GEM N·E·W·S

Editors • Mary L. Johnson and John I. Koivula
Contributing Editors
Dino DeGhionno, Robert C. Kammerling, Shane F. McClure,
GIA GTL, Santa Monica, California
Henry A. Hänni, SSEF, Basel, Switzerland
Karl Schmetzer, Petershausen, Germany

DIAMONDS

Diamond with a fluorescent phantom crystal. Bob Lynn, of Lynn's Jewelry, Ventura, California, found an unusual faceted diamond in his stock and loaned it to the editors for examination. The 1.00 ct near-colorless round brilliant looked normal under standard fluorescent and incandescent illumination; however, when the stone was illuminated by (long- or short-wave) ultraviolet radiation (figure 1), a fluorescent internal octahedral crystal was easily seen. Higher magnification revealed that the fluorescence in the phantom crystal was zoned (figure 1, right).

In other respects, the diamond was not notable. With the standard fluorescent lighting used for grading purposes, the included crystal was visible only as transparent graining and did not set the clarity grade of the stone. In polarized light, the inclusion appeared as a region of concentrated strain lines; it did not form an obvious phantom (unlike the strain phantoms illustrated in, for example, the Fall 1993 [pp. 199–200] and Summer 1995 [pp. 120–121] Lab Notes sections).

Tairus synthetic diamonds in jewelry. Among the many synthetic materials produced by Tairus (a joint venture between the Siberian Branch of the Russian Academy of Sciences and Pinky Trading Co., Bangkok, Thailand) are synthetic diamonds grown in Novosibirsk. Tairus yellow synthetic diamonds are now being marketed in jewelry (figure 2) by Superings, Los Angeles, California. To the best of our knowledge, this is the first example of synthetic diamonds being marketed as such in jewelry. Although the jewelry is not yet available in mass-market quantities, advertising brochures that were distributed by Superings this past spring generated 2,000 calls for further information on these goods in one week, according to Walter Barshai, president of Pinky Trading. Individual samples (mounted in rings) seen at the JC-K Show in Las Vegas this past June ranged between 0.15 and 0.25 ct.

Mr. Barshai also provided details about Tairus's production of synthetic diamonds. Near-colorless, yellow, and blue synthetic diamonds are being produced at their factory in Novosibirsk using the BARS method; also, the yellow synthetics can be treated (by irradiation followed by heat treatment) to produce pink and red colors (see, e.g., Gem Trade Lab Notes, Spring 1995, pp. 53–54). As of early June 1996, Tairus was producing 10–20 colored synthetic diamond crystals per month, but the company hopes to increase production to 100–300 crystals per month by winter, and possibly to 1,000 crystals per month by the summer of 1997. The largest crystal grown by Tairus thus far weighs about 2.5 ct, with most crystals weighing between 1 and 2 ct; by late 1997, synthetic diamond crystals up to 5 ct may be produced. Growth times

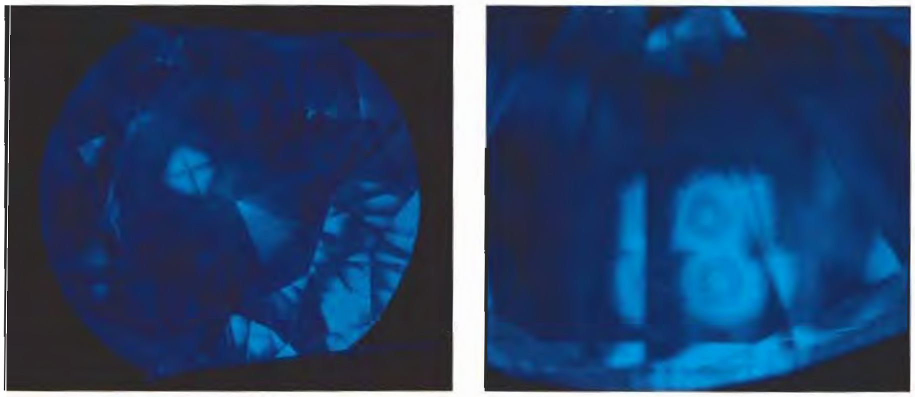


Figure 1. This 1.00 ct diamond (about 6.5 mm in diameter) contained an octahedral phantom crystal that was visible only when the stone was exposed to UV radiation. With higher magnification (right, 7×), the included crystal (also seen reflected in the table facet) showed a zoned fluorescence pattern. Photomicrographs, taken with short-wave UV illumination, by Shane Elen, GIA Research.

are surprisingly fast: in theory, a 5 ct crystal could be grown in three days. Most synthetic diamonds as grown are light yellow-brown to saturated yellow, but blue crystals can be grown if boron is added. Near-colorless stones require additives such as zirconium and special growing conditions; the largest near-colorless crystals grown by Tairus so far weigh only about 0.10 ct.

Approximately 100 carats of Tairus synthetic diamonds—of any color—have been placed in the market to date. Mr. Barshai believes that the market will be much more tolerant of colored than near-colorless synthetic diamonds, so Tairus is concentrating on the production of colored synthetic diamonds.

COLORED STONES AND ORNAMENTAL MATERIALS

Anorthosite rock with uvarovite garnet "speckles." In September 1994, contributing editor Henry Hänni received some pieces of rough from Tay Thye Sun, a Singapore gemologist. One of Mr. Sun's clients acquired the material in the Philippines because it looked like jade. On the weathered skin of the predominantly white samples, deep green idiomorphic crystals were visible. These 0.2–2.0 mm crystals showed excellent rhombic dodecahedron shapes (figure 3, left). Microscopic examination of a polished surface in reflected light (figure 3, right) revealed a granular groundmass that was occasionally interspersed with idiomorphic crystals (about 5% of the volume of the rock). The green crystals had a much higher luster than the matrix.

Raman spectroscopy quickly revealed that the groundmass was plagioclase and the crystals were garnets. Examination with an electron microprobe (by analyst J. Partzsch) determined the exact chemical composition. In fact, the groundmass was two different plagioclases: The main mass consisted of almost pure anorthite ($Ab_{02}An_{98}$: 2 mol.% albite [Ab] and 98 mol.% anorthite [An]), but oligoclase ($Ab_{77}An_{23}$) was present between these grains. The garnet crystals were strongly zoned; they were composed primarily of uvarovite with varying amounts of andradite in solution.

These pieces of rough may be the same material as the snuff bottle that was described and illustrated in the Spring 1994 Lab Notes section (pp. 42–43). The specific gravity of the rough material was 2.80, compared to the 2.76 reported for the snuff bottle.

Figure 2. These three platinum rings contain fashioned yellow synthetic diamonds (0.30–0.40 ct). Courtesy of Superings, Los Angeles; photo by Shane F. McClure.

Update on porous chrysocolla-colored chalcedony. In the Spring 1992 Gem News column, we reported on chalcedony colored by chrysocolla that changed appearance when soaked in water for several hours ("Chrysocolla-colored Chalcedony from Mexico," pp. 59–60). In that material, the soaking caused the blue color to intensify, the material to become more transparent (less opaque), and the piece to gain weight.

Late last year, Chris Boyd of CB Gems & Minerals, Scottsdale, Arizona, brought to our attention chalcedony colored by chrysocolla from Arizona, which showed a similar change in color and transparency that can also be produced by humidity alone. According to Mr. Boyd, this transition happens at about 55% humidity. Stones are "a nice semi-transparent blue" when exposed to humidity

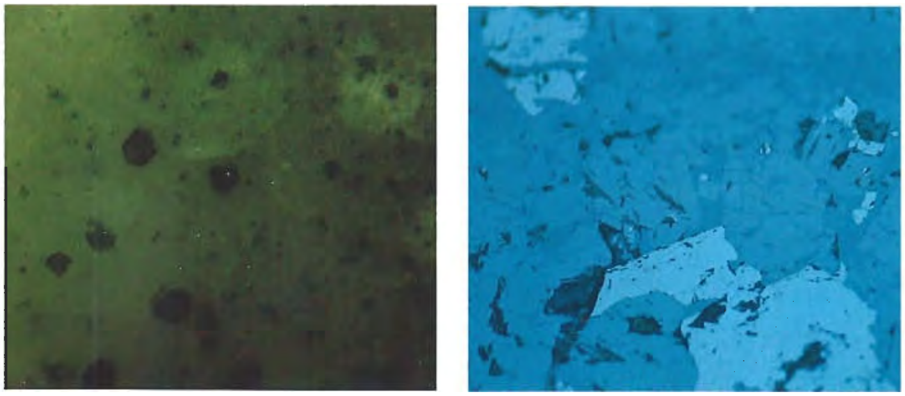


Figure 3. The green hexagons in this polished section of rock from the Philippines (left) are uvarovite garnets; the largest garnet is 2 mm across. In reflected light (right), the high-relief garnets (brightest reflectance) can be distinguished easily from the groundmass of anorthite feldspar (medium gray) and oligoclase feldspar (dark gray). Photomicrographs courtesy of the Swiss Gemmological Institute (SSEF), Basel.

Figure 4. This cabochon and the tablet are made of clinochlore, a chlorite mineral. Photo by Maha DeMaggio.

of 55% or greater, or if soaked in water; when these same stones are exposed to lower humidity, or left under a heat lamp, they lose color intensity and transparency. This process is repeatable.

Mr. Boyd also said that, in his experience, almost 90% of Arizona chrysocolla-colored chalcedony will dry out if exposed to less than 55% humidity.

Chatoyant clinochlore from Russia. One of the interesting "phenomenal" materials seen at the 1995 and 1996 Tucson shows was a chatoyant chlorite-group mineral from Russia. Two samples—a 7.65 ct triangular tablet and a 6.06 ct cabochon (figure 4)—were obtained from Heaven and Earth, Marshfield, Vermont, which was marketing this material as "Seraphinite." Gemological properties were as follows: color—green; diaphaneity—semi-translucent; color distribution—uneven (mottled, fibrous); pleochroism (visible in some more transparent areas) yellow-green/bluish green; optic character—doubly refractive with an aggregate structure. Individual fibrous crystals in the aggregates appeared chatoyant, with a pearly luster. One stone had poorly discernible R.I.'s of 1.580 and 1.585, and the other gave a spot reading of 1.58. Specific gravities were 2.62 and 2.66. Uneven luminescence was seen to both wavelengths of UV radiation: weak yellowish white to whitish yellow for long-wave UV, and very weak white to short-wave UV. In the spectroscope, one stone showed a cutoff edge at about 460 nm and a weak band centered at 500 nm; the other showed these bands as well as a faint band at 470 and 545 nm, and a cutoff edge at about 690 nm. With magnification, both stones showed a radial fibrous structure. Qualitative energy-dispersive X-ray fluorescence (EDXRF) spectroscopy revealed numerous elements in both: Mg, Al, Si, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu (in one sample), Zn, and Ga.

X-ray powder diffraction patterns for both samples were consistent with that of the mineral clinochlore, $(Mg,Fe^{+2})_5Al(Si_3Al)O_{10}(OH)_8$, a member of the chlorite mineral group. The source of this clinochlore is the Korshunovskoye deposit, on the east side of the Bratsk Reservoir, east of Lake Baikal, in Siberia, according to an article by A. A. Evseev in the Russian mineralogical magazine *World of Stones* (1994, No. 4, p. 44). Standard mineralogical references give the hardness of clinochlore as 2–2.5. One sample had been wax treated.

Cat's-eye diopside from Southern India. Many materials that contain parallel acicular inclusions can be fashioned into cabochons to show a cat's-eye effect. Among the green cat's-eye stones are apatite, chrysoberyl, demantoid garnet, emerald, opal, tourmaline, zircon, and zoisite. We were delighted to see recently an unusually bright green example of another material—cat's-eye diopside (figure 5)—from a relatively new locality.

The 4.59 ct oval cabochon (12.70 × 5.70 × 6.57 mm), which was loaned to the editors by Maxam Magnata of Fairfield, California, was a translucent dark green, with weak pleochroism of green and slightly brownish green. Its optic character was aggregate—showing the presence of many individual grains. The refractive index measured 1.67, and a "blink" was seen at 1.70. The stone was inert to both long- and short-wave UV. With the spectroscope, we saw weak general absorption between 400 and almost 500 nm, with two lines at 495 (weaker) and 505 (stronger) nm. Three "chrome lines" were also seen at 640, 660, and 680 nm; despite this evidence of chromium, there was no reaction to the Chelsea color filter. These properties are consistent with those previously reported for chrome diopside. Magnification revealed a fibrous texture, with some coarse channels (or, possibly, needles) present.

The material comes from a relatively new mine near the small town of Iddipadi, in southern India, close to the

Figure 5. This 4.59 ct cat's-eye diopside is from a relatively new find in southern India, near the town of Iddipadi. Stone courtesy of Maxam Magnata; photo by Maha DeMaggio.

Figure 6. Mozambique is the country of origin for these two garnets (1.26 and 1.38 ct), identified as pyrope-almandine. Photo by Maha DeMaggio.

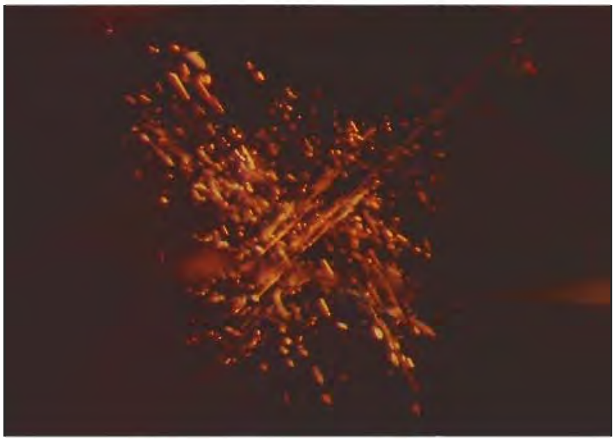


Figure 7. Acicular inclusions were the only internal feature seen in the Mozambique garnets shown in figure 6. Photomicrograph by John I. Koivula; magnified 30×.

cutting center of Karur Kangayam, according to Mr. Magnata. He believes the find was first made about six years ago, with the bulk of the cutting material sent to Hong Kong until recently. The mine is reportedly within 40 m of star diopside and cat's-eye enstatite deposits.

Garnets from Mozambique. African garnets were very much in evidence at the 1996 Tucson shows, including brownish yellow to bright green grossular-andradites from Mali (see, e.g., "Gem-Quality Grossular-Andradite: A New Garnet from Mali," *Gems & Gemology*, Fall 1995, pp. 152–167), orange spessartines from Namibia (Gem News, Spring 1996, pp. 56–57), and various color-change garnets from Tanzania (Gem News, Spring 1996, p. 53). A number of dealers also offered dark orangy red to slightly brownish red stones from still another locality, the southern African country of Mozambique.

Although this locality is not new, garnets from Mozambique have not been characterized in the gemological literature. To do just that, we purchased two brownish red modified triangular brilliant cuts (1.26 and 1.38 ct; figure 6) on which we determined the following properties (where there are two sets of values, the value for the 1.26 ct stone is first): R.I.—1.770, 1.776; S.G. (determined hydrostatically)—3.96, 3.89; singly refractive with strong anomalous birefringence noted between crossed polarizers; inert to both long- and short-wave UV radiation; and spectra (determined with a desk-model prism spectroscope) exhibiting strong bands at about 504, 520, and 573 nm. Magnification revealed a few acicular rutile crystals in one stone (figure 7). On the basis of these properties, and using criteria established by C. M. Stockton and D. V. Manson ("A Proposed New Classification for Gem-quality Garnets," *Gems & Gemology*, Winter 1985, pp. 205–218), we identified the garnets as pyrope-almandine.

Green-and-white jadeite from Russia. Ross Shade of the Addexton Company, Auburn, California, provided us with a 113.90 ct sample of green-and-white mottled jadeite (figure 8) that reportedly came from central Russia. Mr. Shade acquired the material through an (undisclosed) American company that imports stones for the building industry; it was originally imported for use as kitchen and bathroom tiles.

The gemological properties of our test sample were: clarity—semi-translucent to opaque; aggregate structure; R.I.—about 1.66 (some areas, 1.655 to 1.670; others, 1.48–1.50); S.G.—3.29; luminescence—moderate mottled blue-white to long-wave UV radiation, and very weak to weak mottled blue-white to short-wave UV; typical green jadeite spectrum when viewed with a handheld spectroscope.

Further tests helped explain some of these properties. X-ray powder diffraction analysis of scrapings from two areas gave patterns indicating jadeite (predominantly) and minor natrolite. The natrolite, which accounted for the 1.48–1.50 R.I. readings and the slightly low S.G., occupied about 5% of the sample by volume. The infrared absorption spectrum of a thin slice that had been cut and polished from this material showed no evidence of polymer impregnation. However, two small "wax peaks" were found at 2926 and 2855 cm^{-1}. These probably resulted from the oil used in cutting the thin slice.

Visit to Myanma Gems Museum. The October 1993 Emporium was the first such event held in the new Myanma Gems Enterprise (MGE) exhibition hall in Yangon (Rangoon), which was built solely for these biannual sales. In the summer of 1995, the Myanma Gems Museum opened in a building adjacent to the exhibition hall. One of the Gem News editors (RCK) visited this museum in November 1995 and provided the following report on this new facility.

Each of the first three floors consists of a large open showroom containing retail sales outlets for firms licensed by the Myanmar government to sell gems and jewelry (all sales require MGE receipts like those used at the emporia). Ornamental objects fashioned from silver were offered, in addition to loose gems and gem-set jewelry.

The top floor of the building houses the actual museum, which contains many interesting displays. Jadeite is very well represented. Along one wall are sawn jadeite

Figure 8. This 113.90 ct block of jadeite (here cut into three pieces) reportedly came from central Russia. Photo by Maha DeMaggio.

boulders, each identified by its locality. A display of cabochons illustrates the three categories of jadeite—"imperial," "commercial," and "utility"—used in Myanmar gem markets. An exceptional 4.7 kg boulder of imperial jadeite has its own display case. There are also attractive displays of fashioned jadeite, including a plate with chopsticks (total weight 2,390 g) and the remaining 106 kg "water jade" boulder from which they were cut.

Not surprisingly, there are a number of interesting ruby displays, including material from Mong Hsu, from the famous marble quarry at Sagyin in Mandalay Division, and from Pyin Lon in northern Shan State. Among the noteworthy gem-set items is a peacock fashioned from 61.86 g of gold and 256.84 ct of sapphires atop a jadeite base. Also on display is a large gold pendant set with a 329 ct oblong peridot cabochon (labeled as the world's largest cut peridot) and many smaller peridots. Other cases highlight the range of gems found in Myanmar, including zircon, iolite, danburite, diopside, tourmaline, garnet, lapis lazuli, moonstone, enstatite, albite, and fluorite. Cultured pearls from the gold-lipped oyster are also well represented.

A recent report provided by U Tin Hlaing of Taunggyi University, Myanmar (pers. comm., May 1996), lists the following large gems as being among those currently on display at the museum: a 21,450 ct (17.5 cm long × 11 cm wide × 10 cm high) rough ruby from Block No. 14 of the Mogok Stone Tract, which Myanmar officials believe to be the world's largest; a 63,000 ct sapphire from Mogok; and a 23,500 ct piece of jade from the Hkamti area.

Variegated translucent jasper from Mexico. One of the more notable trends at the Tucson gem shows this year was the rising interest in ornamental materials. In addition to the exotic materials seen—such as drusy vanadinite and clinochlore—varieties of quartz and chalcedony were quite prominent, especially those with aesthetic inclusions or patterns. One interesting example was so-called Imperial jasper (figure 9), reportedly mined in Mexico. Cathy Cwynar, of Minneapolis, Minnesota, loaned us three fashioned pieces for characterization.

The gemological properties of the three free-form cabochons (15.43, 16.28, and 17.86 ct) were as follows: color and clarity—variegated between translucent-to-opaque brownish (olive) green to green in some regions and to opaque greenish white in others; optic character—aggregate reaction; R.I. —1.54 in the green area, 1.53 to 1.55 in the white areas; S.G.—2.43 to 2.51 (the white regions were porous, and the more white material there was in the piece, the lower the S.G. was). For the most part, this material was inert to both long- and short-wave UV radiation, but some whitish areas showed a weak blue fluorescence to long-wave UV. Only the darkest (olive) green regions showed a distinct absorption spectrum in the handheld spectroscope, with a lower-wavelength cutoff at about 460 nm, and faint bands at 500 and 520 nm. Other than the typical chalcedony structure, no inclusions were evident with magnification.

Of particular note was the material's unusual behavior in transmitted light: The dark green areas were translucent, with yellow "rims" between the green and opaque areas (figure 9, right)—an effect not evident in reflected light. Qualitative EDXRF spectroscopy revealed no significant differences in chemistry between the white and green regions of one sample examined; both areas showed major silicon, minor potassium, calcium, iron, and titanium, and trace amounts of manganese, zinc, rubidium, and strontium.

An unusual morganite. In fashioned gemstones, fractures are generally considered very undesirable. One exception, however, is found in the variety of rock-crystal quartz known as "iris quartz" (not to be confused with "iris agate"), in which numerous air-filled fractures behave like thin films, imparting a rainbow-like iridescence when the gem is illuminated from above.

Recently, Edward Swoboda, a gem and mineral miner and dealer from Beverly Hills, California, showed the editors another form of "iris" gem. The light pink stone, a 157.19 ct oval step-cut morganite beryl, measured 42.69 × 32.34 × 19.28 mm.

During cutting, instead of removing the fractures and making a number of smaller stones from the rough, the lapidary went against convention and fashioned a single large stone, positioning the fractures so that their plane was just off parallel to the table facet. In this way, light reflected from the fractures was not simultaneously reflected from the table facet, which would otherwise mask or diminish the "iris" effect. As figure 10 shows, this cutting technique produced a morganite with a table that is vividly iridescent when the stone is viewed from above in virtually any direction. As the stone and/or light source is moved, both the pattern and position of the various colors change dramatically.

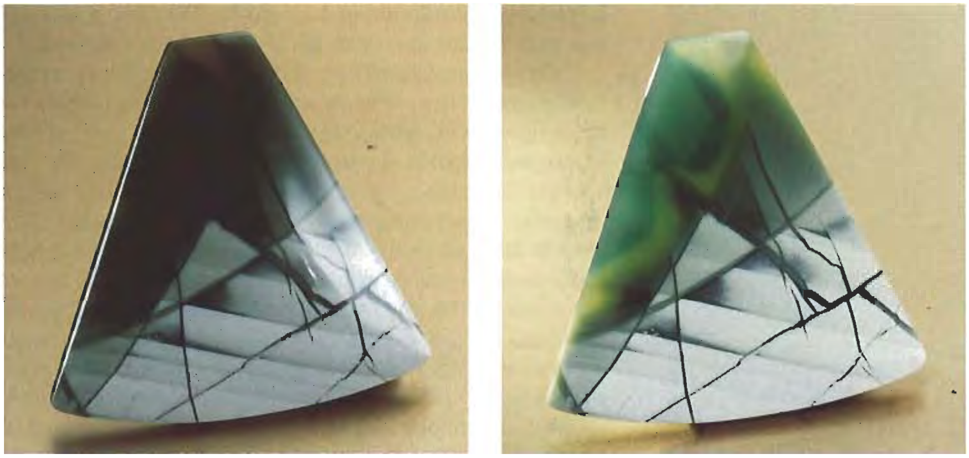


Figure 9. Among the many ornamental gem materials seen at the 1996 Tucson gem shows was this 17.86 ct cabochon of variegated jasper, fashioned by Cathy Cwynar, shown on the left in reflected light. In transmitted light (right), the dark green regions are translucent, revealing yellow rims that are not visible in reflected light. Photos by Maha DeMaggio.

Scottish pearls. One of the most interesting items seen at the February Tucson shows was a double strand of graduated pearls that ranged from 4 to 9 mm on one strand, and 4 to 10 mm on the other (figure 11). The pearls were accompanied by a report from the Gemmological Association and Gem Testing Laboratory of Great Britain in which they were identified as natural. Of particular interest, however, was their provenance: All were collected from freshwater mollusks in the rivers of Scotland, by veteran pearl fisher Bill Abernethy. These pearls, reportedly the result of 40 years of pearl fishing, are particularly well-matched rounds and show the attractive luster that is characteristic of Scottish pearls (see, e.g., E. A. Jobbins and K. Scarratt, "Some Aspects of Pearl Production . . . ," *Journal of Gemmology*, Spring 1990, pp. 5–7). The most important Scottish pearl recovered to date, called the Abernethy pearl, is 11.5 mm in diameter.

Rubies from Madagascar. Blue sapphires from Madagascar have received attention in the trade press since their 1992 arrival on the gemstone market (see the article by D. Schwarz et al. in this issue). However, southern Madagascar is also producing gem-quality rubies, according to Christopher P. Smith of the Gübelin Gemmological Laboratory, Lucerne, Switzerland. Although most fashioned stones weigh 1 ct or less, some as large as 20 ct have been encountered. Recently, the Gübelin laboratory had the opportunity to examine more than 40 faceted Madagascar rubies. These rubies had a richly saturated, even color; most resembled Thai or Cambodian rubies in this respect, although some lighter-toned stones looked like rubies from Burma or Vietnam.

Mr. Smith noted a distinctive combination of internal features in these rubies. Most had dense concentrations of fine needles and platelets that, for the most part, were dull in luster and slightly blue or white in color; they lacked the highly iridescent appearance of rutile needles and platelets observed in rubies from Burma, Sri Lanka, or Vietnam. (It is, therefore, more likely that they are ilmenite or hematite.) Doubly truncated hexagonal dipyramidal negative crystals, surrounded by equatorial thin films or fractures, were another common feature (figure 12). These inclusions are reminiscent of those seen in Thai and Cambodian rubies. In addition, the Madagascar rubies revealed very prominent internal growth structures that gave a roiled appearance with 10× magnification. Many of the rubies also had a distinctive series of linear growth boundaries that created the appearance of a "cellular structure" (figure 13).

Semi-quantitative chemical analysis performed on 30 samples revealed the following contents: 97.3–99.1 wt.% Al_2O_3; 0.27–1.68 wt.% Cr_2O_3; 0.45–0.74 wt.% Fe_2O_3; 0.0–0.07 wt.% TiO_2; 0.0–0.02 wt.% V_2O_5; and 0.0–0.01 wt.% Ga_2O_3.

From his extensive 1922–23 studies of the gem deposits of Madagascar, Lacroix described corundum deposits (ruby and sapphire) in the northern and central parts of the island (*Minéralogie de Madagascar*, Challamel Ed., Paris, 3 Vols.). Later, additional deposits were noted by Besairie in 1956 (*Carte géologique au 1/200000 de Sakoa-Benenitra, 2nd ed.)* and Noizet in

Figure 10. The lapidary fashioned this 157.19 ct morganite to display a pleasing iridescent, or "iris," effect. Photo by Maha DeMaggio.

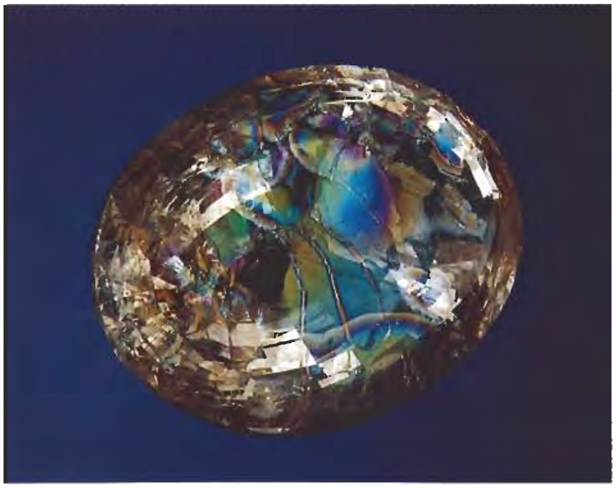


Figure 11. The 154 pearls (4–10 mm) in this double strand were reportedly fished from freshwater mussels in Scottish waters by Bill Abernethy. Courtesy of the Susan Clark Gallery of Gem Art, Vancouver, BC, Canada.

1958 (*Carte géologique au 1/200000 de Ampanihy-Bekily*, 2nd ed.), in the southern portion of the island. In a 1992 geologic report, Dr. Alain Mercier placed the ruby deposits east-southeast of the town of Tulear, in the Fotadrevo-Vohibory region of southern Madagascar, concentrated along northeast-trending faults. Some of the principal deposits include Anavoha, Vohitany, Vohibory, Marolinta, and Ianapcra.

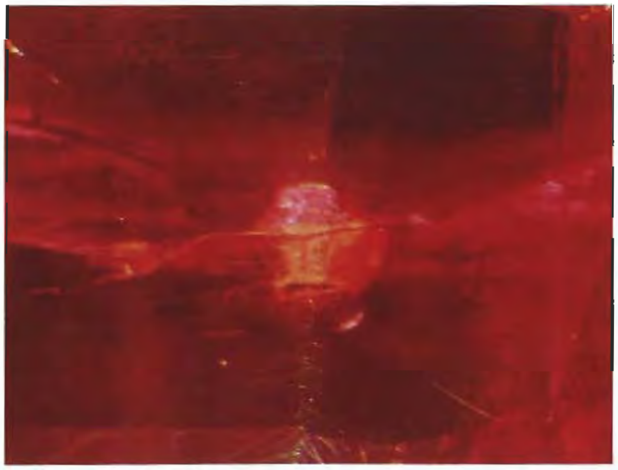
Sapphire mining in Kanchanaburi. The Winter 1990 Gem News section contained an entry on S.A.P. Mining Co., a large, mechanized sapphire-mining operation in Thailand's Kanchanaburi Province, about 100 km (60 miles) west of Bangkok. Mining takes place near Bo Phloi, a town about 40 km (25 miles) north of Kanchanaburi City. Last fall, one of the editors (RCK) revisited S.A.P. Mining and obtained updated information about that operation.

S.A.P. Mining has determined that black spinel is the best indicator mineral for finding sapphires, according to exploration and mining manager Rouay Limsuvan. In general, the larger the spinels found in an area are, the larger the sapphires recovered will be. Dark brown (to black) pyroxene also has proved to be a good indicator mineral. All of the sapphires recovered to date have been from secondary (alluvial) deposits. The actual gem-bearing gravel layers are typically about 1 m thick. They occur as shallow as 5–7 m, or as deep as 13–15 m, below the surface.

Once a prospected area has been selected for mining, modern excavators strip the overburden to reach the gem-bearing gravels, which are then loaded on large dump trucks and taken to the firm's modern processing plant. In a single day, some 250 truckloads of gravel—1,000 m^3 of material—are transported to the processing plant. The gravels are first dumped into a sheet metal–walled pen. High-pressure water cannons help wash material out of the trucks, remove the clay and sand from the gravels, and force the gravels via chute into a large rotating trommel, which removes the bigger rocks. The gravels then pass through one of two rotating trommels with a smaller mesh size (figure 14), after which they are processed in one of three vibrating jig systems (each of which consists of six jigs). The resulting heavy concentrate is then collected and taken to an on-site facility for hand sorting. The amount of rough sapphire recovered daily varies widely, from 200 grams to 2 kg. While the goal is to recover corundum, also found are sanidine, black spinel, garnet, magnetite, pyroxene, and olivine.

Although S.A.P. Mining is still very active, with a claim area covering 250–300 km^2, the overall level of mining activity in the area has decreased in recent years. In the past decade, no fewer than 47 companies have been involved in mining for sapphires in the area. Currently, however, only four firms work the Bo Phloi area; a year earlier, there were seven active operations, according to Mr. Limsuvan. As S.A.P. Mining plans for the eventual end of mining operations on its holdings, it is carrying out an extensive reclamation program. It has

Figure 12. This type of negative crystal—a doubly terminated hexagonal dipyramid with a surrounding equatorial thin film/fracture plane—was a common feature in the Madagascar rubies examined. Similar inclusions are found in rubies from Thailand and Cambodia. Photomicrograph by Christopher P. Smith; magnified 20×.



already developed mined-out portions of the lease area into a golf course.

Update on Tanzanite mining. Gem dealer Michael Nemeth, of San Diego, California, has provided an update on tanzanite mining at Merelani, Tanzania, following a visit there in late 1995. At that time, the D block contained about 200 mines and over 2,000 miners (see Gem News, Winter 1991, p. 262, for a description of the four main "blocks" for which mining rights have been granted at Merelani). "Vietnam Camp," a mine in the D block, was being worked by 28 miners and extended to 3,000 m in length. Mr. Nemeth learned that overall production had been good, and a "7 kg crystal" with excellent color and clarity had been found recently. However, local prices seemed high, probably inflated by the presence of foreign buyers.

The Vietnam Camp mine was one of the few mines with a wooden ladder instead of a rope for access (figure 15). In general, though, mining conditions were primitive (the typical miner's headgear was a flashlight strapped on with a thick band of rubber). Throughout the visit, Mr. Nemeth heard and felt numerous dynamite blasts, after which glittering, graphite-rich dust filled the air of the mine shaft. He was told that "a few miners" are killed weekly by poor ventilation or by the blasts themselves. Some miners stay underground for two to three days at a time, eating only salt and *ugali* (a cornmeal-like porridge compressed into cakes in one's hand).

Figure 16 was taken at a depth about 250 m, at which point the mine shaft became less vertical. Further descent was accomplished by crawling head first down the steeply sloping adit. Over the next 50 m, the shaft narrowed from 1 m to about 60 cm (three to two feet), and turning around was impossible. Mr. Nemeth and his party stopped at this point, since the miners above ground had taken a lunch break and stopped pumping air below.

Mr. Nemeth was told that the miners were paid only with stones found in the mine, not currency. The age-old practice of high-grading by miners to supplement their meager incomes was tolerated as long as amounts were kept to a "single handful," as in general only the mine manager, not the owner, was present.

Figure 13. A distinctive cellular structure is apparent in this ruby from Madagascar. The linear growth features separate zones filled with fine needles and platelets (probably ilmenite or hematite). Photomicrograph by Christopher P. Smith; magnified 25×.

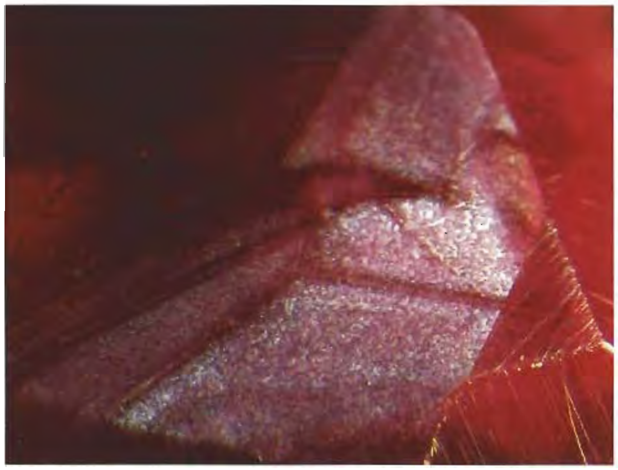


Figure 14. At S.A.P. Mining's modern washing plant near Bo Phloi in Kanchanaburi Province, Thailand, a huge rotating trommel (foreground, right) removes the larger rocks. The gravels then pass through one of two other trommels with smaller mesh sizes, one of which is at left. Photo by Robert C. Kammerling.

"Golden" tourmaline from Kenya. Tourmaline from a new find in Kenya is being described as "savannah" or "golden" tourmaline. Gemologist Yianni Melas recently sent us two samples of rough material for examination (figure 17). The larger (4.50 ct) piece was transparent brownish orangy yellow, with some green areas. The smaller (3.06 ct) piece was a crystal section with a brownish orangy yellow core and a green rim. External morphology of the (broken) crystal section consisted of prism faces only, which were not striated parallel to the c-axis.

We recorded the following gemological properties on the two samples: pleochroism—brownish orange (o) to yellow (ε) in yellow regions, and dark green (o) to light yellowish green (ε) in green regions; optic character—uniaxial; color-filter reaction—none (yellow regions), red (green regions); R.I.—1.630 to 1.650, and birefringence—0.020 (measured on green rim only); S.G.—3.05; fluorescence—inert to long-wave UV radiation (both colors), moderately chalky, moderately strong yellow (to short-

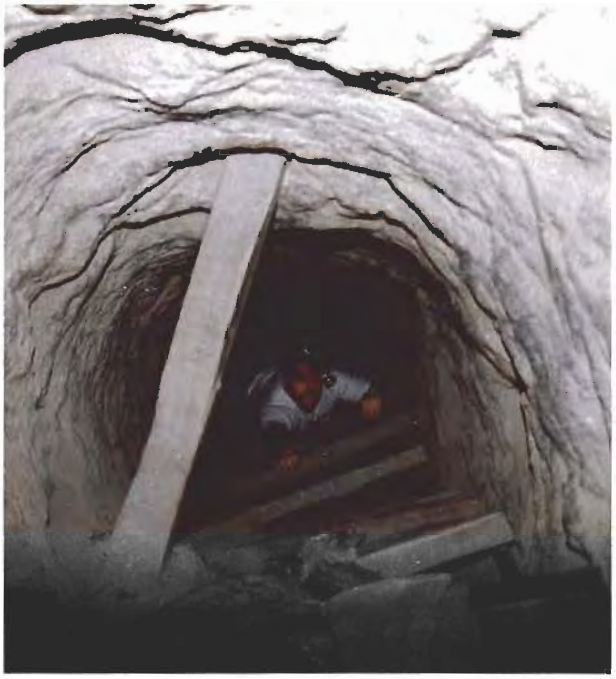


Figure 15. Gem dealer Michael Nemeth cautiously descends the upper shaft of the Vietnam Camp tanzanite mine, in block D at Merelani. Miners use the piece of wood in the foreground to rest during their long descents and ascents. Photo courtesy of Michael Nemeth.

wave UV), with stronger fluorescence in the green rim of one sample. Using a handheld spectroscope, we saw a general absorption in both stones to about 480 nm; the green rim also showed an absorption band between 590 and 630 nm, and lines at 650 and 680 nm. Magnification revealed a small anhedral crystal and a needle (or tube) in the larger piece; the smaller piece contained two-phase (liquid/gas) inclusions in healed fractures ("fingerprints") and hollow tubes.

Figure 16. The shaft of the Vietnam Camp mine continues to narrow as it approaches 300 m depth. Photo courtesy of Michael Nemeth.

Qualitative EDXRF spectroscopy revealed Mg, Al, Si, K, Ca, Ti, Fe, Zn, Ga, and Sr in both samples, with a small Mn peak in one spectrum. Cr was also detected in the green crust of the smaller piece, and the color-filter reaction and absorption spectrum were consistent with the presence of Cr, which causes the green color.

Three possible sources have been cited in the trade press for this or similar material: (1) the Kasigau Mine, 450 km from Nairobi in Kenya's Tsavo West National Park ("What's in a Name—Sales for Brown Tourmaline," *I.C.A. Gazette,* April 1995, p. 7), (2) the Mangari area of Tsavo West National Park, and (3) M'gama Ridge, south of the Taita Hills in south eastern Kenya (the latter two described in "New Find: East African Golden Tourmaline," *Jewelers' Circular-Keystone,* February 1995, p. 66).

TREATMENTS

Novel opal doublets from Brazil. In the editors' experience, two basic types of doublets using natural opal are encountered in the trade. The first type uses a black material—such as dyed chalcedony ("black onyx") or glass—as the backing material. (When the opal is fairly thin and translucent, the backing provides a dark background that accentuates the opal's play-of-color.) The second type of opal doublet uses as the backing material sandstone or ironstone matrix, typical of that seen at opal deposits, to reinforce the opal. If examined carelessly (or if mounted to obscure the demarkation between the two components), this second type can be mistaken for natural boulder opal. The opal in most doublets of both types that we have seen is usually Australian.

While examining gems at the Tucson booth of a Brazilian firm, one editor came across a type of opal doublet that he had not seen previously. These stones had been assembled from two Brazilian gem materials: milky white opal from Piauí State that was backed with sodalite from Bahia State (figure 18). The dark violetish blue of the sodalite provided a good contrast for the opal's weak play-of-color. It also produced a background color similar to that seen in many opal triplets.

As at many other gem shows, the editors also encountered assemblages made with synthetic opal. For example, Manning International, of New York, was offering both doublets and triplets constructed from recent-production Gilson synthetic opal. The backing material on the doublets was ironstone matrix from Australia.

Sapphires with "induced" stars. At the February 1996 Tucson show, one of the editors (DDG) saw several star sapphires. Accompanying literature claimed that the asterism was "induced," but without "additional chemicals." Since no "chemicals" were involved, the literature maintained, this process was different from diffusion treatment. Curious, the editor obtained some of these sapphires for examination (see, e.g., figure 19). One end of a stone was polished flat so that the properties of the interior could be compared to those of the "skin" region.

Gemological testing confirmed that the material was sapphire. With magnification, angular growth layers and two-phase and "fingerprint" inclusions were visible. When the stone was examined with fiber-optic illumination, silk in the outer layer looked similar to the silk seen in synthetic star sapphires. When the stone was immersed in a heavy liquid, a shallow brownish surface layer was evident.

To determine whether the treatment that induced the asterism had changed the stone's chemistry, we examined both the surface and the polished, exposed interior of the stone with quantitative EDXRF spectroscopy. (The penetration depth for X-rays is about 0.1 mm under our standard operating conditions.) We found five times more titanium on the surface of the stone than in its interior (0.19 wt.% Ti as TiO_2 on the surface; 0.04 wt.% TiO_2 in the interior.)

Because of the significant difference in titanium content between the two regions, we concluded that the TiO_2 "silk" must have been produced by diffusing titanium into the surface (despite the seller's claim to the contrary). However, diffusion treatment may not have been the intended result. Dr. John L. Emmett (co-author of "Heating the Sapphires of Rock Creek, Montana," *Gems & Gemology*, Winter 1993, pp. 250–272) remarked recently that he knew of a treater who packed some sapphires in a white titanium-dioxide-bearing powder for heat treatment, hoping that the powder would slow cooling and prevent breakage. When he examined the finished stones, however, the unnamed treater was surprised to discover that his blue sapphires were now both heat treated *and* diffusion treated.

SYNTHETICS AND SIMULANTS

Manufactured composite material imitating jadeite. A great many materials are used to imitate jadeite. These include such natural, untreated gem materials as massive grossular garnet and serpentine; such wholly manufactured materials as glass and plastic; and such treated, natural gems as dyed massive quartz and—more relevant to the following discussion—massive calcite that has been selectively dyed to resemble mottled green-and-white jade.

Figure 17. These two pieces of tourmaline rough (4.50 and 3.06 ct [the latter 12.60 × 6.67 × 5.63 mm]) are from a new find in Kenya. Photo by Maha DeMaggio.

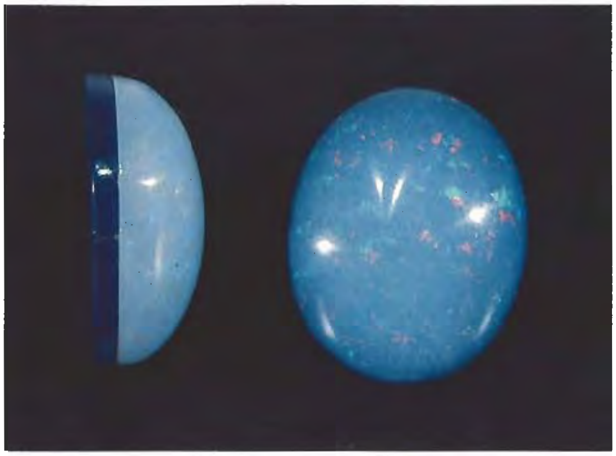


Figure 18. Opal from Piauí has been backed with sodalite from Bahia to produce these Brazilian opal doublets. Photo by Maha DeMaggio.

Last fall, one of the editors (RCK) acquired, from a street vendor in a Chinese neighborhood of Los Angeles, a 239.37 ct statuette (figure 20) that appeared quite similar to some of the mottled-colored, dyed calcite mentioned above. Gemological testing revealed the following properties: diaphaneity—semi-translucent; polariscope reaction—aggregate (appears light when rotated between crossed polarizers); Chelsea color-filter reaction—none (appears same color as the filter); specific gravity (determined by hydrostatic weighing)—1.98. Refractometer testing produced a birefringence blink. With a handheld spectroscope, green areas of the statuette showed a strong band centered at 650 nm, a weak band at 600 nm, and a faint absorption at 500 nm. The statuette luminesced a chalky, moderate-to-strong blue-white to long-wave UV radiation, and a chalky weak blue to short-wave UV. (The green areas had a weaker fluorescence to both wavelengths than the white areas had.)

With a microscope, we saw that the material consisted of white grains in a groundmass of transparent, colorless (or green) material with a resinous luster. X-ray powder diffraction analysis identified the white grains as calcite. The transparent groundmass burned readily when touched with a thermal reaction tester, producing an acrid odor and some liquid. Fourier-transform infrared (FTIR) spectroscopy, performed on a pellet of material scraped from the statuette, gave a spectrum that was very similar to that of an alkyd resin polymer, a synthetic resin used, for example, in house paint.

On the basis of this information, we identified the statuette as a calcite/plastic composite that had been selectively dyed to resemble jadeite. It may have been produced in a mold that was filled with the pre-polymerized resin and finely ground calcite. Although the color and color distribution made it a fairly convincing imitation of some mottled jadeite, both its resinous luster and "heft" (1.98 S.G.) would raise the suspicions of anyone familiar with jade.

"Drusy" silicon, a computer-industry by-product. The Summer 1992 Gem News section (p. 133) discussed and illustrated meteoritic iron used as a gem material. A manufactured material with a similar appearance is elemental silicon (figure 21); at the Tucson shows this year, we saw both fashioned and rough examples of this material.

Bill Heher, of Rare Earth Gallery, Trumbull, Connecticut, loaned us a 31.5 × 40.3 × 5.54 mm elemental silicon doublet for examination. Only a few gem properties from this assembled triangular tablet could be determined: color and luster—metallic gray (backing material—yellow and brown); color distribution—even; diaphaneity—opaque; fluorescence—inert to both long- and short-wave UV radiation. The R.I. was over the limit of our refractometer (greater than 1.81), and no absorption spectrum was detected using a desk-model spectroscope. We also purchased three chunks of elemental silicon from Gems Galore, Mountain View, California. One had a hardness of about 6½ and a specific gravity of 2.34 (hydrostatic method).

Some elemental silicon used in jewelry is different from that used to make computer chips; for instance, one distinguishing feature is the druse-like surface, consisting of many nearly flat-lying crystal faces, on some pieces. (This is the feature that resembles the Widmanstätten pattern observed on some etched iron meteorite surfaces, as in the Summer 1992 illustration.) To the best of our knowledge, the "drusy" elemental silicon is formed from the same starting material as the Czochralski-pulled elemental silicon boules that are the source material for computer chips; the drusy crystals form in the impurity-rich material left remaining in the "pot" after the purified boule is extracted. The trace-element content of the drusy material is thus higher than that of the boules; the silicon surface of the doublet we examined contained trace amounts of arsenic, as determined by EDXRF. Our one boule contained only silicon.

The fashioned tablet had been backed with another material because elemental silicon is brittle. The material is popular in jewelry for people who work in computer fields, according to a Gems Galore representative.

Figure 20. This 239.37 ct imitation jadeite statuette (47.35 × 32.90 × 32.75 mm) is composed of finely ground calcite in a groundmass of alkyd resin polymer (plastic). The green areas were probably produced by selective dyeing. Photo by Maha DeMaggio.

Figure 19. The star in this 3.73 ct (9.18 × 6.82 × 5.39 mm) sapphire was produced by a surface diffusion treatment. Photo by Maha DeMaggio.

A convincing tanzanite substitute. Bill Vance, a gemologist from Denver, Colorado, recently loaned us one of the most superficially convincing imitations of gem-quality tanzanite that we have ever seen. This new tanzanite substitute is now being sold at gem and mineral shows across the United States. Mr. Vance purchased it at just such a show in Denver in September 1995.

Figure 21. This tablet is assembled from drusy elemental silicon and an unidentified backing material. Elemental silicon (shown in its "raw" form on the right) is a byproduct of computer-chip manufacturing. Tablet courtesy of Bill Heher, Rare Earth Gallery; photo by Maha DeMaggio.

Natural tanzanite crystallizes in the orthorhombic crystal system; it is biaxial with strong pleochroism. In fact, strong pleochroism is one of tanzanite's most distinctive characteristics. It would seem unlikely, then, that an isotropic material with no pleochroism could convincingly masquerade as tanzanite. Nevertheless, as figure 22 shows, this new material is a most convincing violet-to-blue.

EDXRF analysis revealed that this manufactured material contains yttrium, aluminum, and europium. The sample we examined was a 7.07 ct transparent oval mixed cut (12.89 × 8.82 × 6.27 mm). The only internal characteristics that we could resolve microscopically were very weak curved striae visible at a slight angle when we looked down the long direction. Through a Chelsea filter, the sample appeared orangy red. Its R.I. was over the limits of a standard refractometer, and its S.G. was 4.62. With a handheld spectroscope, we saw five distinct absorption lines: the strongest at 530 nm, another strong one at 468 nm, two lines of moderate strength at 589 and 472 nm, and a weak one at 480 nm. The sample fluoresced a moderately chalky, strong reddish orange to short-wave UV radiation, with a similar but weaker reaction to long-wave UV. In fact, while all the above-mentioned properties will help separate this substitute from natural tanzanite, the fluorescence to short-wave UV radiation is the easiest test to distinguish the two materials

"Tavalite," cubic zirconia colored by an optical coating. Deposition Sciences Inc., of Santa Rosa, California, is marketing unusually colored cubic zirconia under the trademarked name "Tavalite." Recently, we examined several examples in the six available colors (figure 23). Color descriptions for this material are complicated, as the color is due to a thin optical coating that produces a different appearance in reflected and transmitted light.

Six round-brilliant-cut samples—one of each color—were studied: one 6.5-mm-diameter sample weighing 1.79 ct (not shown in figure 23), and five 4-mm-diameter samples weighing between 0.45 and 0.47 ct. The gemological properties were consistent with cubic zirconia. The color distribution was on the surface only, both crown and pavilion. With magnification, the surface coatings on two samples appeared "dusty," and a third showed a build-up of the coating material at the facet junctions. EDXRF spectroscopy of all six samples revealed yttrium, zirconium, and hafnium; these three elements are consistent with a base material of yttrium-stabilized cubic zirconia. Also discovered were tantalum and silicon, two elements that were probably components of the optical coating. In two examples, titanium was also detected, again probably as part of the optical coating. These coatings may also contain oxygen or nitrogen, but neither can be detected by our EDXRF instrumentation.

Figure 22. This 7.07 ct tanzanite imitation—which contains yttrium, aluminum, and europium—has a very convincing color. Courtesy of Bill Vance; photo by Maha DeMaggio.

As for durability, the surface coating was responsible for all of the color in these samples. The distributor cautioned that strong soaps might affect the surface of "Tavalite"; abrasives and polishing compounds should not be used. However, nonaqueous cleaners (such as rubbing alcohol and "gentle" cleaning with a mild soap—even in an ultrasonic cleaning unit) are acceptable, according to product literature supplied with the samples.

ANNOUNCEMENTS

Sixth annual Cutting Edge Awards. Judges chose 18 winners and 11 honorable mentions from 160 entries in this year's sixth annual Cutting Edge competition, sponsored by the American Gem Trade Association (AGTA) in Dallas, Texas, on April 27 and 28.

Mark Gronlund, of the Custom Jewelry Shop in Deltona, Florida, took three honors, including first place in the Faceting division with his 23.92 ct trillion brilliant-cut citrine. The citrine, when surrounded by specially cut amethysts, also won second place in the Pairs and Suites category (figure 24). First place in Carving went to William Cox, of William H. Cox Enterprises, Provo, Utah, for a 28.67 ct teardrop-shaped sunstone. A 79.10 ct ametrine—fashioned by Steve Walters, of Ramona, California—was awarded first place in the Combination category. Justina De Vries, of Bettenmann-De Vries, Medford, Oregon—who also took second place in the Classic Cuts category—won first place in Pairs and Suites with 7.76 ct and 8.07 ct tourmalines. Objects of Art first place (for the second year in a row) went to Gil Roberts, of North American Gem Carvers, Pilot, Virginia, for a carved chartreuse quartz perfume bottle; Stephen H. Newberg, of CCCC Company, Houston, Texas, was awarded first in Classic Cuts for his 2.52 ct pink spinel.

The competition was open to all colored gemstones of natural origin that were fashioned in North America by a professional lapidary artist. Entries were evaluated on originality of design, quality of work, technique, quality and rarity of the gem material, and overall beauty. The winning gemstones were displayed at the June JC-K Show in Las Vegas, Nevada; winners will be honored at a January 29, 1997, reception at the AGTA Gem Fair in Tucson.

Figure 24. This trillion-cut citrine took first place in the Faceting division of the 1996 AGTA Cutting Edge competition. The citrine with the amethysts took second place in Pairs and Suites. Stones faceted by Mark Gronlund; photo © Tino Hammid.

Gem-related exhibits at American Museums. Several natural history museums currently have exhibits with gem and jewelry themes. In New York City, the **American Museum of Natural History** has "Amber: Window into the Past," which runs through September 2, 1996. It includes major sections on the natural history of amber (including a simulation of an ancient amber-producing forest environment), and on the use of amber in jewelry and decorative objects in many ancient and modern cultures; a catalog is available. In Cambridge, Massachusetts, the **Museum of Cultural and Natural History at Harvard University** is presenting an exhibit on birthstones that is scheduled to remain on display for the next five years. Finally, a traveling exhibit of more than 400 items from the studio of Peter Carl Fabergé, including several Fabergé eggs, is visiting the **Metropolitan Museum of Art** in New York City; the **M. H. de Young Museum** in San Francisco; the **Virginia Museum of Fine Arts** in Richmond; the **New Orleans (Louisiana) Museum of Art**; and the **Cleveland (Ohio) Museum of Art**.

Figure 23. These six 4-mm-diameter samples (about 0.46 ct each) of a cubic zirconia marketed as "Tavalite" owe their colors to thin optical coatings. Photo by Maha DeMaggio.

Special synthetics exhibit at the Sorbonne. The Mineral Collection of the Université Pierre et Marie Curie, 34 rue Jussieu, Paris, features a special exhibit of historical and contemporary synthetic gem materials. (The first synthetic crystals were grown in France in the late 19th century.) This special exhibit, set among the fabulous specimens of this world-class collection, will be open through October 31, 1996.