

LAB NOTES

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A Notable Yellow Synthetic DIAMOND from Russia

At one of the trade shows in the Far East last fall, a diamond dealer and manufacturer showed a tray of about two dozen small, yellow, faceted synthetic diamonds with a sign suggesting that every gemologist should buy one for reference. The 0.23 ct yellow round brilliant shown in figure 1 was obtained at that show and examined in both the East and West Coast labs. The dealer offering these synthetics said that they were grown in Russia, and we found that the properties of this sample were consistent with those reported previously for such material [see, e.g., the comprehensive article on Russian synthetic diamonds by J. E. Shigley et al., *Gems & Gemology*, Winter 1993, pp. 228–248]. However, this stone differs a little from other Russian synthetic diamonds reported in the literature with regard to the graining and color zoning.

Note in particular the geometric arrangement of the brown graining illustrated in figure 2. This series of concentric squares bears some similarity to the phantom graining sometimes seen through the table of a "4-point" natural diamond—that is, one made by sawing a regular octahedron along the cubic direction into two parts, each of which is then polished. In this instance, however, the pattern is seen when the sample is viewed from an oblique profile, a position in which a "4-point" diamond would show intersecting octahedral planes. Furthermore, when the synthetic diamond was turned 90° in profile view (figure 3), we saw an array of concen-

tric angles (perhaps corners) connected by a thick swath of brown color, with a second group of angles slightly offset from the first. Such a pattern is unlike anything we have seen in a natural diamond.



Figure 1. This 0.23 ct round brilliant synthetic diamond, reportedly from Russia, was purchased at a trade show in the Far East.

Confirmation that these growth patterns are typical of those seen in synthetic diamond was found in the pattern of luminescence to long-wave ultraviolet radiation. Figure 4 shows a central square marking cubic sectors, with extensions from the four corners, along the dodecahedral sectors. A similar pattern was evident in the green luminescence to strong visible light. This is another example of the importance of examining a stone thoroughly, from many angles, and testing for several properties before reaching a conclusion as to its identity.

IR

EMERALD Earrings, One Natural and One Imitation

Synthetic emerald is by far the most common substitute for natural emerald that we encounter in the laboratory. This is not surprising, as both flux-grown and hydrothermally grown synthetic emeralds are readily available and aggressively marketed in the trade. However, we occasionally encounter a number of less sophisticated, if not less ingenious, simulants. These include dyed beryl (Winter 1981 *Gem Trade Lab Notes*, pp. 227–228), bezel-set colorless quartz with a green backing (Winter 1984 *Lab Notes*, pp. 228–229), and synthetic spinel and glass triplets (Winter 1986 *Lab Notes*, pp. 236–238).

Recently, the West Coast laboratory received a pair of yellow and white metal earrings for identification of the green emerald cuts (figure 5). The stone in the earring on the right in figure 5, which measured $8.30 \times 7.80 \times 5.25$ mm, had properties consistent with natural emerald: R.I., 1.575–1.582; birefringence, 0.007; uniaxial negative; inert to both long- and short-wave ultraviolet radiation (although under the long-wave UV lamp there was some yellow fluorescence from surface-reaching fractures); and two- and three-phase inclusions, as well as growth and color zoning. Magnification also revealed residue from clarity enhancement. This stone was, therefore, identified as a natural

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

Gems & Gemology, Vol. 32, No. 1, pp. 44–51

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emerald, with a note in the report's conclusion stating that evidence of clarity enhancement was present.

The green emerald cut in the other earring ($9.25 \times 7.05 \times 4.05$ mm) was similar in color and transparency. However, a refractive index taken on the crown produced readings of 1.545–1.552. Examination with magnification revealed that the item was assembled, consisting of an essentially colorless crown and pavilion joined at the girdle plane by a green cement (figure 6). The crown looks green because of the reflection of the green cement, which is also refracted so that it appears as a green band in the pavilion. Because of the mounting, we could not identify the material used for the pavilion; however, we did note that it contained a large partially healed fracture and two-phase inclusions (reminiscent of the internal features found in beryl of pegmatitic origin). On the basis of this examination, we identified this emerald cut as a triplet consisting of a rock crystal quartz crown joined by green cement to a pavilion of undetermined identity.

While it is possible that the pavilion was also quartz (quartz triplets,

known as *soudé* [soldered] emeralds, were a popular emerald substitute in the early 1900s), our staff gemologists have also examined triplets that were constructed of quartz crowns/beryl pavilions and beryl crowns/quartz pavilions. We suspect that two different gem materials were not intentionally used for such stones; rather, they were fabricated from readily available, relatively inexpensive parcels of rough that included both quartz and beryl.

¹ RCK and SFM

GROSSULAR Garnet-Bearing Rock, Resembling Impregnated Jadeite

We have reported before about rocks composed of garnet and other minerals that at first glance resemble jadeite jade. Recent examples include: massive grossular garnet (Winter 1991 Lab Notes, pp. 249–250), a feldspar-garnet snuff bottle (Spring 1994 Lab Notes, pp. 42–43), and grossular-diopside rock (Fall 1994 Lab Notes, p. 186). In August 1995, the West Coast laboratory received for identification several examples of another grossular garnet-bearing rock that resembled jadeite jade in a new way.

The material had the following gemological properties: color—mottled green and white, or a mottled green; optic character—aggregate; spot refractive index—1.73; fluorescence—

Figure 2. The brown graining in the synthetic diamond in figure 1 marks the cubic growth sectors. When examined from an oblique profile view with diffused transmitted light, this graining forms a pattern of concentric squares that could be confused with the phantom graining seen in some natural diamonds. Magnified 10 $\times$.

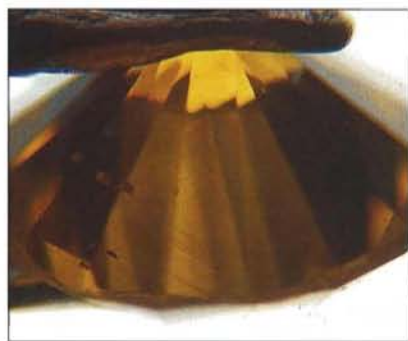


Figure 3. From another angle, the graining seen in this synthetic diamond shows a pattern closer to what has been reported previously in Russian synthetic diamonds, and unlike anything one would see in a natural diamond. Magnified 30 $\times$.

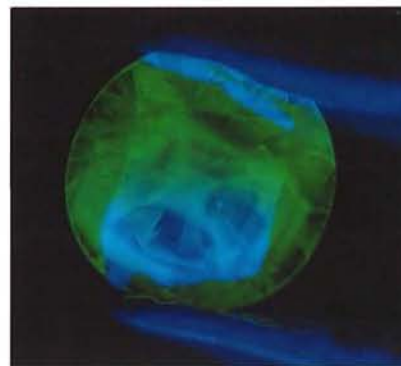


Figure 4. When exposed to long-wave UV radiation, the synthetic diamond in figure 1 showed a fluorescence pattern typical of that seen in synthetic diamonds: a square with extensions from the four corners.

inert to faint yellowish green to long-wave UV radiation, no fluorescence to short-wave UV; and weak 470 and 600 nm bands seen with the hand-held spectroscope. S.G. could not be determined because all the pieces were mounted. As these properties were not sufficient to identify the material, we also took X-ray powder diffraction patterns. One indicated that the bulk of the material was grossular garnet.

Magnification revealed why this material could be confused with jadeite jade: When observed with reflected light, the grossular stood out against the softer undercut areas of white to near-colorless material (figure 7). At first glance, this texture could be confused with that of some polymer-impregnated jadeite jade, or some other plastic-filled rock where the softer plastic also undercuts [see, for instance, "Jadeite Jade: Bleached and Impregnated, with Distinctive Surface Features," Winter 1994 Lab Notes, pp. 266–267]. However, the softer material did not react to the thermal reaction tester ("hot point").

Again, X-ray powder diffraction analysis was used to identify the softer material as a member of the chlorite mineral group. Chlorite minerals are made up of silicate and metal hydroxide layers that are stacked in



Figure 5. The green emerald cut in the earring on the right was identified as a natural emerald, while the emerald cut on the left was found to be a triplet consisting of a rock crystal quartz crown joined by green cement to a pavilion fashioned from an undetermined material.

various ways. In many, they are orderly; in some, there is no long-term order in the stacking arrangements. The latter was the case for

this material. Because energy-dispersive X-ray fluorescence (EDXRF) analysis showed that the rock contained considerable magnesium, we suspect that the softer interstitial mineral is clinocllore, which is consistent with the X-ray powder diffraction pattern of a chlorite mineral.

MLJ

JADEITE JADE

With Copper Inclusions

In the Summer 1994 Lab Notes section (pp. 117–118), we described metallic inclusions (probably pyrite and pyrrhotite) in an unusually translucent jadeite cabochon. Last spring, we saw metallic inclusions in jadeite that had a different appearance.

A necklace of 72 translucent-to-opaque, mottled green-and-white beads was submitted to the West Coast lab for identification. To the best of our client's knowledge, this material was some sort of Central American jade. Tests on one bead revealed the following gemological properties: R.I.—1.66 (spot); an aggregate structure; inert to long- and short-wave UV; and a typical natural-

color jadeite spectrum seen with the handheld spectroscope (437 nm line plus three "chromium" lines, at 630, 655, and 690 nm).

To further characterize this material, we ran an X-ray powder diffraction pattern. This matched that of our standard jadeite reference pattern. Furthermore, we did not see any polymer peaks with Fourier-transform infrared (FTIR) spectroscopy.

Figure 8 shows the most interesting feature of this material: bright brownish orange metallic flakes visible with magnification in some of the beads. X-ray powder diffraction confirmed that these flakes were elemental copper. We also saw a dark green fibrous mineral (figure 9), possibly an amphibole, in some beads. Amphiboles (e.g., glaucophane, actinolite) are typically associated with jadeite in high-pressure, low-temperature rocks (see, e.g., the jadeite chapter in W. A. Deer et al., *Rock-Forming Minerals: Volume 2A, Single-Chain Silicates*, John Wiley and Sons, New York, 1978), and pyrite-rich jadeite has been described from Guatemala (e.g., D. Hargett, "Jadeite from Guatemala: A Contemporary View," *Gems & Gemology*, Summer 1990, pp. 134–141). However, we have been unable to find any previous mention of copper as an inclusion in jadeite.

MLJ

Figure 6. Magnification clearly reveals the separation plane at the girdle of the earring-set assembled stone shown on the left in figure 5. The green band in the pavilion is a reflection of the green cement at the girdle. Magnified 12×.



With "Reconstructed" Area

Periodically, laboratory examination of an item submitted for identification reveals areas that were damaged and then subsequently repaired. In most instances, a portion of a gemstone has been broken off and then reattached with cement (as illustrated by the repaired chalcedony cameo described in the Fall 1982 Lab Notes, p. 169); in some cases, it is repaired with a different material (see Fall 1992 Lab Notes, pp. 193–194). We have also seen mineral specimens with crystals that had been broken and then reassembled. One of the more unusual repaired gems was a baroque pearl with a hole that was plugged with a small natural pearl (Summer 1990 Lab Notes, pp. 155–156).



Figure 7. The uneven surface of this polished cabochon of grossular garnet-rich rock resembles the surface of some pieces of jadeite jade that have been etched and polymer-impregnated. However, the undercut area in this case is a chlorite-group mineral, probably clinochlore. Magnified 16 $\times$.



Figure 8. These metallic brownish orange flakes were seen in a bead of jadeite jade that was reportedly from Central America. They proved to be copper. Magnified 15 $\times$.



Figure 9. A dark green fibrous mineral, possibly an amphibole, was seen included in this jadeite bead from the same necklace as the bead in figure 8. Magnified 15 $\times$.

Last summer, the West Coast lab was asked to identify a pierced carving made from a translucent material that was mottled white, green, and yellowish brown (figure 10). Standard gemological testing—including a spot R.I. of 1.66 and a 437 nm absorption line—showed that the carving consisted of jadeite jade. Other features seen in its spectrum (fine “chromium” lines in the red) proved that the green color was natural. During our examination with a binocular microscope, we noted that an area on the top had been repaired. However, not only had a broken piece of the original carving been reattached, but a translucent material—probably a polymer-like substance—was also used to fashion a replacement for the rest of the broken portion (figure 11). We hypothesized that the damaged surface was first “built up” with some form of cement or plastic, and then fashioned to imitate the missing part.

On the basis of this examination, we identified the carving as jadeite jade, with the green areas being of natural color. A note to the report’s conclusion stated that the carving had been repaired and mentioned that there was evidence of luster enhancement (also discovered

during the examination and probably paraffin, which is commonly used for that purpose). *RCK and SFM*

PEARLS

Abalone

In the past, both the West and East Coast labs have seen several natural abalone pearls shaped like sharks’ teeth. When one particularly fine example arrived at the West Coast lab for identification recently, we decided to report on this recurring phenomenon.

This roughly triangular pearl (39.40 mm long $\times$ 26.78 mm wide $\times$ 12.00 mm thick) displayed a striking combination of body color and orient (iridescence) in green, blue, and purple hues (figure 12). Similar types of pearls frequently have a concave base bordered by a dark horny seam, and are well illustrated in the literature (e.g., Shohei Shirai, *Pearls and Pearl Oysters of the World*, Marine Planning Company, Okinawa, Japan, 1994, p. 92). An X-radiograph (figure 13) revealed the characteristic large hollow center, with roughly the same outline as the pearl, surrounded by several layers of nacre (which is less transparent to X-rays).

Abalone pearls are rarely spherical. The various shapes and colors depend on where they grow in the univalve mollusk. Tooth-shaped

pearls grow next to the shell in the horn-like gonad of the abalone (P. V. Fankboner, “Abalone Pearls: Natural and Cultured,” *Canadian Gemmologist*, Vol. 16, No. 1, 1995, p. 4).

The growing popularity of the abalone pearl’s magnificent iridescent hues has led to the appearance of several abalone pearl-culturing farms along the American West Coast, from Canada to southern California, as well as in several other locations outside North America (see, for example, the “Cultured Abalone Pearls” entry in the Gem News section of this issue). *CYW*

Partially Coated to Conceal Old Drill Holes

Although natural pearls are rarely subjected to other than traditional processing, we have seen some notable exceptions. Among these are the pearls contained in four strands examined by the West Coast lab in 1995. Many of these pearls had been partially coated to conceal old drill holes. The location and shape of these drill holes (near the perimeter, not through the center, of the pearl) indicated that they were probably once used to attach the pearls to fabric. After the old holes were filled, the pearls were redrilled through the center for stringing on a necklace.

Under normal viewing conditions, the old drill holes were cleverly disguised by the soft coating, which had a “pearly” luster and closely



Figure 10. An area on the top of this (10.41 cm high) jadeite carving has been repaired with what appears to be a polymer-like substance.

matched the off-white color of the pearls (figure 14). These drill holes were so well camouflaged that they could have been easily missed had the pearls not been X-rayed or closely examined with magnification.

To determine the composition of the coating, we subjected it to X-ray powder diffraction analysis. However, the results were too vague for conclusive identification. CYW

PERICLASE, Possible Confusion with Grossular Garnet

A 5.49 ct transparent near-colorless emerald cut prompted several questions at the West Coast lab last summer. Gemological properties were: R.I.—1.738; S.G.—3.59; optic character—singly refractive (with slight anomalous double refraction, seen as first-order gray strain colors in the polarized light); no fluorescence to



Figure 11. Magnification revealed not only that a piece at the top of the jadeite carving shown in figure 10 had been glued back on, but also that an adjacent area had been "reconstructed" with a polymer-like substance. Magnified 10 $\times$.

long-wave, but weak yellow to short-wave, UV radiation; and no absorption features seen with the handheld spectroscope. With magnification, we noted a slight cloudiness throughout the stone, which showed graining in a cubic growth pattern when viewed through the pavilion. The surface of the stone had a poor polish, with pitting visible at higher magnification.

One gem material that has these properties is near-colorless grossular garnet, which is known to occur, for instance, in East Africa and in Asbestos, Quebec, Canada. For direct comparison with the unknown material, we examined four colorless grossulars from these two localities. The gemological properties of the unknown stone were not significantly different from the ranges of these garnets: R.I.—1.736–1.738; S.G.—3.59–3.66; optic character—singly refractive, with slight anomalous double refraction; and no distinct absorption features seen with the handheld spectroscope. With magnification, we saw crystalline inclusions in two of the grossulars, but two were "clean." One slight difference we noted between the comparison garnets and the unknown sample was that the grossular comparison stones showed faint orange fluorescence to long-wave UV radiation and



Figure 12. Abalone pearls are noted for their striking iridescence. This 45.53 ct (182.12 grains) shark-tooth-shaped abalone pearl is typical of many that have been seen in the lab.



Figure 13. An X-radiograph of the pearl seen in figure 12 reveals the large hollow center characteristic of natural abalone pearls, surrounded by several layers of nacre, which is less transparent to X-rays.

weak orangy yellow fluorescence (or were inert) to short-wave UV.

However, one staff member sensed that the inclusions and surface polish of the unknown did not "seem right" for grossular garnet. This was confirmed by EDXRF spectrometry (which revealed a high Mg content, less Fe, and possible traces of Ca, Cr, Mn, and Ni) and an X-ray powder diffraction pattern which matched that of periclase (MgO). We could not, though, establish definitively whether the specimen was natural or synthetic. The trace-element contents do not necessarily imply natural origin, since the source material for synthetic periclase is natural magnesite (see G. Brown, "Australian Synthetic Periclase," *Australian Gemmologist*, November 1993, pp. 265–269), which has these same trace elements. In addition, although natural periclase usually occurs in small gray nodules, we could not discount the possibility that fine crystals had been found and not yet reported.

In his description of facetable near-colorless synthetic periclase (see

article cited above), G. Brown noted that much periclase tends to react with the atmosphere to form a surface coating of brucite, $Mg(OH)_2$, or similar phases. This probably accounted for the pitted surface in the sample we examined. A freshly polished periclase might be easily confused with (near-colorless) grossular garnet, since the properties are so close and can overlap. A cause for still greater concern is the green synthetic periclase (colored by chromium) described by H. Bank ("Grüner schleifwürdiger synthetischer Periklas," *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 29, No. 1/2, pp. 88–89), which could be confused with green garnets.

MLJ, SFM, and Dino DeGhionno

Imitation RUBY

Dyed Quartz

A necklace that superficially appeared to be composed of ruby beads (figure 15) was submitted to the East Coast

laboratory for identification. Exposure of the beads to long-wave UV radiation revealed the unnatural orangy red color of a fluorescent dye (figure 16). With that observation and routine gemological testing, which revealed a 1.54 R.I., it was easy to determine that we were dealing with dyed, quench-crackled quartz.

GRC

Ruby/Ruby Doublet

We seldom see doublets consisting of two sections of natural ruby (called "genuine" or "true" doublets by various authors). One such ruby/ruby doublet was reported in the Spring 1987 Lab Notes section (pp. 47–48). Only now, more than eight years later, has the East Coast lab received another such stone. Routine gemological testing established that both parts were indeed natural ruby.

Because the separation plane (figure 17) was below the girdle, the fact that the stone was assembled could be easily disguised when it was mounted, particularly if it was bezel set. This stone weighed precisely 1.00 ct, which illustrates a point made in the 1987 lab note: If the deception is successful, the perpetrator stands to profit handsomely, since natural rubies of one carat or more bring a premium price.

GRC and TM

Figure 14. To help conceal an old drill hole, this pearl was partially coated with an off-white material that has a "pearly" luster. Magnified 16x.

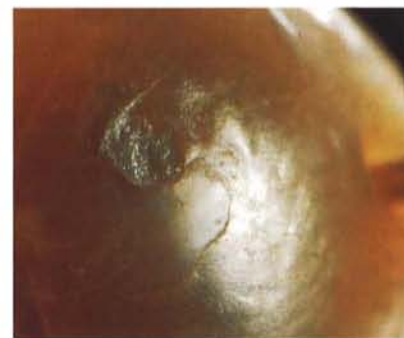




Figure 15. The dyed quench-crackled quartz beads in this necklace (graduated from approximately 22.5×15 mm to 10×6 mm) superficially resemble ruby.

SYNTHETIC RUBY, With Fanciful Polishing Marks

In September 1995, an easily identified material nevertheless provided the West Coast Gem Trade Laboratory with a certain amount of quiet satisfaction, and a small difference in artistic opinion. The material was purplish red, 5.30 ct, and revealed obvious internal clouds (most likely decorated dislocations, but possibly fine gas bubbles) and gemological properties consistent with ruby. The table facet showed the crescent-shaped crazing that is frequently referred to as rapid-polishing marks.

In their book *Gemology* (2nd ed., Wiley Interscience, New York), authors C. S. Hurlbut and R. C. Kammerling noted that similar surface features are occasionally seen in old flame-fusion synthetics, the result of heat from polishing too rapidly. However, such marks are sometimes seen on natural rubies and sapphires as well. In the case of this piece, curved striae as well as the internal clouds proved it to be synthetic. Very likely it was an older Verneuil product, since

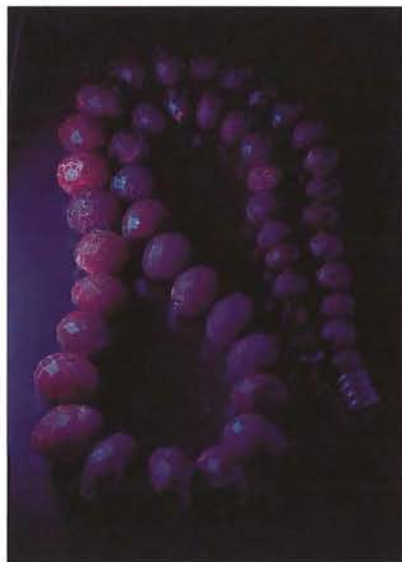


Figure 16. The dye in the beads shown in figure 15 fluoresced readily to long-wave UV radiation.

modern polishing methods almost entirely eliminate such marks.

The satisfaction, and the slight difference in opinion, resulted from viewing the table in two different orientations. One laboratory denizen immediately stated that her view through the microscope resembled a landscape painted in the manner of Chinese watercolors: The rapid-polishing marks looked like mountain tops, and the internal clouds resembled fog (figure 18). However, another resident gemologist, looking at the

Figure 17. This profile view shows the separation plane of a ruby/ruby doublet. Immersion, magnified 17 $\times$.



stone after it had been rotated 180°, but with the table in the same plane, thought that the marks resembled a flock of birds in a cloudy sunset.

MLJ and RCK

SAPPHIRE, With Rounded Facet Junctions

There are instances where the condition of a gem's facet junctions can provide useful information during examination with magnification. Examples include the abraded facet junctions on some zircons and sapphires (both considered to be the result of increased brittleness caused by heat treatment), the dark color outlining facet junctions on diffusion-treated corundums (seen with diffuse illumination) and the exceptionally sharp facet junctions of diamond (which are helpful in distinguishing diamond from its softer imitations—such as CZ). Rounded facet junctions are also seen on glass and plastic imitations of gems that have been “fashioned” by molding rather than cutting on a lap. Occasionally, we see this feature on natural gems, usually on stones of fairly low hardness that appear to have been polished by inappropriate techniques (e.g., too much pressure was applied while the stone was being pol-

Figure 18. The rapid-polishing marks and included clouds resemble a landscape of mountains and fog in this view of a 5.30 ct synthetic ruby. Viewed in another orientation (turn the page upside down), these features resemble a flock of birds at sunset. Magnified 10 $\times$.



ished on a fairly soft, flexible lap). This has also been noted on stones of moderate hardness, such as the tanzanite reported on page 176 of the Fall 1983 Lab Notes section.

In late spring 1995, the GIA Gem Trade Laboratory's West Coast facility was asked to identify a 0.71 ct transparent purplish pink oval modified brilliant. Traditional gem testing methods identified the stone as a pink sapphire. Although the inclusions—fine, short needles and transparent, birefringent crystals—were ambiguous, trace-element analysis showed that the stone was natural. What struck us as highly unusual during the microscopic examination was the condition of the facet junctions, which were very rounded (figure 19). As noted in the above-referenced entry, this may have resulted from an inappropriate polishing method [such as polishing with dia-

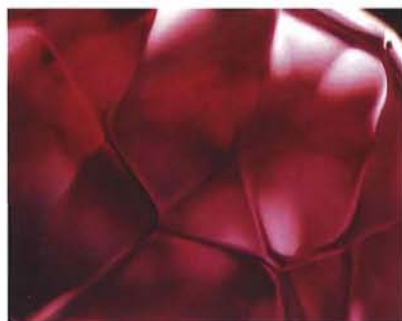


Figure 19. It is very unusual to see rounded facet junctions—like those evident on this 0.71 ct purplish pink natural sapphire—on corundum gems. Magnified 40 $\times$.

mond grit on a soft lap), or it could have occurred if the stone was repolished with a buff normally used for polishing cabochons rather than a faceting lap. RCK

Green SYNTHETIC SAPPHIRE

In the Spring 1995 Lab Notes section (pp. 57–58), we described a green synthetic star sapphire that was examined in the West Coast lab. As noted



Figure 20. The origin of this 5.90 ct synthetic sapphire, shown here with a 116.71 ct boule of green synthetic sapphire, was determined on the basis of its absorption spectrum and inclusions.

in that entry, green star sapphires—natural or synthetic—are not commonly encountered in the gem trade. However, another green gem (not asteriated) with the properties of corundum was received for examination in the West Coast lab late last summer.

This 5.90 ct transparent green cushion mixed cut (figure 20) had R.I. values of 1.762–1.770, a birefringence of 0.008, and an S.G. (determined hydrostatically) of 4.00; a uniaxial interference figure was noted between crossed polarizers, and the item was inert to both long- and short-wave UV radiation. All of these properties are consistent with a sapphire, either natural or synthetic. However, with a desk-model spectroscope we noted the following: a cut-off at about 410 nm, weaker general absorption from 440 to 470 nm, and a diffused band at about 640–680 nm. This last feature is similar to, but broader than, the one absorption feature we noted in the synthetic star sapphire mentioned above, and the diffused band in the 400 nm range is quite different from the “iron series”

in the 450–470 nm range typical of natural green sapphires. Examination with magnification revealed curved color zones that contained clouds of gas bubbles, confirming that this was a synthetic. The curved growth was most clearly resolved when the gem was examined while it was immersed in methylene iodide.

EDXRF analysis revealed only aluminum, an essential component of corundum (Al_2O_3), and cobalt. As with the previously examined green synthetic star sapphire and with commercially available nonphenomenal green synthetic sapphires manufactured in Switzerland, we believe that Co^{3+} is the sole cause of color in this specimen. RCK

PHOTO CREDITS

Nicholas DelRe supplied the pictures used in figures 1–4 and 15–17. Shane McClure provided figures 5–7, 10–12, 14, and 19. The photomicrographs in figures 8, 9, and 18 were taken by John I. Koivula. Maha DeMaggio provided figure 20. The X-radiograph in figure 13 is by Cheryl Y. Wentzell.