# GEM TRADE LAB NOTES

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## DIAMOND

### With Etched Dislocation Channels

Some unusual inclusions in a 2.04-ct light pink pear-shaped diamond were illustrated in the Fall 1992 Lab Notes section (p. 194). Subsequently, we were shown a 1.28-ct fancy pink diamond, reportedly from Australia, with similar inclusions: rectangular hollow channels (figure 1), some of which "zigzagged" for quite a distance (figure 2).

Emmanuel Fritsch, of GIA Research, informed us that X-ray topographers use the term *zigzag dislocations* for features of similar geometry seen with X-radiography (the phenomenon is not limited to diamond). The dislocations represent zones of weakness in the crystal structure. Under certain geologic conditions, the dislocations may become etched, in which case they are called *etched dislocation channels*.

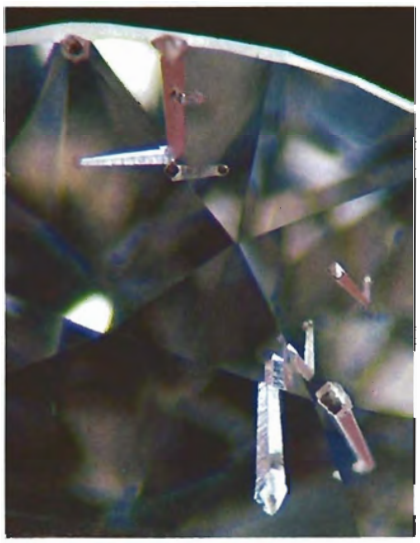


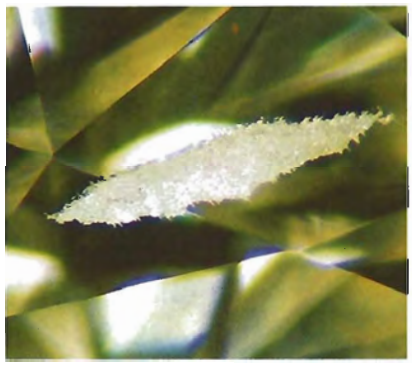
*Figure 1. The surface-reaching inclusions in this 1.28-ct light pink diamond are actually rectangular hollow tubes. Magnified 33×.*

*Figure 2. At 63× magnification, one can see the extent of the "zigzagging" in one of the inclusions shown in figure 1.*

The channels that we observed in the two diamonds mentioned above would appear to be related to the various etch phenomena noted by Hofer in his article on pink diamonds from Australia (*Gems & Gemology*, Fall 1985, pp. 147–155). Although Hofer describes these etch phenomena as typical of Argyle pink diamonds, we also noted an open cleavage that had been etched in a 0.87-ct fancy yellow diamond (figure 3) that was reportedly from Argyle.

It is possible that the series of long, blade-like, nearly parallel inclusions observed in still another, 0.75-ct diamond could also be evidence of etched dislocation channels. When the round brilliant was viewed faceup, these inclusions were reflected in other facets, so that the whole stone resembled a kaleidoscope (figure 4). Of necessity, many jewelers have been forced to handle dia-

*Figure 3. This etch feature, typically associated with pink diamonds from Argyle, was seen in a 0.87-ct fancy yellow stone, also reportedly from that locality. Magnified 45×.*



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

*Gems & Gemology, Vol. 28, No. 4, pp. 262- 267*

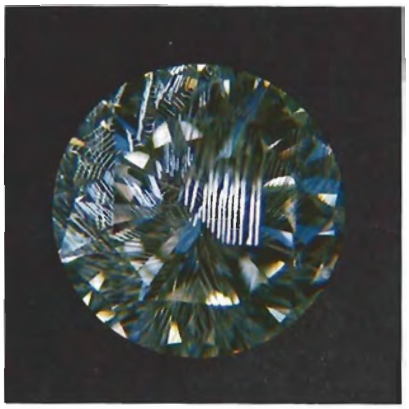


*Figure 4. These long, blade-like inclusions produce a kaleidoscopic effect when this 0.75-ct. diamond is viewed faceup. Magnified 16×.*

monds with lower clarity grades than they had been accustomed to handling in the past. It is interesting that these inclusions were first observed while our client was examining stones for evidence of fracture filling, turning what might have been a chore into an opportunity to discover heretofore unappreciated beauty in the inclusions themselves. *GRC*

### Colored Diamond Crystal Set in a "Renaissance Ring"

The increasing popularity of fancy-color diamonds is also often associated with the Argyle deposit, because of the many brown and pink diamonds it produces (see, e.g., *Modern Jeweler*, April 1987). Consumer awareness has been heightened recently by jewelry manufacturers' promotions of finished pieces that incorporate these colored diamonds.

The ring shown in figure 5 was sent to the East Coast laboratory for identification of the stone and, if it proved to be a diamond, whether the color was natural or treated. The dark brown octahedron was, without a doubt, a diamond. It measured 5.00 × 4.85 mm wide where mounted into the bezel; the closed-back setting prevented measurement of its height. Using the microscope and diffused lighting, we observed pronounced brown graining. This, together with the absence of sharp absorption bands in the hand

*Figure 5. The ring in which this dark brown diamond octahedron is set reportedly dates from the Renaissance period.*

spectroscope and the weak yellow flourescence to long-wave ultraviolet radiation, confirmed that the color was natural.

This ring is very similar in style to a ring from the Renaissance period in Europe that is featured on page 97 of *Gems and Jewels: A Connoisseur's Guide*, by Benjamin Zucker (Thames and Hudson, New York, 1984). Although old styles are often reproduced, empirical evidence such as the purity and the patina of the gold, along with the burnished effect on the bezel that occurs with wear, indicates that this is an original antique. The intricate workmanship, and the fact that the ring is very well preserved, suggests that colored diamonds have been desirable for centuries. Also, the apparent age of the ring leads us to believe that the diamond is of Indian origin.

*TM*

## SYNTHETIC EMERALD

### Overgrowth on Faceted Beryls Used in Jewelry

One of the earlier commercial synthetic emerald products consists of a pre-faceted colorless or pale-colored natural beryl over which a layer of synthetic emerald has been grown by the hydrothermal method. Although the synthetic emerald layer is typically very thin, comprising only a small percentage of the entire gem, the faceup color is generally a uniform, medium to medium-dark green. Because this product was developed by Johann Lechleitner, it is commonly referred to by gemologists as "Lechleitner synthetic emerald overgrowth."

We rarely see these synthetic emerald overgrowths in the GIA Gem Trade Laboratory; when we do, it is generally as individual, loose stones. It was thus unusual for the West Coast lab to receive for examination the white metal pin shown in figure 6. Gemological testing proved that all four of the large (up to 11.7 × 9.5 × 7.7 mm) green emerald cuts are examples of synthetic emerald overgrowth on natural beryl. Typical features, noted with magnification, included a "crazed layer," consisting of many fine, intersecting fractures at the interface of the synthetic emerald layer and the beryl core. Growth features on several facets of each specimen

*Figure 6. The four green stones in this pin, which range from approximately 8.2 × 6.1 × 3.8 mm to 11.7 × 9.5 × 7.7 mm, are synthetic emerald overgrowths on natural beryl.*

proved that little or no repolishing had been done after the overgrowth process.

*SFM and R. C. Kammerling*

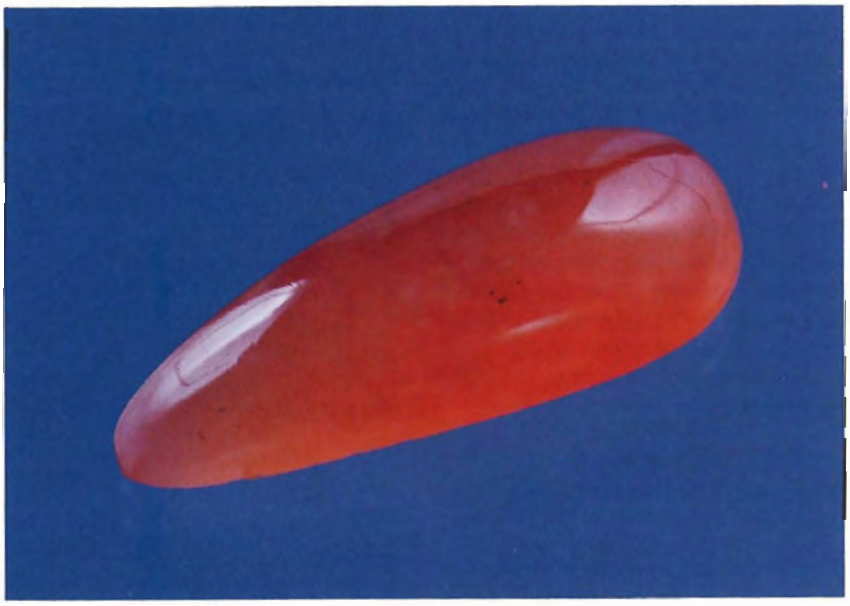
### Pink Hydrogrossular GARNET

Although we regularly receive for identification a wide variety of transparent, single-crystal garnets, only infrequently do we examine nontransparent aggregate types (see, e.g., the entry on a massive grossularite garnet carving in the Winter 1991 Lab Notes section). It was thus a pleasant surprise for the West Coast lab to receive the translucent, orange-pink 8.57-ct pear-shaped cabochon shown in figure 7.

The stone produced an "aggregate" reaction in the polariscope and a spot R.I. reading of 1.69. The specific gravity, determined hydrostatically, was 3.30. Although the R.I. and S.G. values are within the published ranges for hydrogrossular garnet, they are somewhat lower than what we have encountered in the past and could make this a difficult identification for some gemologists. X-ray powder diffraction analysis, however, proved that the stone was hydrogrossular garnet. Energy-dispersive X-ray fluorescence (EDXRF), performed by GIA Research, revealed the presence of manganese, which is believed to be responsible for the gem's color.

*SFM and R. C. Kammerling*

*Figure 7. The R.I. and S.G. values of this 8.57-ct hydrogrossular garnet (20.7 × 7.3 × 6.1 mm) are at the low end of the range for this gem species.*



### Black OPAL

In the trade, the term *black opal* is used to describe solid (i.e., unassembled) opals that display their play-of-color against a dark, essentially opaque background when viewed with overhead lighting. However, there does not appear to be a consensus as to what "dark background" means. Because black opal is so desirable, there is a tendency to use the term for materials with backgrounds that are dark brown or dark gray rather than black. Some traders use the term even more loosely, describing stones with only light gray backgrounds as black opal. (For more on opal description and valuation, refer to *Opal Identification and Value*, by Paul B. Downing [Majestic Press, Tallahassee, Florida, 1992].)

Regardless of how the term is defined, opals with a truly black background are uncommon, so the West Coast laboratory appreciated the opportunity to examine the 7.37-ct oval cabochon seen in figure 8. Against its black background, this stone exhibited large, vivid patches of color, mainly red and orange, but with some blue, green, and violet as well. When viewed from some angles, the opal displayed orange play-of-color across more than two-thirds of its surface.

*Figure 8. This 7.37-ct stone (19.8 × 11.8 × 4.7 mm) is a fine example of opal with a truly black background.*

Because this cabochon contains two thin seams of dark potch (i.e., common opal), an unwary gemologist might mistake it for an assembled stone. Therefore, a note was added to the conclusion on the GIA-GTL report that this opal is not assembled.

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### Freshwater Natural PEARL from Alabama

In their classic work, *The Book of the Pearl* (Century Co., New York, 1908), Kunz and Stevenson discuss natural pearls formed in bivalve mollusks that live in freshwater rivers and lakes. In America, pearls are primarily found in mollusks from the family *Unionidae*, which live in the Mississippi and Tennessee Rivers and their tributaries,

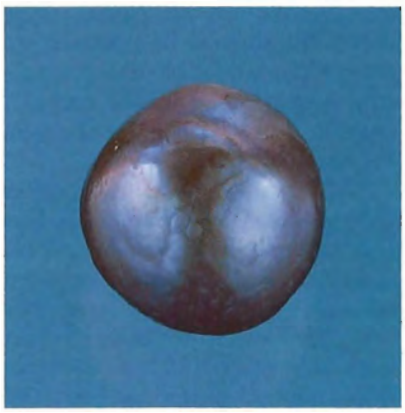


*Figure 9. The Chattahoochee River in Alabama is the source of this 12-mm natural pearl.*

as well as in the Colorado River. The West Coast laboratory has just learned that some natural pearls were found recently in Alabama, a lesser-known pearl source.

The attractive pinkish purple pearl in figure 9 was found in the Chattahoochee River near Dothan, Alabama. The slightly off-round pearl measured approximately 12 mm in diameter and weighed about 52 grains (13 ct). The X-radiograph showed the very dense structure and thin conchiolin layers commonly seen in freshwater natural pearls. Because of the fairly dark tone and coloration of this pearl, X-ray luminescence was only moderately strong. The pearl fluoresced greenish yellow to long-wave ultraviolet radiation. Unfortunately, it is not known which species produced this lovely pearl.

*KH*

### Synthetic Green QUARTZ

The laboratory periodically receives amethyst for identification, primarily to determine whether it is natural or synthetic. Amethyst, however, is not the only variety of quartz that is synthesized by the hydrothermal process.

Recently, two separate clients submitted to the West Coast laboratory faceted specimens of a transparent, dark green gem material that visually resembled tourmaline (see, e.g., figure 10). In both cases, the material had been represented to our clients as a new type of natural green quartz from Brazil.

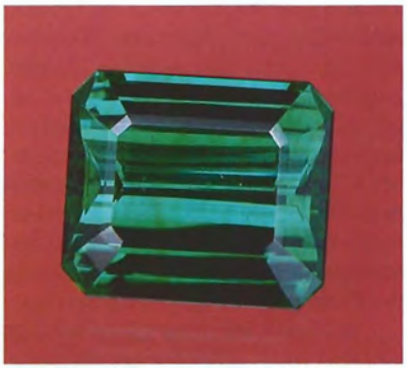
Gemological testing revealed properties consistent with quartz, both natural and synthetic. When the stones were immersed in water and examined with a polariscope, they proved to be untwinned, with a "bull's-eye" interference figure. Magnification revealed parallel green color banding, similar to that seen in a synthetic green quartz reference stone of Russian origin (see the Gem News section, Spring 1992). We also noted some angular brown color zoning running perpendicular to the green banding, a feature we have seen in other colors of hydrothermal synthetic quartz, but not in the natural counterpart. One specimen also contained numerous tiny white pinpoint inclusions.

EDXRF analysis in GIA Research detected the presence of silicon, potassium, and iron. This differed only slightly from the chemistry of our reference sample, which also contained minor amounts of chromium.

On the basis of these results, we identified the specimens from both clients as synthetic green quartz. The iron may be responsible for the green coloration of these stones, as it is in natural green quartz and in "greened amethyst" (produced by the heat treatment of some natural amethyst). It is important to note that, while green quartz (sometimes referred to by the trade name "praseolite") does occur naturally, such material is typically light in tone. To our knowledge, there are no reports of natural green quartz with this darkness of tone.

*SFM and R. C. Kammerling*

*Figure 10. This 12.30-ct synthetic green quartz had been misrepresented to our client as a new type of natural quartz from Brazil.*



### SAPPHIRE

#### Color-Zoned Sapphire

Some of the most interesting sapphires we encounter are those that exhibit distinct color zoning, such as the stones reported in the Spring 1986 and Fall 1989 Gem News sections. The West Coast laboratory recently examined an unusual sapphire that exhibited distinct orange and pink zones. In the faceup position, most of this 3.51-ct stone took on an orangy pink color with purple overtones, although distinct areas were more orange (figure 11).

*Figure 11. While the faceup color of this 3.51-ct sapphire is primarily orangy pink with purple overtones, the stone has distinct orange and pink color zones.*

This stone reminded us of an exceptional 1,126-ct sapphire crystal from the Ratnapura area of Sri Lanka illustrated in the Spring 1983 *Gems & Gemology* ("Padparadscha: What's in a Name?," by Robert Crowningshield), with a follow-up entry in the Spring 1986 Lab Notes column. That crystal also exhibited color zoning in predominantly pink and orange hues. It is pos-

sible that the stone described here was cut from a similar crystal.

*SFM and R. C. Kammerling*

### Durability of Diffusion-Treated Sapphire

An item in the Summer 1992 Lab Notes section reported unusual wear of the crown facets on a diffusion-treated blue sapphire. In that item, we surmised that repeated heating of some diffusion-treated sapphires may have produced a lower resistance to wear. However, the appearance of another diffusion-treated stone with badly abraded crown facets suggests that something more than just heating may be involved. An approximately 4-ct stone, set in a ring with side diamonds (figure 12), was submitted to the East Coast lab for identification. The lack of any evidence of wear to the setting leads us to believe that it could not have been worn for a long time. Yet, "micro-chipping" at the edge of the table (figure 13) resembles the damage seen on a heat-treated zircon that has been worn for years. Thus, we are forced to consider the possibility that the surface layer of at least some diffusion-treated sapphires is just not as durable as the surface of an ordinary heat-treated sapphire.

*Figure 12. Abraded table facet junctions are readily seen on this approximately 4-ct diffusion-treated sapphire which has been set in a ring with diamonds.*

*Figure 13. At 35× magnification, the full extent of the abrasion damage to the table facet junctions of the stone shown in figure 12 is apparent.*

We do not know how prevalent this problem is, given the many thousands of carats of blue diffusion-treated sapphires that have entered the trade in recent years. It appears, however, that some diffusion-treated sapphires are as prone to wear as heat-treated zircons. *GRC*

### Yellow Sapphire with Unusual Fluorescence

Reaction to ultraviolet radiation is often a useful gemological test. One specific application is to determine if corundum gems have been subjected to heat treatment. For example, blue heat-treated "geuda" stones from Sri Lanka often fluoresce a chalky bluish white to greenish yellow to short-wave U.V. radiation. Occasionally, we have also seen rubies that showed a patchy bluish fluorescence to short-wave U.V. (see, e.g., the Summer 1984 Lab Notes section).

Recently, the West Coast lab was asked to issue an identification report on an 8.27-ct transparent, light yellow, oval mixed cut. Gemological testing proved the stone to be a natural sapphire. Magnification revealed small discoid fractures around the included crystals, clear evidence that the stone had been heat treated.

The moderate orange fluorescence to long-wave U.V. radiation has been seen before in both heat-treated and untreated yellow sapphires. However, we were surprised to see an atypical overall yellow fluorescence to short-wave U.V. Examination of the stone with a microscope that had been modified for use with U.V. radiation sources revealed the cause of the yellow appearance: Most of the stone fluoresced orange to short-wave U.V., but some areas fluoresced a chalky bluish white. These areas corresponded to light blue color zones that might have developed during the heat treatment. It appears that the areas of chalky bluish white fluorescence combine with the underlying orange fluorescence to produce an overall yellow appearance to short-wave U.V. radiation.

*SFM and R. C. Kammerling*

### SYNTHETIC STAR SAPPHIRE of Unusual Color

Synthetic star corundums are produced by the flame-fusion method in a great variety of colors. One of the most prevalent colors mimics the appearance of ruby. In our experience, synthetic star stones tend to be semitranslucent to almost opaque, because of the high concentration of acicular synthetic rutile inclusions responsible for the asterism. These synthetic rutile needles not only lower the transparency of the synthetic stones, but they also contribute a strong purple appearance that is due to scattering of light. It is because of this effect of rutile on the overall color appearance (of natural as well as synthetic stones) that the laboratory allows more leeway in making the distinction between ruby and purple sapphire in star stones.

On rare occasions, we see synthetic star rubies that contain lower concentrations of the needle-like inclusions. Such stones invariably have a more natural appearance. They not only exhib-

*Figure 14. The combination of a high degree of transparency and a reddish purple body color makes this 7.08-ct synthetic star sapphire unusual.*

it slightly less distinct stars, but they also are semitransparent with a less purple, more red body color. Even more unusual, in our experience, is the 7.08-ct synthetic star sapphire shown in figure 14, which was recently examined in the West Coast laboratory. Although this stone exhibited the high degree of transparency associated with lower concentrations of rutile, the dark reddish purple body color resulted in it being identified as a synthetic star sapphire rather than a synthetic star ruby.

*SFM and R. C. Kammerling*

### Unusual Bicolor ZOISITE

The blue to violet variety of zoisite known as tanzanite, which is produced primarily in the Merelani Hills of Tanzania, first entered the gem market in the 1960s. Much more recently—in 1991—commercial quantities of a transparent green zoisite were also discovered in the Merelani Hills (see "Gem-Quality Green Zoisite," by N. R. Barot and W. Boehm, in the Spring 1992 *Gems & Gemology*).

In our experience, both tanzanite and the newer transparent green zoisite tend to have quite uniform color distribution throughout the stone. Staff gemologists in the West Coast lab were therefore surprised to receive for identification the 2.52-ct emerald cut illustrated in figure 15. This zoisite is very unusual in that it is distinctly bicolored, displaying violetish blue in one half and yellowish green in the other.

Standard gemological testing confirmed that the stone was zoisite. Ultraviolet-visible spectroscopy and EDXRF chemical analysis were performed in GIA Research to explore the difference in color between the two zones. A qualitative EDXRF analysis showed that both the violetish blue and yellowish green sectors contain, besides zoisite's normal components, traces of strontium, vanadium, and possibly chromium. However, the blue sector was found to have significantly more vanadium than the green sector, but none of the titanium that was present as an additional impurity in the green sector. No iron was found in the crystal, in either color sector. In their article, Barot and Boehm also noted the presence of strontium and the absence of iron in both the green and the blue samples, although no ultraviolet-visible absorption spectra were provided. They identified Cr as the primary chromogen responsible for the green color, versus the established chromogen V in the blue material. Their blue and green samples all contained comparable amounts of Ti.

Unpolarized absorption spectra, taken in the same orientation in both the blue and green zones, show identical features, with the exception of an additional absorption in the green zone that has a "two-humped" broad band with apparent maxima at about 445 and 466 nm. A band at about 444 nm has in the past been tentatively attributed by Faye and Nickel (*Canadian Mineralogist*, Vol. 10, No. 5, 1971, pp. 812–821) to $Ti^{3+}$ in zoisite. However, this interpretation poses some problems that remain unresolved. For example, this absorption may be related to titanium in a more indirect manner, such as a charge transfer with some other ion; there are no previously known absorptions around 466 nm. Therefore, the color difference between the two zones of this zoisite is not clearly understood at this time.

*R. C. Kammerling and Emmanuel Fritsch*

*Figure 15. This 2.52-ct zoisite (10.3 × 5.5 × 4.6 mm) is unusual in that it is distinctly bicolored. The green portion is actually greener in the stone than it appears in this photograph.*

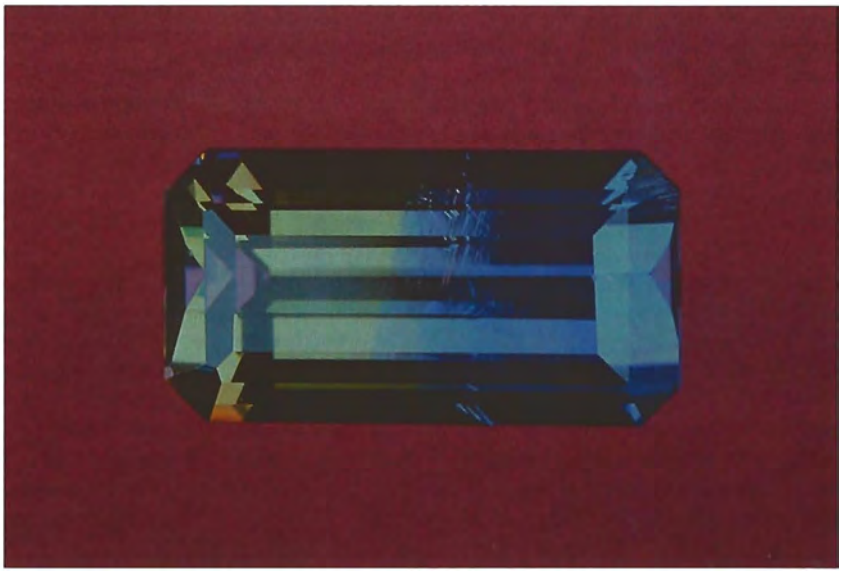


*PHOTO CREDITS*
*Vincent Cracco took the pictures in figures 1-3. Nicholas DelRe supplied the photos in figures 4, 5, 12, and 13. The photographs used for figures 6–11, 14 and 15 were taken by Shane F. McClure.*