrared absorption spectrum displayed a feature at 2803 cm^{-1} , which indicates the presence of small amounts of boron (figure 14). Consistent with this finding, the sample was electrically conductive in a few directions.

When examined with long-wave UV radiation, the synthetic diamond was inert and showed no phosphorescence. The short-wave reaction was an unevenly distributed weak yellowish green, with a weak to moderate greenish phosphorescence that lasted more than one minute. Cathodoluminescence and DiamondView

Figure 14. The mid-infrared absorption spectrum of this synthetic diamond indicates the presence of small amounts of boron, as demonstrated by the feature at 2803 cm^{-1} . As would be expected, the synthetic diamond was electrically conductive in some directions.



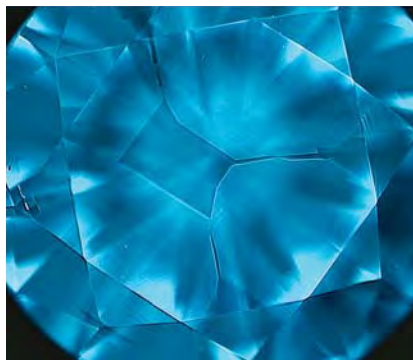


Figure 15. Cathodoluminescence (left) and DTC DiamondView (right) testing of the near-colorless synthetic diamond showed the cuboctahedral growth pattern and strong blue phosphorescence typical of synthetics.

reactions were pale blue and uneven, with a cuboctahedral growth pattern (i.e., square and cross-shaped zones) as well as strong blue phosphorescence, both of which are typical of synthetic diamonds (figure 15).

Although the rarity of high-quality colorless synthetic diamonds makes it easy to believe that one will not encounter such material in the trade, this sample serves as a strong reminder that these diamonds do exist and can be difficult for gemologists to identify without very careful examination of inclusions and fluorescence reactions.

Kimberly M. Rockwell

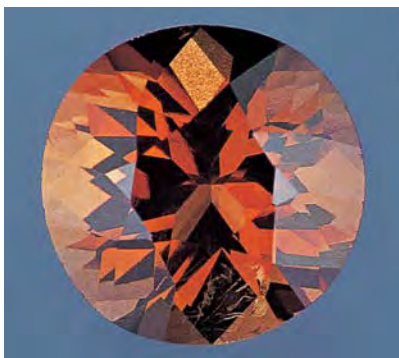
Orangy Brown IOLITE From Madagascar

A 4.45 ct transparent orangy brown oval modified brilliant was recently submitted to the West Coast laboratory for identification (figure 16) by Mark Kaufman of Kaufman Enterprises, San Diego, California. Gemological testing revealed that it was biaxial with R.I.'s of 1.532–1.541 (birefringence 0.009) and an S.G. of 2.57 (determined hydrostatically). It did not fluoresce to either long- or short-wave UV radiation and had only a weak-to-medium absorption band centered at 490 nm. The stone was represented as iolite from Madagascar, and the properties we recorded

were consistent with those previously reported in the literature for this gem (see R. Webster, *Gems*, 5th ed., rev. by P. G. Read, Butterworth-Heinemann, Oxford, 1994, pp. 345–346). Due to its unusual color, we decided to perform Raman analysis, which confirmed that it was indeed iolite. Microscopic examination of the stone revealed fractures, iridescent dust-like particles throughout, “fingerprints,” short needles, and spotty orange-brown color concentrations, along with unusual “roiled” growth zoning.

Most in the trade are familiar with the gem iolite (also known as cordierite) and its typical, attractive violetish blue color. It usually has strong pleochroism, consisting of deep

Figure 16. This 4.45 ct orangy brown stone proved to be iolite. The color is very unusual for iolite, which is typically violetish blue.



violetish blue and near-colorless to light yellow-brown colors that can be observed without the aid of a polarizing filter (see Spring 2001 *Gem News International*, pp. 69–70). The iolite reported here also displayed fairly strong pleochroism, but the strengths of the individual colors were reversed. Whereas the violetish blue pleochroic color is typically the strongest in iolite, this orangy brown iolite's dominant pleochroic color was yellow-orange. It did have a grayish violet pleochroic component, but this was quite a bit weaker than the yellow-orange, so much so that it was not easily visible with the unaided eye.

In researching this material, we found very few references that listed brown as a possible color for iolite, and even the ones we found stated that this color was rare. None of the gemologists in the West Coast lab had previously seen an iolite of this color.

Elizabeth P. Quinn

Flashing LABRADORITE

Labradorite is a relatively common member of the feldspar group. It is so common, in fact, that large polished slabs of rock containing labradorescent phenocrysts of this mineral are used in the building and construction industries for walls and countertops. Like all gem materials, however, there is a very limited supply of fine-quality labradorite suitable for gem and jewelry applications.

The West Coast laboratory recently examined two well-polished labradorite gems, said to be from India, that were sent to us by lapidary Leon M. Agee of Deer Park, Washington. These stones displayed very attractive and dramatic banded labradorescence, which seemed to flash as the stones and/or overhead light source were moved back and forth in a direction perpendicular to the obvious lamellar twin structure.

The larger of the two stones was an 85.58 ct polished trapezoidal piece that measured 40.15 × 28.16 × 8.61 mm, while the other was a 34.98 ct

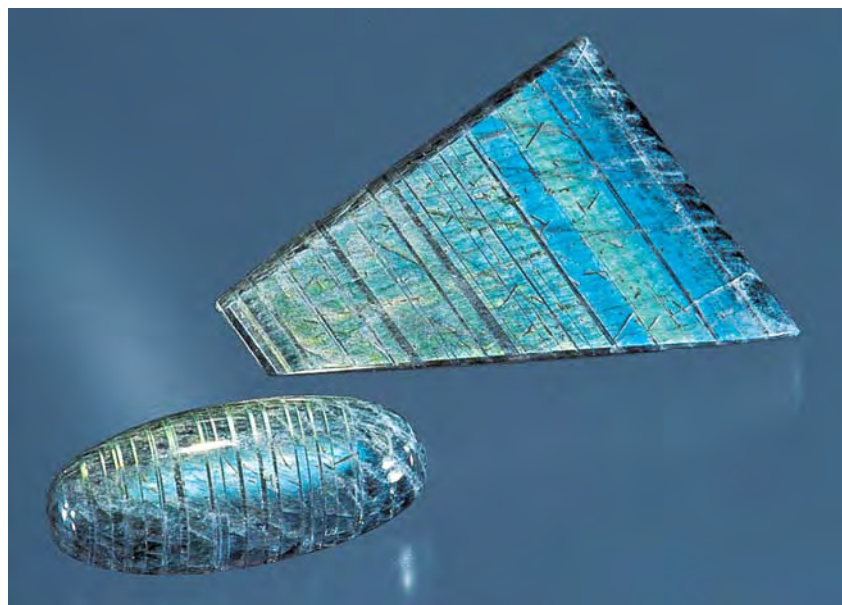


Figure 17. Accented by their characteristic labradorescent colors, these two phenomenal labradorites, weighing 85.58 and 34.98 ct, show distinct lamellar twinning. The cabochon also displays chatoyancy.

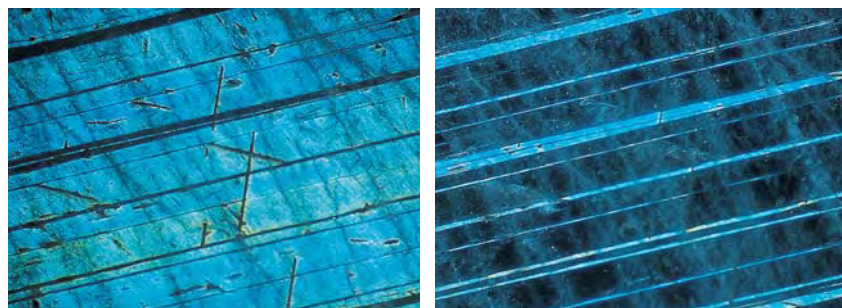
oval cabochon measuring $33.09 \times 14.30 \times 6.17$ mm. As shown in figure 17, the labradorescence presented itself in relatively typical intense-to-muted shades of blue, green, and yellow. In addition to the labradorescent flash shown by both stones, the cabochon displayed a blue chatoyant band (also seen in figure 17), which seemed to be independent of the shift in color of the lamellar twin layers.

The labradorescent shift was par-

ticularly interesting when viewed with low magnification. As seen in figure 18 (left), almost the entire surface area displayed labradorescent interference colors; only a few thin twin bands appeared dark. When the light position was shifted 90° across the stone (figure 18, right), the broad colored areas went dark, while the once-dark thin twin layers showed bright labradorescence.

John I. Koivula and Maha Tannous

Figure 18. When examined with low (5 $\times$) magnification, almost the entire imaged surface of the trapezoidal labradorite displayed interference colors, with only a few thin twin bands remaining dark (left). When the incident light was shifted 90° (right), the thin twin layers showed labradorescence, while the rest of the stone went dark.



Natural Saltwater Mussel PEARLS

Nacreous saltwater pearls almost invariably originate from oysters (e.g., *Pinctada* sp. and *Pteria sterna*) or one of several species of abalone. Although there are some attractive non-nacreous "pearls" that originate from various mollusks (conch, melo melo, scallop, clam, etc.), it is rare to see attractive, colorful nacreous pearls from such an ordinary bivalve as a common saltwater mussel. The West Coast laboratory recently had the opportunity to examine two such natural pearls. The first was a 22.77 ct grayish purple and white baroque-shape pearl (figure 19) submitted by Jeremy Norris of Oasis Pearl in Albion, California. Mr. Norris reported that the pearl was recovered from the Pacific Coast of Baja California, Mexico. He also provided a shell of the saltwater mussel species from which he thought the pearl originated (again, see figure 19). Comparison to photos of various saltwater mussels and consultations with malacological experts indicated that the shell was that of *Mytilus californianus*, the California mussel (2004 pers. comms. from, e.g., Paul Valentich-Scott, Curator of Malacology, Santa Barbara Museum of Natural History).

The first task was to determine whether the specimen was a true nacreous pearl. This was readily proved by examination with magnification, which revealed a nacre platelet structure. However, the appearance of the overlapped "suture lines" (figure 20) differed from that seen in an oyster pearl, suggesting that it was from another type of mollusk.

X-radiography revealed a structure that was typical of natural pearls. Long-wave UV fluorescence was very weak dark brown to inert, mottled with weak light yellow and moderate to strong whitish areas that corresponded to the white areas on the pearl.

The pearl did not fluoresce to X-rays, which is typical for dark-colored pearls regardless of their freshwater or saltwater origin. EDXRF analysis, however, confirmed the absence of



Figure 19. This attractive grayish purple pearl ($18.35 \times 16.30 \times 10.85$ mm) is shown with a saltwater mussel shell from *Mytilus californianus* (the California mussel). Both were recovered from the Pacific Coast of Baja California, Mexico.

Mn, which proved the pearl was of saltwater origin.

With the saltwater mussel shell available, we decided to obtain UV-Vis and Raman spectra for both the pearl and the shell to see if there was a close correlation between the two. In fact, the UV-Vis reflectance spectra proved to be very similar, with a transmission maximum centered around 600 nm that would contribute to the reddish modifying component

in the color of the pearl. Likewise, the Raman spectra for the pearl and the shell were nearly identical, with two distinct peaks at approximately 1094 and 1482 cm^{-1} that are consistent with the presence of carotenes.

These matching spectra would suggest that the pearl originated from

this, or a closely related, type of mollusk. However, since it could not be confirmed that the pearl was produced by the type of mussel whose shell was provided, Mr. Norris sent us another darker, but very similar, 3.82 ct grayish purple mussel pearl with an accompanying shell that a local fisherman stated was the same as the host of that pearl (figure 21). Mr. Norris reported that these items also were recovered from the Pacific Coast of Baja California, where they are found in intertidal, estuary, and mangrove areas. Although the interior of the *M. californianus* shell contained a small patch of highly iridescent nacre toward its outer edge (again, see figure 19), the color of this area and the dark violet pigments in the colored part of the shell interior did not closely resemble that of the pearl's nacre. The second saltwater mussel shell, however, was smaller, slightly different from the first, and had an interior mother-of-pearl surface with a reddish purple color that closely matched that of the two pearls (again, see figure 21). Experts agreed that the smaller shell was that of *Modiolus capax* (e.g., P. Valentich-Scott, pers. comm., 2004). *M. capax*, the fat-horse mussel, has a

Figure 20. The suture lines of this mussel pearl are notably different from those of saltwater oyster pearls, with a textured zone along the leading edge that causes them to appear coarser and more broadly defined. Magnified 25 $\times$.



Figure 21. This smaller, darker grayish purple pearl ($10.15 \times 9.15 \times 5.75$ mm) rests on the shell of the saltwater mussel *Modiolus capax* (also found in Mexico), which has an interior surface that more closely matches the appearance of both this pearl and the one in figure 19.



reddish shell, a nacreous interior, and grows up to approximately 14 cm in length, a size capable of producing the large pearl shown in figure 19. Like *M. californianus*, it is also of the family *Mytilidae*.

UV-Vis and Raman spectra were collected for the second pearl and shell specimens to compare with the first. The UV-Vis reflectance spectra were all very similar to each other, and the Raman spectra were all nearly identical, with the same carotene absorption peaks. The Raman spectra also matched those for another common North American saltwater mussel that was found in Carlsbad, California, most likely a *Mytilus galloprovincialis* (European blue mussel or bay mussel). The similarities among these Raman spectra are in contrast to the distinct differences from those for a pink conch pearl, which had a CaCO_3 peak at 1085 cm^{-1} and carotene peaks at 1124 and 1512 cm^{-1} , as well as from those of several purple to pink freshwater pearls, which had a 1084 cm^{-1} CaCO_3 peak and carotene peaks at 1130 and 1523 cm^{-1} . The similarity in the data between the purple saltwater pearls and their accompanying mussel shells, along with the dissimilarity to data collected from more disparate species, strongly indicated that the purple pearls originated from one of a group of closely related mussels, probably of the *Mytilidae* family, and quite possibly from genus *Modiolus*.

CYW and Shane Elen

Treated-Color “Golden” South Sea CULTURED PEARLS

Determining the origin of color for “golden” South Sea cultured pearls has been an increasingly important challenge in recent years. The growing demand for these cultured pearls, for which natural-color supplies are limited, has led to a greater variety of treated-color products in the marketplace.

Two recent *G&G* articles by S. Elen addressed the identification of treated-color “golden” South Sea



Figure 22. These three strands of drop-shaped “golden” South Sea cultured pearls proved to be treated color.

pearls (“Spectral reflectance and fluorescence characteristics of natural-color and heat-treated ‘golden’ South Sea cultured pearls,” Summer 2001, pp. 114–123; “Update on the identification of treated ‘golden’ South Sea cultured pearls,” Summer 2002, pp. 156–159). The 2001 article showed that the natural-color cultured pearls exhibit a broad absorption feature from 330 to 460 nm, which is the combination of two individual absorption features: 330–385 nm and 385–460 nm. The treated-color “golden” South Sea cultured pearls examined had UV-visible absorption features in the 330–385 nm region that were consistently weaker than those of their natural-color counterparts. Some—but not all—of the treated-color samples also exhibited color concentrations in nacre defects and/or around the drill holes.

The East Coast laboratory recently examined three strands containing a total of 87 drop-shaped “golden” South Sea cultured pearls (as indicated by X-radiography) ranging from $18.15 \times 15.55 \times 14.90\text{ mm}$ to $13.50 \times 12.45 \times 12.10\text{ mm}$. The overall color was an unnatural orangy yellow with an

unusual pinkish cast evident in some lighting conditions (figure 22). With $10\times$ magnification, all these cultured pearls showed a slightly mottled nacre with small raised spots and patches. They also exhibited visible signs of dye, including an unevenly distributed color accompanied by small concentrations of a deep red dye. Some of the dyed areas were dendritic in shape, whereas others were visible below the surface, indicating the cultured pearls were dyed after drilling.

Reflectance spectra were collected for all 87 of the cultured pearls (figure 23). We then compared the reflectance spectra of these treated-color samples to the spectrum of a natural-color cultured pearl shown in Elen (2001, figure 8). The natural-color spectrum exhibited the characteristic broad absorption from 330 to 460 nm, with stronger absorption in the UV (330–385 nm) than in the blue (385–460 nm). The treated-color cultured pearls showed increased absorption (i.e., lower reflectance) at $\sim 305\text{ nm}$, in contrast to the well-defined reflectance feature in natural-color cultured pearls. A very weak $\sim 345\text{ nm}$ absorption and a 415–430

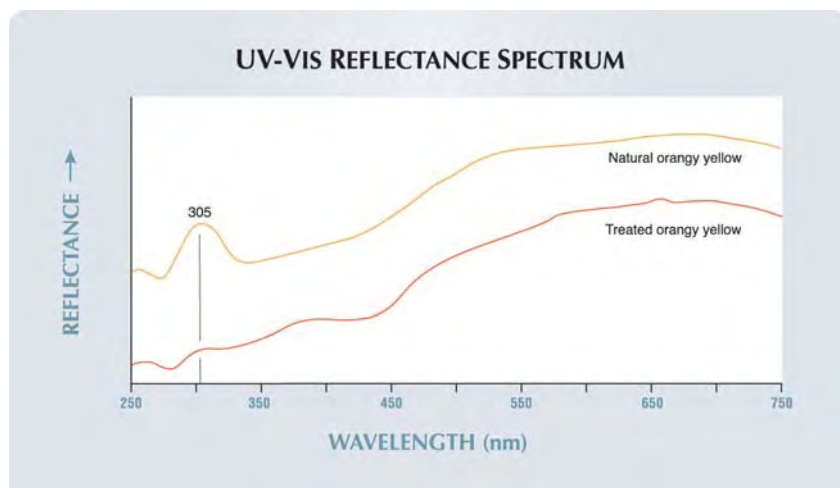


Figure 23. The South Sea cultured pearls in this study exhibited absorption features at ~345 and 415–430 nm that previously were reported in treated-color cultured pearls. The absence of a 305 nm reflectance feature is also consistent with treatment; natural-color cultured pearls show a well-defined 305 nm reflectance feature. (The spectrum of a natural-color orangy yellow pearl shown here is from Elen, 2001.)

nm absorption feature for 84 of the 87 treated-color cultured pearls were consistent with the Elen results, particularly for orangy yellow treated-color cultured pearls (see Elen, 2001, figure 9).

These results support Elen's conclusion that the absence of a 330–385 nm absorption is characteristic of treated-color "golden" cultured pearls. In addition, the absence of a well-defined reflectance feature at ~305 nm was characteristic of these treated-color "golden" cultured pearls. Differences between the spectra of the treated-color samples in Elen's studies and those described here probably result from differences in the pre-treatment characteristics of the cultured pearls and/or variations in the treatment method.

Carolyn van der Bogert

QUARTZ in Three Colors

In the Spring 2003 Lab Notes section (pp. 44–45), we discussed how some gem materials gain apparent bodycolor through the presence of brightly colored inclusions. The material featured in that note was quartz that

was colored dark grayish blue by randomly scattered indicolite rods and needles. Apparent blue color in natural quartz was also mentioned as resulting from various other mineral inclusions, among them ajoite, a hydrated potassium sodium copper aluminum silicate hydroxide.

The West Coast laboratory recently had the opportunity to examine a freeform step-cut quartz (figure 24,

left) that was colored a pleasing light blue by the presence of numerous fibers of ajoite (figure 25), which were identified by Raman analysis. This 3.52 ct gem ($15.50 \times 9.49 \times 6.17$ mm) was faceted by Art Grant of Coast to Coast Rare Gems in Martville, New York, who sent it to the laboratory for examination. The original rough material was from the Messina mine, Transvaal, Republic of South Africa, a locality well known among collectors for its specimens of quartz with inclusions of copper minerals.

At approximately the same time, the laboratory received for study two additional faceted quartzes that were colored by mineral inclusions. The largest of these was a 9.41 ct shield-shaped step cut (figure 24, center) that was fashioned from Russian "strawberry" quartz by Leon M. Agee. As expected for so-called strawberry quartz, and as shown in figure 26, this stone was colored by ultra-thin intense red inclusions of hematite (identified by Raman analysis), but it was unusual for the intensity and evenness of the color.

The third quartz (figure 24, right) was a 3.38 ct mottled dark green, pear-shaped step cut provided for examination by mineral collector Edward R. Swoboda of Beverly Hills, California, who reported that the locality was Kastamonu, in northern Turkey.

Figure 24. These three quartz gems are colored by mineral inclusions. Left to right, the color results from ajoite (3.52 ct), hematite (9.41 ct), and népouite (3.38 ct).

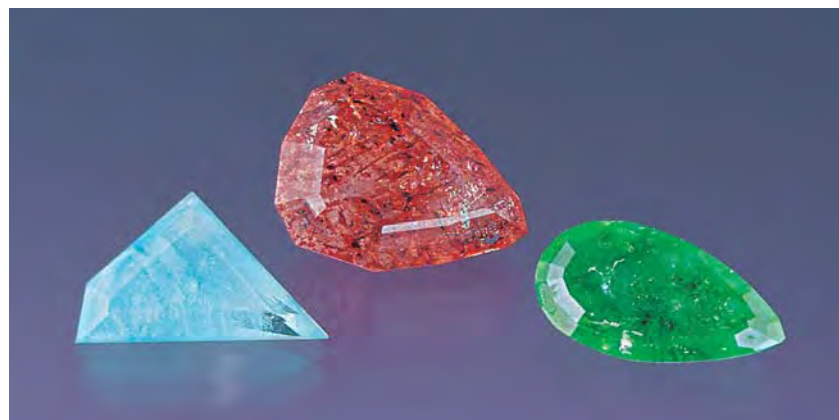




Figure 25. Colored by the presence of copper, these ajoinite fibers are responsible for the blue face-up appearance of their otherwise colorless quartz host. Magnified 15×.

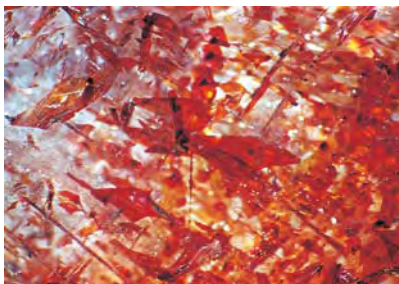


Figure 26. This quartz gained its color from the presence of numerous red transparent-to-translucent inclusions of hematite. Magnified 10×.

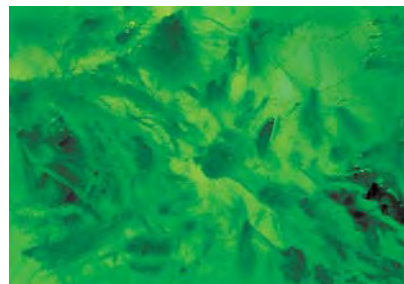


Figure 27. The green color of this quartz was provided by numerous dense sprays and compact masses of népouite, which in turn gets its color from nickel. Magnified 10×.

Magnification showed that the green bodycolor came from numerous dense sprays and compact masses of a green mineral (figure 27). X-ray powder diffraction analysis of a small amount scraped from the surface of the stone revealed the mineral to be a close match for népouite, a nickeliferous member of the kaolinite-serpentine group.

These three gems illustrate how mineral inclusions can provide very pleasing colors to stones that would otherwise be near-colorless. In all three cases, we were told, the color

provided by the inclusions was the main reason these stones were cut.

John I. Koivula, Maha Tannous, and Dino DeGhionno

ERRATUM

The clarity-enhanced ruby entry in the Fall 2004 Lab Notes section (pp. 247–249) incorrectly stated that the glassy residue left by heat treatment of natural rubies can facilitate the partial healing of a fracture. It is *flux* that facilitates partial healing by dissolving the walls of a fracture, and

then new crystallization (synthetic growth) occurs. The areas closest to the walls of a fracture are often synthetic corundum, and the center of the “filled fracture” is a noncrystalline glass byproduct.

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