GEM NEWS International 2004

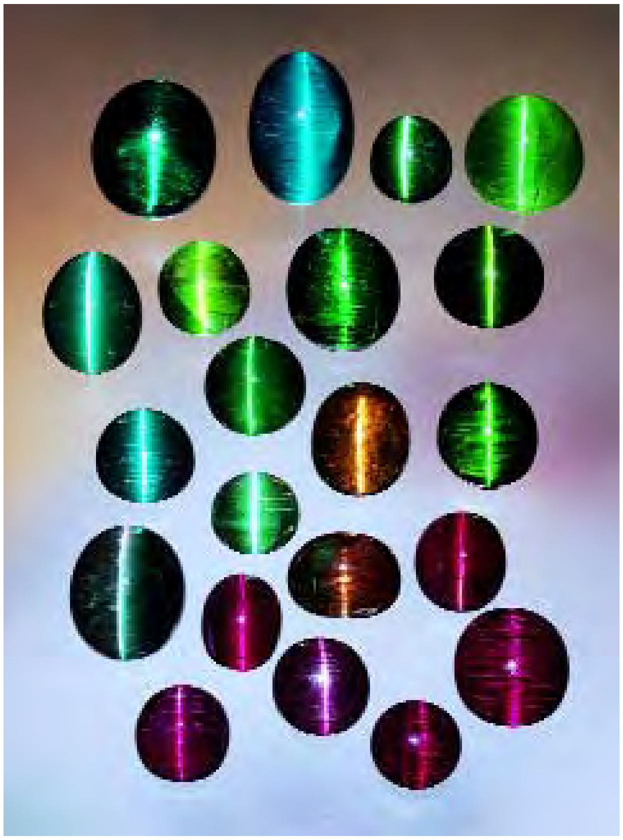
Tucson Report 2004

The annual gem and mineral shows in Tucson, Arizona, showcased a spectacular variety of products. In addition to large quantities of common gems from traditional localities, the shows remain an excellent source of rare and unusual items for the collector. One example was a spectacular suite of cat's-eye tourmaline from Brazil that was brought to our attention by Michael Kazanjian of Kazanjian Bros., Beverly Hills, California (figure 1). Although few new items debuted at this year's show, we saw additional production of interesting materials from several sources, as well as some new developments in synthetic and treated gems. Some of these items are described below, and others will be included in the upcoming Summer 2004 GNI section. *G&G* thanks our many friends who shared information with us this year.

COLORED STONES AND ORGANIC MATERIALS

Yellow cat's-eye beryl from Brazil. At the GJX show, Robert Van Wagoner of Maui Gems, Haiku, Hawaii, had a few cabochons of brownish yellow cat's-eye beryl from Brazil (see, e.g., figure 2). Mr. Van Wagoner first sold this material at the June 2003 JCK show, but only recently did he obtain specific information on it. According to his source in Brazil, the material was mined from a pegmatite in the Padre Paraíso area, which is located 85 km north of Teófilo Otoni in Minas Gerais State. Only a small amount of gem-quality rough was obtained, ranging from translucent to semitransparent. The cat's-eye cabochons typically weigh 5 to 20 ct, although larger stones are believed to exist. Reportedly the yellow color in about 60% of the material was produced by irradiation in a linear accelerator.

Figure 1. This remarkable suite of cat's-eye tourmaline (6.36–36.75 ct) is part of a larger collection of such stones, all from Brazil, that was purchased at one of the Tucson gem shows by Michael Kazanjian. Photo © GIA and Harold & Erica Van Pelt.



Some additional information was provided by Steve Perry of Steve Perry Gems, Davis, California, who also has sold these cat's-eye beryls. His source indicated that a small amount of the material was mined in March 2003. Mr. Perry indicated that both "golden" beryl and aquamarine are produced from this region.

BML

Update on demantoid and cat's-eye demantoid from Iran. During the Tucson show, one of these contributors (MD) showed GIA personnel two cabochons of cat's-eye demantoid from Kerman Province, southern Iran. Based on the experience of this contributor, who regularly visited the deposit from early 2001 to November 2003, this report provides an update on the mining and production of the demantoid from this area, as well as the appearance of the chatoyant material. The gemological properties and color range of this Iranian demantoid were described in the Spring 2002 Gem News International section (p. 96).

The site is located at 28°19′N and 57°45′E, between the villages of Bagha Borch and Soghan, which lie approximately 150 km south of the town of Jiroft. Travel from Tehran to Jiroft takes about 16 hours, although considerable delays may be encountered along the highway, which is heavily patrolled to prevent drug smuggling. The journey onward from Jiroft to the site requires three hours of driving on a rough road.

The mining area (figure 3) is situated approximately 1,500 m above sea level, and consists of several tunnels and small pits scattered across an area of approximately 500 m^2. Mining is done by hand, mostly in December–March when the weather is cooler. The workings range from 2 to 8 m deep, and about 10 miners are active during the cool season.

The demantoid crystals are hosted by regionally metamorphosed asbestiform rocks. The garnets range from yellowish green to dark "emerald" green, and faceted stones are known up to 7 ct, although they typically weigh about 0.7 ct. Round nodules up to three grams, mostly in dark green and orangy yellow, have also been found, as well as large, well-crystallized translucent specimens on the order of 5 cm in diameter. Approximately 20 kg of rough was extracted during the 2003–2004 season. Of this, 1.5 kg was facet-quality, with about 200 grams yielding stones of more than 2 ct in good color and clarity.

Editor's note: Interested contributors should send information and illustrations to Brendan Laurs at blaurs@gia.edu (e-mail), 760-603-4595 (fax), or GIA, 5345 Armada Drive, Carlsbad, CA 92008. Original photos will be returned after consideration or publication.

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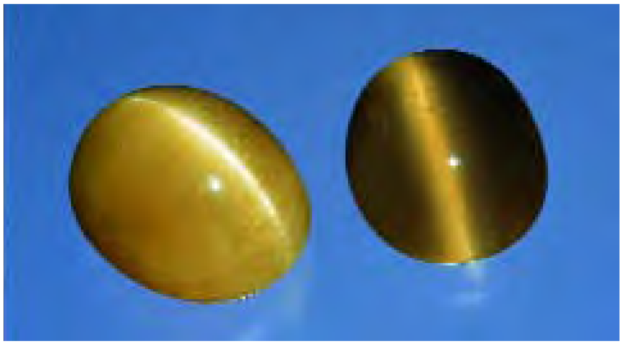

Figure 2. These brownish yellow cat's-eye beryls from Brazil have sharp "eyes" and range from translucent (left, 15.17 ct) to semitransparent (right, 11.47 ct). Courtesy of Maui Gems; photo by Maha Tannous.

Chatoyant demantoid from this area was first encountered by one of these contributors (MD) in November 2003. Approximately 35 grams of crystals and crystal fragments were collected, some of which were polished into cabochons of 5–10 ct (figure 4). A few chatoyant demantoid crystals also were noted, such as the 41.73 ct specimen in figure 4. The chatoyancy is caused mainly by

Figure 3. Demantoid garnets from Iran have been mined in shallow workings such as this tunnel, which Makhmout Douman visited in November 2003. Although this tunnel proved uneconomic, other workings on nearby hills have yielded significant quantities of the garnets. Photo by R. Sadeghi.

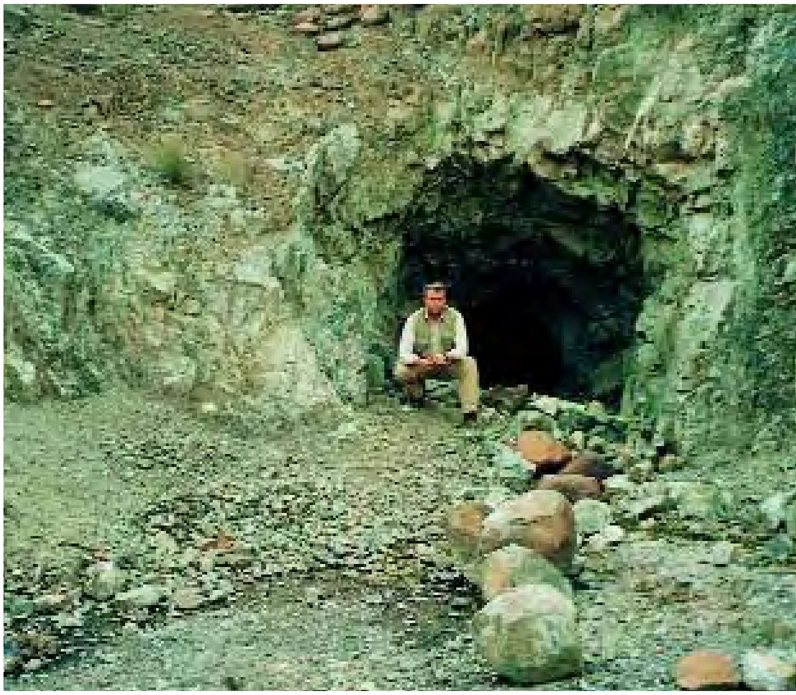

Figure 4. Some of the Iranian demantoids are chatoyant, such as the 7.06 and 5.00 ct examples shown here. The 41.73 ct composite crystal also contains the chatoyancy-causing fibers. Photo © GIA and Jeff Scovil.

concentrations of parallel fibers (figure 5) that are, based on their appearance, possibly chrysotile or byssolite.

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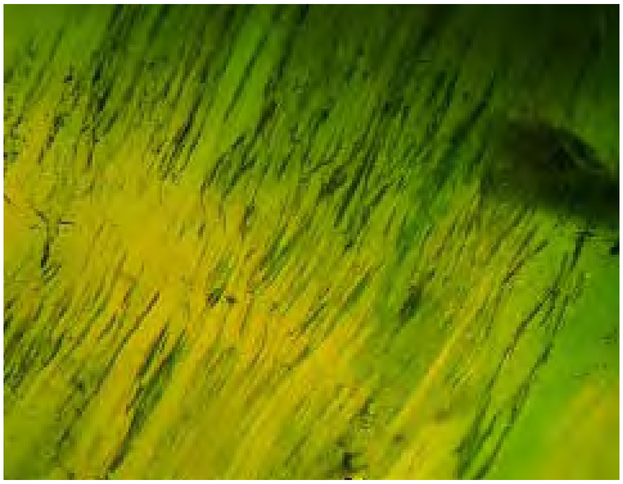
Figure 5. Parallel to semi-parallel fibers (possibly chrysotile or byssolite), together with associated oriented micro-cracks, are responsible for the chatoyancy seen in some of the demantoid garnets from Iran. Photomicrograph by John I. Koivula; magnified 20×.



Blue omphacite from Guatemala. A small number of rough and polished specimens of a new dark blue omphacite "jade" were displayed by Ventana Mining Co. (Los Altos, California) at the Pueblo Inn and by Leher Designs (San Rafael, California) at the GJX show and at the Westward Look Resort. Ideally $(Ca,Na)(Mg,Al)Si_2O_6$, omphacite is a member of the pyroxene group, and is composed of a solid solution of jadeite and calcic clinopyroxene (e.g., diopside) with subordinate aegirine.

The material was first recovered by one of these contributors (WRR) in June 2003, and so far it has been found in a relatively restricted part of a claim held by Ventana Mining Co. The deposit is located in the Quebrada Seca area, near Carrizal Grande in Jalapa Department, Guatemala. (For information on recent jadeite discoveries in this area, see the Winter 2002 Gem News International, pp. 352–353.) The blue omphacite occurs as fine veins that cross-cut large alluvial boulders of greenish blue jadeite that were situated near outcrops consisting of blueschist, eclogite, and jadeite. Because the veins are rather narrow (i.e., from 2 to 20 mm thick), the material lends itself to small cabochons and carvings.

Three of the four oval cabochons shown in figure 6 were loaned to GIA for examination, and the following properties were determined by one of us (EPQ): color—mottled grayish greenish blue to mottled dark grayish greenish blue; diaphaneity—translucent; R.I.—spot readings of 1.67 to 1.68; S.G.—3.33–3.41 (measured hydrostatically); no Chelsea filter reaction; fluorescence—inert to long- and short-wave UV radiation; and no absorption features were observed with the desk-model spectroscope. Microscopic examination revealed that the stones had an aggregate structure with a mottled granular texture, irregular fractures, and nondescript white globular masses. In one of the cabochons, small transparent near-colorless crystals were observed. FTIR spectroscopy did not detect any polymer impregnation. Although not identified in these particular cabochons, the blue omphacite from Guatemala has been reported to contain minor amounts of phengite and sphene, and traces of zircon, monazite, allanite, and rutile (G. E. Harlow, "Blue omphacite in jadeitites from Guatemala and Japan: Crystal chemistry and color origin," Geological Society of America Annual Meeting, Seattle, Washington, November 2–5, 2003, http://gsa.confex.com/gsa/2003AM/finalprogram/abstract_65497.htm).

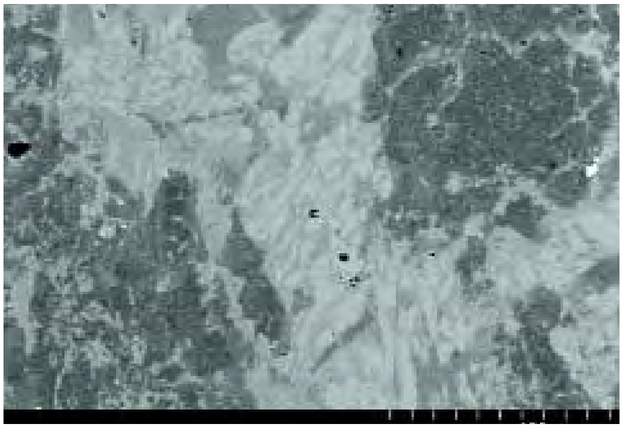
Electron-microprobe analyses of a fourth blue cabochon by one of us (GEH) revealed that it was composed predominantly of omphacite. Backscattered-electron imagery of the cabochon and of another blue vein sample (figure 7) showed strong compositional zoning within the individual omphacite grains. Expressed in terms of jadeite and diopside components, the average composition of the omphacite in the cabochon was $Jd_{55}Di_{39}$ (range $Jd_{30-87}Di_{9-62}$; see figure 8). The compositional range of another sample of the same type of blue omphacite was $Jd_{38-77}Di_{22-47}$. In both cases, small amounts of hedenbergite

Figure 6. These cabochons (approximately 0.35 ct each) of blue omphacite show the distinctive color of this new material from Guatemala. Courtesy of Ventana Mining Co.; photo © Lee-Carraher Photography, San Francisco, California.

and aegirine components also were present. In the cabochon, total iron (reported as FeO) averaged 1.23 wt.%, with a range of 0.4–1.9 wt.%; titanium averaged 0.29 wt.% TiO_2, with a range of 0.03–1.5 wt.%.

Vis-NIR spectroscopy of another sample of the blue omphacite by one of these contributors (GRR) showed a transmission window in the visible region centered near 500 nm (figure 9). This feature was defined by a sharp absorption band at 438 nm—superimposed on a tail that rises in intensity toward shorter wavelengths—and a broader band system that reaches its maximum at about 712 nm. The 438 nm feature arises from Fe^{3+}, and the broad band system correlates to the interaction of Fe^{2+} and Fe^{3+}. The broad features at longer wavelengths arise from Fe^{2+}. In contrast, a sample of green jadeite from Guatemala showed absorption bands due to Cr^{3+} that define the transmission window near 530 nm (again, see figure 9). The absorption was modified by features from both Fe^{3+} (sharp feature at 438 nm) and broader features below 900 nm from Fe^{2+}.

Figure 7. This backscattered-electron image is of a vein of blue omphacite cutting greenish blue jadeite. The omphacite is visible as the lighter area in the center, whereas the surrounding jadeite appears much darker. The minute bright spots are zircon grains, and the black spots are quartz. Note the compositional zonation shown by individual pyroxene grains of the omphacite; the lighter areas correspond to more Fe, and the darker areas have more Ti.



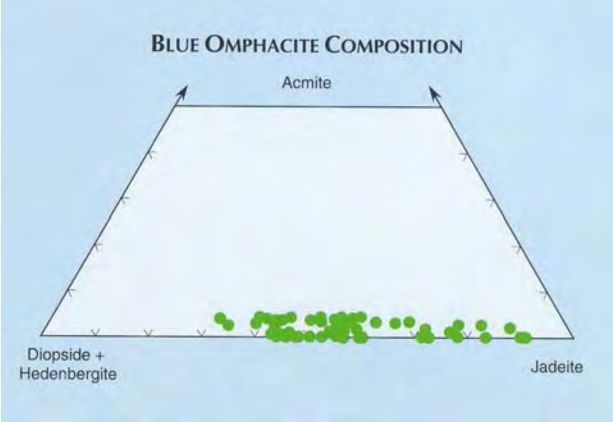


Figure 8. The blue omphacite was composed of strongly zoned grains of the jadeite-diopside series, as revealed by electron microprobe analysis.

The absorption spectra show that the color of the green jadeite is due primarily to Cr^{3+}, whereas the blue omphacite is colored by iron—at least in part. Since the depth of the

Figure 9. These Vis-NIR absorption spectra show that the blue omphacite is dominated by iron-related features, whereas the green Guatemalan jadeite has absorptions related to chromium and subordinate iron.

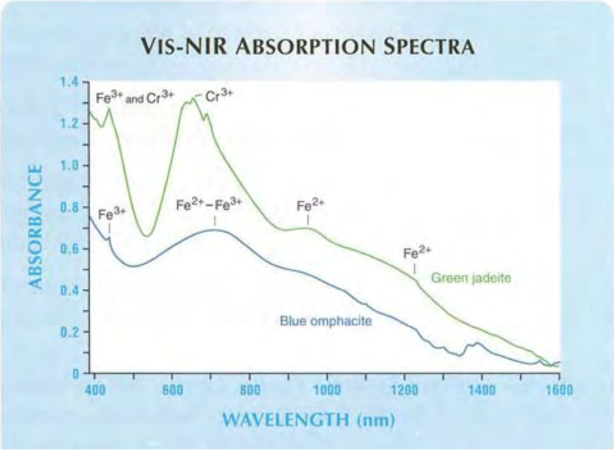


Figure 10. These cultured pearls (8.5–9 mm in diameter) were selected to show the range of color commercially available from southern Japan. Note how the colors of some of the cultured pearls resemble those seen in the shell of the P. margaritifera *oyster in which they are cultured. Cultured pearls courtesy of A&Z Pearls, and shell donated by A&Z Pearls and Tasaki Shinju Co. (GIA Collection no. 30484); photo by Maha Tannous.*

blue color showed a direct relation to titanium content in the samples analyzed, it appears that Ti^{4+} may also play a role in the coloration. The exact cause of the unusual blue color in this omphacite will remain unknown until further work is done to characterize the absorption features.

Although blue omphacite also has been found in Japan and Canada (Harlow, 2003), this new Guatemalan omphacite represents the first occurrence of gem-quality material.

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Black cultured pearls from Japan. At the AGTA show, Avi Raz of A&Z Pearls, Los Angeles, had some recently harvested black cultured pearls from the southernmost region of Japan. They were cultured in *Pinctada margaritifera* oysters at farms owned by Tasaki Shinju Co. in the Oshima Straits, at Ikomo Bay, and at Yakiuchi Bay of the Amami Oshima Islands. The oysters are smaller than those from French Polynesia, as the Amami Oshima islands are at the northernmost habitat limit for this species (where colder waters slow the oysters' growth and metabolism).

According to Shodai Tasaki of Tasaki Shinju Co., the hatchery-bred oysters are nucleated at three to four years of age with small beads (i.e., 4.5–6.0 mm in diameter). Harvesting takes place after two to three years, in September–October. The cultured pearls are reportedly produced in a variety of colors, such as "peacock," gray, "silver," "gold," and reddish purple, in sizes ranging from 6 to 14 mm, with 7–8 mm being the most common. According to Japanese researchers, the relatively cold water results in a finer surface texture and superior luster, similar to Akoya cultured pearls. The first commercial harvest occurred in 1993; however, annual production is still less than 20,000 cultured pearls and a similar-sized crop is expected in September–October 2004. Due to their small size and high production cost, quantities of these black cultured pearls will likely remain limited.

Mr. Raz loaned GIA 14 of the cultured pearls (8.5–9 mm in diameter; see, e.g., figure 10). These samples were near-round to round, and one had been cut in half. The colors included light greenish yellow and light gray to dark gray, with overtones varying from weak to moderate reddish purple and green. Such variations in overtone and color are typical of black cultured pearls from French Polynesia, and resemble those seen in shells from the host *P. margaritifera* oyster (again, see figure 10). The nacre thickness of the sliced sample averaged 1.5 mm (figure 11), with very slight variations. X-radiography of the other cultured pearls showed similar nacre thickness. UV-Vis reflectance spectra of these samples exhibited an absorption feature at 700 nm, which is characteristic of the *P. margaritifera* oyster. Other sig-

Figure 11. The nacre thickness of this sliced black cultured pearl from Japan averaged 1.5 mm. Courtesy of A&Z Pearls; photo by Maha Tannous.

nificant absorptions occurred at 405 and 495 nm. Fluorescence to long-wave UV radiation was also typical of this species, with the darker samples exhibiting a reddish brown luminescence.

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New ruby production from Malawi. At the AGTA show, Columbia Gem House of Vancouver, Washington, had some recently produced untreated rubies and pinkish orange sapphires from Chimwadzulu Hill, Malawi. The deposit is located about 150 km southeast of the capital, Lilongwe, and only 5 km from the Mozambique border. Chimwadzulu Hill consists primarily of a metamorphosed ultramafic intrusive complex exposed over an area of about 1 km^2, and is surrounded by various Precambrian metasedimentary rocks. The corundum is found in deeply weathered iron-rich soil and is easily liberated by standard washing processes. Because of the long winter rainy season, the mining period lasts from April to October. The mine was closed during the late 1980s and early 1990s before being reopened in 1994 by a U.K. company (for more on the history and geology of this mine, see Spring 2000 Gem News, pp. 71–73). Since the beginning of 2003, systematic prospecting and an expansion in mining have significantly improved the quality and quantity of the production.

According to Eric Braunwart, president of Columbia Gem House, there are approximately 70 people working at the mine. They have been producing up to 1 kg of cuttable ruby rough per month, yielding mostly small, calibrated gemstones up to 3/4 ct. There are a significant number of fine stones from 1 to 3 ct, but those above 3 ct are rare. The largest faceted ruby known from the deposit was a 16 ct pinkish red heart-shaped gem. Since most of the material being mined has no obvious rutile inclusions and is attractively colored, heat treatment is not necessary.

Unlike earlier mining efforts, no facet-grade blue sapphire has been recovered so far. Mr. Braunwart estimates that the mine will yield approximately 5 kg of cuttable rough per month of ruby and pinkish orange sapphire once a new processing plant, currently under construction, is built. He also predicts that almost half of the pinkish orange gems will grade "padparadscha" without the need for heat treatment.

This contributor examined three of the rubies (1.50–3.78 ct; figure 12). Selected to show the range of colors available, they were pinkish red, slightly orangy red, and purplish red, with obvious red to orangy red pleochroism. All contained boehmite along twinning planes, a typical inclusion scene in East African rubies. Microscopic examination also revealed short rutile needles and platelets in the largest stone. The refractive indices (1.762–1.770) obtained from the three samples were also comparable to the properties reported in the literature for these rubies (see, e.g., U. Henn et al., "Red and orange corundum [ruby and padparadscha] from Malawi," *Journal of Gemmology*, Vol. 22, No. 2, 1990, pp. 83–89).

Figure 12. These untreated rubies (1.50–3.78 ct) were recently mined from the Chimwadzulu Hill deposit in Malawi. Courtesy of Columbia Gem House; photo by Maha Tannous.

Columbia Gem House and its jewelry-manufacturing subsidiary are marketing this untreated material as "Nyala ruby," after the rare Nyala antelope that is native to the game reserve close to the mine. This product is being sold under the company's "Fair Trade Gems" initiative, which was launched at this year's Tucson gem show. This program supports a clean environment, employee-friendly policies, and complete product integrity from mine to market. The strict chain of custody also ensures non-treatment designations where appropriate, and eliminates the possible introduction of undisclosed treated gems or synthetics into the supply chain. To the benefit of locals in the Chimwadzulu Hill area, the company has built a school and is providing medical insurance for all mine personnel.

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Pink to pink-orange spinel from Tanzania. At the GJX show, Menahem Sevdermish of Advanced Quality, Ramat Gan, Israel, had some attractive spinel from a new find in the Mahenge region of south-central Tanzania. His stock consisted of about 2,000 carats of faceted stones (ranging up to 3 ct) and 1 kg of rough. According to Mr. Sevdermish, the new spinel discovery occurred in August 2003, although ruby and pink-to-red spinel have been mined from this area for several years (see Summer 1993 Gem News, pp. 136–137). Several kilograms of rough spinel were recovered, ranging from pink to pink-orange to brownish red. Most notable are the pink-orange stones, with a color similar to that of some "padparadscha" sapphires. He also indicated that the material is mined from alluvial and eluvial deposits, and is not heated or subjected to any other forms of treatment. The rough typically consists of small octahedra or broken fragments that weigh 0.1–2 grams; less than 30% is facetable, and the remainder is bead- or cabochon-quality, in Mr. Sevdermish's experience.

Some of the rough has made its way to Asian markets. According to Scott Davies of American-Thai Trading (Bangkok), some dealers in Bangkok have been marketing

Figure 13. These spinels (0.68–2.28 ct) show the range of color of the new material being mined in the Mahenge region of Tanzania. Courtesy of Advanced Quality; photo by Maha Tannous.

the faceted orange-pink stones as spinel from Vietnam's Luc Yen region. Mr. Davies reported that the largest stone he has cut weighed 3.39 ct, and that stones containing eye-visible inclusions can make attractive rose cuts.

Mr. Sevdermish loaned GIA six Mahenge spinels (0.68–2.28 ct) that were representative of the range of color for this material: purplish pink, pink, orangy pink, red-orange, and orangy red (figure 13). Gemological properties obtained by one of us (EPQ) showed refractive indices ranging from 1.710 to 1.712 and (hydrostatic) specific gravity values of 3.60–3.63. There was no birefringence or pleochroism, as expected for a singly refractive gem material, but all samples displayed weak anomalous double refraction when viewed between crossed polarizing filters. Long-wave UV radiation produced a red fluorescence, which ranged from weak to moderately strong for the various samples. With short-wave UV radiation, the orangy red to red-orange spinels were inert, but the three pink stones fluoresced very weak to weak orangy red. When examined with a desk-model spectroscope, all samples showed several absorption lines in the red region (typical of Cr^{3+}) and a weak band from 520 to 590 nm. Microscopic examination revealed that all of the spinels contained stringers of particles, three of them had clouds throughout, two had fractures, and one had a "fingerprint." The stones did not exhibit any transmission luminescence, as has been documented previously for pink Tanzanian spinel (see the Summer 1990 Lab Notes, pp. 156–157).

The properties of these stones are generally consistent with those listed for spinel by R. Webster (*Gems*, 5th ed., revised by P. Read, Butterworth-Heinemann, Oxford, England, 1994, pp. 142–145), although the R.I.'s recorded for these stones are just slightly lower.

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Large tsavorite and green grossular from Tanzania. At the GLDA show in the Radisson Hotel, Axel Henn of Idar-Oberstein, Germany, had several large examples of tsavorite and green grossular from the tanzanite deposit in Merelani, Tanzania. According to Mark and Eric Saul of Swala Gem Traders, Arusha, Tanzania, the garnets were recovered in three "pockets" from December 2002 to February 2003. About 2.5 kg of rough tsavorite and green grossular were recovered as well-formed crystals (figure 14) and fragments. Many of the stones were relatively clean and of large size. The smaller stones were typically light green, while the larger ones were a vivid green. Where present, eye-visible inclusions consisted of "fingerprints" (mostly in smaller rough) and mineral inclusions (probably pyrite; in the larger pieces).

The Sauls also reported that most of the production was purchased by only a few parties, with the majority sold in Idar-Oberstein and the remainder in Bangkok. In addition to one 100+ ct, one 50+ ct, and four 20+ ct faceted stones, they also cut and sold a half-dozen examples in the 20–55 ct range and at least 10 weighing 10–20 ct. A few cabochons weighing 50–100 ct also were cut.

Most of the rough purchased by Mr. Henn was faceted in August–November 2003. The largest tsavorite he had in Tucson weighed 72 ct, although even larger ones have been faceted by his firm (e.g., 88 and 144 ct).

Mr. Henn arranged for one of us (WMM) to examine an

Figure 14. Fine crystals of tsavorite and green grossular were recovered from Merelani, Tanzania, from late 2002 to February 2003. This specimen measures approximately 1.5 cm in diameter. From the collection of F. Lietard; photo © Jeff Scovil.

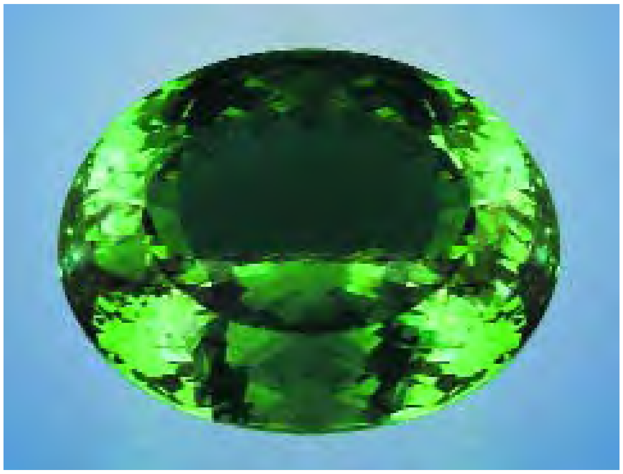

Figure 15. This 88.03 ct tsavorite provides a fine example of the notable size and transparency of the new material from Merelani. Courtesy of Henn GmbH; photo by Elizabeth Schrader.

88.03 ct tsavorite at the East Coast laboratory. This oval modified brilliant was a strongly saturated yellowish green (figure 15). The refractive index was 1.731 and specific gravity was 3.60. No absorption features were visible with the desk-model spectroscope. Observation with the polariscope revealed anomalous double reaction, which is not uncommon in garnets. With magnification (up to 60×), the stone showed only some subtle straight, angular growth zoning. Although the R.I. value was within the accepted range for grossular—albeit slightly lower than the range given by R. Webster (*Gems*, 5th ed., p. 202) for material from East Africa—it was in a range that could overlap, in rare instances, with natural spinel. The green color was not at all typical for natural spinel with this R.I., but combined with the stone's unusually large size and lack of inclusions, we performed Raman analysis to further confirm the stone's identity as grossular.

One particularly interesting aspect of this tsavorite was its UV fluorescence. Although the moderate orange long-wave UV fluorescence was not uncommon, when exposed to short-wave UV radiation the stone fluoresced a weak greenish yellow with straight, angular zones of weak-moderate orange, some of which corresponded to the growth zoning seen with the microscope. Even more unusual were two concentrically zoned "spots" of fluorescence. The stronger of these is shown in figure 16. Closer observation of this area with the De Beers DiamondView instrument (see figure 16, inset) revealed that the "spot" was not actually round, but was characterized by angular zones that corresponded to the growth zoning and the orange short-wave fluorescence.

Coincidentally, in August 2003 *Gems & Gemology* was informed about similar unusual fluorescence characteristics in Tanzanian tsavorite by Kaushal P. Mehta, who is a laboratory gemologist in Bangkok. He reported that a 65.72 ct sample fluoresced moderate orange to long-wave and moderate yellow to short-wave UV radiation. EDXRF spectroscopy yielded a composition that was typical for tsavorite. Mr. Mehta subsequently learned that tsavorite from the recent Tanzanian production commonly shows this unusual fluorescence.

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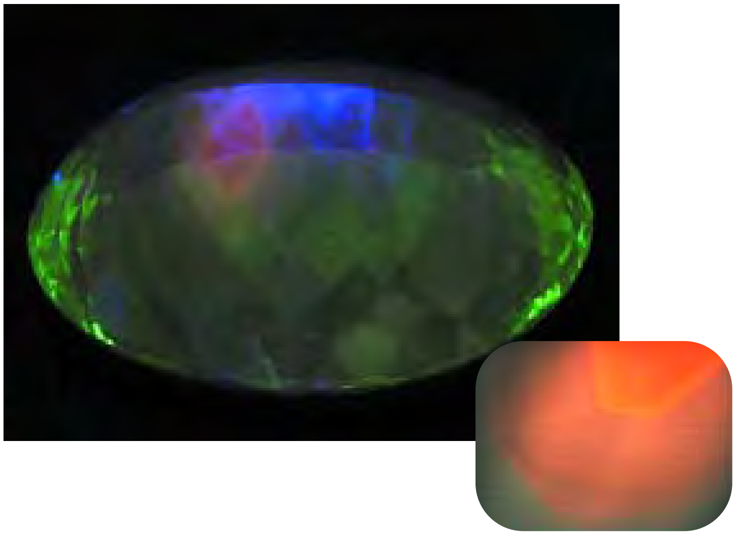
BML

SYNTHETICS AND SIMULANTS

Color-change glass, imitating alexandrite. At the G&LW show at the Holidome, House of Williams of Loveland, Colorado, had numerous faceted pieces of color-change glass. According to Michael Williams, this alexandrite imitation has been around for several years, and was trademarked as "Zandrite" about three years ago. Although the material is not new, the lack of published technical information prompted this report.

This contributor acquired a transparent 4.45 ct modified oval brilliant that had an attractive (almost pastel) color change. In sunlight and daylight-equivalent light sources, it was slightly bluish green (figure 17, left); in incandescent light, it was purplish pink (figure 17, right). The R.I. was 1.521, and the S.G. (taken hydrostatically) was 2.66. The sample displayed no birefringence or pleochroism, as expected of an amorphous material, although it did display weak anomalous double refraction. There was no reaction to the Chelsea filter, but the sample fluoresced very weak bluish green to long-wave UV

Figure 16. Unusual fluorescence behavior was shown by the 88.03 ct tsavorite, as evident here in short-wave UV radiation. When viewed in the De Beers DiamondView instrument, the fluorescent "spot" was seen to consist of angular zones (see inset). These patches corresponded to the growth zoning and the orange short-wave UV fluorescence of this feature. Photos by Elizabeth Schrader.



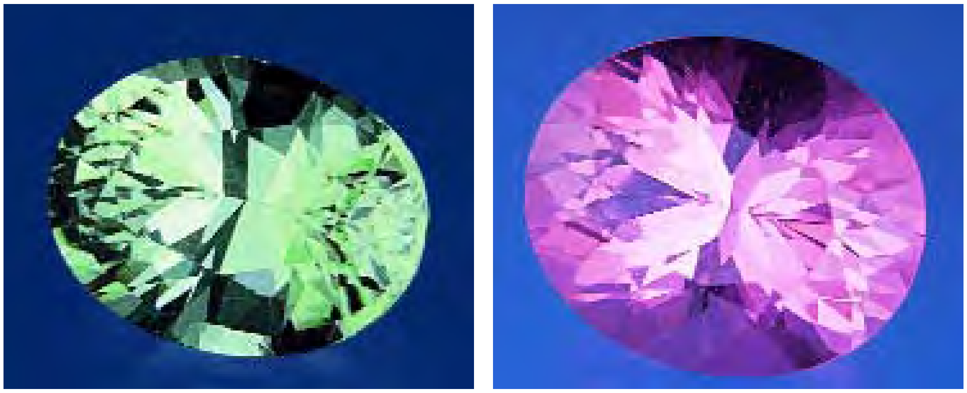
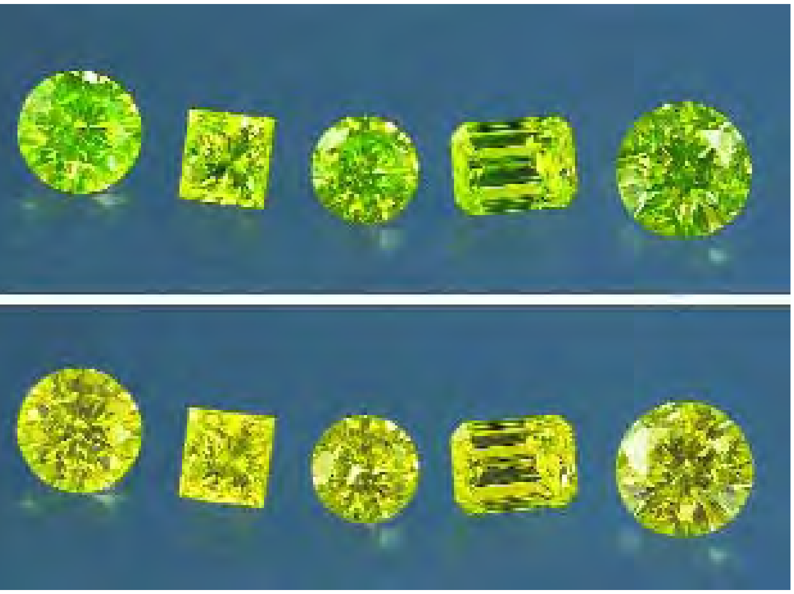


Figure 17. This 4.45 ct oval modified brilliant is color-change glass. In daylight-equivalent fluorescent light, the sample is a slightly bluish green (left). With incandescent light, the color changes to an attractive purplish pink (right). Photos by Maha Tannous.

radiation (and was inert to short-wave UV). The material had a rare-earth spectrum, visible with the desk-model spectroscope, that consisted of strong absorption lines and bands at 435, 440–450, 465, 476, 480, 483, 510, 520–535, 560–595, 600, and 660 nm, with weak lines at 500, 550, and 610 nm. EDXRF spectroscopy performed by senior research associate Sam Muhlmeister found Si, Na, K, Ca, Zn, and Nd. This composition, together with the visible spectrum, indicates that Nd is responsible for the coloration; this is consistent with information that was subsequently provided by Mr. Williams.

Elizabeth P. Quinn

Figure 18. Commercial production of highly saturated green-yellow diamonds is being done with HPHT treatment, specifically to show a change in color appearance in different light sources. Due to strong green fluorescence from the H3 center, these diamonds (here, 0.50–1.16 ct) appear greener in daylight-equivalent fluorescent light (top) than in incandescent light (bottom). Courtesy of Lucent Diamonds; photos by Elizabeth Schrader.



TREATMENTS

Commercial production of HPHT-treated diamonds showing a color shift. More than half a dozen mechanisms are known to cause a green hue in naturally colored diamonds. These include irradiation, H2- and hydrogen-related absorption, and chameleon behavior. However, "chartreuse," or green-transmitter, diamonds are very different in terms of color origin, as their green color results not from a selective absorption, but from fluorescence that is related to the H3 defect (zero-phonon line at 503 nm). The H3 system absorbs blue and violet light and emits green light that is slightly lower in energy. These diamonds, which appear predominantly yellow in incandescent light, can emit such strong green light in fluorescent or natural lighting conditions that in some cases this green transmission dominates the color of the diamond. I. Reinitz and T. Moses (Summer 1997 Lab Notes, p. 136) pointed out that highly saturated combinations of yellow and luminescent green are quite rare in natural-color diamonds. A historical example is an intense greenish yellow 2.15 ct diamond that reportedly once belonged to Pedro II, the emperor of Brazil during the mid-19th century (see Spring 1997 Lab Notes, pp. 54–55).

However, while rare in natural-color diamonds, this color-causing mechanism can routinely be produced in the laboratory by annealing certain brown diamonds at high pressure and high temperature (I. M. Reinitz et al., "Identification of HPHT-treated yellow to green diamonds," Summer 2000 *Gems & Gemology*, pp. 128–137). At the 2004 Tucson gem show, Alex Grizenko of Lucent Diamonds, Lakewood, Colorado, informed these contributors that his company has started commercial production of green-transmitter HPHT-treated diamonds, at approximately 500 carats per month, to showcase the different hues these diamonds display in different lighting conditions (figure 18). They range from less than 1 ct to over 8 ct. Both rough and faceted diamonds from Australia and Russia are being annealed to 2,100–2,500°C at elevated pressures.

Spectroscopic analysis of 12 faceted samples (0.50–1.36 ct) supplied by Mr. Grizenko revealed properties similar to those reported by Reinitz et al. (2000); all were type IaA/B and showed widely different amounts of nitrogen. A very strong H3 center and a relatively weak H2 were detected in all tested samples.

As the green color component is due to fluorescence of the H3 system, which absorbs blue and violet light, it follows that the intensity of the green color varies according to the light source. Thus, these stones appear greener in natural daylight or blue-rich daylight-equivalent fluorescent light (which also contains some ultraviolet content) than in standard incandescent or spot lighting (figure 18). The strength of the color shift varied significantly from sample to sample, as shown in the diamonds selected for figure 18. This variation in color appearance is very different from the well-known alexandrite effect, which is caused by selective absorption.

Many factors in a diamond can affect H3 fluorescence. While the concentration of this defect largely determines the intensity of fluorescence, A-aggregates of nitrogen can significantly quench luminescence from H3 and N3 centers, which may help explain the varying intensity of the green component from one HPHT-treated diamond to another. Nevertheless, this process makes what is a difficult-to-obtain color—and color shift—in untreated natural diamonds available in a range of sizes and qualities in treated stones.

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CONFERENCE REPORT

Accredited Gemologists Association conference. About 100 people attended the AGA conference on synthetic diamonds, held February 4 at the Marriott University Park hotel in Tucson.

Tom Chatham of Chatham Created Gems, San Francisco, said that synthetic diamond production of all types (mostly industrial) totals about 600 million carats per year, but in general it is still cheaper to mine gem-quality diamonds than produce them synthetically. He told the audience that Chatham is working with an Asian manufacturer to produce about 400 carats monthly in four colors: pink, yellow, blue, and green. Most of the faceted goods weigh approximately 1 ct, although some are up to 1.5 ct. Colorless synthetic diamonds are still too expensive to produce profitably, he said.

Dr. Robert Linares of Apollo Diamond Co., Boston, outlined the production of synthetic diamonds by chemical vapor deposition, and stressed that both the jewelry and high-technology industries require diamond of high purity and large size. Apollo will be expanding production by adding new equipment that can quadruple output. CVD synthetic diamond, he said, is identical to natural diamond in structure. "It has the same four C's, though CVD [synthetic] diamond is often clearer and harder."

Carlos Valeiras of Gemesis Corp., Sarasota, Florida, told the audience that his company has taken the BARS process of producing synthetic diamonds by HPHT "to the next level," resulting in high quality and attractive color. He said that it takes 80–100 hours to grow 1 ct crystals and that the process is very difficult, "so it is unlikely there will be many producers coming into the market." He announced that Gemesis was ready to expand its production to commercial quantities—the majority being equivalent to Fancy Intense yellow and Fancy Vivid orange, and faceted into princess and Asscher cuts. All of their synthetic diamonds over 0.25 ct will be laser inscribed; those over 1.0 ct will carry EGL grading reports.

Alex Grizenko of Lucent Diamonds, Lakewood, Colorado, predicted that the future diamond market will consist of three segments: mined diamonds, synthetic diamonds, and "restored" (treated) diamonds. He said that his company produces a variety of colors including reds, which are subjected to beta (electron) radiation and HPHT annealing. Lucent also has a partnership with LifeGem (Elk Grove, Illinois), which creates synthetic diamonds from human remains (see Spring 2003 Gem News International, p. 62). "This is certainly a specialty product, but one with great potential," he said.

Shane McClure of the GIA Gem Laboratory, Carlsbad, explained a number of common identification techniques for synthetic diamonds, including distinctive color zoning, metallic (flux) inclusions, and UV fluorescence patterns. **Dr. Henry Hänni** of the SSEF Swiss Gemmological Institute, Basel, noted that most synthetic diamonds are type Ib, though a small minority are type IIb, which are much more difficult to detect. They do, however, display the same growth patterns in the De Beers DiamondView instrument as are shown by type Ib synthetics. **Branko Deljanin** of EGL USA, Vancouver, Canada, reported that CVD synthetic diamonds can often be identified by weak yellow fluorescence to long-wave UV radiation and moderate to strong yellow-green fluorescence to short-wave UV. He added that they can also show a characteristic Raman photoluminescence peak at 575 nm, but for CVD material that has been subjected to HPHT annealing to remove brown color, a 637 nm peak can be diagnostic.

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GNI Regular Features

DIAMONDS

Update on proprietary diamond cuts. An updated version of the chart of proprietary diamond cuts, which originally appeared in the Winter 2002 issue of *Gems & Gemology* (see T. W. Overton, "Legal protection for proprietary diamond cuts," pp. 310–325), is now available in the *Gems & Gemology* Data Depository (www.gia.edu/pdfs/diamond_cuts.pdf). Following is a brief summary of recent developments in the legal protection of diamond cuts.

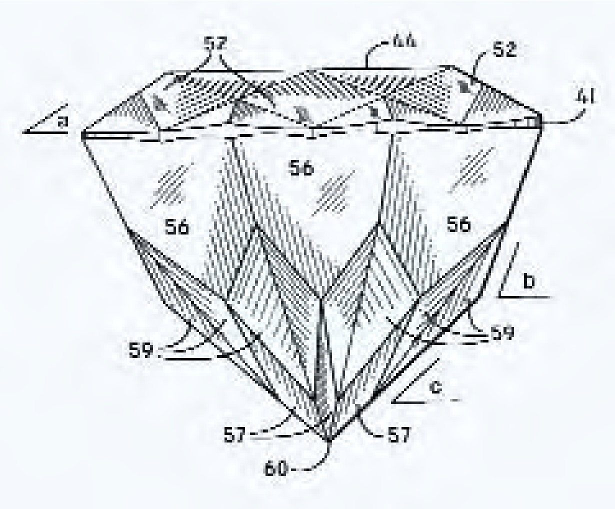
Consistent with other major changes in the diamond market, the trends identified by Overton (2002) have accelerated in the last year. New branded cuts are being introduced every month (see, e.g., figure 19), and nearly all of them have been protected by trademark, patent, or both. Between January 2003 and January 2004, the U.S. Patent and Trademark Office (USPTO) issued 59 patents and published five applications for gemstone cuts (compared to 29 patents from January 2000 to January 2001); this represents a 127% increase in just three years.

The U.S. officially joined the Madrid Protocol (see Overton, 2002) in November 2002. This allows U.S. trademark holders to enjoy trademark protection in any member country by filing an international registration application with the USPTO or WIPO (World Intellectual Property Organization).

Beginning in January 2003, the European Community (EC) Office for Harmonization in the Internal Market began accepting design registrations (see Overton, 2002). This contributor is aware of a number of diamond cut designs that enjoy EC design protection (these are indicated on the updated chart). The maximum 25-year term of an EC design registration, compared to the 14-year term of a U.S. design patent, makes this a protection method that should not be overlooked despite its limited geographic reach.

There also may be protection available beyond that of traditional patent and trademark. At least one "mainstream" cut design, the Elara, is now protected by U.S. copyright registration (H. B. Rockman, "Obtaining U.S. copyright registration for the Elara square cut-cornered brilliant diamond," Fall 2003 *Gems & Gemology*, pp. 210–213). (Another design, the rather fanciful "Buddha" cut, also has copyright registration.) This should have manufacturers exploring copyright protection for their designs, given the much longer term of copyright (currently 95 years for works-for-hire versus 14 or 20 years for a patent) and the much simpler application procedure.

Figure 19. The Solei cut, a modified round brilliant design created by Michael Schachter and Uri Peleg for Diamco of New York, was one of the new diamond cuts for which patents were issued in 2003. This drawing is taken from the patent application.



Last year also saw what this contributor believes to be the first lawsuit over a diamond cut patent. In August 2003, a U.S. federal court in Chicago held the design patent for the Elara cut, owned by Kuwayama Europe and Elara Diamond USA, unenforceable as a result of a dispute with another manufacturer, National Diamond Syndicate. This lawsuit has been discussed in more detail in various trade publications (see V. Gomelsky, "Elara diamond design patent invalidated by court," *National Jeweler*, Vol. 97, No. 18, 2003, pp. 28, 30; I. Solotaroff, "Brand name: Chicago," *Modern Jeweler*, Vol. 102, No. 11, 2003, pp. 42–44, 105–107).

Twenty-seven new cuts have been added to the chart. Of these, 20 are believed to be protected by patent (or pending applications), while an equal number have registered trademarks. Thirteen are protected by both trademark registration and patent, six have registered trademarks but no patents, and seven appear to have patents but unregistered trademarks.

Although several cuts (which this contributor believes are obsolete) have been removed from the chart, and several more (which this contributor believes are basically the same cut) were condensed into single entries, the number of identified cuts on the chart rose from 81 to 101. A strong trend toward patent protection is now apparent: 64 of 101 are believed to be patented or patent pending. Somewhat less than half (42) enjoy both patent protection and trademark registration. (These numbers do not include the Elara, because of the court decision mentioned above.)

It is safe to say that patent protection is now the rule rather than the exception, and the benefits afforded by patent and trademark are an increasingly important element of diamond branding.

This contributor thanks the numerous diamond manufacturers who responded with information on their proprietary cuts.

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A diamond exhibiting a spectacular phantom. This contributor recently encountered a natural diamond exhibiting a spectacular phantom cloud of cuboid shape. The phantom was particularly visible when the 0.20 ct Fancy grayish greenish yellow diamond was viewed with darkfield illumination (figure 20). Phantom clouds are rarely seen in diamonds and are often indistinct, although some good examples were recorded by J. I. Koivula (*The Micro World of Diamonds*, Gemworld International, Northbrook, Illinois, 2000). While phantoms are frequently

Figure 20. With darkfield illumination, this 0.20 ct diamond displays a most unusual phantom cloud. Photomicrograph by T. Hainschwang; magnified 20×.

associated with an elevated hydrogen content, this is not always the case, as rare type Ib diamonds with high nitrogen content may also exhibit such inclusions; some examples have been described by this contributor (T. Hainschwang, "Classification and color origin of brown diamonds," Diplôme d'Université de Gemmologie, University of Nantes, France, 2003).

Typically, these clouds exhibit a cuboid shape and are formed by very small particles of unknown nature. Depending on the viewing direction, such clouds may appear to have hexagonal symmetry (see, e.g., Gem Trade Lab Notes: Spring 1999, pp. 42–43, and Fall 2000, pp. 255–256). In the diamond described here, the cloud displayed numerous distinct layers with a cross-like feature in the center, forming an overall flower-like pattern. The cross-shaped parts of the cloud separate the octahedral sectors, whereas the "flower-petal" portions lie along dodecahedral directions (see W. Wang and W. Mayerson, "Symmetrical clouds in diamond—The hydrogen connection," *Journal of Gemmology*, Vol. 28, No. 3, pp. 143–152). The diamond exhibited homogeneous strong chalky blue fluorescence to long-wave UV radiation and medium chalky greenish blue fluorescence (and weak yellow phosphorescence) to short-wave UV.

FTIR spectroscopy performed on a Perkin-Elmer Spectrum BXII spectrometer revealed that this diamond was a type IaA/B with high nitrogen and hydrogen contents, and was thus typical for a diamond with phantom inclusions. In addition to showing hydrogen-related features (see E. Fritsch and K. Scarratt, "Gemmological properties of type Ia diamonds with an unusually high hydrogen content," *Journal of Gemmology*, Vol. 23, No. 8, 1993, pp. 451–460), the spectrum included a triplet of peaks at 1546, 1518, and 1500 cm^{-1}; in the experience of the author this triplet is frequently observed in hydrogen-rich diamonds and thus also may be associated with this impurity.

A Vis-NIR transmission spectrum was recorded using an SAS2000 spectrophotometer, with the stone immersed in liquid nitrogen. The low-temperature spectrum showed characteristic absorptions associated with high hydrogen and nitrogen contents, as well as nickel impurities (figure 21; see K. Iakoubovskii and G. J. Adriaenssens, "Optical characterization of natural Argyle diamonds," *Diamond and Related Materials*, Vol. 11, 2001, pp. 125–131). Some of the observed peaks (e.g., at 894 nm) have not yet been described in the literature.

This contributor has found that many "straw" yellow to "olive" yellow diamonds with such spectra exhibit a chameleon-like color change when heated to approximately 200°C ("Characterization of hydrogen rich diamonds from Argyle/Australia with Vis/NIR—and photoluminescence—spectroscopy," www.gemlab.net/research1_1.htm). However, the color change is unlike that seen in typical chameleon diamonds, as it is mainly characterized by increases in saturation and in the green color component.

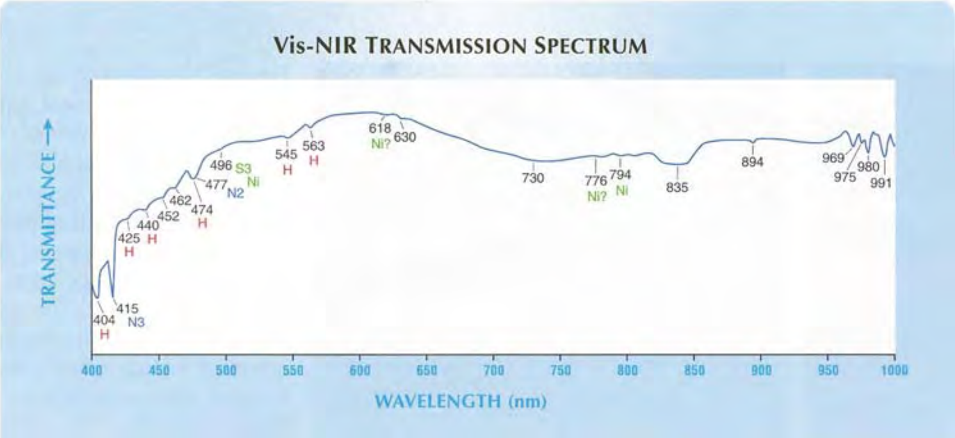

Figure 21. The low-temperature Vis-NIR transmission spectrum of the 0.20 ct diamond shows absorptions due to nitrogen (N3, N2), hydrogen, and nickel impurities.

Figure 22. This necklace of lustrous black beads proved to be black (horn) coral with a polymer coating. Photo by H. A. Hänni, © SSEF.

In this contributor's experience, typical chameleon diamonds show a more distinct change in color from "olive" to orangy yellow, and the Vis-NIR and FTIR spectra of such stones also are very different. Thus it appears that there are two different groups of diamonds exhibiting a chameleon effect—those with a more yellow stable color and those with an "olive" stable color.

Based on its properties, the 0.20 ct diamond described here could potentially show chameleon behavior (i.e., with the more yellow stable color). However, this diamond did not change color when heated on a hot plate. This was not surprising since only a small percentage of such hydrogen-rich "yellow" diamonds exhibit the chameleon behavior.

At first sight, this small diamond appeared to be just a commercial "olive" yellow diamond, but the microscope revealed an amazing internal treasure.

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COLORED STONES AND ORGANIC MATERIALS

Black horn coral coated with artificial resin. A client recently submitted a black bead necklace to the SSEF Swiss Gemmological Institute for identification. He had purchased a number of these necklaces from a Chinese supplier, who represented them as black coral. He became concerned when testing by another lab indicated the material was plastic.

The necklace contained 27 beads that measured 14 mm in diameter (figure 22). The specific gravity (determined hydrostatically on one bead) was 1.325, and the R.I. was approximately 1.56. Both of these values are consistent with those expected for black coral.

Black coral (also called horn coral) typically shows characteristic curved growth lines and concentric cracks that are oriented parallel to the long axis of the branches. These features were not present in the beads of the necklace. However, scattered reddish brown reflections were apparent, as is typical for black coral, and linear arrays of tiny holes or spots were seen on some of the spheres. A dark gray surface color was seen with strong fiber-optic light, and minute bubbles were found sporadically. It became clear that instrumental analysis would be necessary for a proper identification.

EDXRF spectroscopy of a few of the beads revealed characteristic elements for black coral: chlorine, bromine, and iodine. A Fourier-transform infrared spectrum of one of the beads was compared to a reference spectrum of black coral, and the peaks showed a full agreement. However, a Raman spectrum from the surface of one of the beads showed a 1605 cm^{-1} peak, indicating the presence of a polymer.

We informed the client of our identification of the beads as black horn coral coated with an artificial substance, and asked for permission to cut one of the beads in half. In cross-section, we could see the extent and result of the treatment (figure 23). A coating consisting of several very thin layers covered the surface of the beads. Fissures and cracks were sealed by the artificial resinous

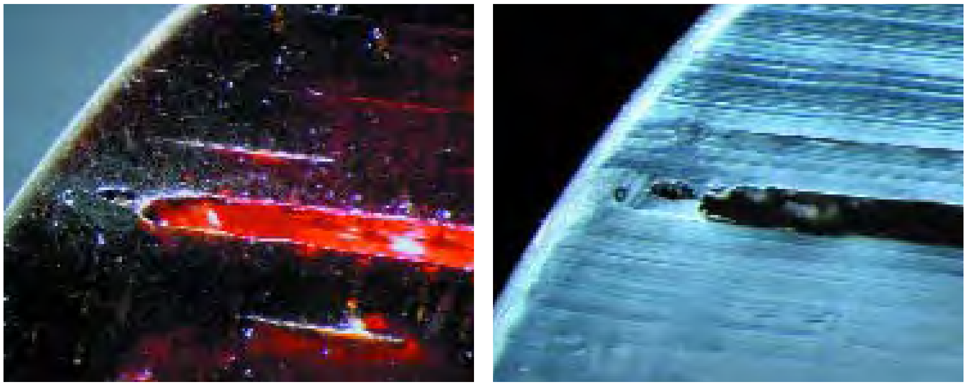

Figure 23. In these cross-sections of a black coral bead, the outer portion of one of the characteristic cracks is filled by a polymer; note the trapped bubbles. In transmitted light (left), the polymer appears gray along the thin surface layer. In reflected light (right), the polymer and bubbles are even more apparent. Width of both photos is 3 mm. Photos by H. A. Hänni, © SSEF.

substance, creating a very smooth appearance, which explained the lack of typical surface structures for black coral. This example demonstrates, once again, how only a combination of tests can safely identify the nature and treatment of gem materials.

HAH

Petroleum inclusions in quartz from Pakistan: A photo-essay. Hydrocarbon inclusions are quite fascinating, to the point that some gems are specifically cut with them for sale to collectors. Most fluid inclusions containing hydrocarbons, typically in quartz and fluorite, consist mainly of liquid natural petroleum and methane gas, sometimes with water as an immiscible liquid. Opaque black to dark brown translucent bituminous material may also be present, usually within the fluid inclusions as a solid daughter phase, but also as isolated solid inclusions within the host. Such bituminous organic solids are usually lumped under the general heading of asphaltite, the group name for solid bituminous hydrocarbons, unless a more specific analysis has been done.

At the Munich gem and mineral show in October 2002, Michael and Patricia Gray of Graystone Enterprises and Coast-to-Coast Rare Gems (Missoula, Montana) obtained a large parcel of more than 400 quartz crystals with fluid inclusions of natural petroleum that ranged from very light yellow (the smaller inclusions) through bright yellow to yellowish brown. Many of these fluid inclusions also contained dark brown to black solid phases of asphaltite. Asphaltite inclusions also were noted as solids within the quartz itself. All 400 quartz crystals were provided to these contributors for examination. Herb Obodda (H. Obodda, Short Hills, New Jersey) and Hussain Rezayee (All Access Co. Ltd., Bangkok) also loaned several similar crystals from this new find.

Of the more than 400 specimens examined during this study, a representative sample of seven crystals ranging from 0.99 to 6.28 ct is shown in figure 24. Some of the crystals were of suitable quality for faceting (figure 25) although according to Mr. Gray, their heat sensitivity makes this somewhat difficult: If they get too hot, they are prone to cracking, which will subsequently drain any inclusions that rupture and breach the surface.

Magnification revealed that the hydrocarbon fluid inclusions contained two different immiscible liquids: (1) a yellow portion that was natural petroleum, and (2) a colorless aqueous fraction that was situated along some edges of the negative crystals. The gas bubbles were primarily methane, while one or more black asphaltite solid phase(s) were also present (figure 26, left). The odor of motor oil or kerosene was apparent when a crystal from this contributor's collection was cracked or crushed, and in the presence of a flame, the liquid and gas released were seen to be flammable.

On exposure to long-wave UV radiation, the yellow petroleum in most of these fluid inclusions luminesced either bright yellow or bright blue (figure 26, right), although orange was also observed in a few samples. Much weaker fluorescence, or no reaction, was seen with short-wave UV. No phosphorescence was noted in any of the samples examined. This characteristic luminescence is useful in the identification of natural petroleum-containing fluid inclusions.

As shown in figure 27, another curious identifying characteristic of the yellow liquid in these fluid inclusions is that when they were illuminated from the side with an incandescent fiber-optic light source, they showed a slightly bluish green to green transmission luminescence.

During the examination of these quartz crystals, a few

Figure 24. These seven quartz crystals (0.99–6.28 ct) all contain fluid inclusions composed of various hydrocarbons and water. They are representative of more than 400 Pakistani quartz crystals examined for this report. Photo by Maha Tannous.

Figure 25. Measuring 16.75 mm long, this 9.23 ct quartz crystal shows the intriguing natural beauty of these petroleum-rich rock crystals from Pakistan. The 2.33 ct faceted stone illustrates that gems can be cut from some of these crystals, although their sensitivity to heat requires great caution. Courtesy of Graystone Enterprises; photo by Maha Tannous.

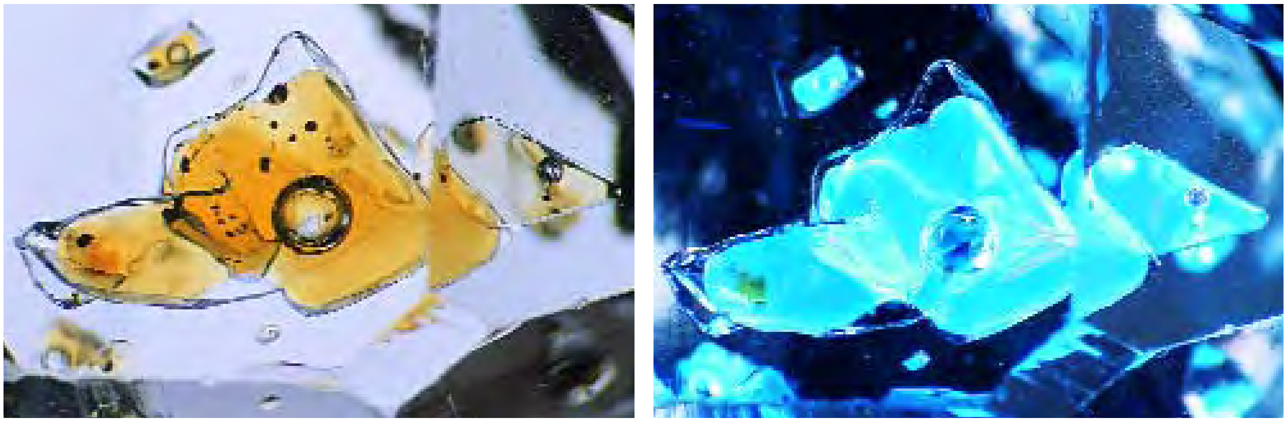

Figure 26. As shown on the left, the hydrocarbon inclusions in the Pakistani quartz crystals were observed to contain two immiscible liquids—a yellow portion (natural petroleum) and a colorless fraction (water) along some edges of the negative crystals. The gas bubbles are primarily methane. A black bituminous asphaltite solid phase also is present. When exposed to long-wave UV radiation, the petroleum in most of these fluid inclusions glows either bright yellow or (as shown on the right) bright blue, although orange also was observed in a few samples. This luminescence is characteristic of such fluid inclusions, and helps identify them. Photomicrographs by John I. Koivula; magnified 5×.

oddities also were noted. Four of them contained black bituminous material that moved freely within the petroleum. The most impressive of these was a 4.42 ct, 12.59-mm-long crystal that contained a spherical globule of petroleum, half filled with tiny black asphaltite particles that moved freely (figure 28), coating the meniscus between the petroleum and the aqueous solution surrounding it. The strangest inclusion, shown in figure 29, was a trigonal negative crystal that seemed to be lined with a brown bituminous film and small black blebs of asphaltite.

The geographic locality of these crystals has been variously represented as Baluchistan, Pakistan; Kandahar, Afghanistan; or "somewhere in China." Considering that Baluchistan is also known for the production of fluorite with oil-bearing fluid inclusions (A. H. Rankin et al., "Unusual, oil-bearing inclusions in fluorite from Baluchistan, Pakistan," *Mineralogical Magazine*, Vol. 54, 1990, pp. 335–342), it would not be surprising if these quartz crystals came from that area, as well. The location of the petroleum-bearing quartz deposit was subsequently confirmed as Baluchistan by Mr. Obodda, and also by Farooq Hashmi (Intimate Gems, Jamaica, New York), both of whom recently visited Pakistan.

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Figure 27. Another curious identifying characteristic of yellow petroleum inclusions is that when they are illuminated with a white light fiber-optic source from the side, they show slightly bluish green transmission luminescence. Photomicrograph by John I. Koivula; magnified 5×.

INSTRUMENTS AND TECHNIQUES

New Swarovski triplet loupe. Swarovski Optik has been producing high-quality binoculars and telescopes for over 50 years. Recently, they have expanded their product line with a newly developed loupe. As can be seen in figure 30, this loupe has a gray matte finished lens holder and a black housing, and is connected to an adjustable lanyard.

The lens is an asymmetrical Taylor-Cook triplet (three optical elements) with 10× magnification. The design of this triplet results in a thinner and smaller lens system, resulting in a lighter overall weight (by approximately 30%) compared to similar commercial loupes. The loupe has a field of view of 20 mm and a free working distance of 18.2 mm. The optical surfaces have a high-grade coating to avoid hindering reflections, and to improve chromatic neutrality and the hardness of the optical surface. For best performance, the loupe should be positioned 20 mm away from the subject and approximately 15 mm away from the eye, depending on the eyesight of the user. The view is unidirectional; the loupe

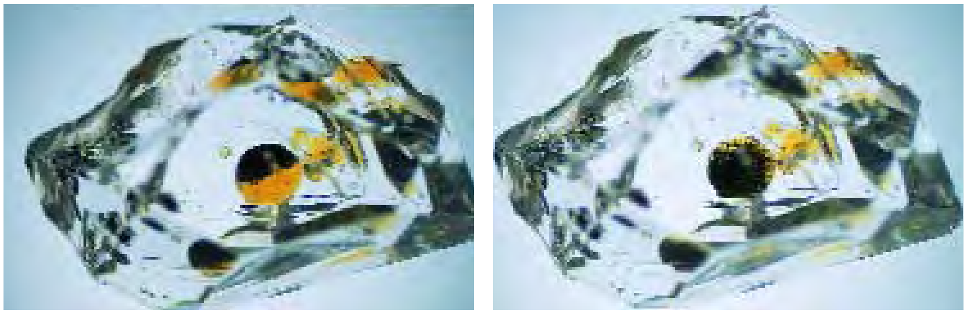

Figure 28. Four of the petroleum-containing quartz crystals had black bituminous material that was free to move within the petroleum. The movement of the bitumen is readily apparent in these photos of a 12.59-mm-long crystal. Photos by John I. Koivula.

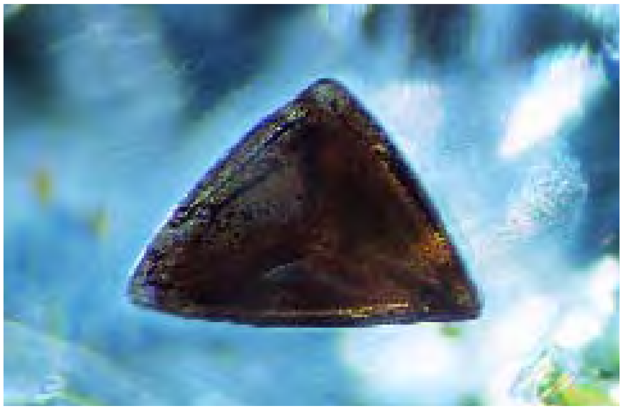

Figure 29. The strangest inclusion encountered in the hydrocarbon-included quartz crystals from Pakistan was this trigonal negative crystal that appeared to be lined with a brown bituminous film and randomly decorated with small black spots of asphaltite. Photomicrograph by John I. Koivula; magnified 10×.

works best with the recessed grip toward the user.

We have noticed that this loupe performs differently from traditional 10× triplet loupes. A ring covering the perimeter of the lens creates a slightly more limited field of view, but at the same time acts as an aperture creating a larger depth of view. As a result, the center of the image is sharper than in the traditional 10× triplet loupes, but the aperture design shields the periphery. Therefore, for optimal results the object being examined should be in the center of the field of view. This is a slight adjustment for those accustomed to other loupes, but is quite comfortable after a few minutes of use. The loupe is therefore very useful for observing inclusions, but the more limited view does not allow for clearly observing an entire stone if it is larger than 8–10 mm.

Overall, this new loupe is a welcome tool for jewelers and gemologists, offering excellent optics and ergonomics.

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CONFERENCE REPORTS

Diamond presentations at the Australian Diamond Conference. Approximately 200 people attended the annual Australian Diamond Conference, which was held in Perth on December 1–2, 2003, and comprised 28 presentations and a concluding panel discussion. The mood of the conference attendees was buoyant and optimistic. Following the opening address by the Honorable Richard Court, former premier of Western Australia, **James Picton**, diamond analyst with W. H. Ireland, London, emphasized that if the predicted 4% annual rise in demand for diamond rough continues for the next decade, by 2012 there

Figure 30. This newly developed 10× loupe from Swarovski Optik has several innovative features, including an ergonomic design and a much lighter lens. Photo by Elizabeth Schrader.

will be a shortfall of US$3.5 billion that cannot be met by the present rate of discovery. This will further increase the price of rough and fuel more diamond prospecting. **Bill McKechnie** of the De Beers Group, Johannesburg, South Africa, said that in 2004 De Beers plans to spend US$6.3 million on diamond exploration in Australia, which is unchanged from 2003. This represents 8% of their world annual budget, versus 40% in Canada, 9% in South Africa, 32% elsewhere in Africa, 7% in India, 2% in Russia, and 2% elsewhere. He said that 2002 was a good year for rough sales and 2003 was very good.

Veston Malango of the Ministry of Mines and Energy, Windhoek, Namibia, said that his government's new mining act and mineral exploration policy was well received by the international mining community. A new NamGem diamond cutting factory, which is 100% owned by Namdeb, recently opened in Windhoek. Seven other privately owned factories have opened since 1999. **Ashok Damarapurshad** of the Ministry of Minerals and Energy, Johannesburg, South Africa, said that the new mining act requiring incorporation of Black Economic Empowerment groups in every mining project was generally well received. At present there are 37 diamond mining operations in South Africa, of which 16 are mining kimberlites, 12 are alluvial, and seven are beach deposits. Of the kimberlites, nine are pipes and seven are fissures. South African diamond production for 2003 is estimated at 10.1 Mct (down from 2002 = 11.1 Mct), worth US$950 million (up from 2002 = $900 million).

Many speakers reported on the results and progress of their respective companies. **David Jones** and **Peter Danchin** of Kimberley Diamond Co., Perth, presented the latest news on the Ellendale diamond mine. First-year production (i.e., July 2002 through June 2003) was 51,819 carats, at an average value of US$159/ct and an average ore grade of about 9 carats/100 tonnes (cpht) recovered from the western area of pipe 9. The mine produces a relatively high proportion of fancy yellows. Recent results from a bulk sample in the eastern area of pipe 9 indicated an average grade of 9.25 cpht and an average size of 0.41 ct. The latest sale in Antwerp of last year's production generated US$310/ct. Prospecting and ore reserve calculations were greatly improved by using the 2.5-m-diameter Bauer drill rig, which provides 10 tonne samples for each meter drilled. An in-ground value of US$450 million has been calculated for a mine life of 13 years.

Colin Williams of Argyle Diamonds, Perth, indicated that alluvial operations at the Argyle mine ceased at the end of 2002, and the mine now produces about 30 Mct annually. All rough is sold direct to the market except for pinks, which are retained and sold as polished tenders. Argyle production by volume is 5% gem, 70% near gem, and 25% industrial; by color, 72% brown, 27% near colorless to light yellow, and <1% pink to red. Widening of the open pit by stepping back the west wall in 2000 has extended its life to 2007. An A$70 million study to be completed in 2005 is investigating the feasibility of an underground mine, which would extend mine life to 2020 at 5 million tonnes of ore per year and a diamond recovery at about half the current level.

Tom Reddicliffe of Striker Resources, Perth, reported on the latest results from Seppelt 5 in North Kimberley, which is connected by a 2.5-km-long kimberlite dike to Seppelt 2. Both pipes yielded grades in excess of 200 cpht. Many diamonds exceeding 2 ct were recovered, the largest being 8.5 ct, near colorless, and gem quality. Investigations have begun into the feasibility of an open pit plus underground mine for Seppelt 2 and 5. Striker also has acquired the Merlin Orbit properties. These consist of six tenements totaling 1,800 km^2 surrounding the former Merlin diamond mine, which operated from 1998 to 2002 and is fully owned by Rio Tinto. The Merlin Orbit leases contain many promising targets resembling the known Merlin pipes, which were found by Mr. Reddicliffe when he was exploration manager for Ashton Mining. Striker also acquired a three-year usage of the Rio Tinto kimberlite indicator mineral database for nearly the entire Kimberley region.

Several South African properties also were reviewed. **Charles Mostert** of Crown Diamonds, Perth, introduced this new diamond mining company, which was created through a merger of previous alluvial miner Majestic Resources (Australia) and Messina Investments (South Africa). Two operating fissure mines in South Africa, Messina and Star, produced 31,700 carats in 2002, of which 90% were gem quality. The Messina mine is located in the Bellsbank area, 80 km northwest of Kimberley, and the Star mine is located in Orange Free State near Welkom. A 52.51 ct gem-quality diamond was recovered from a Crown Diamonds mining operation in November 2003. In the same month, Crown completed negotiations to purchase the Helam fissure mine in the western Transvaal region. Future plans include upgrading the production of all three mines to reach 250,000 carats/year by 2006. **Wolf Marx** of Tawana Resources, Melbourne, discussed their Daniel project (owned 30% by Tawana, which can earn up to 40%, the remainder owned by BHP), a buried alluvial channel 7 km long and 2 km wide, which is 6 km down slope from the Finsch mine. It is estimated that about 1,400 m of the Finsch pipe has been eroded, with many of the diamonds transported through the Daniel channel. The bedrock is dolomite and contains many pot holes, which form ideal diamond repositories. **Karl Simich** of Namakwa Diamonds, West Perth, said that 1% of an onshore diamond deposit on the Atlantic coast of Namaqualand has been estimated to contain 411,000 carats with a value of $100/ct. Environmental plans were approved, and Namakwa may be the first diamond mining company to be granted a license under the new mining legislation in South Africa.

Pamela Strand of Shear Minerals, Edmonton, Canada, gave a review of that company's exploration in the Churchill diamond project, located on the west side of Hudson Bay, where in two years' fieldwork 18 kimberlites have been found, some of which are diamondiferous. Many other speakers discussed their exploration projects, but none of them had reached advanced stages.

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"Science of Gem Materials" session at the MRS meeting. In December 2003, for the first time, the large Materials Research Society meeting in Boston, Massachusetts, included a session on gem materials. Conference abstracts are available at www.mrs.org/meetings/fall2003/program/AbstractBookII.pdf, and summaries of some of the presentations from this two-day session are provided below.

Dr. Jeffrey Post of the Smithsonian Institution, Washington, D.C., described the U.S. national gem collection; notable pieces include the Blue Heart (30.62 ct) and Hope (45.52 ct) diamonds (see Winter 2003 Gem News International, pp. 322–325), a giant Brazilian topaz crystal (weighing approximately 50 kg), and the 127 ct Portuguese diamond with very strong blue fluorescence.

Dr. Reza Abbaschian of the University of Florida, Gainesville, and colleagues discussed recent progress in the growth of synthetic diamonds by Gemesis Corp. (Sarasota, Florida). Yellow crystals up to 3–3.5 ct are produced routinely. The largest crystal grown to date weighed about 5 ct, which should cut a 3.5 ct synthetic diamond; 10 ct crystals are reportedly possible. For near-colorless synthetic diamonds, slow growth is needed (less than 2 mg/hour); a 1 ct crystal requires 100 hours to grow. By comparison, colored synthetic diamonds (e.g., yellow and blue) grow faster, at about 16 mg/hour.

Branko Deljanin of EGL USA, Vancouver, Canada, and colleagues discussed the jewelry-quality synthetic diamonds that Apollo Diamond Co. has grown using chemical vapor deposition (CVD). Single-crystal synthetic diamond films 1–2 mm thick are grown on diamond seeds, and the films are then sawn off with a laser. Brown, "colorless," and blue samples have been grown. They contain traces of nitrogen, hydrogen, and/or silicon, and are types IIa or IIb. CVD synthetic diamonds often show four growth sectors, and microscopic examination revealed inclusions parallel to the seed plate but no graining. In addition to their brown or orange cathodoluminescence, spectral characteristics were described. HPHT annealing of CVD synthetic diamond resulted in a near-colorless product with blue or violet cathodoluminescence and a stronger 637 nm than 575 nm photoluminescence (PL) peak.

Matthew Hall of the GIA Gem Laboratory, New York, and colleagues discussed HPHT annealing of gray-blue type IIb diamonds. Through experiments, they found that annealing reduces the gray component of these diamonds and produces a blue color, sometimes at the Fancy Intense or Fancy Vivid level. (According to Mr. Hall, before HPHT annealing, some of the boron in such diamonds is compensated by hydrogen. The treatment process makes this boron available to cause absorption in the mid-IR to higher-wavelength portion of the visible spectrum, producing the blue color.) Although the saturation of their color was altered by the treatment, their tone (lightness or darkness) did not change appreciably (figure 31). The diamonds show characteristic infrared and PL spectral features.

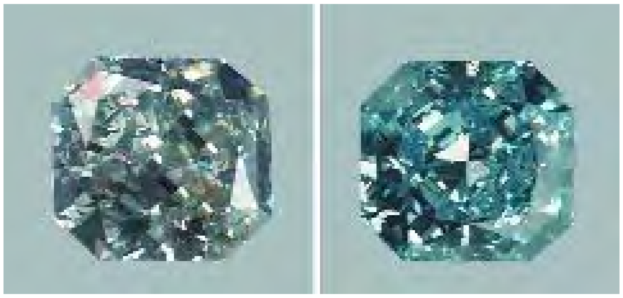

Figure 31. A GIA laboratory study has shown that HPHT annealing of some type IIb diamonds can reduce the gray component and produce blue color, as illustrated by this approximately 0.65 ct diamond before (left) and after (right) HPHT treatment. Photos by Elizabeth Schrader.

This contributor (and colleagues) discussed GIA's computer modeling of the appearance aspects of a faceted diamond. Several additional brightness and fire metrics have been developed for round brilliants (based on different assumptions about environments and observer conditions), and about 50,000 observations of actual diamonds have been performed to identify the metrics that best agreed with various observers' perceptions of brightness and fire under standardized conditions. The patterns of light and dark seen in round brilliants were found to affect people's decisions as to what makes a good-looking diamond; these pattern effects can also be calculated.

Dr. Lee Groat of the University of British Columbia, Vancouver, and colleagues discussed gem beryl localities in Canada: emerald from Regal Ridge in the Yukon Territory (described in the Spring 2002 Gem News International [GNI], pp. 93–94), dark blue aquamarine from the Yukon (see Winter 2003 GNI, pp. 327–329), and green beryl from Lened, just across the border in the Northwest Territories. The Lened skarn occurs in the vicinity of a tungsten mine and tin-tungsten deposit, as well as a spodumene-bearing pegmatite, but there is no granite exposed in the area. The green beryl is transparent but very pale, with crystals reaching 30 × 5 mm. It is colored by vanadium, not chromium, although some Fe^{3+} is also present as a chromophore.

Dr. Alain Cheilletz of CNRS, Vandoeuvre-les-Nancy, France, and colleagues discussed the occurrence of deuterium (a heavy isotope of hydrogen) in emeralds, and its use for determining emerald sources. With infrared spectroscopy, they have developed a database for emeralds from 46 deposits. **Dr. John Rakovan** of Miami University, Oxford, Ohio, discussed the role of surface structure in the incorporation of rare-earth elements in sector-zoned fluorite. For fluorite from Long Lake, New York, sector zoning shows up with irradiation. The blue color of some fluorite from Bingham, New Mexico, is unstable to sunlight. **Margaret Broz** of the University of Minnesota, Minneapolis, and co-authors discussed hardness and surface-contact properties of gems and minerals. Depth-sensitive indentation (DSI) behavior can be determined from measurements with Vickers and Berkovich devices; these produce measurements of hardness, toughness, stiffness, and bulk modulus. The Mohs hardness scale is nonlinear relative to the DSI hardness scale: Minerals with high Mohs values have much greater measured hardnesses than one would expect from the measured values of minerals with lower Mohs values. **Kenneth Scarratt** of the AGTA Gemological Testing Center, New York, described different types of natural and cultured pearls (freshwater, saltwater, black, and "golden") from various bivalve mollusks, as well as non-nacreous "pearls" (conch, melo, etc.) from gastropods.

Dr. Laurence Galoisy of the University of Paris, France, and colleagues examined neolithic jewels containing variscite ($AlPO_4 \bullet 2H_2O$) from Er-Grah and Luffagh (two sites in Brittany, France), both dating from 4400–3900 BC. When compared to variscite from various other European sources, the best spectral match for the Luffagh jewel was nearby Pannecé, but for the Er-Grah piece, Sarrabus in Sicily was the best match. Consequently, it appears that trade routes covered a large area of southern Europe at the time. **Vera Borisovna Kovalevskaia** of the Institute of Archaeology, Moscow, traced gem trade routes to the Scythians and Samartians in the Caucasus, Central Asia, and eastern Europe during the first millennium AD. The gems included amber, topaz, emerald, agate, carnelian, jet, and lapis. Beads came from India via Iran and the Volga River to the steppes; gems and jewelry from Byzantium came via the Red Sea to Europe; and amber spread south and southeast from the Baltic. Locally cut beads can be distinguished from Indian-cut beads by differences in cutting styles and in the quality of the material.

Drs. Peter Heaney and Donald Fisher, both of Penn State University, University Park, Pennsylvania, compared the chatoyant gems tiger's-eye and pietersite. Tiger's-eye quartz typically occurs as seams up to a few centimeters thick in banded iron formations; most is mined near Griquatown in South Africa. Although tiger's-eye was formerly explained as quartz pseudomorphs after crocidolite (riebeckite) asbestos fibers, in fact the quartz is granular and includes wisps of oxidized crocidolite; these parallel fibrous inclusions cause the chatoyancy. Pietersite is always brecciated; this quartz gem occurs as silicified nodules in limestone, near Windhoek, Namibia. Again, the quartz did not replace crocidolite; instead, the original siliceous material in these nodules was fibrous chalcedony, occurring with hematite. The quartz replacement of chalcedony reorganized the hematite into segregations, and sodium metasomatism caused hematite and chalcedony to react to form crocidolite (and granular quartz).

Dr. Emmanuel Fritch of IMN, Nantes, France, and colleagues discussed the microstructure of play-of-color and common opals. Mineralogists distinguish opal-A (which is X-ray amorphous) from opal-CT (which shows cristobalite and/or tridymite lattice spacings in its X-ray diffraction pattern). Australian sedimentary opal-A owes its play-of-color to 200 nm array elements; this gem mainly consists of silica, with the holes between the intergrown spheres organized in an array. Volcanic-related opal-CT may not show play-of-color. Examples include fire opal (from Brazil, Kazakhstan, Mexico, and Ethiopia); pink opals showing fibrous opal microstructures and colored by palygorskite microfibers (from Peru and Mexico); opals with microscopic platelets; and those with "lepispheres"—resembling tiny gypsum roses—of cristobalite-like opal-CT. All these have spheroids of silica of about the same size, 20–40 nm. **Dr. Orlin Velev** of North Carolina State University, Raleigh, summarized the research his group has done on opal-structured materials. Controlled crystallization is necessary to create the opal microstructure. In their laboratory experiments, colloidal polymer spheres were "crystallized" in an organized fashion to create play-of-color; spheres 100–1000 nm in diameter resulted in play-of-color effects in materials such as plastic films, graphite, and gold.

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Sinkankas tourmaline symposium. The 2nd Annual John Sinkankas Memorial Symposium was co-hosted by the San Diego Mineral & Gem Society and GIA on April 10, 2004. The all-day event took place at GIA's headquarters in Carlsbad, where approximately 120 attendees were treated to seven presentations on tourmaline. Each participant received an informative proceedings volume that contained excerpts of some of the presentations, selections from previous publications on tourmaline, and a bibliography.

After opening remarks by convener **Roger Merk** (Merk's Jade, San Diego, California), **Dr. William B. "Skip" Simmons** of the University of New Orleans reviewed the complex chemical variations and the 14 currently recognized species of the tourmaline group, which are divided into alkali (e.g., elbaite), calcic (e.g., liddicoatite), and X-site vacant (e.g., rossmanite) tourmalines. He then took the audience on a "virtual field trip" to the Transbaikalia Malkhanski pegmatites near Lake Baikal in Siberia, Russia. At the most important deposit, the Mokhovaya pegmatite, gem-quality tourmaline in a variety of colors has been systematically mined from a large open cut since the early 1990s.

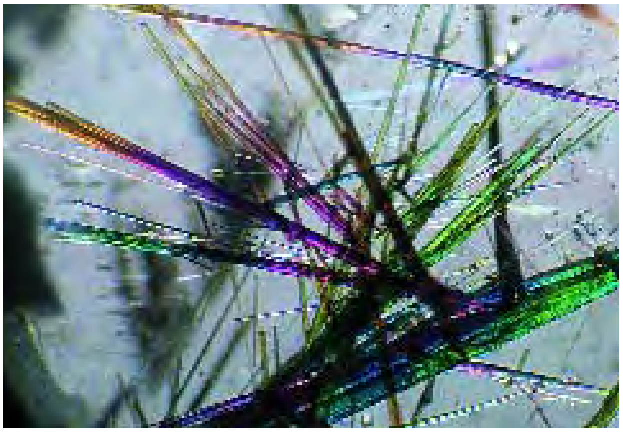

Figure 32. Needle-like inclusions of tourmaline (probably schorl) in this sample of quartz from Governador Valadares, Brazil, show brilliant interference colors between partially crossed polarizing filters. Photomicrograph by John I. Koivula; magnified 5×.

Si Frazier of El Cerrito, California, reviewed the common crystal forms of tourmaline, provided simple diagrams to illustrate the angular relationships between various pyramidal forms, and showed interesting examples of tourmaline inclusions in quartz. **Jesse Fisher** of UK Mining Ventures, San Francisco, summarized important tourmaline localities of the world. Some of the most significant producers of gem-quality tourmaline include Minas Gerais, Brazil (the Araçuaí area and the region around Teófilo Otoni and Governador Valadares), eastern Afghanistan (e.g., the Paprok, Mawi, and Darre Pech areas), and southern California (e.g., the Himalaya and Tourmaline Queen mines).

Meg Berry of Mega Gem, Fallbrook, California, provided useful insights on faceting tourmaline. She emphasized the importance of polishing tourmaline lengthwise on the wheel to avoid stress fracturing, and explained how emerald cuts of bicolored stones and those with a "closed" (or dark-colored) c-axis should be faceted with steeply inclined ends (i.e., at least 75°). **William Larson** of Pala International, Fallbrook, California, then described some of the historic literature on tourmaline, including rare manuscripts dating back to the 18th century.

John Koivula of the GIA Gem Laboratory in Carlsbad reviewed the inclusions and optical phenomena in gem-quality tourmaline. Growth tubes, negative crystals, various solid-liquid-gas assemblages, and distinctive color zoning may be found in tourmaline, whereas tourmaline has been documented as inclusions in minerals such as apatite, beryl, cassiterite, quartz (figure 32), pezzottaite, and topaz. The visibility of minute inclusions can be enhanced with certain lighting conditions, such as shadowing, fiber-optic illumination, or the use of polarizing filters.

Dr. George Rossman of the California Institute of Technology, Pasadena, gave the closing presentation, on the coloration of tourmaline. The most common chromophores are Fe^{2+}, Fe^{3+}, Ti^{4+}, Mn^{2+}, and Mn^{3+}, although Cr^{3+}, V^{5+}, and Cu^{2+} can also cause color. Multiple coloration mechanisms can be present in a single sample, and post-crystallization color modifications can occur through exposure to ionizing radiation (gamma rays) in the pegmatitic environment or laboratory (i.e., colorless Mn^{2+} converted to pink Mn^{3+}).

The theme of next year's Sinkankas symposium will be beryl.

BML

ANNOUNCEMENTS

Dr. Henry A. Hänni receives AGA Bonanno Award. SSEF Swiss Gemmological Institute director (and GNI contributing editor) Dr. Henry A. Hänni has received the Accredited Gemologists Association's Antonio C. Bonanno Award for Excellence in Gemology. This award recognizes people in the gemological field who have made significant contributions to the field or defended and upheld gemological standards in ways that benefit the gem and jewelry community. Dr. Hänni was honored for his nearly 30 years as a leading gemological researcher and educator, and his contributions to gem treatment reporting standards.

Dr. George R. Rossman receives Feynman Prize. Dr. George R. Rossman, professor of mineralogy at the California Institute of Technology in Pasadena and a longtime member of the *G&G* editorial review board, has been named the recipient of Caltech's most prestigious teaching honor, the Feynman Prize for Excellence in Teaching. The award, given to an outstanding faculty member each year, recognizes "exceptional ability, creativity, and innovation in both laboratory and classroom instruction." Dr. Rossman has taught mineralogy at Caltech for more than 30 years.

Conferences

JCK Show—Las Vegas. Held at the Venetian Resort & Hotel on June 3–8, 2004, this show will also host a comprehensive educational program beginning June 3. Scheduled seminars will cover industry trends, diamond sales and marketing strategies, legal issues for retailers and manufacturers, and developments in gemology. AGTA will also be offering seminars focusing on color and fashion on June 3 at the AGTA Pavilion. To register, call 800-257-3626 or 203-840-5684. Visit http://jckvegas2004.expoplanner.com.

Jewelry Camp 2004. The 25th Annual Antique & Period Jewelry and Gemstone Conference will be held July 17–24 at Hofstra University, Hempstead, New York. The program covers hands-on jewelry examination techniques, methods of construction, understanding materials used throughout history, and the constantly changing marketplace. Visit www.jewelrycamp.org, call 212-535-2479, or e-mail jwlrycamp@aol.com.

Geoscience Africa 2004. Hosted by the University of the Witwatersrand in Johannesburg, South Africa, July 12–16, this conference will feature a symposium titled "Kimberlites, Diamonds and Mantle Petrology." Field trips to the Premier diamond mine and alluvial diamond deposits along the Orange River will be offered. Visit www.wits.ac.za/geoscienceafrica.

International Geological Congress. The 32nd Session of the International Geological Congress will take place August 20–28, 2004, in Florence, Italy. Symposia are planned that will cover such topics as gem materials, inclusions in minerals, and mineral spectroscopy. Visit www.32igc.org/default1.htm.

5th European Conference on Mineralogy and Spectroscopy. Held September 4–8, at the University of Vienna, Austria, this meeting will be held in conjunction with the *6th European Mineralogical Union School on Spectroscopic Methods in Mineralogy*, which takes place from August 30 to September 8. Students will gain exposure to optical (UV-Vis-NIR) and luminescence spectroscopy, vibrational spectroscopy (Raman and infrared), Mössbauer spectroscopy, nuclear magnetic resonance spectroscopy (NMR), and X-ray absorption spectroscopy (XANES and EXAFS). Visit www.univie.ac.at/Mineralogie/ECMS2004 and www.univie.ac.at/Mineralogie/EMU_School.

Gems of Pacific continental margins. The International Association on the Genesis of Ore Deposits will host a symposium titled "Gem Deposits Associated with the Pacific Continental Margins" at the Interim IAGOD Conference on Metallogeny of the Pacific Northwest: Tectonics, Magmatism & Metallogeny of Active Continental Margins. The conference will take place September 11–19, in Vladivostok, Russia. Visit www.fegi.ru/IAGOD.

Diamond 2004. A review of the latest scientific and technological aspects of natural and synthetic diamond (as well as related materials) will take place at the 15th European Conference on Diamond, Diamond-like Materials, Carbon Nanotubes, Nitrides & Silicon Carbide, September 12–17, 2004, in Riva del Garda, Italy. Visit www.diamond-conference.com.

ICAM 2004 in Brazil. The 2004 International Congress on Applied Mineralogy will be held in Águas de Lindóa, Brazil, September 19–22, 2004, and will include a special session on gem materials. Pre- and post-conference field trips will tour colored gemstone and diamond deposits in the Ouro Preto and Diamantina areas, as well as agate and amethyst mines in Rio Grande do Sul State. Visit www.icam2004.org.

Hong Kong Jewellery & Watch Fair. Held at the Hong Kong Convention and Exhibition Centre on September 19–22, this show will also host GIA GemFest Asia 2004 on September 20, and an educational seminar given by the Gemmological Association of Hong Kong on September 21, in addition to several jewelry design competitions. Visit http://www.jewellerynetasia.com/exhibitions/default.asp?siteid=5&lang=1.

Exhibits

GIA Museum exhibits in Carlsbad. *Magic, Myths, and Minerals*, a traveling exhibition of Chinese jades from the Smithsonian Institution's Arthur M. Sackler Gallery, will be on display in GIA's Museum Gallery, from May 24 to October 31, 2004. In addition, the exhibit *All Natural, Organically Grown Gems* will share the Museum Gallery space until October 31. New pieces continue to be added to *From the Vault: Gifts to Our Collection*, on view in the Rotunda through December 2004. Contact Alexander Angelle at 800-421-7250, ext. 4112 (or 760-603-4112), or e-mail alex.angelle@gia.edu.

ERRATA

1. Regarding the Summer 2001 Gem News International entry on "Canary" tourmaline (pp. 151–152), it has subsequently come to our attention that this material was produced from an existing deposit near the city of Chipata in Zambia, not far from the Malawi border (see, e.g., K. Schmetzer and H. Bank, "Intensive yellow tsilaisite [manganese tourmaline] of gem quality from Zambia," *Journal of Gemmology*, Vol. 14, No. 3, 1984, pp. 218–223). Tourmaline from this locality also has been incorrectly reported by suppliers as being from Tumbuka, Mozambique (see March 2001 *Jewellery News Asia*, p. 209), although more recent publications correctly refer to Zambia as the source (see April 2004 *Jewellery News Asia*, pp. 128, 138, 140).

2. The article "Gem-quality synthetic diamonds grown by a chemical vapor deposition (CVD) method" in the Winter 2003 issue contained an incorrect reference. The reference for De Beers Industrial Diamonds et al. (2001) should have been:

> Vagarali S.S., Webb S.W., Jackson W.E., Banholzer W.F., Anthony T.R., Kaplan G.R. (2003) *High Pressure/High Temperature Production of Colorless and Fancy-colored Diamonds*. U.S. patent application 20030143150, filed January 8.

Gems & Gemology regrets the error.