GIA GEM TRADE LAB NOTES

DIAMOND

Fancy Black, with Iron

One technique that we sometimes apply to diamonds suspected of being synthetic is energy-dispersive X-ray fluorescence spectroscopy (EDXRF). Because iron (Fe) and nickel (Ni) are used in the catalyst for synthetic diamond formation, these elements are found in the metallic flux inclusions in many synthetic diamonds and are detectable by EDXRF even if no flux inclusions can be identified. However, the mere presence of Fe and/or Ni is not proof of synthetic origin.

Last summer, the West Coast laboratory received a 9.61 ct semi-translucent, marquise-cut black diamond for origin-of-color determination. Natural-color black diamonds typically owe their color to numerous black inclusions. Magnification revealed that this heavily included stone was no exception: The black inclusions were arranged in bands, with brown and near-colorless bands also present. In addition, large fractures in the stone showed brown staining. Although an EDXRF spectrum was not needed to determine cause of color, we ran one to see if it would show anything about the inclusions. It revealed that iron was present in the stone, probably as the brown iron-oxide stains in the large fractures. Another possible source is residue from the polishing wheel. Such build-up is particularly common in black diamonds, because they contain so many fractures and cavities. The black inclusions that gave the stone its color were probably graphite, since no additional elements showed up on the EDXRF (which cannot detect carbon and other low-atomic-number elements).

Thus, the presence of iron in a diamond does not by itself prove that the stone is synthetic. However, this stone was not attracted to a powerful hand-held magnet, despite its detectable iron content; the iron-nickel flux found in synthetic diamonds is strongly magnetic. *MLJ*

Fracture-Filled with Unusual Material

Although we have known of fracture-filling as a diamond treatment since the mid-1980s, only recently has this treatment received widespread publicity. Consequently, some stones that were treated in the 1980s may have gone through several owners by now. Even if treatment had been disclosed originally, such disclosure might not have been passed down to subsequent owners. As another complicating factor, the body color of the stone can obscure the diagnostic flash colors in fracture-filled diamonds, making recognition of this diamond treatment more difficult in fancy-color stones (see, e.g., "A Visual Guide to the Identification of Filled Diamonds," by S. F. McClure and R. C. Kammerling, *Gems & Gemology*, Summer 1995, pp. 114–119; as well as the Summer 1991 [p. 109] and Fall 1995 [pp. 198–199] Lab Notes).

In September 1995, the West Coast laboratory received a 1.07 ct yellowish orange cut-cornered rectangular modified brilliant (figure 1) for an origin of color report. The apparent clarity of the stone was low (in the I_2–I_3 range); one large feather traversed the table, and others were present. We were surprised to find blue and orange flash colors associated with the larger feathers (figure 2). Even more surprising was that EDXRF spectroscopy, which we used to confirm the presence of the filling substance, showed that the filler contained thallium (Tl) in addition to the more typical Pb and Br that we have previously documented in filled diamonds. Some early fillers had been rumored to contain thallium, a heavy element that contributes to high refractive indices in glass, but is hazardous to work with because of its extreme toxicity. It is possible that this toxicity is why thallium has not been found in more recent filling materials studied by the GIA Gem Trade Laboratory (see R. C. Kammerling et al., "An Update on Filled Diamonds: Identification and Durability," Fall 1994, pp. 142–177, as well as the above-mentioned references). Therefore, we suspect that this stone may have been one of the earlier filled diamonds.

MLJ, SFM, and Dino DeGhionno

JADEITE JADE

Extremely Thin Carving

A Fall 1995 Lab Note (pp. 199–201) described two "carvings" that the West Coast lab determined were really assemblages. They consisted of

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

Gems & Gemology, *Vol. 31, No. 4, pp. 266–273*

Figure 1. The presence of thallium in the substance with which this 1.07 ct diamond was filled suggests that it was treated some time ago, possibly in the mid-1980s.

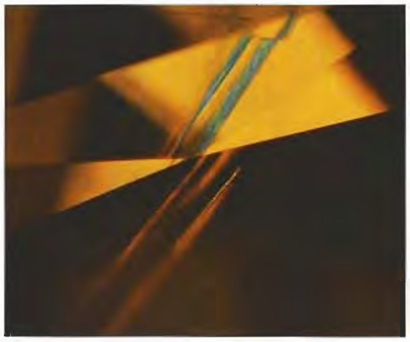


Figure 2. The yellowish orange body color of the diamond shown in figure 1 almost masked the orange darkfield flash color; even the blue brightfield color seems subdued. Magnified 25×.

thin, hollowed-out shells of natural-color green jadeite jade that were filled with a transparent, colorless plastic. In early fall 1995, we received for identification what initially appeared to be a related item: a translucent, mottled green-and-white piece of a carving (figure 3). Standard gem-testing methods revealed a 1.66 spot R.I., an aggregate polariscope reaction, and a 437 nm absorption line, which confirmed that it was jadeite jade. Fine absorption lines in the red portion of the spectrum proved that the green color was natural. The item was unusual not only for its extreme thinness, but also because it had been carved so that raised areas on one side complimented recessed areas on the opposite side. We speculated that this might have been done to maintain a uniform thickness—and resultant uniform depth of color—across the entire item. During the examination, we also saw a colorless foreign material on small scattered areas of the surface (which we noted in the report's conclusion; possibly this material was the glue used in the setting process).

At first we thought that the item might be the top layer of an assemblage, similar to the assemblages described in the previously mentioned Fall 1995 Lab Note (but minus the plastic filling). However, in a subsequent discussion with the client we learned that the carving, which had been mounted in a pendant, was damaged while being transported in a suitcase. Therefore, it is possible that the carving originally was just a thin shell of jadeite. Without the added durability provided by a plastic filler, the item would have been quite susceptible to breakage when pressure was applied to its surface.

RCK and SFM

A Testing Precaution

Submitted to the East Coast laboratory for examination, the ring-mounted cabochon in figure 4 was determined to be natural-color jadeite jade by standard gem-testing methods. However, testing for plastic impregnation by infrared spectroscopy—routinely done on all jadeite submitted to the laboratory—was inconclusive.

We therefore asked the client to have the stone removed from the setting for further testing. Once the stone was out of the setting, we saw that it was really a half bead, with the remnants of the drill hole clearly visible along its base. We also noted that the half bead had been cemented into the setting; the adhesive fluoresced weakly to long-wave UV radiation (figure 5). When the polymer cement was completely removed, further infrared spectroscopy testing gave no indication of polymer.

This instance should serve as a caution to gemologists: Examine jadeite pieces carefully for evidence of repairs, setting cements, and the like. Otherwise, an "innocent" piece of jade might be wrongfully identified as "B" (plastic-impregnated) jade.

GRC

Impregnated SYNTHETIC OPAL

The Summer 1995 Gem News column contains a preliminary report on plastic-impregnated synthetic opal being produced by the Kyocera Corporation of Kyoto, Japan (pp. 137–139). When samples were first obtained for examination—at the Tucson gem shows in February 1995—the material was reportedly only being test marketed in Korea and Japan.

Shortly after the Gem News entry appeared, the West Coast lab received for identification a 3.42 ct piece of partially polished, translucent, black rough with play-of-color.

Figure 3. This jadeite carving (26.55 × 18.00 mm) is extremely thin, only about 0.13 mm in some areas, as shown by the chip at the bottom left.

Figure 4. The material used to cement this natural-color jadeite "cabochon" (7.55 × 7.63 × 8.45 mm) to its setting produced ambiguous readings in the stone's infrared spectrum.

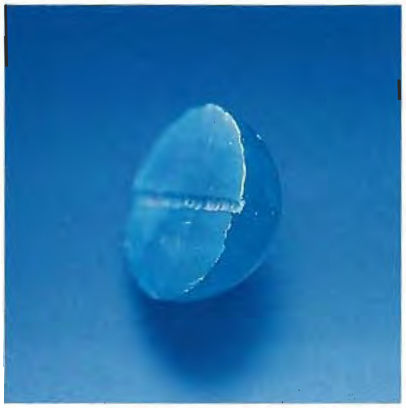


Figure 5. Once the stone in figure 4 was taken out of its setting, we realized that the "cabochon" was actually half a bead. Note the weak fluoresence of the adhesive to long-wave UV.

Because the piece closely resembled (in body color, diaphaneity, and play-of-color pattern) some of the treated synthetic opals we had recently examined, our suspicions were immediately aroused.

An R.I. reading taken from the side of the piece gave a value of 1.44. However, the top gave a reading of 1.50, unusually high for either natural or synthetic opal. We tentatively attributed this to surface "overflow" of the impregnating substance (see below). Specific gravity, determined hydrostatically, was 1.82, too low for untreated synthetic opal, but only slightly lower than the lowest values that we had obtained on the Kyocera treated synthetic opal.

The faint orange fluorescence to short-wave ultraviolet radiation, with no reaction to long-wave UV, was consistent with our observations on Kyocera test samples with a similar body color. Magnification revealed the "lizard-skin" pattern typical of synthetic opal and a pronounced columnar structure perpendicular to this pattern. With magnification, we also saw that the surface that gave the higher R.I. value had a thin, transparent, colorless coating.

Because of the unusually low S.G. and our recent experience with plastic-impregnated synthetic opals, we examined the specimen with Fourier Transform infrared (FTIR) spectroscopy. Opal is opaque to the infrared below 4000 cm^{-1}; however, this spectrum showed several absorptions between 6000 and 4000 cm^{-1}, which are not seen in natural opal (but were seen in the Kyocera material) and which we attribute to an impregnating polymer.

On the basis of all of these results, and following GIA Gem Trade Laboratory policy of disclosing any treatments detected, the specimen was identified as impregnated synthetic opal. *RCK and SFM*

SYNTHETIC QUARTZ, Green and Yellow Bicolor

Green quartz, sometimes known by the trade name "prasiolite," is a challenging material to identify. In the past, much of the green quartz on the market was heat-treated amethyst, the so-called "greened amethyst" (see, e.g., Summer 1983 Lab Notes, p. 116). Natural green quartz occurs in at least one area in California where amethyst was subjected to natural heating (volcanic activity; see T. Paradise, "The Natural Formation and Occurrence of Green Quartz," *Gems & Gemology*, Spring 1982, pp. 39–42). Citrine is also found at this locality. Recently, synthetic quartz from Russia has become available in many colors, including green; synthetic green quartz, misrepresented as natural material from Brazil, was discussed in a Winter 1992 Lab Note (p. 265).

In May 1995, the West Coast lab received for identification a bicolored—yellowish green and orangy yellow—emerald cut (figure 6). Most of the gemological properties were typical for quartz, but they were not useful in determining whether this stone was natural, treated, or synthetic. Among the properties that pointed to synthetic origin were: color zoning in planes perpendicular to the optic axis (not known to occur in natural quartz), lack of twinning (twinning was seen in three natural [control] "prasiolites" examined), and scattered "breadcrumb" inclusions (much more common in synthetic than in natural amethyst, which is what we would expect this stone to have originated as if it was natural quartz).

However, EDXRF, UV-visible, and infrared spectroscopy also demonstrated features unlike those typical for natural citrine or green quartz, including: significant potassium (seen with EDXRF); sharp peaks in the UV-visible spectra of both green and yellow regions at about 345, 398, 420, 458, and 487 nm (may be caused by Co^{3+}); and a "hump" in the infrared absorption spectrum at about 3000 cm^{-1}. This combination of features proved that this material was indeed synthetic quartz.

MLJ, SFM, RCK, and Emmanuel Fritsch

ROCK Resembling Jadeite

The opaque variegated green-and-white cabochon (15.50 × 7.00 mm) in figure 7 was cemented to a snuff-bottle stopper. According to the client who submitted it to the East Coast lab for identification, this material closely resembled that of the bottle to which it belonged.

Although a spot reading on the refractometer was within the jadeite range, there was a noticeable birefringence—in fact, a "carbonate blink" —from 1.50 to 1.65. However, no effervescence occurred when a minute drop of dilute HCl acid was placed in an inconspicuous spot on its surface. Effervescence would be expected if the cabochon were either of the carbonate minerals calcite or aragonite.

As our testing at this point was inconclusive, we performed X-ray diffraction analysis. This revealed that the cabochon was a rock consisting principally of dolomite, a little quartz, and other, unidentified, minerals. Dolomite is one of the few carbonate minerals that do not effervesce (unless powdered) to a weak HCl acid solution. To determine what the unidentified minerals were, petrographic testing would have been required. We informed the client of this in the report's conclusion.

GRC

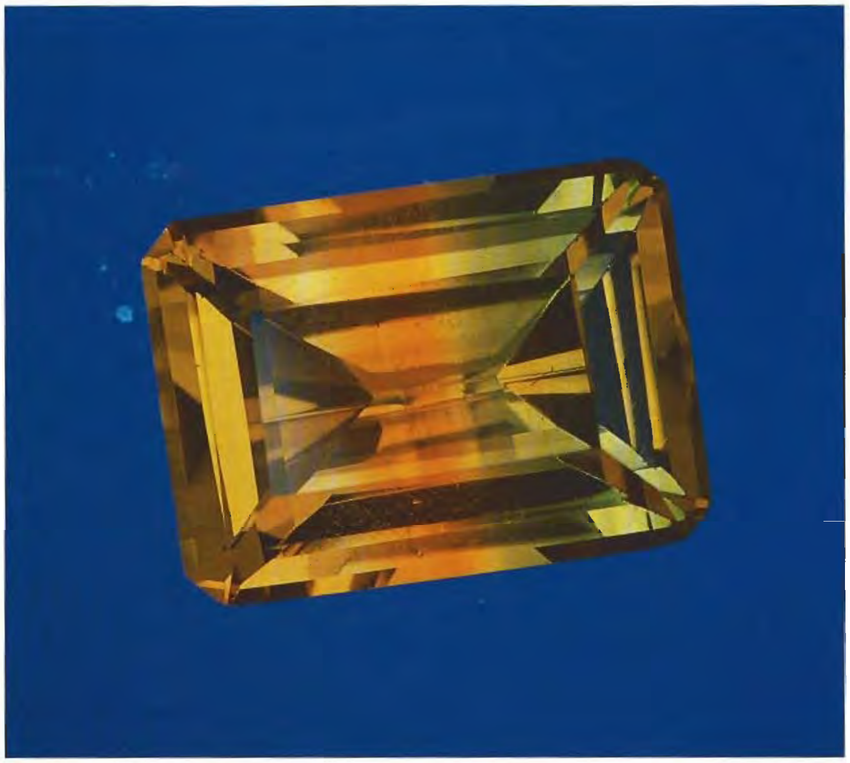


Figure 6. Testing revealed that this 8.47 ct green-and-yellow bicolor is a synthetic quartz.

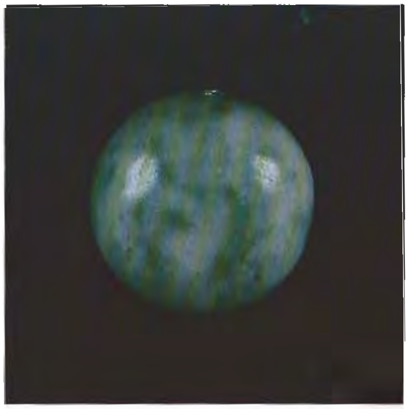
RUBY

With Atypically High R.I.'s

The article "Update on Diffusion-Treated Corundum: Red and Other Colors" (S. F. McClure et al., *Gems & Gemology,* Spring 1993, pp. 16–28) focused on treated stones in purplish pink, reddish purple to purplish red, and orangy red hues. One feature documented in many of these sample stones, in contrast to documented blue diffusion-treated sapphires, was the presence of unusually high refractive indices. The authors speculated that this was due to the high chromium content in the diffused surface layer, and they made reference to a report in the literature mentioning high R.I. readings from high-chromium-content rubies and orange sapphires from Malawi.

Recently, the West Coast lab was asked to identify a 1.19 ct red oval mixed cut. Standard gemological testing identified the stone as natural ruby, and internal features were indicative of heat treatment. We were surprised, however, by the unusually high refractometer readings: n_ε = 1.769, n_o = 1.778. EDXRF chemical analysis by GIA Research revealed an unusually high chromium content: 2.77 wt.% Cr_2O_3.

Figure 7. This cabochon, which formed the top of a snuff bottle stopper, consists of dolomite, some quartz, and other, unidentified, minerals.



In "Rubies from Mong Hsu" (*Gems & Gemology,* Spring 1995, pp. 2–26), authors Peretti et al. note that rubies from this relatively new Myanmar locality have unusually high chromium contents (as high as 2.86 wt.% Cr_2O_3 in one stone they analyzed) and, furthermore, may show high R.I. values (n_ε = 1.760–1.770, n_o = 1.768–1.780). The 1.19 ct ruby we tested had a chromium content and R.I. values that fall within the upper limits of those reported in that article, and its other internal characteristics were consistent with those reported for Mong Hsu stones. The above-referenced article by Peretti et al. also pointed out that heat-treated Mong Hsu rubies may contain glass-filled fissures, a feature that has resulted in their being misidentified as flux-grown synthetics. The high

Figure 8. A nearly colorless area can be seen at the base of this natural ruby cabochon (about 16.5 × 11.7 × 8.0 mm).

R.I. values of some Mong Hsu rubies may help separate them from flux-grown synthetics (which typically fall in the range 1.762–1.770).

This was the first of these high-R.I. rubies seen in the West Coast laboratory. Given what we know about Mong Hsu rubies and the quantities that are currently entering the marketplace, as well as the occurrence of Malawi rubies with high refractive index readings, we suspect that we will be seeing more high-R.I. stones in the future.

RCK and SFM

Two Stones with Unusual Features

A ring-set cabochon ruby (figure 8) seen recently in the East Coast lab had a near-colorless zone at the base. At first glance, it looked very much as if it was an area where dye had not "taken." Routine examination with a hand spectroscope revealed a typical ruby chromium spectrum, with no evidence of dye. Microscopic examination not only confirmed that the stone was natural with no dye, but it also showed that it had not been heat treated.

An attractive 9.57 ct natural star ruby with another anomaly was also seen in the East Coast lab. Not visible in the face-up view in figure 9 is an area on the bottom and part of one side that contained a soft, epoxy-like filling (figure 10). If the stone was carefully mounted, this area would probably not be seen and, in any event, it was undoubtedly deemed preferable in appearance to the large cavity that it filled. Although "glass"-filled cavities in ruby are not uncommon, this was one of the few instances we have encountered of a soft, epoxy-like filling in this gem material. *GRC*

Figure 9. This 9.57 ct star ruby (about 14.05 × 9 × 7 mm) shows no evidence of cavity filling when observed face-up.

Figure 10. In this side view of the star ruby shown in figure 9, a large cavity with an epoxy-like filling is evident.

SAPPHIRE, with Zoned Transmission Luminescence

Some gem materials luminesce when high-intensity visible light is transmitted through them, a feature gemologists call "transmission luminescence." In practice, we usually see this during routine gem testing with a desk-model spectroscope, which employs intense transmitted illumination, or when we use similar lighting to examine a stone with a Chelsea color filter. Gem materials that may exhibit this feature include natural and synthetic emerald, natural and synthetic ruby, synthetic alexandrite, synthetic blue spinel, and natural "cobalt" blue spinel. In all of these examples, the luminescence is an evenly distributed red. An exception is the green transmission luminescence of some diamonds, which normally occurs in fairly distinct planes or zones.

Figure 11. Red luminescence to intense transmitted light is confined to distinct bands, such as the one shown here, in this 19.45 ct blue sapphire. Magnified 20×.

In early 1995, the West Coast lab received for identification a 19.45 ct transparent blue mixed cushion cut. Routine gem testing identified the stone as a natural sapphire of natural color (that is, not heat treated or otherwise enhanced). When we examined this stone with a desk-model spectroscope, we were surprised to see a strong red luminescence that appeared to be unevenly distributed. When we used magnification in conjunction with a fiber-optic light source, it became clear that the luminescence was confined to distinct bands (figure 11). We then performed three EDXRF chemical analyses, with the stone at different orientations to the X-ray beam so we could measure different areas. One analysis

Figure 12. After only about three minutes' exposure to short-wave UV radiation during testing, this 4.57 ct near-colorless synthetic sapphire (left) turned brownish yellow (right).

revealed the presence of chromium, to which we attribute the visible-light luminescence. We surmise that the chromium is unevenly distributed in the stone, with the greater concentrations in those zones that show the unusual luminescence. *RCK*

SYNTHETIC SAPPHIRE, with Color Changed by UV Radiation

Laboratory irradiation has been used to change or develop color in many gem materials. Examples include the development of yellow in beryl, pink-to-red in tourmaline, blue in topaz, brown (the "smoky" color) in quartz, and various colors in diamond. (For more information, see K. Nassau's comprehensive *Gemstone Enhancement*, 2nd ed., 1994, Butterworth/Heinemann, Oxford, England, and C. E. Ashbaugh's "Gemstone Irradiation and Radioactivity," *Gems & Gemology*, Winter 1988, pp. 196–213.)

Radiation also causes yellow in corundum, but apparently more than one type of color center can be produced. Some radiation-induced yellow is stable to light (e.g., natural-color yellow sapphires from Sri Lanka and the yellow component of "padparadscha" sapphire). In other such sapphires, the color will fade on exposure to light. All such yellow color is faded by heat. For example, experimenting with synthetic sapphire, one of the editors has had a deep yellow induced in colorless synthetic sapphire and a pinkish orange produced in synthetic pink sapphire by exposure to radiation in a gamma cell. In both situations, it was found that the yellow color could be removed by gentle heating in the flame of an alcohol lamp.

In summer 1995, the West Coast lab received for identification a 4.57 ct transparent, near-colorless emerald cut, measuring 10.00 × 7.98 × 5.59 mm (figure 12, left). Gemological testing revealed refractive indices of 1.760–1.768, a birefringence of 0.008, and a uniaxial negative optic character—properties consistent with both natural and synthetic corundum. Magnification with various lighting techniques, including darkfield and brightfield, failed to reveal any inclusions or growth structures that could be used to determine whether the stone was natural or synthetic. Because we have had some success in resolving curved growth striae using magnification in conjunction with short-wave UV radiation (see, e.g., "Synthetic Sapphire, Another Striae-Resolution Technique," Winter 1994 Lab Notes, p. 270), we used this method to examine the stone. We successfully resolved curved striae, proving that it was a synthetic sapphire.

However, we were not prepared for the appearance of the sample when it was removed from the microscope's stage after the approximately three-minute examination: It had turned a medium brownish yellow (figure 12, right). Approximately six hours' exposure in a solar simulator removed most of the induced color, but the synthetic sapphire was ultimately returned to its original, near-colorless condition only by a few minutes of gentle heating in the flame of an alcohol lamp. This is the first instance we have encountered in which a yellow color was induced in corundum by such a relatively weak dosage of radiation.

RCK and SFM

Magnetic SERPENTINE

Many fine-grained translucent green materials may resemble jade—espe-

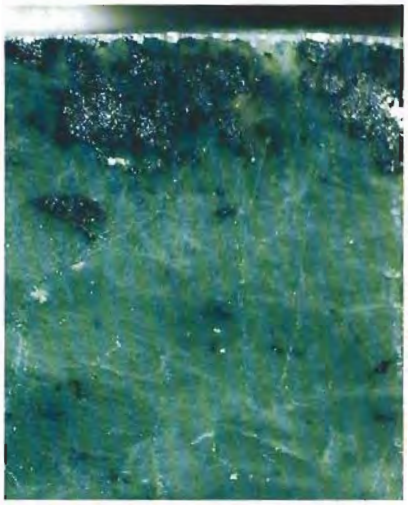


Figure 13. There were enough magnetite inclusions in this serpentine to attract the material to a magnet. Magnified 10×.

cially nephrite jade—at first glance. In August 1995, a semi-translucent, partially polished, green-and-black piece of rough material was submitted to the West Coast laboratory for identification. Aggregate gem materials such as rocks often require extra identification effort. Some properties (such as S.G.) represent averages of the components present, whereas other properties (such as R.I.) are representative of individual grains and not of the material as a whole. In the case of this rough material, we quickly eliminated nephrite as a possibility, but more work was required for positive identification.

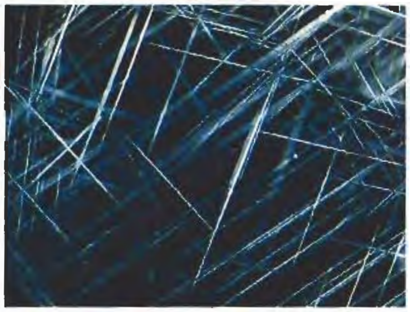
We determined the following gemological properties: R.I.—about 1.57 (spot); S.G.—2.63; optic character—aggregate; fluorescence—mottled, with faint chalky blue areas, to long-wave UV and inert to short-wave. Weak absorption at 500 nm was visible through the hand-held spectroscope. With magnification, the material appeared soft, revealing a poor polish with many fine scratches and rounded edges on small fractures. The material also revealed an aggregate structure and black, equidimensional inclusions. Some brown areas, which looked like iron staining, were visible. All these properties were consistent with those of serpentine.

Our curiosity was piqued, however, by the black inclusions. Polishing of the piece had left a hackly (as if cut with a dull hacksaw) fracture exposed on some of these inclusions (figure 13). Using low-angle reflected illumination, we saw neither a white surface (as would be the case with a titanium oxide or ilmenite) nor a brown surface (as with hematite or pyrite). Attempts to rub the black material off on a piece of paper were unsuccessful, which indicates that it was not graphite. However, the fact that the piece was attracted to a hand-held magnet suggested that the inclusions were magnetite, a member of the spinel mineral group. This identification was confirmed by X-ray powder diffraction analysis of a small scraping taken from an exposed inclusion. MLJ

SPINEL, with Högbomite(?) Inclusions

In February 1995, the West Coast lab received a 21.38 ct (19.24 x 14.78 × 9.28 mm) oval mixed-cut stone for identification. The stone was singly refractive, had a refractive index of 1.718, and was inert to both long- and short-wave UV radiation. Its absorption spectrum, as seen with a hand-held prism spectroscope, was typical for dark blue spinel.

Figure 14. The reflective "needles" (actually, thin plates) in this 21.38 ct color-change spinel may be högbomite, a mineral related to spinel. Magnified 15×.



Two features of this natural spinel were noteworthy: its color, which changed from violetish blue (in fluorescent light) to purple (in incandescent light), and its needle-like inclusions (figure 14). These inclusions—actually long, thin flat plates—formed in oriented aggregates in at least four different directions. On the basis of their appearance, GIA GTL's chief research gemologist John I. Koivula suggested that these plates might be exsolution lamellae (flat sheets) of högbomite, $(Mg,Fe^{2+})_2$-$(Al,Ti)_5O_{10}$, similar to those reported by K. Schmetzer and A. Berger ("Lamellar Iron-Free Högbomite-24R from Tanzania," *Neues Jahrbuch für Mineralogie Monatshefte*, 1990, No. 9, pp. 401–412, and "Lamellar Inclusions in Spinels from Morogoro Area, Tanzania," *Journal of Gemmology*, Vol. 23, No. 2, 1992, pp. 93–94).

Högbomite comes out of solution in spinel as the crystal cools from high temperatures. According to Schmetzer and Berger, it has only been seen in gem spinels from the Morogoro area of Tanzania, although it is found in rock-forming spinels from other areas. Although Tanzanian högbomite is rich in titanium, no titanium was detected in this stone with EDXRF spectroscopy. We suspect that these exsolution plates are too small to affect the stone's overall chemistry. MLJ

A TOPAZ Assemblage

The assembly of various materials to imitate gems has been with us throughout the centuries, dating back to Minoan and Roman times. Ancient writings such as the fifth century A.D. Greek *Papyrus Holmiensis*, and *Natural History* by Roman scholar Pliny (23–79 A.D.), have enlightened us on this practice (see, for example, the fascinating article by K. Nassau, "An Early History of Gemstone Treatments," in *Gems & Gemology*, Spring 1984, pp. 22–33). Doublets and triplets were very common imitations of such prized gems as ruby and emerald, at

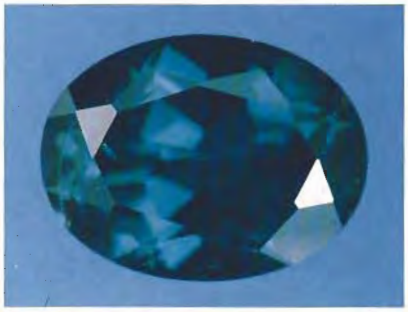


Figure 15. This 1.48 ct stone resembles some Paraíba tourmaline, but it is in fact a topaz triplet.

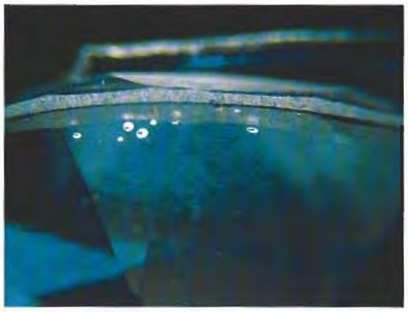


Figure 16. Magnification at 20×, with immersion in methylene iodide, reveals the separation plane at the girdle of the assembled stone in figure 15.

least until the advent of synthetics. The most common assembled stones GIA GTL has seen in recent years are opal doublets and triplets, as well as combinations of natural/synthetic corundum and natural/synthetic spinel. Much less frequently, we have also seen asteriated assemblages (see, for example, the Fall 1993 Lab Notes, p. 205).

Recently, however, the East Coast lab encountered a new type of assemblage, in a 1.48 ct faceted oval stone (figure 15). The color resembled that of some Paraíba tourmaline (see, e.g., the Fall 1989 issue of *Gems & Gemology*, p. 182, figure 8, second stone from the left).

Microscopic examination of the stone with immersion revealed that it was actually a triplet, composed of a near-colorless crown and pavilion held together by a greenish blue cement (figure 16). Refractive indices read about 1.60 to 1.61 (birefringence of 0.01) on both the crown and pavilion. Biaxial optic figures on both pieces confirmed that they were colorless topaz.

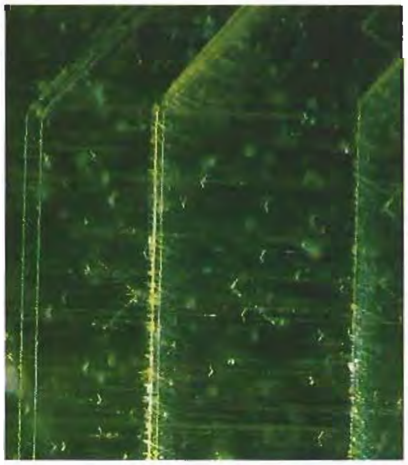
We can only speculate why this unusual triplet was created. However, Paraíba tourmaline of fine color and especially in larger sizes has become very scarce in the market and commands high prices; in addition, no synthetic tourmaline has been produced commercially as yet.

Nicholas DelRe

ZIRCON, with Phantom Planes

Sometimes, identifications are not particularly difficult, but a stone may contain features that are both photogenic and good teaching examples. Such was the case with a 9.24 ct green oval mixed cut that arrived in the West Coast lab early in 1995. Identifying it as zircon was straightforward: Strong doubling of the back facets was seen with magnification; the R.I. was over-the-limits of the standard gemological refractometer; the S.G. was 4.04 (measured hydrostatically); the stone was inert to long-wave UV and fluoresced faint green to short-wave UV; and its absorption spectrum (as observed with a desk-model prism spectroscope) showed "fuzzy" bands at 530, 580, and 650 nm (the last being the strongest). The stone was also slightly radioactive.

Figure 17. The decorated phantom planes in this 9.24 ct faceted zircon reveal much about its formation. Magnified 20×.



Magnification revealed an excellent illustrative set of inclusions: parallel zoning, V-shaped inclusions, skeletal inclusions (typical of low-property zircons), and especially angular zoning. The angular growth planes in figure 17 are probably the first- and second-order prism faces of zircon, {100} and {110}. At the time these faces were at the surface of the stone, they were being exposed to one or more episodes of deposition or dissolution (possibilities include the preferential deposition of solids or trace elements, dissolution of the zircon by fluids, or deposition of exotic material leading to *later* dissolution of the zircon). They appear as lines because the photo was taken looking parallel to the planes of these faces, that is, down the c-axis. These planes are decorated phantom faces.

An additional feature of these planes is that they reveal the relative growth rate of the two faces. The larger (longer) face ({100}?) grew more rapidly than the smaller face ({110}?), so the larger face became relatively shorter as crystal growth proceeded (from the bottom of the photo to the top). Although these features can be seen in many zircon samples, they are particularly well represented in this stone.

MLJ

Erratum: *The 115.56 ct synthetic ruby described in the last Lab Notes section (Fall 1995, p. 203) was not produced by Czochralski pulling, but rather by a related proprietary technique.*

PHOTO CREDITS

Figure 1 was taken by Maha DeMaggio. The photomicrographs in figures 2, 11, 14, and 17 are by John I. Koivula. Shane McClure provided figures 3, 6, 12 (left and right), and 13. Nicholas DelRe supplied the pictures used in figures 4, 5, 7-10, 15, and 16.