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DIAMONDS

Bar code technology applied to diamonds. Inscribing diamonds using lasers and other technologies has become a routine method for identifying a stone and personalizing it for individual situations. At the same time, bar coding has evolved from the traditional one-dimensional array of lines to a two-dimensional matrix code that can hold far more information.

Diamond laser inscription technology has now progressed to the point where a miniature matrix code can be inscribed on the girdle of a diamond (see, e.g., figure 1). Instead of just a grading report number, the matrix code can store all of the information in the report itself, such as clarity, cut, and color grades, as well as country of origin (if known), the name of the manufacturer, and other specifics. This has distinct advantages for diamond dealers and manufacturers when managing inventory, security issues, and finances. Unlike traditional laser inscriptions, which can be read with a loupe or a microscope, a matrix code requires a scanner to decode the information. While this does entail investment in additional equipment, it can also provide confidentiality to the owner of the stone.

One manufacturer of the inscription and code-reading equipment, PhotoScribe Technologies of New York, noted that the cost of applying a diamond matrix code is comparable to that of current laser inscriptions.

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U.S. Supreme Court ruling may affect viability of some diamond cut patents. On April 30, 2007, the United States Supreme Court handed down a decision in the case of *KSR International v. Teleflex* (available online at www.supremecourtus.gov/opinions/06pdf/04-1350.pdf). Although this case involved a patent for an automobile gas pedal, the ruling affects the standards by which the U.S. Patent and Trademark Office (USPTO) awards patents, and consequently it may affect the validity of a number of patents on diamond cut designs.

A general review of U.S. patent law as it applies to diamond cuts can be found in the Winter 2002 *G&G* (T. W. Overton, "Legal protection for proprietary diamond cuts," pp. 310–325). One of the factors that the USPTO considers in awarding a patent is whether the claimed invention is a development that would be "obvious" to a person having ordinary skill in the relevant field. An obvious invention is not eligible for a patent. Until the *KSR International* case, the U.S. Court of Appeals for the Federal Circuit (which has jurisdiction over patent disputes) applied a fairly narrow definition of obviousness: whether a specific motivation or suggestion to combine prior inventions or knowledge (referred to as *prior art* in patent law) could be found in the patent literature, the nature of the problem, or the knowledge of a person having ordinary skill in the field. The justification for this narrow test was the straightforward recognition that nearly all inventions involve some synthesis of previous knowledge, and that fact alone does not make an invention obvious.

Editor's note: The initials at the end of each item identify the editor or contributing editor who provided it. Full names and affiliations are given for other contributors.

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Figure 1. This simulated data matrix bar code on the girdle facet of a diamond reads "PhotoScribe." The data matrix measures 80 × 80 μm; the same inscription using letters would require about 10 times the space. Courtesy of PhotoScribe Technologies, New York City; magnified 130×.

In this case, the invention consisted of an adjustable electronic gas pedal design that was a combination of several previous patents covering the component parts and the method by which they were arranged. Teleflex (the patent holder) sued KSR for infringement. Although KSR argued that the progress of science would have inevitably led to the combination at issue here (and previous patents had addressed the problem in a general sense), the Federal Circuit upheld the patent because, looking strictly at the language in the previous patents, there was no specific suggestion to combine them.

The Supreme Court, however, held that the Federal Circuit was applying this test too rigidly. Instead, the Court held that obviousness should be determined against a general background considering the scope of the prior art, the differences between the prior art and the invention, and the level of ordinary skill—essentially, much more of a holistic, common sense approach. Where a certain combination of elements is something obvious to try—as it was in this case—the invention itself is likely obvious as well.

Although this new standard implicates a broad range of issues, this contributor believes it presents a particular hazard to diamond cut patents, since so many recent cut designs are minor variations of previous cuts (see, e.g., Overton, 2002; Spring 2004 Gem New International, pp. 75–76). As the Supreme Court stated, "If a person of ordinary skill can implement a predictable variation, [the law] likely bars its patentability" (*KSR International*, p. 13). Further, the Court held that when there is market pressure to solve a problem for which there are a finite number of predictable solutions, an invention resulting from the pursuit of known options is likely the product not of innovation but of ordinary skill and common sense. For this reason, it will likely be more difficult to defend those cut patents that are but minor evolutions of previous designs. There is, after all, little question that there has been substantial market pressure in recent years for manufacturers and jewelers to develop in-house variations of traditional round and square diamond cuts.

This decision (which effectively overturns several decades of established precedent) still needs to be interpreted and applied by the Federal Circuit and the USPTO, so it is premature to say whether any particular diamond cut patent is in danger. It does, however, counsel caution in the enforcement of existing cut patents and in the development of new designs.

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COLORED STONES AND ORGANIC MATERIALS

First discovery of amazonite in Mexico. Amazonite is a bluish green variety of potassium feldspar that has been found on every continent except Antarctica (see M. Ostrooumov, "L'amazonite," *Revue de Gemmologie*, Vol. 108, 1991, pp. 8–12). More than 100 large amazonite deposits are known, and there are numerous smaller ones. Recently, blue to bluish green amazonite was discovered for the first time in Mexico (figures 2 and 3). This material is hosted by the Peñoles pegmatite, which is located about 60 km southeast of the village Valle de Allende (Sierra de Peñoles, Allende municipality, Chihuahua State). The pegmatite is genetically related to a Li-F granite of Miocene age (32 million years, according to K-Ar dating); this is younger than all other known amazonite deposits. The pegmatite consists of an outer zone of coarse-grained albite-oligoclase and quartz with a small amount of pale blue amazonite. Toward

Figure 2. Amazonite was recently discovered in Chihuahua State, Mexico. This specimen is 28 cm wide; photo by Juan Manuel Espinosa.

Figure 3. These beads and cabochons (4.82–11.32 ct) of Mexican amazonite were recently cut in the mineralogical laboratory at the University of Michoacán. Photo by Robert Weldon.

the interior, the pegmatite attains >50 vol.% amazonite, which occurs as distinctly blue crystals up to 2–3 cm in longest dimension that are associated with albite, quartz, and micas (biotite and zinnwaldite). The central zone of the pegmatite consists mainly of a quartz core with bluish green crystals of amazonite. Chemical analysis (by EDXRF spectroscopy) of the amazonite from the outer zones to the core of the pegmatite showed increasing K, Rb, Cs, Pb, Tl, Ga, Be, Sr, U, and Th, and decreasing Al, Na, Fe, and Ba. X-ray diffraction analysis and optical microscopy showed that the amazonite is microcline with a high degree of Al-Si order.

Five samples of rough amazonite (measuring 1–2 cm in longest dimension) were gemologically characterized for this report, and the following properties were determined: color—blue and bluish green; pleochroism—weak to moderate; RI—n_α=1.516–1.520, n_β=1.518–1.525, and n_γ=1.525–1.529; birefringence—0.007–0.010; hydrostatic SG—2.56–2.60; and fluorescence—yellow-green to long-wave and inert to short-wave UV radiation. Microscopic examination revealed perthitic and microperthitic textures with albite.

UV-Vis absorption and electron paramagnetic resonance spectroscopy, UV fluorescence, and heating/irradiation experiments on the Mexican amazonite showed that the various shades of the blue-green color are caused by absorption bands in the red-orange region (at 625 and 740 nm) and in the near-UV region (380 nm) of the spectrum. All of the absorption bands were strongly polarized in the β-direction [i.e., perpendicular to (001)] and weakly polarized in the a-direction [i.e., perpendicular to (010)]. The coloration mechanisms of the Mexican material are the same as for other amazonite (see M. Ostrooumov et al., "On nature of color of amazonite," in M. Ostrooumov, Ed., *Amazonite*, Nedra, Moscow, 1989, pp. 151–161).

Although the economic potential of the Mexican amazonite discovery has not been evaluated, and the material is not yet available commercially (there has been no organized mining to date), the deposit shows mineralogical, geochemical, and geological characteristics that are analogous to other important amazonite deposits worldwide (Ostrooumov, 1991).

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Astorite—A rhodonite-rich rock from Colorado. *Astorite* is the trade name for a rhodonite-rich gem from Colorado (although this term also has been used as a synonym for richterite, which is an amphibole, and the name *asterite* has been applied to star sapphire; see J. de Fourestier, *Glossary of Mineral Synonyms*, Canadian Mineralogist Special Publication 2, Mineralogical Association of Canada, Ottawa, Ontario, 1999, p. 29). Astorite originates from the Toltec mine in the San Juan Mountains of southwestern Colorado, approximately 18 km from Silverton. This historic mine, which was originally opened for gold and other metals, was once the property of Colonel John Jacob Astor IV, who among other accomplishments cofounded the Waldorf-Astoria Hotel in New York City before perishing on the *RMS Titanic* in 1912 (J. C. Zeitner, "Astorite: A new gem material," *Rock & Gem*, Vol. 32, No. 9, 2002, pp. 70–71; J. R. Yakabowski, "Astorite—A distinctive new gem material," *Wire Artist Jeweller*, Vol. 6, No. 6, 2003, pp. 4–5).

Since May 2003, the Astorite claim has been held by Keith and Connie McFarland of K&C Traders in Silverton. The material is mined from a vein approximately 0.2–0.4 m wide, and is worked on a small scale by drilling and blasting. There is no road leading to the mine, and it is only accessible for part of the summer season, so the production is limited to less than a ton of mixed-grade rough material per year.

Several samples of Astorite have been donated to the GIA Collection by the McFarlands; these consist of seven cabochons (six were between 5.67 and 7.09 ct, while the largest weighed 58.84 ct) and two tumbled pieces (10.96 and 12.41 ct). Since we were not aware of a previous gemological description of this material, we characterized some of these samples for this report. As can be seen in figure 4, the samples displayed an attractive mixture of pink, gray, black, and brown. Although the material superficially resembled rhodonite, a visual inspection established that it was a polymineralic aggregate. Gemological properties were determined on two of the cabochons (6.71 and 58.84 ct): color—predominantly pink with bands of gray and brown and small patches of black (larger cabochon), or black and pink with small patches of gray and brown (smaller sample); spot RI, taken on pink areas—1.71; SG—3.22 and 3.42 for the larger and smaller cabochons, respectively; diaphaneity—translucent to opaque; luster—subvitreous; and no spectrum seen with the desk-model spectroscope. The samples were mostly inert to long-wave UV radiation, with patches of violet and orange in some areas, and a similar but weaker reaction to short-wave UV. The areas of violet fluorescence corresponded to transparent colorless material, while those with orange fluorescence generally correlated to pale brown/"peachy" colored material. Probably because of the heterogeneous nature of our samples, these results differed somewhat from those for rhodonite, which has the following properties: RI—1.733–1.747 (spot reading usually 1.73); SG—3.5 ± 0.3; absorption spectrum—a broad band centered at around 545 nm and a line at 503 nm; and UV fluorescence—inert (*Gem Reference Guide*, GIA, Santa Monica, CA, 1995, pp. 201–202).

Raman spectroscopy was performed to further characterize both samples. The Raman spectra of some pink areas provided good matches for rhodonite, while other pink areas were identified as rhodochrosite or a mixture of both rhodonite and rhodochrosite. Some of the gray areas were identified as quartz (which probably caused the lower SG value of the larger cabochon, in which it was more abundant). The transparent colorless areas with violet fluorescence matched fluorite (for which this fluorescence color is consistent). Raman spectra from small whitish gray areas matched calcite (which could possibly be responsible for the orange fluorescence, as could rhodochrosite). Various spots analyzed in the black areas gave matches to chalcocite, galena, pyrite, and sphalerite. EDXRF spectroscopy of a pink area on the larger sample was consistent with rhodonite. Hence, these two samples of Astorite were characterized as a rock composed of rhodonite, quartz, and rhodochrosite, with traces of calcite, chalcocite, fluorite, galena, pyrite, and sphalerite. This composition is consistent with the literature, except that calcite and chalcocite were not previously mentioned and additional components were listed by Zeitner (2002) and Yakabowski (2003): chalcopyrite, tennantite, tetrahedrite, native metals, helvite, tephroite, and friedelite.

Figure 4. This material, sold under the trade name Astorite, *proved to be a rock composed of rhodonite, quartz, rhodochrosite, and other minerals. The largest piece in the center weighs 58.84 ct. Gift of Keith and Connie McFarland, GIA Collection no. 37095 (all samples); photo by Maha Tannous.*

The McFarlands indicated that the Astorite is polished into cabochons of graduated sizes ranging from 5 mm rounds to 40 × 50 mm ovals. They also produce freeform and inlaid Astorite jewelry.

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Color-change bastnäsite-(Ce) from Pakistan. In February 2007, the Asian Institute of Gemological Sciences (AIGS) Laboratory in Bangkok had the opportunity to examine an unusual 2.09 ct bastnäsite (figure 5), which is a rare-earth carbonate mineral. It was submitted for identification and study by gem dealer Scott Davies (American-Thai Trading,

Figure 5. This unusual 2.09 ct bastnäsite shows a distinct color change, from brownish yellow in daylight/fluorescent light (left) to orange in incandescent light (right). Photos © Scott Davies.

Bangkok), due to its distinct color change; he reported that very few of the bastnäsites he has cut have displayed any significant change of color.

Mr. Davies purchased the original piece of rough in Peshawar in 2006. The material was reportedly mined at the Zagi Mountain deposit northwest of Peshawar, which is known for bastnäsite and other rare-earth minerals (H. Obodda and P. Leavens, "Zagi Mountain, Northwest Frontier Province, Pakistan," *Mineralogical Record*, Vol. 35, No. 3, 2004, pp. 205–220). Bastnäsite gemstones up to nearly 20 ct have been faceted from this locality (see Summer 1999 Lab Notes, pp. 136–137; Obodda and Leavens, 2004).

The following gemological properties were determined on this sample: color—brownish yellow in daylight/fluorescent light and orange in incandescent light; diaphaneity—transparent; RI—1.720 and >1.81 (i.e., over the limits of our standard refractometer); optic character—uniaxial positive; SG (measured hydrostatically)—5.09; and inert to both long- and short-wave UV radiation. Except for the color change, these properties are comparable to those reported for bastnäsite in the Summer 1999 Lab Note and by W. L. Roberts et al. (*Encyclopedia of Minerals*, 2nd ed., Van Nostrand Reinhold, New York, 1990, pp. 73–74).

The visible spectrum obtained with a spectrophotometer showed typical rare-earth absorptions at 444, 461, 468, 482, 511, 521, 532, 578 (strong), 625, 676, 688, and 739 nm (strong). X-ray micro-fluorescence (XRMF) analysis, performed at the Central Institute of Forensic Science (CIFS) Laboratory in Bangkok, revealed the presence of cerium as well as minor amounts of lanthanum, praseodymium, and iron. The IR spectrum showed peaks at 6484 (strong), 6320, 5827, 5070, 4464, 4294, ~4000 (strong), 3590, 3494, 3407, and 3154 cm^{-1}. Raman spectroscopy revealed peaks at 1736, 1435, 1095 (strong), 735, 397, 350, and 260 cm^{-1}. The visible, IR, and Raman spectra—available in the *G&G* Data Depository at www.gia.edu/gemsandgemology—are in agreement with the bastnäsite-(Ce) data we have in our library, and are also comparable to previous reports (e.g., the Summer 1999 Lab Note).

The origin of the unusual color-change behavior in this bastnäsite is unknown. There are a number of gem materials, both natural and synthetic, in which color change is linked to the presence of rare-earth elements. Examples include color-change monazite, fluorite, zircon, and some types of manufactured glass. The process responsible for this color behavior is complex. It is known, however, that light-induced electronic transitions of the rare-earth elements (i.e., f-f transitions) are responsible for most of the sharp absorptions seen in the visible spectrum of these minerals (e.g., L. R. Bernstein, "Monazite from North Carolina having the alexandrite effect," *American Mineralogist*, Vol. 67, 1982, pp. 356–359), and it is these sharp absorptions that are responsible for any change of color. Therefore, the color change in the present bastnäsite may be due to the specific proportions of its constituent rare-earth elements. The rare earth–induced color behavior is in contrast to the "alexandrite effect" exhibited by alexandrite and color-change garnet, among other minerals, which is due to a small number of broad bands linked to chromium and/or vanadium absorption.

Figure 6. This 30.32 ct citrine from Minas Gerais, Brazil, contains abundant inclusions of pyrite. GIA Collection no. 36747; photo by Robert Weldon.

To the best of our knowledge, color change has not been reported previously in bastnäsite, and this was the first example of color-change bastnäsite seen in the AIGS Laboratory.

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Citrine with pyrite inclusions. At the 2007 Tucson gem shows, these contributors were shown some unusual faceted stones and cabochons of citrine that contained conspicuous inclusions of pyrite. The material was offered by Michele Macrì (Laboratorio di Gemmologia Geo-Land, Rome, Italy), who indicated that it was mined in approximately 2002 in Minas Gerais, Brazil. Until recently, only clean citrine gemstones had been cut from the rough, while all the material containing inclusions had been stockpiled. Mr. Macrì obtained ~1 kg of the rough material containing pyrite inclusions from the mine owner, which yielded about 400 carats of faceted stones and cabochons. The color of the citrine reportedly is natural, and the material has not been treated in any way. According to the mine owner, the property was closed in 2005, but the deposit still contains additional reserves of the material.

A 30.32 ct dark brownish orange oval buff-top citrine was donated to GIA by Mr. Macrì and examined for this report (figure 6). Standard gemological testing verified that this gem was quartz, while the condition of the pyrite (figure 7) and intact fluid inclusions provided evidence that the citrine was natural and untreated. Although beautifully

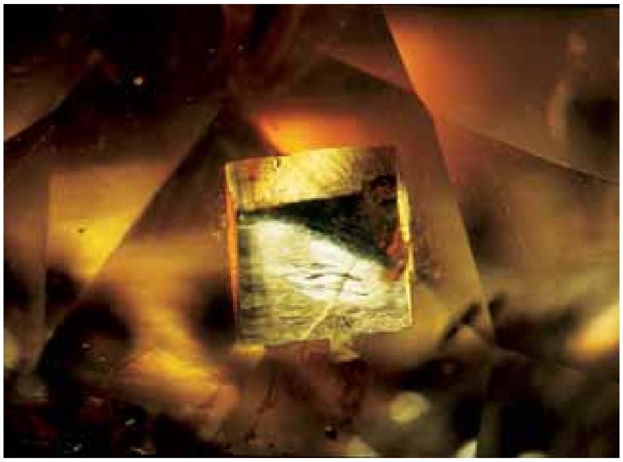

Figure 7. Measuring approximately 1.6 mm across, this well-formed cubic pyrite inclusion in the citrine illustrated in figure 6 shows a metallic luster, brassy color, and surface details that are characteristic of this sulfide mineral. Photomicrograph by J. I. Koivula.

formed pyrite crystals are known to occur in colorless rock crystal, such inclusions are very unusual in both amethyst and citrine. The inclusions of pyrite examined for this report are the best we have seen to date in any citrine.

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BML

Figure 8. This matched pair of bright yellow danburites weighs a total of 34.60 ct. Courtesy of Pillar & Stone International, San Francisco; photo by Judy Chia.

Unusual danburite pair. At the 2007 Tucson gem shows, this contributor saw an unusual matched pair of yellow danburites set as earrings (figure 8) at the booth of Pillar & Stone International (San Francisco, California). The stones had a total weight of 34.60 ct and displayed a strikingly saturated yellow hue. According to the owners, Roland and Nata Schlüssel, they were mined west of the town of Kyatpyin, in Myanmar's Mogok region.

The refractive indices of the yellow danburites were n_o=1.630 and n_e=1.634, yielding a birefringence of 0.004, and they fluoresced blue to both long- and short-wave UV radiation. These properties matched those described in the *Gem Reference Guide* (Gemological Institute of America, Santa Monica, CA, 1995, pp. 84–85), except that reference did not mention the saturated yellow color, and the birefringence we obtained was lower than the reported value of 0.006 (probably because the mountings prevented us from measuring the maximum birefringence). Danburite has a Mohs hardness of 7–7.5.

With magnification, both samples showed overlapping "fingerprints" (figure 9). One had elongate growth tubes that sometimes ended in a curled shape (figure 10). No growth

Figure 9. The danburites contained multiple overlapping "fingerprint" inclusions. Photomicrograph by Hpone Phyo Kan-Nyunt; magnified 20×.

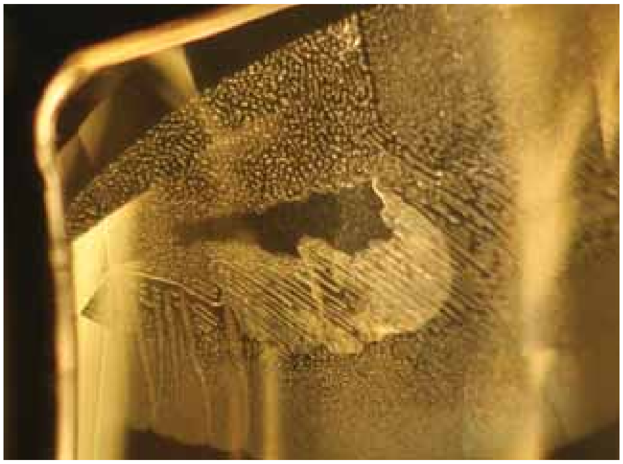

Figure 10. One of the danburites also contained elongate growth tubes. Photomicrograph by Hpone Phyo Kan-Nyunt; magnified 20×.

Figure 11. These crystals of gem-quality fluorite (8.6 g total weight) were selected to show the range of color of material from a new source in southern Ethiopia. Photo by M. Macrì.

banding was observed; however, one of the danburites showed variable color concentration between the center of the stone and the rim. No other inclusions or growth features were present.

EDXRF chemical analysis revealed Ca and Si as major elements; this is consistent with the chemical formula of $CaB_2(SiO_4)_2$ for danburite (boron cannot be detected with EDXRF). In addition, a minor amount of Sr was detected. The Raman spectrum matched that of our danburite reference, confirming the identification.

According to Mark Smith (Thai Lanka Trading Ltd., Bangkok), yellow danburite is known from several alluvial and primary deposits in the Mogok region. Recently, it has been recovered from pegmatites near Molo in the Momeik area; a pegmatite in this same region has also produced pezzottaite (see Spring 2006 Gem News International, pp. 70–72). Other *in-situ* deposits are known at Dat Taw, Sakangyi, and an important new locality called Lay Gyi. Mr. Smith also noted that the local miners are adept at identifying danburite (due to its distinctive etched surface and characteristic growth-tube inclusions), and they value it highly as a jewelry stone.

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Fluorite from Ethiopia. Ethiopia has grown rapidly in gemological importance during the past several years. Among other developments, it has become a significant source of gem-quality opal (see, e.g., M. L. Johnson et al., "Opal from Shewa Province, Ethiopia," Summer 1996 *Gems & Gemology*, pp. 112–120). As a result of this growing interest, there has been much recent exploration for gem materials and efforts to open new mines.

In March 2007, one these contributors (MM) encountered a new gem material at the Bologna mineral show in Italy. Mr. Tesfay Desta, an Ethiopian dealer, had an interesting 500 g parcel of some unidentified gem-quality rough. The material was reportedly from a mine in the Guji zone, southern Ethiopia. Five samples (figure 11) were purchased for testing.

The crystals weighed approximately 1–2 g each, and were crystallized as pentagonal icositetrahedra with slightly concave faces. They were colorless, reddish brown to brownish red/pink, and pale blue-violet. The following gemological properties were determined from two of the samples using standard techniques: RI—1.434; SG—3.16; fluorescence—inert to moderate green to long-wave UV, inert to strong green to short-wave; and phosphorescence—moderate green. Internal features consisted of fluid inclusions, and straight parallel growth features and color zoning. These properties are consistent with those for fluorite (see M. O'Donoghue, *Gems*, 6th ed., Butterworth-Heinemann, Oxford, UK, p. 411), although the crystal habit is unusual for this mineral.

X-ray powder diffraction data collected for three samples on a parallel-beam Bruker AXS D8 Advance automated diffractometer confirmed the identification as fluorite. The lattice parameter *a* extracted via Rietveld refinement is $a = 5.46378(1)$ Å, in agreement with V. A. Streltsov et al. ("Electronic and thermal parameters of ions in CaF_2: Regularized least squares treatment," *Kristallografiya*, Vol. 33, 1987, pp. 90–97).

At the Verona mineral show in late May 2007, Mr. Desta had a 25 kg parcel of rough Ethiopian fluorite that included some color-change material. The color appeared

Figure 12. Some of the fluorite from Ethiopia (here, 21.0 g total weight) shows a color change from blue or grayish blue in sunlight to purple or reddish purple in incandescent light. Photos by M. Macrì.

blue to grayish blue (similar to iolite) in sunlight and in daylight-equivalent fluorescent light, and purple (like amethyst) to reddish purple in incandescent light (figure 12). In addition, some of the deep reddish brown fluorite crystals appeared deep red (like rhodolite) in incandescent light. The other colors did not show the color-change effect, so it was estimated that only 3–5% of the stones show this behavior.

Ethiopian fluorite has the potential to be an interesting collector's gem. According to Mr. Desta, the total weight of rough material available on the market as of May 2007 was approximately 200 kg.

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Heliodor and other beryls from Connecticut. For more than a century, granitic pegmatites of the Middletown District in Connecticut have been known for producing small amounts of gem beryl and tourmaline, although they have been principally mined for industrial feldspar, mica, beryl, and other minerals (see E. N. Cameron et al., *Pegmatite Investigations, 1942–1945, in New England*, U.S. Geological Survey Professional Paper 255, 1954, 347 pp.; J. A. Scovil, "The Gillette Quarry, Haddam Neck, Connecticut," *Mineralogical Record*, Vol. 23, No. 1, 1992, pp. 19–28). A variety of beryl colors have been reported from these pegmatites, including colorless, "golden" yellow, blue to green, and pink (e.g., Scovil, 1992).

Figure 13. Strong "golden" yellow coloration is shown by these attractive beryls (2.36 and 1.54 ct) from Connecticut. Courtesy of Jim Clanin; photo by Robert Weldon.

At the 2007 Tucson gem shows, Jim Clanin (JC Mining, Hebron, Maine) obtained two faceted heliodors from Connecticut that were notable for their saturated "golden" yellow color (figure 13). The stones were purchased from Jan Brownstein (Songo Pond Gems, Bethel, Maine), who had cut them from a collection of gem rough that he recently obtained from the Howard Hewitt estate. This beryl collection consisted mostly of rough pieces, polished rough, and preforms of various colors (e.g., figure 14) that were mined by Mr. Hewitt over the past several decades from three quarries in Connecticut: Merryall (or Roebling) in Litchfield County ("golden" yellow), Slocum near East Hampton ("lemon" yellow), and Turkey Hill near Haddam (pale blue, with inclusions; John Betts, pers. comm., 2007). In total, Mr. Brownstein obtained a few kilograms of the Connecticut beryl, and he has faceted about 250 stones so far with a maximum weight of ~13 ct. All of the rough material consisted of broken pieces that most likely were derived from beryl crystals that were "frozen" in the pegmatite matrix; there was no evidence of any crystal faces indicative of growth in gem pockets.

Examination of the two cut heliodors (1.54 and 2.36 ct) by one of us (EAF) showed the following properties: color—orangy yellow to orange-yellow, with no pleochroism; RI—1.575–1.581; birefringence—0.006; hydrostatic SG—2.73 and 2.75; Chelsea filter reaction—none; and fluorescence—inert to long- and short-wave UV radiation. These properties are consistent with those reported by M. O'Donoghue (*Gems*, 6th ed., Butterworth-Heinemann, Oxford, UK, 2006, pp. 124–129) for aquamarine, which O'Donoghue indicates has properties equivalent to yellow beryl. Microscopic examination revealed numerous fine growth tubes and clouds of pinpoint-sized particles. The stones displayed a weak absorption band around 500 nm when observed with the desk-model spectroscope, as mentioned for strongly colored yellow beryl by O'Donoghue (2006). This reference also indicated that the Merryall mine has been the only important source of yellow beryl in the United States.

BML

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Figure 14. Beryl from Connecticut comes in a variety of colors, as shown by these gemstones (1.87–3.18 ct) and preforms (1.3–2.5 g). Courtesy of Jan Brownstein; photo by Robert Weldon.

Figure 15. All of these chatoyant gems (6.45–19.32 ct) are currently available from Tanzania. From left to right, they are scapolite, K-feldspar, opal, and apatite. Courtesy of Anil B. Dholakia Inc.; photo by Robert Weldon.

Cat's-eye K-feldspar and other chatoyant gems from Tanzania. A wide variety of cat's-eye and star gems have been reported from Tanzania and Kenya, including apatite, beryl, corundum (ruby and sapphire), garnet (almandine, grossular, and rhodolite), kyanite, kornerupine, scapolite, tourmaline, and zoisite (N. R. Barot et al., "Cat's-eye and asteriated gemstones from East Africa," *Journal of Gemmology*, Vol. 24, No. 8, 1995, pp. 569–580). During the 2007 Tucson gem shows, Anil Dholakia (Anil B. Dholakia Inc., Franklin, North Carolina) showed one of these contributors (BML) some cabochons that he was selling as cat's-eye feldspar from Tanzania. He indicated that such material has been identified as labradorite by some gemologists, and also shows a close resemblance to Tanzanian cat's-eye scapolite. The feldspar/scapolite confusion was reinforced by gem dealer Scott Davies, who purchased some Tanzanian rough sold as "red moonstone" in 2004 that proved to be scapolite. He indicated that both gems show good chatoyancy and have a similar color range (light brownish red to very dark reddish brown).

Mr. Dholakia loaned some cabochons of each gem to GIA for examination, as well as chatoyant opal and apatite from Tanzania for comparison. A representative sample of each gem (6.45–19.32 ct; figure 15) was selected for characterization by one of us (EAF), and the results are given in table 1.

The properties of the cat's-eye feldspar were consistent with alkali feldspar, rather than labradorite (a calcic plagioclase). This was confirmed by EDXRF analysis, which detected major amounts of Al, Si, and K, and traces of Ca and Ba. Similar alkali feldspars were documented by U. Henn et al. ("Chatoyancy and asterism in feldspars from Tanzania," *Gemmologie: Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 54, No. 1, 2005, pp. 43–46), although only faint asterism was seen when our sample was rotated in front of a fiber-optic light source. Henn et al. (2005) attributed the optical phenomena to ori-

TABLE 1. Properties of some chatoyant gems from Tanzania.[a]

Property	K-feldspar	Scapolite	Opal	Apatite
Weight (ct)	19.32	13.70	6.45	15.13
Color	Orangy brown	Brown-red	Orange-brown	Yellowish green
RI (spot)	1.53	1.55	1.45	1.63
SG (hydrostatic)	2.59	2.75	2.09	3.23
Fluorescence				
Long-wave	Inert	Inert	Inert	Inert
Short-wave	Very weak red	Very weak red	Inert	Inert
Spectroscope spectrum	General absorption to 510 nm	No features seen	General absorption to 550 nm	Line at 530 nm and doublet at 580 nm
Inclusions	Fine black needles, small reddish trigonal platelets, and long orangy rectangular platelets	Small red angular platelets, fine red needles, and small black dendritic platelets	Long needles with an almost fibrous appearance	Fine iridescent needles or growth tubes

[a] *No pleochroism or reaction to the Chelsea filter was seen in any of the samples.*

ented lath-shaped inclusions of hematite. A similar K-feldspar (from an undisclosed source) was described in a Summer 1997 Lab Note (p. 137), but in that cabochon the platy inclusions were too large and poorly oriented to account for the chatoyancy or asterism.

The properties obtained for the chatoyant scapolite are consistent with those previously reported for this gem variety (e.g., Summer 2003 Gem News International, pp. 158–159; Spring 1984 Lab Notes, pp. 49–50) except that the RI we measured was slightly lower. Since the refractive indices (and specific gravity) of scapolite increase with greater Ca content, our results indicate a composition that is closer to the marialite end member ($3NaAlSi_3O_8 \bullet NaCl$) of the solid-solution series with meionite ($2CaAl_2Si_2O_8 \bullet CaCO_3$). A further decrease in Ca content would be expected to cause a spot-RI value that is at or slightly below 1.54 (e.g., P. C. Zwaan and C. E. S. Arps, "Properties of gemscapolites [*sic*] from different localities," *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 29, No. 1–2, 1980, pp. 82–85), which is quite similar to that of K-feldspar.

The properties of the other chatoyant gems documented in this study are consistent with those described in the literature for Tanzanian opal (Summer 1998 Gem News, pp. 138–140) and apatite (E. Gübelin and K. Schmetzer, "Eine neue Edelstein-Varietät aus Tansania: Gelbe, grüne und rötlich-braune Apatit-Katzenaugen," *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 31, No. 4, 1982, pp. 261–263).

The cat's-eye K-feldspar can be readily separated from chatoyant opal and apatite by its standard gemological properties. However, distinguishing it from scapolite might be difficult in cases where a stone cannot be unmounted for SG measurement. In such situations, a careful RI reading can separate the two minerals, but an accurate identification may depend on performing more advanced (spectroscopic) testing.

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Green opal. During the 2007 Tucson gem shows, one of these contributors (BML) was shown some cabochons of bright green opal by Hussain Rezayee (Pearl Gem Co., Beverly Hills, California). Mr. Rezayee obtained the rough in December 2004 while in Turkey, but he was not able to confirm its source. From several tons of mostly low-quality material, he selected 100 kg of usable pieces that ranged from 20 g to 1 kg. He subsequently cut about 5,000 carats of cabochons, which weighed up to 70–80 ct each. He reported that none of the cabochons were treated in any way.

Five of the opal cabochons (5.36–17.74 ct; e.g., figure 16) were loaned to GIA by Mr. Rezayee for examination, and the following gemological properties were determined by one of us (KMR): color—semitranslucent-to-translucent light green; spot RI—1.46–1.47; hydrostatic SG—2.10–2.13; fluorescence—weak green to long-wave and very weak green to short-wave UV radiation, with no observable phosphorescence; and general absorption below 450 nm and above 620 nm seen with the desk-model spectroscope. These properties are consistent with those reported for green opal from Serbia in the Fall 1995 Gem News section (p. 208), except that the sample documented in that report was opaque and also inert to short-wave UV. Microscopic examination of Mr. Rezayee's samples revealed fine veins and cavities lined with small spheroids of botryoidal opal (identified by JIK). EDXRF chemical analysis (performed by EAF) detected minor amounts of Ni, as well as traces of Ca and V.


Figure 16. Although the rough material was purchased in Turkey, these green opal cabochons (5.36–17.74 ct) have properties comparable to those recorded for Serbian material. Courtesy of Hussain Rezayee; photo by Robert Weldon.

The Fall 1995 Gem News entry indicated that the properties of the Serbian material are comparable to those of green opal from Tanzania (see J. I. Koivula and C. W. Fryer, "Green opal from East Africa," Winter 1984 *Gems & Gemology*, pp. 226–227), and that green Ni-bearing opal has also been found in Poland, Australia, and Peru. The opal described in the present report is most likely from Serbia, given its similarity to the material described previously and information provided to Mr. Rezayee at the 2007 Tucson shows by a German opal dealer, who indicated that the opal was very similar to material from the province of Kosovo.

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Chinese akoya cultured pearls. In 2006, Chinese farmers produced about 20 tonnes of akoya cultured pearls along the southern coasts of Guangdong and Guangxi provinces (You Hong Qing, Xuwen Jinhui Pearl Co., pers. comm.,

Figure 17. These Chinese akoya cultured pearl strands are composed of natural-color, silver-blue baroques (7.5–11.3 mm) and bleached white rounds that show a rosé overtone produced by "pinking" (7.5–8 mm). Courtesy of J. Shepherd; photo by Kevin Schumacher.

2007). The production region extends east from the Vietnam border past Beihai, around the Leizhou Peninsula and Hainan Island, and continues east toward Hong Kong. Beihai in the west and Xuwen on the peninsula are two processing centers. Between the Beihai area and the Leizhou Peninsula's east side, there are more than 2,000 akoya pearl farms. About 100 farms maintain more than 500,000 nucleated mollusks, about 200 culture 200,000–500,000 mollusks, and about 1,700 maintain fewer than 200,000.

Chinese akoya farmers identify the mollusk they use as *Pinctada fucata martensii*. This is the same species that farmers in Japan identify as the akoya mollusk. However, there has been so much hybridization with closely related species that *P. fucata martensii*'s purity as a cultured pearl producer in China and Japan is questionable (Shigeru Akamatsu, Mikimoto Co., pers. comm., 2006; You H. Q., pers. comm., 2007). On Chinese akoya farms, all the mollusks are hatchery bred, although hatcheries do introduce wild mollusks to ensure genetic diversity. There are at least 12 hatcheries in the pearl-culturing region, two of which are government-run facilities on Hainan Island.

In April 2007, the present authors visited several pearl farms and nucleation facilities on Longye Bay near Xuwen. Nucleators there implanted one or two spherical shell-bead nuclei ranging from 5 to 7.75 mm, each with a tissue piece from a donor mollusk, in host mollusks that measured 6.4–7 cm in diameter. At that size, the mollusks are about 18 months old. We were told that the pearl-growth period ranges from six months to two years, but 10–12 months is most common. Nacre thickness (per radius) ranges from 0.1 to 1.2 mm, while 0.4–0.6 mm is most common. Cultured pearl sizes range from 2 to 11 mm. Shapes are round, near-round, semibaroque, baroque, drop, pear, and oval. Colors include bleached white with a rosé overtone produced by "pinking" (immersing the cultured pearls in an extremely dilute red pigment) and natural silver-blue (figure 17). Quality ranges from commercial to gem grade.

According to Mr. You, processors in the Xuwen area bleach about 98% of the akoya cultured pearls they handle. Many are also heavily dyed, with black being the most common color. A medium-volume processing factory produces about 10,000 temporary strands (16–16.5 inch [40–42 cm]) per year, while a large factory produces about 42,000 such strands annually.

About 50% of the Chinese akoya cultured pearls are sold in Hong Kong, either at trade fairs or by direct sale through five Hong Kong wholesalers. Local wholesalers in the culturing region sell the balance by direct sale. In 2006, the top wholesale markets were Japan, the U.S., and Europe.

The 2006 volume was down from the 27 metric tons produced in 2005, and production is expected to dip again in 2007 (You H. Q. and Cissy Wong, pers. comms., 2007). The decline is partly due to falling demand, but the motives of hundreds of independent Chinese akoya pearl farmers also contribute. For akoya farmers in China, pearl culturing is very much a dollars-and-cents business. When the short-term gain looks better in shrimp farming or another type of aquaculture, many farmers switch products. The akoya volume we see now can be determined by how the farmers' economic picture looked about a year ago.

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Pyrope-almandine from Tanzania. John D. Dyer (Precious Gemstones Co., Edina, Minnesota) had some attractive orange-red to orangy red garnets that he marketed as "rose malaya" at the 2007 Tucson gem shows. This trade name was based on the identification of the material as pyrope-spessartine by independent gemologists. The garnets reportedly have been produced since mid-2005 from Tanzania's Umba Valley.

Mr. Dyer loaned three samples and donated an additional 1.35 ct garnet to GIA for examination (figure 18). The following properties were determined on all four stones by one of us (EAF): color—orange-red; RI—1.742; no birefringence; hydrostatic SG—3.80; Chelsea filter reaction—none; fluorescence—inert to long- and short-wave UV radiation; and absorption lines at 504, 520, and 573 nm

Figure 18. These attractive orange-red garnets (1.35–6.92 ct) from Tanzania's Umba Valley proved to be pyrope-almandine. The trilliant is a gift of Precious Gemstones Co.; GIA Collection no. 36746. Photo by Robert Weldon.

visible with the desk-model spectroscope. There was no observable shift in color between daylight-equivalent and incandescent light sources. These properties are similar to those reported for pyrope-spessartine, but they are more consistent with pyrope-almandine, according to C. M. Stockton and D. V. Manson ("A proposed new classification for gem-quality garnets," Winter 1985 *Gems & Gemology*, pp. 205–218). Microscopic examination revealed no inclusions and only minor surface abrasions on the stones.

EDXRF spectroscopy of the 1.35 ct garnet showed major amounts of Si, Al, Mg, and Fe, as well as minor Ca and Mn. Electron-microprobe analysis of the other three samples at the University of New Orleans confirmed the identification as pyrope-almandine, yielding the following components: 71.1–73.1% pyrope, 18.9–21.7% almandine, 7.0–8.5% grossular, and 0.2–0.4% spessartine, along with traces of the andradite component.

East Africa is a common source for pyrope-almandine that typically ranges from reddish orange to red-purple, with the latter color referred to as *rhodolite* by the gem trade. The red-purple coloration of rhodolite is very different from the orange-red color of the pyrope-almandine examined for this report. Rhodolite also commonly contains abundant oriented needle-like rutile crystals (e.g., P. C. Zwaan, "Garnet, corundum, and other gem minerals from Umba, Tanzania," *Scripta Geologica*, Vol. 20, 1974, pp. 1–41), which were not seen in the pyrope-almandine garnets we studied.

East Africa is also known for producing pyrope-spessartine in the pink to red to orange to yellow-orange range, which has been marketed as *malaya* garnet (see Stockton and Manson, 1985; K. Schmetzer and H. Bank, "Garnets from Umba Valley, Tanzania—Members of the solid solution series pyrope-spessartine," *Neues Jahrbuch für Mineralogie, Monatshefte*, Vol. 8, 1981, pp. 349–354). A wide range of compositions have been reported for malaya garnets from East Africa, with most having a 30–55% spessartine component, but some having as low as 10–30% spessartine (Stockton and Manson, 1985).

The garnets examined for this report did not contain enough spessartine component to be called malaya garnets, and they are best referred to as pyrope-almandine since they lack the purple hue of rhodolite.

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Pink-to-red tourmaline from Myanmar. Rubellite tourmaline from Myanmar is well known as fibrous mushroom-like crystals from the Mogok area (see T. Hlaing and A. K. Win, "Rubellite and other gemstones from Momeik Township, northern Shan State, Myanmar," *Australian Gemmologist*, Vol. 22, 2005, pp. 215–218). From late 2006 to February 2007, well-formed prisms of pink-to-red tourmaline were mined from a pegmatite located about 80 km northeast of Mandalay, at Letpanhla in Singu Township. The pegmatite is hosted by rocks of the Mogok metamorphic belt that strike in a north-south direction.

The tourmaline crystals had typical striated prism faces and were terminated by rhombohedral faces (e.g., figure 19). This contributor estimates that ~5 kg of fine-quality crystals were produced, as well as >100 kg

Figure 19. A new source of Burmese tourmaline was found in late 2006 at Letpanhla, located between Mogok and Mandalay. The Letpanhla crystals shown here range from 3.5 to 7.1 cm tall. Courtesy of Pala International, Fallbrook, California; photo by Robert Weldon.

Figure 20. This 31.5 ct cabochon of Letpanhla tourmaline shows a saturated pink color that is considerably more intense than is typically seen in tourmaline from this locality. Courtesy of U Tin Hlaing.

Figure 21. Chatoyant tourmaline has also been cut from the Letpanhla material (here, 6.24 and 7.21 ct). Photo by Mark Smith, Thai Lanka Trading Ltd., Bangkok.

of lower-quality pink material. The tourmaline typically contains fine tubes parallel to the c-axis and abundant fluid inclusions (trichites). Several hundred cabochons have been cut, ranging from 5 to 50 ct each (e.g., figure 20). Rare cat's-eye cabochons also have been produced from the Letpanhla material (figure 21).

There appears to be good potential for additional finds of tourmaline and other pegmatite minerals from the Mogok metamorphic belt in the area between Thabeikyin and Sagyin.

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SYNTHETICS AND SIMULANTS

Glass object with circular bands. Rock crystal quartz is often used as a carving material for various symbolic objects in India, but these items are commonly imitated by colorless glass, so they are routinely sent to gemological laboratories for identification. Recently, at the Gem Testing Laboratory in Jaipur, India, we received an approximately 188 ct colorless specimen (figure 22) in the shape of a "Shivling," which is the symbol representing Lord Shiva in Hindu theology.

Our initial observation included the use of fiber-optic lighting to look for tell-tale signs of glass, such as gas bubbles or swirls. The most conspicuous feature was a curved zone of whitish bands visible through the base of the object (figure 23, left); these bands resembled the curved striae seen in flame-fusion synthetic sapphire. However, the specimen had a lighter heft than would be expected for that material. When viewed from the side (in a direction perpendicular to the axis of curvature of the whitish bands), straight parallel lines were seen (figure 23, center).

At higher magnification, the curved bands appeared to be composed of planes of white pinpoint inclusions (figure 23, right) that created a hazy effect in some areas of the specimen. Also present were scattered whitish crystallites and gas bubbles.

The combination of the white crystallites, gas bubbles, and swirls identified the material as glass; a spot RI value of 1.52 was consistent with this identification. Still, further tests were performed for our records. Examination between crossed polarizers revealed a strain pattern (as is typically seen in glass) along the edges of the curved whitish zone. When exposed to short-wave UV radiation, a strong pinkish purple fluorescence was confined to this zone, which was bordered by a narrow fringe of blue fluorescence (figure 24); the sample was inert to long-wave UV. We have noted

Figure 22. This 188 ct "Shivling," approximately 4.0 cm tall, was represented as rock crystal quartz, but proved to be manufactured glass. Photo by G. Choudhary.

Figure 23. A zone of concentric whitish bands, similar to those seen in flame-fusion synthetic sapphire, was visible through the base of the glass object (left); note the white crystallites along the inner edge of the zone. When the glass object was viewed from the side (center), the curved whitish bands appeared as straight parallel planes, as would be expected for a cross-section through concentric cylindrical tubes. At higher magnification (right), the circular bands were seen to be composed of planes of white pinpoint inclusions. Photomicrographs by G. Choudhary; magnified 10× (left and center) and 65× (right).

similar fluorescence behavior in many colorless glasses.

In the past we have encountered some unusual features in glass, but this was the first time we had seen these circular features.

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Heat-treated Kashan flux-grown synthetic ruby. In March 2006, a 10.12 ct transparent purplish red oval mixed cut (figure 25) was submitted for identification to the Dubai Gemstone Laboratory. The client indicated that it had been purchased in and originated from Myanmar.

Standard gemological testing established the following properties: RI—1.762–1.770; birefringence—0.008; optic sign—uniaxial negative; pleochroism—moderate orangy red to purplish red; SG (determined hydrostatically)—3.98; fluorescence—strong red to long-wave and moderate red to short-wave UV radiation, with a strong chalky blue luminescence on the surface; and "chrome" lines seen in the absorption spectrum with a desk-model spectroscope. These properties were consistent with ruby, while the strong chalky blue surface fluorescence to short-wave UV radiation suggested heat treatment.

When examined with magnification, this sample at first showed internal features that looked very much like those seen in flux-assisted heated natural rubies (figure 26). However, when examined carefully, these inclusions proved to be various forms of flux residue, such as are found in flux-grown synthetics. Also apparent were white, high-relief, parallel rods; feather-like structures or "fingerprints"; rain-like structures resembling comets; and discoid features with so-called paint splash inclusions (figure 27). These inclusions are typical of Kashan flux-grown synthetic ruby. Also present were dissolved white flux-filled negative crystals with associated discoid fis-

Figure 24. The zone containing the whitish bands exhibited strong pinkish purple fluorescence to short-wave UV radiation (upper left in this photo), and the edge of this zone fluoresced blue. Photo by G. Choudhary.

Figure 25. This 10.12 ct sample proved to be a heat-treated Kashan flux-grown synthetic ruby. Photo by S. Singbamroong, © Dubai Gemstone Laboratory.

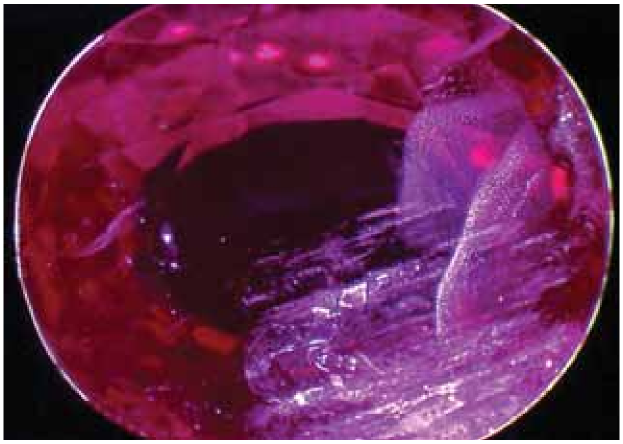

Figure 26. The synthetic ruby contained internal features that resemble those seen in flux-assisted heated natural rubies. Photomicrograph by S. Singbamroong, © Dubai Gemstone Laboratory; magnified 6×.

sures, which are indicative of heat treatment (figure 28).

UV-Vis absorption spectroscopy showed broad bands centered at 410 and 560 nm, and a small peak at 694 nm; these are typically responsible for ruby color. However, the spectrum also showed UV transmission at 305 nm that was stronger than the visible-region transmission at ~475 nm (blue region), which is suggestive of synthetic ruby (G. Bosshart, "Distinction of natural and synthetic rubies by ultraviolet spectrophotometry," *Journal of Gemmology*, Vol. 18, No. 2, 1982, pp. 145–160). Note that the opposite trend in the 305 and ~475 nm transmission windows was recently documented in polarized spectra of a heat-treated Kashan synthetic ruby by K. Schmetzer and D. Schwarz ("The causes of colour variation in Kashan synthetic rubies and pink sapphires," *Journal of Gemmology*, Vol. 30, No. 5/6, 2007, pp. 331–337); this is probably due to the higher Ti content of the sample that they heated. Infrared spectroscopy revealed no peaks related to the OH-group (hydroxyl), as expected for flux-grown synthetic ruby. EDXRF analysis revealed traces of Ca, Ti, V, Cr, Mn, Fe, and Ga; no Ni, Cu, La, W, Pt, Pb, Bi, or Mo was detected. The low amounts of Fe, V, and Ga, combined with slightly higher amounts of Ti, are distinctive of Kashan flux-grown synthetic ruby (see S. Muhlmeister et al., "Separating natural and synthetic rubies on the basis of trace-element chemistry," Summer 1998 *Gems & Gemology*, pp. 80–101). We also compared the EDXRF results to those for our reference collection of flux-grown synthetic rubies, and these matched very well the spectrum of the Kashan specimen in our collection. Our EDXRF data also fell within the values listed by Schmetzer and Schwarz (2007), except for slightly higher V and the presence of a trace of Ga.

Since the 1990s, a variety of heat-treated synthetic rubies have been reported (see, e.g., H. Kitawaki, "Heat treated synthetic ruby," Research Lab Report, GAAJ Research Laboratory, May 23, 2005, www.gaaj-zenhokyo.co.jp/researchroom/kanbetu/2005/kan_2005_06en.html). Heat treatment of synthetic ruby makes identification more difficult and complicated. Thus, more careful examination and sophisticated testing were necessary to complete this identification.

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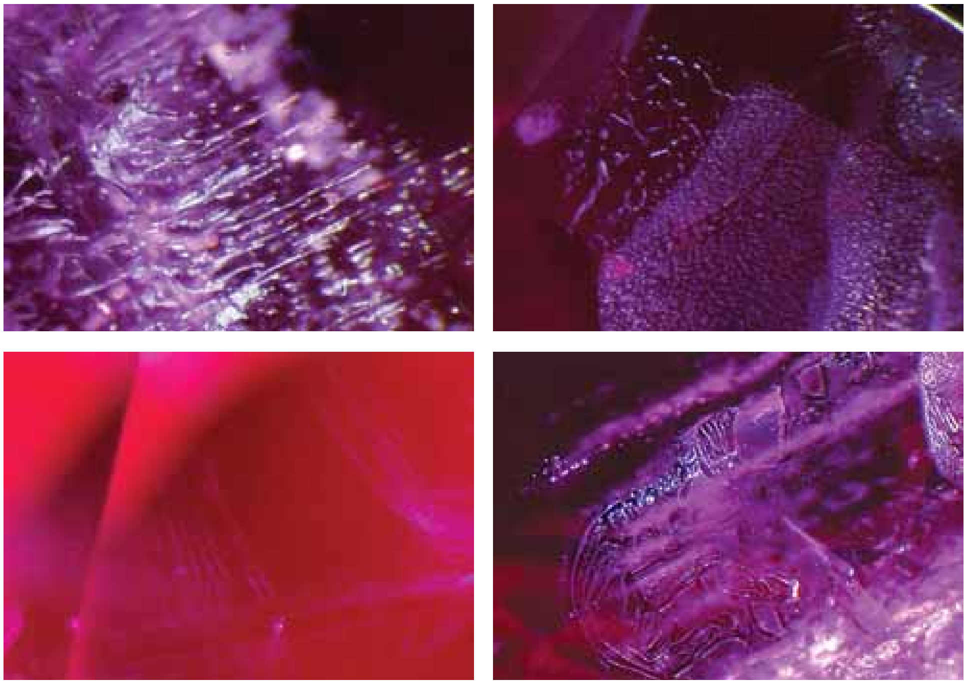

Figure 27. Various forms of flux residue were found in the synthetic ruby: white, high-relief, parallel rods (top left, magnified 40×); feather-like structures or "fingerprints" (top right, 20×); rain-like structures resembling comets (bottom left, 32×); and discoid features with "paint splash" inclusions (bottom right, 16×). Photomicrographs by S. Singbamroong and N. Ahmed, © Dubai Gemstone Laboratory.

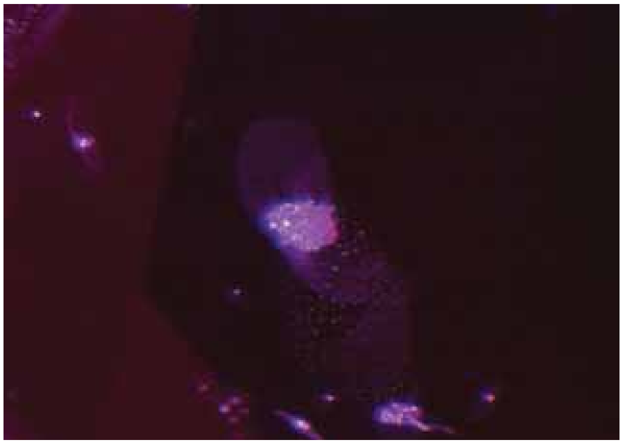

Figure 28. Dissolved white flux-filled negative crystals with discoid fissures, indicative of heat treatment, were also observed in the synthetic ruby. Photomicrograph by S. Singbamroong, © Dubai Gemstone Laboratory; magnified 50×.

Figure 29. This 4.63 ct cabochon proved to be a synthetic star sapphire with hexagonal zoning in its core, which initially suggested natural origin. Photo by G. Choudhary.

Synthetic star sapphire with hexagonal features. Hexagonal color/growth zoning is a classic identifying feature for natural corundum. Recently, however, at the Gem Testing Laboratory in Jaipur, India, we encountered a synthetic star sapphire (figure 29) with hexagonal zoning. Our initial examination indicated that the sample was a natural sapphire with a diffusion-induced star, as suggested by the wavy appearance of the rays and the presence of "silk" inclusions. The 4.63 ct cabochon fluoresced chalky blue to short-wave UV radiation and showed chromium lines when observed with the desk-model spectroscope.

With magnification and immersion, a hexagonal zone was evident in the core of the cabochon when it was viewed from above (figure 30, left). This zone was surrounded by a wavy stress pattern (see figure 30, left and right). Also present were fine needles oriented in three directions, which were responsible for the star effect.

When the cabochon was viewed from the back, however, we were surprised to discover numerous tiny whitish pinpoints (likely gas bubbles) arranged in curved clouds (figure 31, left). When the stone was viewed in immersion with diffused illumination, curved color bands also became apparent (figure 31, right). These features are diagnostic of a flame-fusion synthetic origin.

The cause of the hexagonal zone is not clear. We speculate that it may have been the result of a crystallographically oriented concentration of silk in the core. Using higher magnification and a strong fiber-optic light, we noted a concentration of needles in the core as compared to the surrounding area. This was the first time we observed both hexagonal zoning and curved color bands in a single sample. It provides an important reminder that a gemologist should avoid making an identification without considering all of the evidence presented by a sample. If this stone had been mounted in a closed-back setting, it would have been very difficult to make a correct identification.

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Figure 30. The central hexagonal core was visible when the synthetic star sapphire was observed with magnification and immersion (left). A wavy stress pattern was present in the area surrounding the core (left and right). Photos by G. Choudhary; magnified 30× (right).

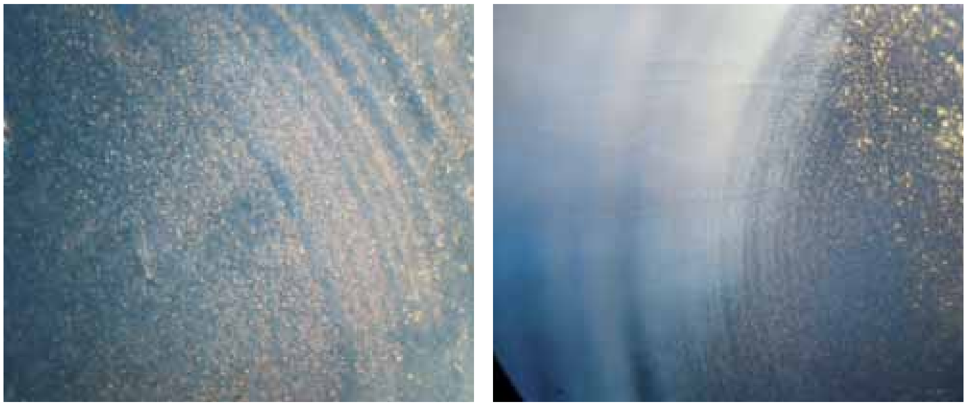


Figure 31. Curved clouds of whitish pinpoints (apparently gas bubbles) were evident on the base of the cabochon (left). With immersion and diffused illumination, curved color bands were also seen (right); these are conclusive of synthetic origin. Photomicrographs by G. Choudhary; magnified 25× (left) and 20× (right).

Pink synthetic spinel colored by iron. Recently, the SSEF Swiss Gemmological Institute was asked to test a parcel of stones represented as pink sapphires. Among them was a 15 ct antique cushion shape (figure 32) with inclusions that were very different from those seen elsewhere in the parcel. In addition to slightly curved dotted lines, there were many stretched and irregular hollow tubes (figure 33). These were similar to the features described by E. J. Gübelin and J. I. Koivula (*Photoatlas of Inclusions in Gemstones*, ABC Edition, Zurich, 1986, p. 514) and L. Kiefert (Fall 2003 Gem News International, pp. 239–240) in flame-fusion synthetic spinel.

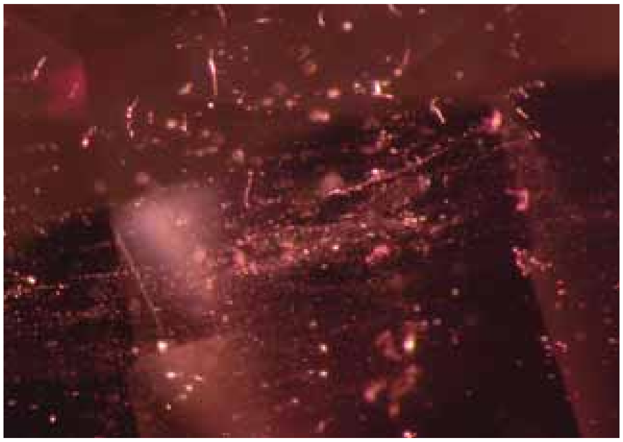
Gemological testing revealed that the specimen was singly refractive with an RI of 1.728; the hydrostatic SG was 3.64. With crossed polarizing filters, the sample showed prominent anomalous birefringence. However, in contrast to chromium-bearing pink and red spinel, it showed no reaction to long- or short-wave UV radiation. EDXRF spectroscopy revealed a preponderance of Al over Mg, which is characteristic for flame-fusion synthetic spinel. Iron was the only trace element present. Cr, V, Co, Zn, and Ga were all at or below the detection limit (0.001–0.002 wt.% oxide).

The identification of the stone as a flame-fusion synthetic spinel was further confirmed by Raman spectroscopy, which showed relatively wide Raman peaks at 866, 786, 693, and 413 cm^{-1}, compared to the characteristic narrow peaks at 764, 662, and 406 cm^{-1} in natural and flux-grown synthetic spinel. The broadening and shift in these peaks is due to structural disorder in Verneuil-synthetic nonstoichiometric spinel resulting from excess Al (P. Schaub, "Spectroskopische Untersuchungen an Al-Spinell," unpublished diploma thesis, University of Basel, Switzerland, 2004). The absence of Cr was further confirmed by a Raman photoluminescence spectrum (514 nm laser), which showed no characteristic chromium emission bands.

Pink flame-fusion synthetic spinel is very rare, because chromium is not readily introduced as a chromophore during the Verneuil process. The UV-Vis absorption spectrum showed a predominant broad absorption band at 553 nm, a smaller absorption centered at 630 nm, a series of smaller absorption shoulders at 442, 472, and 530 nm, and an absorption cut-off at 400 nm (figure 34). Light violet-pink spinels colored by iron (attributed to

Figure 32. This unusual 15 ct flame-fusion synthetic spinel proved to be colored by iron. Photo by M. S. Krzemnicki, © SSEF.

Figure 33. These curved particle trails and straight/kinked hollow tubes identified the sample in figure 32 as a flame-fusion synthetic. Photomicrograph by M. S. Krzemnicki, © SSEF; magnified 30×.



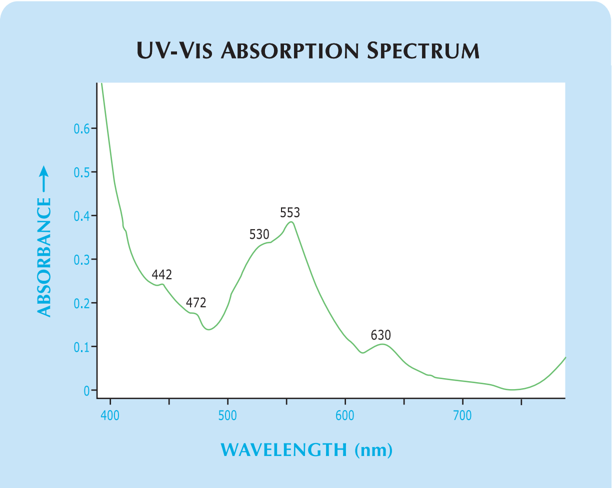


Figure 34. The UV-Vis absorption spectrum of the synthetic pink spinel in figure 32 shows absorption bands that are attributable to iron.

spin-forbidden electronic transitions of tetrahedrally coordinated Fe^{2+}) have shown similar absorption bands (see V. T. Gritsyna et al., "Spectroscopic features of iron-doped magnesium-aluminum spinel crystals," *Journal of Applied Spectroscopy*, Vol. 45, No. 2, 1985, pp. 837–840; M. N. Taran et al., "Electronic absorption spectroscopy of natural (Fe^{2+}, Fe^{3+})-bearing spinels of spinel s.s.-hercynite and gahnite-hercynite solid solutions at different temperatures and high-pressures," *Physics and Chemistry of Minerals*, Vol. 32, No. 3, 2005, pp. 175–188). It is possible that very low concentrations of cobalt also contribute to the pink color of this sample.

Although flame-fusion synthetic spinel is typically an easy identification, this specimen was unusual in terms of its pink color, the abundance of inclusions, and the absence of any reaction to UV radiation. Most flame-fusion synthetic spinels are colorless, yellowish green to dark green, or light blue to blue. They often show a reddish fluorescence to long-wave UV radiation (due to cobalt) and a chalky white fluorescence to short-wave UV. Nevertheless, the RI and SG values, and the absence of naturally occurring inclusions, provide identification criteria for an experienced gemologist.

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A new imitation of Imperial topaz. Topaz is a popular gem due to its attractive appearance, ready availability, and generally low price. The one exception—which is both rare and costly—is the deep yellow-orange-pink variety known as Imperial topaz. By far the most important source of this gem is the Ouro Preto area in Minas Gerais, Brazil. Unlike many other gem materials, synthetic Imperial topaz is not commercially available, and common imitations such as citrine, synthetic spinel, and glass are easily detectable.

While in Minas Gerais in August 2006, one of these contributors (MM) was offered two loupe-clean rough samples that were represented as Imperial topaz, which he subsequently had cut (figure 35). The two pieces had an irregular triangular shape, which the dealer indicated would maximize the yield from the rough. The color and the vitreous-to-subadamantine luster resembled Imperial topaz.

The two pieces (1.18 and 2.03 ct) were analyzed in the Department of Earth Science of the University of Rome "La Sapienza," and the following gemological data were obtained: color—orange-yellow-"rose"; diaphaneity—transparent; RI—n_o=1.770 and n_e=1.761; birefringence—0.009; optic character—uniaxial negative; SG—4.05; fluorescence—inert to long- and short-wave UV radiation; and no inclusions were seen with a gemological microscope. These properties identified the pieces as corundum; their synthetic origin was strongly suggested by the lack of any natural-appearing inclusions (typical of flame-fusion material) and the relatively inexpensive price. The synthetic origin was confirmed by LA-ICP-MS analysis at GIA of the 2.03 ct sample (donated to GIA by Mr. Macrì); the lack of Ga was characteristic of flame-fusion synthetic corundum. The instrument did find traces of Cr, Ni, Ti, and Mg, but no Be, which indicates that the color of the synthetic corundum was not influenced by Be-diffusion treatment.

Although the color and luster of this synthetic corundum are strikingly similar to Imperial topaz, the two materials can be easily separated by their standard gemological properties. Still, this imitation could present a problem for the unsuspecting buyer. Interestingly, similar-colored synthetic corundum was recently sold as spessartine in the Tanzanian market (see Winter 2006 Gem News International, p. 282).

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Figure 35. These two samples of synthetic corundum (2.03 and 1.18 ct) were sold in Minas Gerais, Brazil, as Imperial topaz. Photo by M. Macrì.

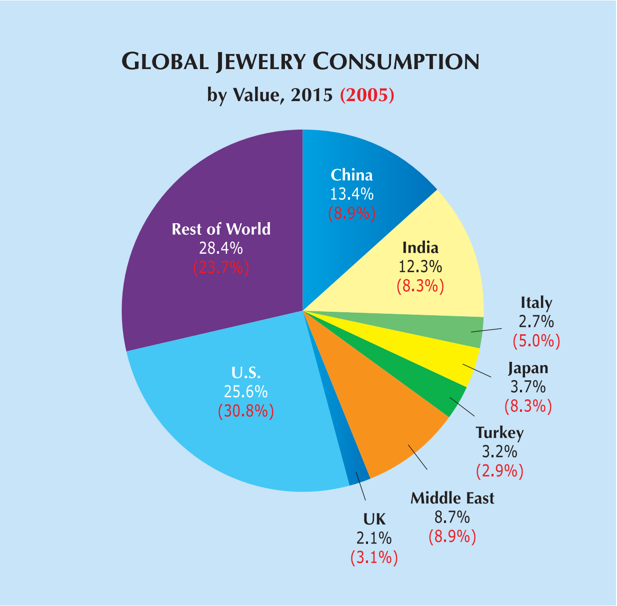

Figure 36. This chart shows the estimated global jewelry consumption by value for the eight key world markets, projected to 2015 (total US$230 billion). Shown in parentheses are values for 2005 (total $146 billion). Modified from The Global Gems and Jewellery Industry—Vision 2015: Transforming for Growth*, by KPMG India.*

MISCELLANEOUS

KPMG report predicts growth for the global jewelry industry. KPMG is a global network of professional firms that provide audit, tax, and advisory services. In December 2006, KPMG India released a comprehensive study of the diamond and jewelry industry worldwide, *The Global Gems and Jewellery Industry—Vision 2015: Transforming for Growth* (see www.in.kpmg.com/pdf/Gems_Jewelry_report_06.zip). The report predicts that global jewelry sales will grow by a combined 4.3% annually, from about US $146 billion in 2005 to $230 billion in 2015 (figure 36). The study also indicates that 2015 sales have the potential to reach $280 billion, if the industry were to reform its marketing practices, adopt more transparent and professional business methods, and invest more in product research.

Diamond jewelry accounted for 47.2% of world jewelry sales in 2005, according to the report, followed by plain gold at 41.6%. Platinum was 6.2% (mainly in Japan and China), with colored stones and cultured pearls at 5%. The U.S. accounted for 30.8% of world jewelry sales, with China second at 8.9%, and Japan and India tied for third at 8.3% each (again, see figure 36). Italy was the largest European consumer, with a 5% world market share, while the UK accounted for 3.1%.

Within the 2005 value chain that comprised the total sales of $146 billion, retail margins accounted for nearly half ($67.2 billion), while rough diamond production was $12.7 billion and polished wholesale diamond sales were $17.6 billion. Precious metals accounted for $40.6 billion, and jewelry manufacturing costs were pegged at $20.6 billion. (The sales figures of the individual categories total $158.7 billion, rather than $146 billion, due to some overlap between them.) However, the report offered few details about colored stone and cultured pearl sales, citing the lack of transparency and available statistics. (Note, though, that the Jewelers of America's *Cost of Doing Business Survey* for 2006 reported that colored stone jewelry accounted for 9% of U.S. retail jewelry sales.)

In 2015, diamond jewelry is projected to decline to 41% of worldwide sales, with plain gold remaining steady at ~41%. Platinum will rise slightly to 7% (with another 6% added for palladium jewelry). Synthetic diamonds will likely grab some market share from natural diamonds. KPMG also sees a decline in U.S. retail share of global demand to 25.6%, losing ground to China (13.4%) and India (12.3%). Japan will see its market share halved to 3.7%. Between 2005 and 2015, KPMG predicts, the industry will see further fragmentation of diamond sources and heavy consolidation in the wholesale and retail sectors.

The De Beers Diamond Trading Company's share of rough diamond production is expected to fall to less than 40% (from about 55% in 2005), as more small mining companies market their goods through rough diamond traders. Additionally, more rough will be sold on the open market through invitational auctions, or through "partner" players upstream in the manufacturing and retailing sectors. The polished diamond and finished jewelry markets will see the rise of large, fully integrated mine-to-retail players. Manufacturers will concentrate in low-wage countries, although there will be an increase in smaller niche manufacturing. The industry will undergo consolidation, as difficult cash flow, financing problems, and unsustainable inventory positions force a number of mergers and cause others to go out of business.

The KPMG report offered recommendations for improving marketing and business practices that could, purportedly, result in an additional 15% growth over the 10-year period:

- Promote jewelry as a category, combining separate (and often competing) campaigns by the diamond, gold, and colored stone/cultured pearl sectors into a unified effort that enhances the value proposition of jewelry.
- Identify and serve new consumer needs and segments, create new occasions to sell jewelry, and make jewelry more accessible to consumers.
- Create more innovative designs and products in established markets, while generating demand in emerging markets.
- Improve the industry's public image. Lack of transparency and concerns over quality and treatments dampen consumer demand and discourage involvement by the financial industry.
- Attract talent from outside the industry—particularly the luxury goods sector—and professionalize family-owned businesses.

The report noted that reducing finance costs by adopting these reforms (i.e., making the industry more attractive to lenders) and improving credit practices could increase cash flow. Adoption of these measures could generate an additional $50 billion in annual sales by 2015.

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CONFERENCE REPORTS

Sinkankas Symposium: The Jades. This fifth annual symposium in honor of John Sinkankas took place April 21 at GIA in Carlsbad. Approximately 140 people attended the sold-out event, which was co-hosted by GIA and the San Diego Mineral and Gem Society. As in previous years, the Symposium was organized by Roger Merk (Merk's Jade, San Diego) and the participants were treated to displays of items from various collections (see, e.g., figure 37).

Figure 37. This peacock and lotus flower carving of Burmese jadeite (12 cm tall, without the wooden stand) was on display during the 2007 Sinkankas Symposium. Courtesy of William Larson; photo by Wimon Manorotkul.

Fred Ward (Gem Book Publishers and Friends of Jade, Malibu, California) surveyed the various uses for jade (i.e., jewelry, decorative objects, utensils, and ritual items) and described several important localities for jadeite and nephrite. In particular, he indicated that Myanmar is the world's leading source of jadeite jade, whereas most nephrite jade comes from British Columbia, Canada. **Si Frazier** (El Cerrito, California) surveyed various types of jade, including an interesting slab of white to pale blue jadeite from Myanmar that showed distinct patches of a brighter blue in transmitted light (figure 38). **Mary Lou Ridinger** (Jades S.A., Antigua, Guatemala) described several varieties of Guatemalan jadeite that have been mined from seven quarries discovered near the Motagua fault zone from 1974 to 2004. She indicated that her company's manufacture of realistic replicas of jade artifacts has drastically reduced the demand for illegally recovered antique jades from Guatemala.

Don Kay (Mason-Kay Inc., Denver, Colorado) outlined value factors for fine jadeite according to its color and form (i.e., beads, bangles, and carvings). Pure green colors are much more valuable than lavender, yellow, red, and black varieties. In recent years, semitransparent colorless "ice" jadeite (from Myanmar) has commanded high prices, but it is seldom seen on the market. Mr. Kay demonstrated how high-quality jadeite bangles give a distinct "chime" when tapped together; the sound is not as distinct in jadeite with an inferior structure or that has been polymer impregnated (or both). **Richard Hughes** (AGTA Gemological Testing Center, Carlsbad) described some of the challenges he faced during his three visits to the Burmese jade mines near Hpakan, most recently in 2004: obtaining permission from the government, dealing with the politics of the area, and enduring the rugged travel conditions that required several types of transportation and negotiating roads that were impassable due to deep mud.

Figure 38. This unusual slab of Burmese jadeite (7.4 cm long) appeared white to pale blue in reflected light (left), but showed distinct patches of a brighter blue in transmitted light (right). Courtesy of Si Frazier; photos by George Rossman.

Dale Blankenship (San Diego) outlined several steps—and the corresponding equipment—that he uses for carving jade: trimming with a saw, coring with a drill press, grinding with a rotating wheel and a flex-shaft tool, sanding with a flex-shaft tool using resin rods dipped in a diamond compound, and polishing with Linde A and Linde B media. **John Koivula** (GIA, Carlsbad) described the inclusions that have been found in jade: zircon, chromite, vesuvianite, native copper, aegirine, lawsonite, albite, pyrite, and muscovite. **Dr. George Rossman** (California Institute of Technology, Pasadena) differentiated the origins of color in jadeite and nephrite. In jadeite, green is caused by Cr^{3+} substituting for Al^{3+}, while a lavender hue is produced by Mn^{3+}; red-orange is due to microscopic grains of hematite, while yellow is probably caused by grains of an iron hydroxide such as lepidocrocite. Green in nephrite is mainly due to Cr^{3+} with some contribution from Fe^{3+}.

BML

ANNOUNCEMENTS

New CIBJO *Blue Book* available. CIBJO—The World Jewellery Confederation has released an updated version (2006-1) of its *Blue Book*, which provides standardized guidelines pertaining to the nomenclature, treatments, and/or care requirements for diamonds, colored stones, and pearls. The updated *Blue Book* was ratified at the March 2007 CIBJO Congress in Cape Town, South Africa. PDF files for each of the three sections are available for free download at www.cibjo.org.

AGTA Spectrum Awards competition. The 2008 AGTA Spectrum Awards will recognize outstanding colored gemstone and cultured pearl jewelry designs from North America, as well as achievements in the lapidary arts. Winning entries will be displayed and award recipients honored at the 2008 AGTA GemFairs in Tucson and Las Vegas. The entry deadline is September 25; the competition will be held in New York City during October. For entry forms and more information, visit www.agta.org or call 800-972-1162.

Conferences

PegCamp 2007—East. This one-week course, held August 6–13 in Poland, Maine, will cover the mineralogy, internal structure, and evolution of granitic pegmatites through the field examination of pegmatites and related granites. Visit www.pegmatology.com/pegcamp.htm.

NAJA 28th Annual Mid-Year Education Conference. The National Association of Jewelry Appraisers will hold this conference August 11–14 at the Cobb Galleria Convention Center in Atlanta, Georgia. Topics will include financial tips for appraisers, appraising antique jewelry, and expanding appraisal skill sets. Visit www.najaappraisers.com.

Goldschmidt 2007. The *17th Annual V. M. Goldschmidt Conference* will take place August 19–24 in Cologne, Germany, and will feature a session titled "Applied geochemistry—from brines and rare-earth elements to diamonds" in honor of longtime *G&G* contributor Dr. Alfred A. Levinson. The session will consist of two parts: "Exploration Geochemistry" and "Gem Mineralogy, Diamonds and Gemstones." Visit www.goldschmidt2007.org.

24th European Crystallographic Meeting. Held August 22–27 in Marrakech, Morocco, this conference will include a session titled "Crystallography in Art and Archeology." Visit www.ecm24.org.

Diamond Symposium in Kimberley. The Geological Society of South Africa's Directorate of Professional Programmes will host this colloquium August 23–24 in Kimberley, South Africa. The conference program will include field trips on August 25 to diamond deposits in the Kimberley area. Visit www.gssa.org.za and www.rca.co.za.

IV International Conference on the Application of Raman Spectroscopy in Art and Archaeology. This meeting, held September 5–8 in Modena, Italy, will explore current trends and advanced techniques in the application of Raman spectroscopy to art and cultural heritage research. Visit www.chimica.unimore.it/RAA2007/raa2007.htm.

Diamond 2007. The *18th European Conference on Diamond, Diamond-like Materials, Carbon Nanotubes, and Nitrides* will be held in Berlin, Germany, September 9–14. Presentations on the growth, processing, and characterization of diamond will be given. Visit www.diamond-conference.elsevier.com.

GIA GemFest Hong Kong. This free educational seminar will be held during the Hong Kong Jewellery and Watch Fair September 27, 8:30–10:30 a.m., in Room 210B of the Hong Kong Convention and Exhibition Centre. Dr. Mink Stavenga, dean of GIA's School of Business, will speak on the state of the global jewelry industry, and senior vice president of Laboratory & Research Tom Moses and director of GIA Research (Thailand) Ken Scarratt will provide an update on the GIA Laboratory's current activities. To RSVP by September 14, visit the GIA Alumni Association web site at www.gia.edu, e-mail: events@gia.edu or giahk@netvigator.com, or phone 760-603-4205 (in the U.S.) or +852-2303-0075 (in Hong Kong).

II International Conference "Crystallogenesis and Mineralogy." Held October 1–5 in St. Petersburg, Russia, this conference will explore mineral formation, crystal growth in nature and the laboratory, and crystal morphology. Visit www.minsoc.ru/KM2007.

CGA Gem Conference 2007. The Canadian Gemmological Association's annual gemological conference will take place October 19–21 in Vancouver, British Colombia. Visit www.gemconference2007.com.

GSA Annual Meeting. The Geological Society of America will be holding its annual meeting October 28–31, 2007, in Denver, Colorado. The program will include a short course (on Oct. 28) covering the fundamentals and applications of laser ablation–inductively coupled plasma–mass spectrometry (LA-ICP-MS) to the geological sciences and other fields. Visit www.geosociety.org/meetings/2007.

Mineralientage München. The 44th Munich mineral show in Germany will take place November 2–4 and feature a special exhibit on gem crystals from Pakistan. Visit www.mineralientage.com.

Art2008. Held May 25–30, 2008, in Jerusalem, Israel, the *9th International Art Conference on Non-destructive Investigation and Analysis* will focus on items of cultural heritage, but will have implications for gem testing. Visit www.isas.co.il/art2008.

Quebec 2008: GAC-MAC-SEG-SGA. Held May 26–28 in Quebec City, Canada, this joint conference organized by the Geological Association of Canada, Mineralogical Association of Canada, Society of Economic Geologists, and the Society for Geology Applied to Mineral Deposits will include a symposium titled "Challenges to a Genetic Model for Pegmatites." Visit www.quebec2008.net.

SEG-GSSA2008: Africa Uncovered—Mineral Resources for the Future. Diamond presentations will be covered at this conference, hosted by the Society of Economic Geologists and the Geological Society of South Africa in Muldersdrift, South Africa, on July 6–9. Visit www.seg-gssa2008.org.

Goldschmidt 2008. Held July 13–18 in Vancouver, British Columbia, Canada, this geochemistry conference will include a session titled "Diamonds and Fluids in the Mantle." Visit www.goldschmidt2008.org.

Exhibits

Exhibits at the GIA Museum in Carlsbad. From now through March 2008, "Reflections in Stone" will showcase famed gem carver Bernd Munsteiner's work during the period 1966–2003. On display in the Mikimoto Rotunda, the exhibit includes carved quartz, tourmaline, and beryl, ranging from pieces set in jewelry to large table-top sculptures. Also currently on display in the S. Tasaki Student Lecture Hall is "Celebration of Life," an exhibit of 21 award-winning tanzanite jewelry designs from the Tanzanite Foundation's Celebration of Life Awards held in New York in January. The exhibit will only be on display at GIA during July and August; this is also the final U.S. visit for this collection. Advance reservations for both exhibits are required; to schedule a tour, call 760-603-4116 or e-mail museum@gia.edu.

Gold at AMNH. "Gold," an exhibition exploring the historical fascination with this precious metal, is on display at the American Museum of Natural History in New York through August 19, 2007. The exhibit includes both rare natural specimens and significant cultural artifacts. Visit www.amnh.org/exhibitions/gold.

Wine and Gems in Dijon. "Colour Sparkles: Legendary Wines and Gemstones," a unique exhibition of fine gems and fine wines, is being held in the Sciences Garden at the Parc de l'Arquebuse, Dijon, France, through December 9, 2007. Items from the French National Museum of Natural History are on display with wines from the great vintners of Burgundy and beyond. The exhibit includes both wine tasting and hands-on experiments in light and color. Visit www.dijon.fr/fiche/eclats-de-couleurspierres-et-vins-de-legende.evt.5604.php.

Jewelry of Ben Nighthorse. Ben Nighthorse Campbell, who represented Colorado in the U.S. Senate from 1992–2004, has enjoyed a successful second career as an innovative jewelry designer. This collection of his work, which debuted at the Smithsonian Institution's National Museum of the American Indian in 2004, is on display at the Colorado History Museum in Denver through December 31, 2007. Visit www.coloradohistory.org.

Gems! Colors of Light and Stone at the Bowers Museum. The Michael Scott collection has returned to the Bowers Museum in Santa Ana, California, with an expanded display of rare colored stones, carvings, and sculptures. The exhibit will run until June 16, 2008. Visit www.bowers.org.

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