GEM N·E·W·S

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

TUCSON '96

The annual February series of shows held in Tucson, Arizona, has become such an industry institution that it almost requires no introduction. The many Tucson exhibitors represent four distinct approaches to natural products, from unprocessed minerals through finished jewelry: fashioned stones (including diamonds and colored stones of every description) and ornamental materials; findings and jewelry supplies (including beads); finished pieces (mostly jewelry, but also carvings and other *objets d'art*); and items for collectors (such as mineral and fossil specimens). This year, the editors and contributing editors were helped by many people. Special thanks go to GIA's Bill Boyajian, Brook Ellis, Debbie Hiss-Odell, D. Vincent Manson, Andrea McShane, and James E. Shigley, as well as *G&G*'s technical editor Carol Stockton and GIA Gem Trade Laboratory's Nick DelRe and Cheryl Wentzell.

DIAMONDS

Matrix diamond specimens from China and Russia. D. J. Parsons, Rapid City, South Dakota, had three approximately 2 cm samples of eye-visible diamonds in matrix from Mengyin, Shandong Province, China. Several dealers had Russian diamond-in-matrix specimens, some with exact localities such as the Udachnaya kimberlite pipe.

Synthetic diamonds are in the marketplace. The Morion Company, Brighton, Massachusetts, had synthetic diamond crystals on display and for sale. One of the editors (MLJ) looked at three crystals at their booth: The crystals were yellow octahedra with one truncated pyramidal corner. Gray to somewhat blue color zoning was eye-visible in the center of each crystal. A Morion representative reported that these crystals are produced in a factory outside of Moscow, at a rate of 15–20 carats per month. Prices ranged from \$265 per carat (for half-carat crystals) to \$1,750 per carat for 2.29 ct crystals, according to a price list Morion handed out at the show.

Another firm, Pinky Trading of Los Angeles, California, also had about 10 faceted Russian synthetic diamonds for sale at Tucson. These samples appeared to be similar to the synthetic diamonds manufactured in Novosibirsk and reported on by Shigley et al. (*Gems & Gemology*, Winter 1993, pp. 228–248).

Synthetic moissanite as a diamond simulant. A "new" diamond simulant debuted at Tucson this year: Although not a new material, synthetic moissanite previously had not been actively marketed as a diamond substitute. Synthetic moissanite (silicon carbide, SiC) is probably more commonly known in its polycrystalline form—carborundum—which is used as an abrasive.

Over the years, the GIA Gem Trade Laboratory has examined several faceted examples of synthetic moissanite that were submitted for identification. These samples—all of which were green—were visually convincing as diamond simulants. Now, a company called C3 Diamante of Raleigh, North Carolina, is preparing to market synthetic moissanite, not only the typical dark green color, but also pale green to pale brown. Although synthetic moissanite in these latter colors had been reported before, previous efforts to control the color (or even the growth) of facetable single crystals were unsuccessful (see, for instance, Kurt Nassau, *Gems Made by Man*, Chilton Book Co., Radnor, Pennsylvania, 1980). Representatives of C3 Diamante believe that they have overcome at least some of these problems and will be able to market this material later this year.

We were not able to acquire any samples for testing purposes by press time. The more than a dozen faceted samples we saw at the show were for display only. However, we did briefly examine one faceted synthetic moissanite with a microscope. Although uniaxial, the stone was cut with the optic axis perpendicular to the table facet, so no doubling of back facets was observed when the sample was viewed table up. When we exam-

Figure 1. In fluorescent light (left), this 3.29 ct color-change pyrope-spessartine has the bluest color that we have yet seen in a garnet; it is shown in incandescent light on the right. Photos by Shane F. McClure.

ined the stone through the girdle, doubling of the most distant facets was seen. We will examine and report on this material in more depth when samples become available.

Published properties for synthetic moissanite (Joel Arem, *Encyclopedia of Gemstones*, 2nd ed., Van Nostrand Reinhold, New York, 1987) are: crystal symmetry—hexagonal, rarely cubic; refractive indices of $n_o = 2.65$, $n_\varepsilon = 2.69$; hardness—9½; birefringence—0.043; dispersion—about 0.09; specific gravity—3.17 to 3.20; cleavage—none.

COLORED STONES AND ORGANIC MATERIALS

Color-change garnet. The Fall 1988 issue of *Gems & Gemology* (pp. 176–177) reported on four exceptional garnets from East Africa with a color change that approached that of fine Russian alexandrite. Color-change garnets of that quality have continued to be extremely rare. This year in Tucson the editors saw one such garnet (figure 1) at the booth of K & K International of Falls Church, Virginia.

Gemological testing of this 3.29 ct stone showed properties consistent with those reported in 1988: a refractive index of 1.770 and an absorption spectrum (as seen in a Beck desk-model prism spectroscope) typical for color-change pyrope-spessartine garnets (see "A Proposed New Classification for Gem Quality Garnets," by C. M. Stockton and D. V. Manson, *Gems & Gemology*, Winter 1985, pp. 205–218). Energy dispersive X-ray fluorescence (EDXRF) analysis showed relatively high amounts of manganese and vanadium, and a comparatively small amount of chromium; these findings were also consistent with the stones previously examined.

One important feature of this particular garnet did separate it from the ones reported earlier—its color, which changes from reddish purple (in incandescent light) to bluish green (in day or fluorescent light). For many years, gemologists have searched for a truly blue garnet; still, blue is the only color in which garnets have not been found. We do (rarely) see color-change garnets that have a blue hue in day or fluorescent light, but—to date—the blue has always been a secondary color, that is, modifying the predominantly green hue. The daylight color of this stone has more blue than we have yet seen in a garnet, using a standard gemological illuminant.

A caution concerning this stone is warranted, especially since we have already seen others like it. The color change of this garnet is so much like that of a fine alexandrite that visually they are virtually indistinguishable. Of course, a simple test for double refraction or pleochroism would show that it is not an alexandrite, but we have seen garnets similar to this one traded as alexandrites in the past. As always, gemologists should remember never to rely on visual appearance—or any single test—to identify a stone. Identifying this stone as an alexandrite would be a costly mistake indeed.

Heliodor from Tajikistan. Previous Gem News entries have reported on purple scapolite (Fall 1995, pp. 211–212) and red spinel (Fall 1995, p. 212) from Tajikistan. New at Tucson this year was yellow beryl—heliodor—from this nation. Mark Herschede, of Turmali & Herschede, Sanibel, Florida, loaned the editors five faceted examples and nine rough crystals for examination (see, e.g., figure 2).

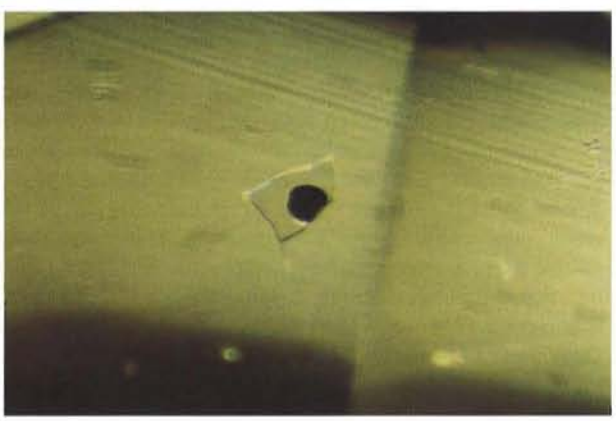
The faceted stones ranged from 6.80 to 14.39 ct. All were yellow, with even color distribution and very weak pleochroism in yellow to slightly darker yellow. The stones were uniaxial negative (R.I.'s of 1.571–1.575 [n_ε] and 1.578–1.581 [n_o]) with birefringences of 0.006–0.007. S.G.'s ranged from 2.69 to 2.72; the stone with the highest refractive indices also had the highest S.G. We did not see any spectra with the handheld spectroscope; nor did any of the stones react to the (Chelsea) color filter. All were inert to long-wave UV radiation; one stone fluoresced a faint, even greenish yellow to short-wave UV, but the others were inert. Among the inclusions were fine, wispy or small, liquid fingerprints; needles (for the most part running the length of the stone, with some in random orientation), straight and angular internal growth zoning, and pinpoints. Two-phase inclusions (figure 3)

Figure 2. These faceted stones and crystals of heliodor come from Tajikistan. The longest crystal is 50.75 mm (49.92 ct); the three faceted stones weigh (from left to right) 8.10, 11.76, and 10.03 ct. The cut stones were fashioned by David Brackna, of Germantown, Maryland. Photo by Maha DeMaggio.

were seen in two of the stones. EDXRF spectroscopy revealed Al, Si, Mn, Fe, Zn, Ga, Cs, and Rb.

The nine rough crystals weighed 9.70–49.92 ct; the largest measured 50.75 × 11.45 × 9.07 mm. These were singly or doubly terminated hexagonal prisms; each of the doubly terminated crystals had at least one severely etched termination. Faces observed were tentatively identified as prisms (10$\bar{1}$0) and (21$\bar{3}$0); pinacoid (0001); and pyramids (10$\bar{1}$1) and (11$\bar{2}$1); overall, the crystals resembled examples from Mursinka, Ural Mountains, Russia, as illustrated in Goldschmidt's *Atlas der Kristallformen* (originally published in 1913; reprinted by Rochester Mineral Symposium, Rochester, NY, 1986). In some cases, the prism faces were also etched (figure 4), and some crystals showed conchoidal fracture surfaces. A white micaceous material was visible in etch pits on two samples, and one crystal contained a 3.5-mm-long dark greenish brown crystal with the morphology of tourmaline.

Figure 3. A two-phase (liquid and gas) inclusion is evident in this 6.80 ct faceted heliodor from Tajikistan. Length of inclusion, about 0.25 mm; photomicrograph by John I. Koivula.



Mr. Herschede and Rob Lavinsky (The Arkenstone, San Diego, California), who distributes mineral specimens from this region, provided some locality and production information. The heliodor mine, called *Zelatoya Vada* (approximate translation, "yellow water") by its owners, is located near Lake Rangkul, east of the town of Murgab. Each pocket in this pegmatite produces a slightly different set of associated minerals. The matrix material is the clevelandite variety of albitic feldspar, and is similar to that from deposits in Pakistan. Other associated minerals include: white and purple apatite, schorl, topaz, red-to-orange spessartine, quartz, and minerals tentatively identified as loellingite and stibiotantalite.

Figure 4. Deep surface etching is evident on the prism face of a 9.74 ct heliodor crystal from Tajikistan. Field of view, about 5.5 mm; photomicrograph by John I. Koivula.

The Zelatoya Vada deposit was discovered in 1991; the first pocket produced a "minimal" amount of facet-grade rough and matrix mineral specimens. The pegmatite itself may be 3 to 5 km long; by the time of the Tucson shows, pockets first uncovered in 1994 had produced about 30–40 kg of material. Mr. Herschede believes that his source will produce 4–10 kg per month as the operation grows. All mining is now done with hand tools and manual labor, and there are no plans to mechanize mining at such a remote and poorly accessible location.

"Leopard opal" from Mexico. Although the editors saw few genuinely new gem materials at Tucson this year, they discovered one while exploring the many gem-and-mineral-laden rooms at the Executive Inn: a black-and-white opal-bearing rock that has been tentatively named "leopard opal" by its distributor, gemologist-geologist Warren F. Boyd, of R. T. Boyd Ltd., Ontario, Canada. In its best quality, "leopard opal" is a black vesicular basalt in which the vesicles are filled with white opal that shows green, red, blue, and yellow play-of color; when viewed as a whole, the stone appears to have black-and-white spots (hence the trade name), with flashes of color that quickly change as the stone or the light source is moved.

We obtained a 4.87 ct cabochon (figure 5) and a rough sample for gemological documentation. A spot R.I. of 1.46, typical for opal, was the only reading that could be determined. Because the material can be somewhat porous, we did not attempt to test for specific gravity. The opal portions fluoresce bluish white, with a stronger reaction to long-wave than to short-wave UV.

The material was found in the state of Hidalgo, in southern Mexico, according to Mr. Boyd. He could not give a more specific locality because the property is in the early stages of development. He did say, however, that reserves look very promising. One special feature of this material is that it can be cut in any size without having to make allowances for distribution of color or patches of matrix, as is the case for solid opal. "Leopard opal" can be used for beads and carvings as well as calibre-cut cabochons and other fashioned stones.

An impressive 2 kg boulder of the basaltic rough was being used to prop open the door to Mr. Boyd's room in the Executive Inn. However, because the discovery is so new, only a few cabochons were available. If the mining operation goes well, and if the size of the "door stop" is any indication, perhaps next year we will see a significant amount of "leopard opal" in Tucson.

Cultured abalone pearls. Cultured abalone pearls, long rumored to be in production, have finally reached the market. (For a brief discussion of natural abalone pearls, see the Lab Notes section of this issue.) According to research by biologist P. V. Fankboner, of Simon Fraser University, Burnaby, British Columbia (Canada), the American red abalone (*Haliotis rufescens*) is the largest and most prolific producer of gem-quality cultured abalone pearls. However, cultured abalone pearls are being produced elsewhere as well; one of the newest localities is New Zealand. Liz and Michael McKenzie, directors of Empress Pearl of Christchurch, New Zealand, were at Tucson this year with their first production of cultured blister pearls from the paua abalone (*Haliotis iris*), which is being promoted by the McKenzies as the Empress abalone. Although the McKenzies did not have a booth, they did have several trays of cultured abalone blister pearls. These samples were mostly large (about 2 cm), round, high-luster blister pearls that had been fashioned into mabe-type pieces with a polished paua shell backing (figure 6; for more information on this type of cultured blister pearl, see the entry on an "Abalone 'Mabe' Pearl" in the Winter 1994 Lab Notes section, p. 268). Since the paua abalone produces the most iridescent nacre of all abalone, its pearls boast the most colorful orient. The hues range from shades of blue and green—normally associated with nat-

Figure 5. This 16-mm-long (4.87 ct) cabochon of "leopard opal" is from the state of Hidalgo, Mexico. Stone courtesy of Warren F. Boyd; photo by Maha DeMaggio.

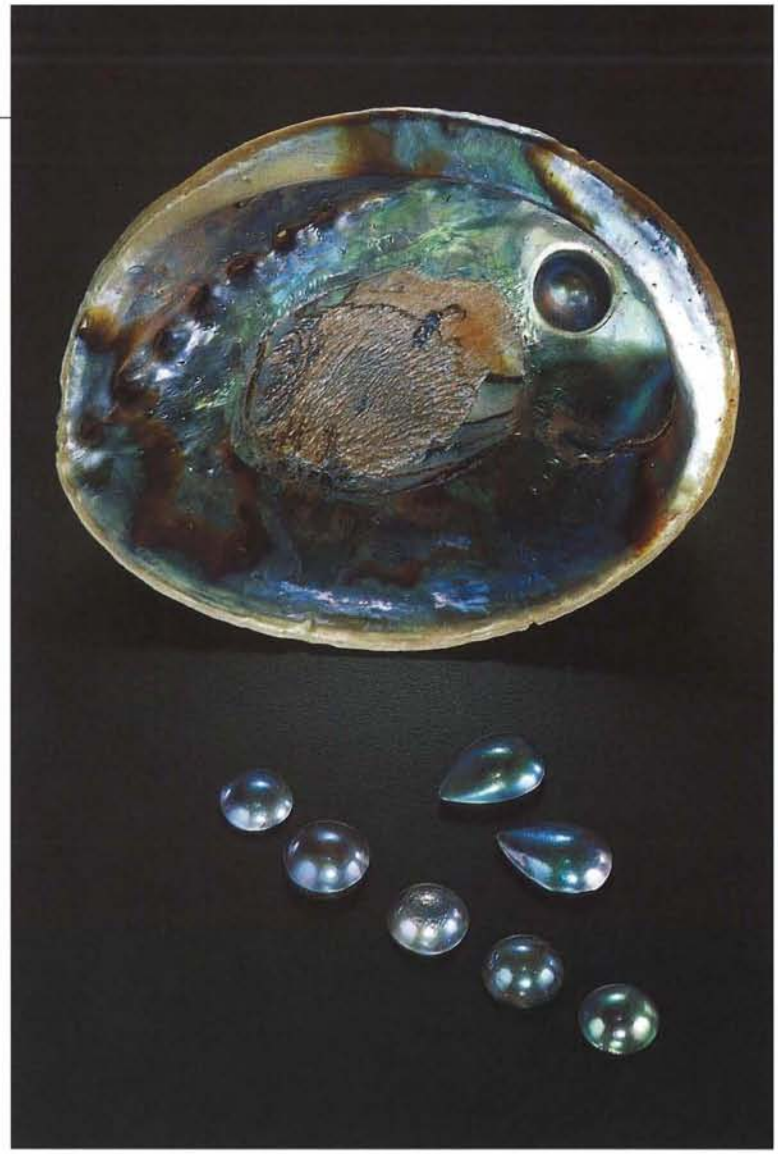


Figure 6. These abalone blister pearls (the buttons are about 2 cm in diameter) are from a culturing operation in New Zealand that uses paua abalone shells like the one shown here. Photo by Robert Weldon.

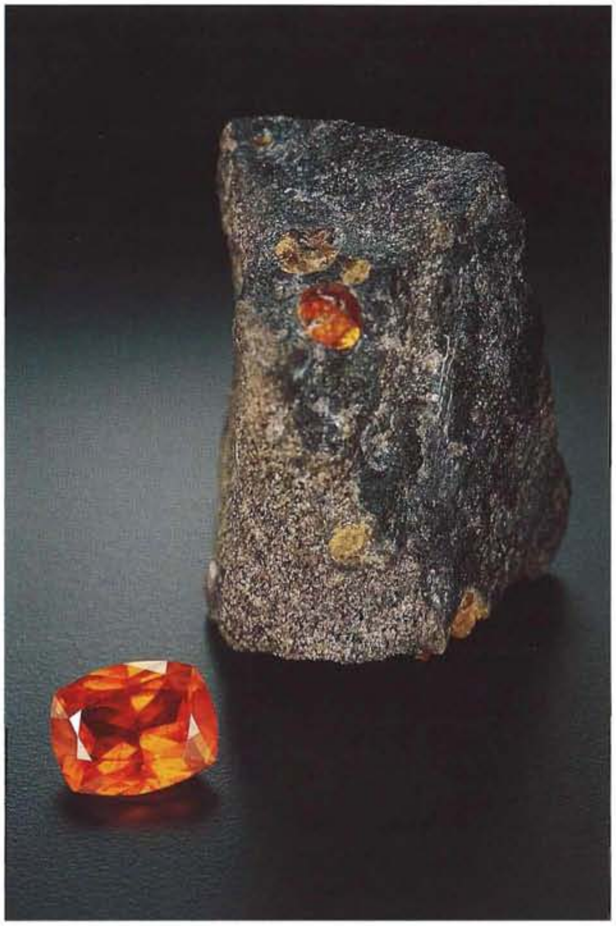


Figure 7. This 29.71 ct cushion-cut spessartine ("Mandarin" garnet) is from the vicinity of the Marienfluss River, Namibia. The matrix piece behind it (about 7 cm high) shows how the garnets are found in black, manganese-rich veins. Courtesy of Colgem Ltd.; photo by Robert Weldon.

ural abalone pearls—to a distinct purple that, in our experience, is very unusual. The McKenzies said the purple was their rarest color.

One major difficulty in culturing abalone pearls has been the implantation of nuclei. Free-forming (nonblister) pearls are difficult to cultivate because the bead is so easily rejected by the univalve abalone, which can use its large foot to eject the implanted nucleus. Formerly, the greatest success in culturing blister pearls in this mollusk was achieved by attaching the bead nucleus firmly to the shell beneath the mantle tissue. According to the McKenzies, Empress Pearl culturists currently use special tools to slide the plastic nucleus behind the mantle of the abalone and insert it into the cavity in the "horn" of the shell, from which the abalone has difficulty ejecting it. This process must be done with great care, as abalones are "hemophiliacs" and will likely die if wounded. The blister pearls take about 30 months to grow, at which time they are cut from the shell, filled with a polymer, and backed with abalone shell. The abalones can only be used for pearl culturing once, after which the meat is sold to restaurants and stores.

An article on this subject is intended for a future issue of *Gems & Gemology*.

Update on Namibian spessartine. Namibian spessartine—sometimes called "Hollandine" or "Mandarin" garnet—has been described in earlier Gem News sections, including Spring 1993 (pp. 61–62), Winter 1993 (p. 293), and Summer 1995 (p. 134). This material was conspicuous at the Tucson shows this year, especially a noteworthy 29.71 ct stone and some matrix specimens (figure 7).

The Summer 1995 Gem News section described the chemistry of these garnets. Contributing Editor Henry A. Hänni, who provided the analyses for that report, has sent additional information. At this time, two companies are working at least two different mining sites in northwest Namibia. The SSEF Swiss Gemmological Institute received the first material they examined from Israel Eliezri, of Colgem Ltd., Ramat Gan, Israel, who is working with one of the mines in northwest Namibia. The mining area lies in metamorphic terrain in a remote region just east of the Skeleton Coast and south of the Kunene River (which forms the northern border with Angola), near the Marienfluss River. The parent rock consists of inclined mica schist strata in which the spessartines occur both as nodules and as beautifully developed idiomorphic crystals. At Tucson, Mr. Eliezri informed another editor (MLJ) that the garnets are found in the black streaks of higher manganese concentration that run through the host rock. Frequently, the garnets nucleate on individual particles of black manganese oxide.

In Winter 1993, SSEF received Namibian spessartines from another mine, worked by Alan Roup of G.E.M. Namibia Pty. Ltd., Jerusalem, Israel. This mine is 28 km south of the Kunene River contact with the Marienfluss, and 320 km by road northwest of the village of Opuwo. The mine is situated along a ridge that consists of mica schist—similar to the Colgem occurrence—which protrudes from the desert plain. Here the garnets also occur in (somewhat larger) nodules, but the nodules appear to have been fractured at some point in the past. Fibrous inclusions reduce the clarity in much of the most recently found material, although the garnets are comparable in color to those from the Colgem occurrence.

SSEF analyses of the spessartines from the Kunene occurrence revealed characteristics similar to those previously reported: R.I.—1.789–1.790; optic character—isotropic; S.G.—4.12 to 4.14; absorption spectrum (with a handheld spectroscope)—dominant lines at about 412, 424, 432 (edge), 462, and 485 nm (typical of spessartine) as well as a line at 495 nm. X-ray diffraction analysis gave a unit-cell edge length (lattice constant *a*) of 1160.2 picometers (11.60 Å).

The chemical compositions of seven samples, as measured by electron microprobe on at least two points

Figure 8. Among the features seen in spessartine from Kunene, another Namibian locality, are colorless fibers (tirodite) and black anhedral inclusions (iron and manganese oxides). Photo courtesy of SSEF; magnified 30×.

per stone, and normalized to garnet end-members, were in the following range: 12–15 mole percent (mol%) pyrope; 0.0–1.5 mol% almandine; 84–86 mol% spessartine; and 1.0–1.5 mol% grossular. We can understand the color of these garnets, given this chemistry. The Kunene material contains almost no almandine component, which adds a brown tint to the bright orange color when present. Any almandine component present would be very strongly colored, so that only concentrations less than 1 mol% do not appreciably influence the spessartine color. In addition, pure pyrope and grossular are colorless, so these components do not add color but dilute the intrinsic spessartine color.

Among the inclusions observed were colorless grains (found to be quartz), colorless fibers, and black anhedral shapes (figure 8). These inclusions were identified by SEM-EDS and microprobe. In the Summer 1995 Gem News section, the colorless fibers—birefringent acicular crystals—were tentatively identified as tremolite, undoubtedly because they resemble the tremolite inclusions in Sandawana emerald. Professor B. Lasnier, from Nantes (France), suggested that they might be tirodite (figure 9), a Mn-Mg-amphibole, which SSEF has confirmed by SEM-EDS and X-ray diffraction analysis. The black inclusions were ilmenite, hematite, and senaite, a Mn-Fe-Ti-Pb oxide that occurred as tiny black spots in some of the spessartines. One inclusion was identified as barite by means of the Raman microprobe.

The pure orange seen in most of the Namibian production is also encountered in some spessartines from California (the Little Three Mine) and Madagascar.

Large taaffeite crystal from Sri Lanka. U. A. Ranatunga, of Lanka Rare Gems Exporters and Lapidary, Ratnapura, Sri Lanka, showed one of the editors (MLJ) a light purplish pink rounded bipyramidal crystal with some iron staining on its surface. A gemological report that accompanied the crystal said that it was a 36.05 ct taaffeite, with refractive indices between 1.718 and 1.723; the report also contained a photograph that clearly matched the crystal.

Tanzanite beads. Among the more unusual items we saw this year were four single-strand necklaces of graduated, faceted tanzanite beads (much like the emerald beads mentioned in last year's Tucson report, Spring 1995, p. 61). Seen at the booth of the Black Star Trading Company of Flagstaff, Arizona, these strands were about 36 cm (14

Figure 9. In some broken pieces of Kunene spessartine, tirodite fibers were seen extending above the surface, here by about 7.5 mm. Photo courtesy of SSEF.

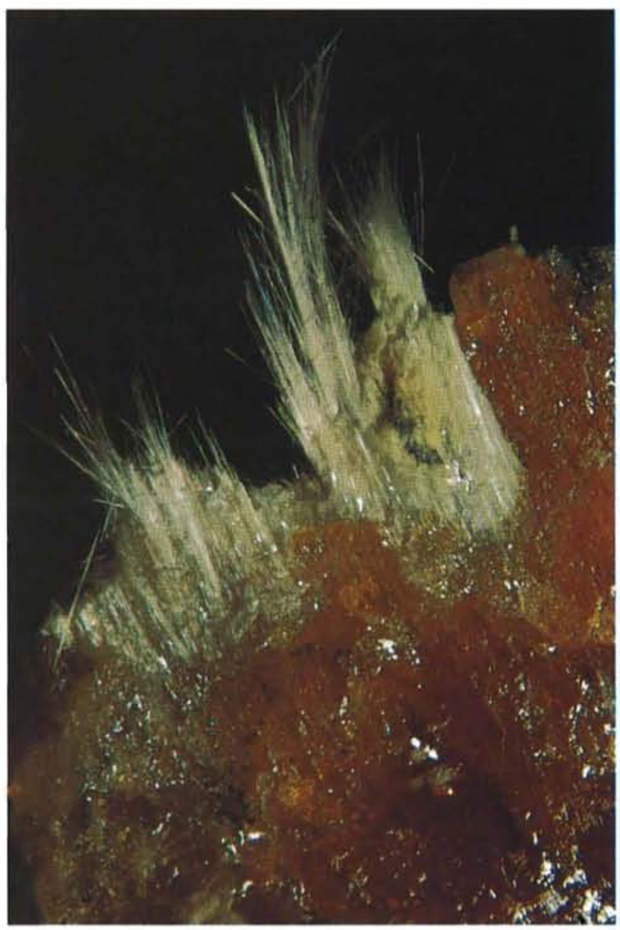


Figure 10. This 7.19 ct alexandrite (as it appears in fluorescent [left] and incandescent [right] illumination) is from the Tunduru region of Tanzania. Photos by Robert Weldon.

inches) long. The largest bead measured about 5.5 mm in diameter. Some variation in body color—from blue to violet—was noted among the beads, and many contained small black inclusions.

Gem materials from the new locality at Tunduru, Tanzania. Finds of gem materials in Tanzania were reported in the Spring 1995 (pp. 64–65) and Summer 1995 (pp. 133–134) Gem News sections. At Tucson this year, we saw a broad variety of gem materials from the region near the town of Tunduru, in the far south of Tanzania. Many dealers have likened the wealth of gem species in the area to that of Sri Lanka. Steve Ulatowski of New Era Gems, Grass Valley, California, said that among the gem materials from Tunduru are: ruby; blue, pink, and other colored sapphires; spinel; chrysoberyls, including an unusual "mint" green (vanadium) variety, as well as alexandrites and cat's-eyes; garnets, including chrome pyrope, rhodolite, color-change, and light pink garnets; tourmaline; topaz; amethyst; tsavorite; zircon; and even some diamonds. Horst Krupp, of La Costa, California, confirmed this list and added that aquamarine—as well as green, white, and yellow beryls—have also been found in this area along arteries of the Ruvuma River. (He also noted that gem materials are being recovered across the border, in Mozambique.) Especially notable at Tucson was a 7.19 ct alexandrite from Tunduru (figure 10), shown by Michael Couch and Associates of Cumming, Iowa.

Unwilling or unable to specify exact amounts, producers would only say that quite a lot of material had been removed from Tunduru. Many reported a vast gem field (Dr. Krupp estimated that the gem-bearing area exceeded 500 km^2 [about 200 square miles]) that appears to hold large reserves (figure 11). Most of the mining, which is almost entirely alluvial, was proceeding with the use of very simple techniques, but some miners had pumps. One of the more sophisticated operations (figure 12) used a motorized dredge to mine around rocks in deep areas of the river.

In mid-January, all mining permits held by foreign nationals in were suddenly revoked. New regulations, as of March 1, prohibit mechanized mining in Tunduru and restrict claims to Tanzanian nationals, according to Abe Suleiman in the April 1996 *ICA Gazette*. To further pro-

Figure 11. This aerial photo of the Muhuwesi River, part of the Tunduru gem field (taken in December 1995), shows the main gem-mining camp left of the bridge and, on the far right, the dredging area for this operation (which is about 3 km away). Photo courtesy of Randy Wiese, Michael Couch and Associates.

tect small-scale mining and develop a cutting industry in Tanzania, foreign involvement is limited to joint ventures for the export of polished goods only.

**Editor's note: We believe that the material tentatively identified as being from Songea in the Summer 1995 Gem News entry was probably from Tunduru.*

ENHANCEMENTS

Update on polymer-impregnated malachite. The Fall 1995 Gem News section (p. 213) reported on fibrous malachite that was impregnated with Opticon resin. Joe Jelks has corrected some of the information provided in that entry. Specifically, Opticon hardener *is* used at one stage of the impregnation process: Fibrous malachite (from Morenci, Arizona) is heated, filled with Opticon resin, heated again, slabbed, and heated once more, filled with Opticon resin, and heated yet again. Then, after the stones have been preformed, Opticon rèsin *with* hardener is brushed on them. Adding the hardener at this stage eliminates what would otherwise be a long wait between sanding steps in the final polishing of this material.

SYNTHETICS AND SIMULANTS

Beryl triplets imitating Paraíba tourmaline. The Winter 1995 Lab Notes section (pp. 272–273) reported on topaz triplets that resemble Paraíba tourmaline. Grimm Edelstein, of Idar-Oberstein, Germany, was marketing another Paraíba imitation—triplets that reportedly consist of top and bottom pieces of near-colorless beryl held together (and colored) by a layer of blue-green glue. These convincing pieces rapidly sold out.

Figure 12. Randy Wiese, left, works a dredge on the Muhuwesi River, near the town of Tunduru, in December 1995. Photo courtesy of Randy Wiese.

Figure 13. This 75 ct construct (about 48 × 15 × 15 mm) was made from five individually fashioned pieces of quartz. Photo by Robert Weldon.

Faceted quartz construct. A quartz construct, "Congrego 1," was one of the more unusual pieces seen at Tucson this year. Carved by Klaus Schäfer of Idar-Oberstein, Germany, the approximately 75 ct piece (figure 13) is actually a composite of five separate carvings cemented together with a UV-setting epoxy. Such a technique enables sharp re-entrant angles in the finished construct.

The construct was displayed at the booth of Bernhard Edelsteinschleiferei, also of Idar-Oberstein.

The Winter 1995 Gem News section included abstracts and field trip reports from the November 1995 International Gemmological Conference (IGC) meeting in Rayong, Thailand. This issue's Gem News presents more reports from this meeting.

DIAMONDS

Fingerprints of natural diamonds—observations with cathodoluminescence. In the laboratory at the Gemmological Association of All Japan in Tokyo, Junko Shida has conducted extensive research into distinctive growth patterns in a variety of commercially important gems, including natural and synthetic rubies, sapphires, and diamonds. Her IGC presentation concentrated on the distinct cathodoluminescence patterns shown by many natural diamonds.

Each stone has a unique pattern. Because no two are exactly alike, when such a pattern is present it serves as a distinctive fingerprint for its diamond. During her research, Ms. Shida also observed that the cutting orientation of the original rough crystal sometimes could be determined from the pattern observed in a fashioned diamond. In the cathodoluminescence image in figure 14, the triangular pattern shows that an octahedral face of the original crystal was almost parallel to the table, making this stone a "three-point" diamond. By contrast, the essentially square image in figure 15 shows that this stone is a "four-point diamond," with the orientation of the table parallel to a possible cube face in the original rough.

COLORED STONES AND ORGANIC MATERIALS

Mineral inclusions in quartz. Dr. Edward J. Gübelin of Lucerne, Switzerland, showed photomicrographs of interesting and colorful mineral inclusions in quartz, including bright blue-green dioptase crystals (figure 16). The inclusions discussed and shown in this talk all had been identified by a variety of techniques, including Raman microspectrophotometry and X-ray powder diffraction analysis.

When quartz crystallizes, associated minerals from the geologic environment may be incorporated within a developing crystal, he said. Since quartz occurs in such a wide range of geologic environments, and can be found as a major or minor component in many rock types, it is not surprising that many different mineral inclusions are found in quartz. Examination of these inclusions and their position in the host quartz can help determine mineral crystallization sequences. When sufficient inclusions are present, the growth and subsequent geologic history of a quartz crystal can be recorded.

Montana sapphires. Robert E. Kane, of Helena, Montana, briefly discussed the history of sapphire mining and current mining activities in Montana at Yogo Gulch, the Missouri River deposits, and Dry Cottonwood Creek. He also detailed the mining and processing of sapphires from the Rock Creek deposit (Gem Mountain), near Phillipsburg, Montana.

Sapphire-bearing gravels are mined using excavators and then are screened, washed, and sluiced to separate heavy concentrates (including sapphires and any gold) from the waste material. The remaining waste is returned to the mine site for reclamation. After the sapphire is hand-separated from any obvious nontransparent, nonsapphire material, the sapphire concentrate is put into methylene iodide to insure that all materials with specific gravities less than 3.32 (such as quartz) are removed. It is then cleaned in acid and put under fluorescent lamps, where any remaining garnets are removed by hand before heat treating.

Details of the heat-treatment process are regarded as proprietary. However, Mr. Kane did say that the sapphires are initially heated under oxidizing conditions, after which the fancy yellows, oranges, and pinks are ready for cutting. The blue and green stones (which constitute the majority of Rock Creek sapphires) are subsequently heated under reducing conditions.

Figure 14. Cathodoluminescence reveals that the table facet of this diamond was oriented almost parallel to an octahedral face on the original crystal. Photo by Junko Shida.

Figure 15. The square pattern revealed by cathodoluminescence means that the table facet of this diamond was oriented along a possible cube face in the original crystal. Photo by Junko Shida.

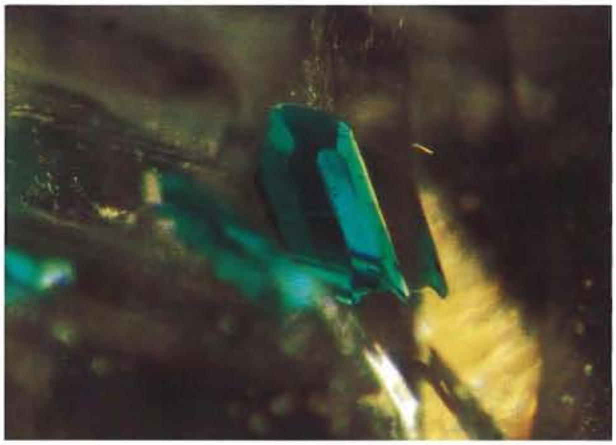


Figure 16. These colorful dioptase crystals in quartz from Congo are oriented along a growth plane in their host. Photomicrograph by Dr. Edward J. Gübelin; magnified 66×.

Sapphires and rubies from Laos. George Bosshart, managing director of the Gübelin Gemmological Laboratory, Lucerne, Switzerland, described corundum varieties found with black spinel and orange zircon in the gemstone placers of Ban Hua(e)i Sai (sometimes spelled Ban Houay Xai) in northwestern Laos, near the Mekong River and the Thai border.

Blue sapphire is the dominant gem material; however, because of sporadic production and limited quantities, this material has been absorbed by local markets rather than exported. These limitations, and the comparatively dark color of the stones, explain why Laotian sapphires have gone largely unnoticed thus far on the world market. In the past, up to six eluvial and alluvial gravel deposits have been mined in the hills and valleys behind Ban Houay Xai, usually by "independent" miners and with traditional extraction methods. The sapphires originate from nearby Quaternary alkali basalts.

Occasionally, Laotian sapphire occurs in good color. Some finished stones have weighed up to 10 ct. In addition to blue sapphires, violet-to-purple color-change sapphires and (contrary to earlier reports in the literature) small quantities of rubies in sizes below 10 mm recently have been confirmed from the open-pit diggings. Preliminary investigation of all three colors of Ban Houay Xai corundum—blue sapphires, color-change corundums, and rubies—revealed that all have properties consistent with a basaltic origin. The violet-to-purple stones appear more closely related to the rubies than to the blue sapphires, on the basis of very similar inclusions, absorption characteristics, and chemical compositions (Cr+V; (Fe+Ti)/Ga ratio). It is conceivable, therefore, that the rubies and fancy-color sapphires originate from another basaltic source in the same general area as the source for the blue sapphires.

A common problem encountered when heat treating Laotian and other basalt-associated sapphires is that of Fe^{2+}–Fe^{3+} intervalence charge transfer, which causes the gray (to black) tone typical of basaltic sapphires. However, greenish blue sapphires can be modified to light blue by a two-stage annealing (oxidizing/reducing) process, and dark blue colors can be improved somewhat by conventional heating with charcoal or petroleum. Saturated, attractive blue stones are not heat treated.

Mr. Bosshart has been studying various mineral inclusions in the Laotian corundums, using SEM, Raman, XRD, FTIR, and microscopic techniques. High-type zircon inclusions are ubiquitous and are commonly accompanied by columbite- and monazite-group minerals, albitic feldspar, rutile, graphite, and possibly apatite. Negative crystals in basal orientation, containing two-phase (fluid and gas) fillings, are surrounded by iridescent fluid rosettes reminiscent of those seen in Thai rubies.

George Bosshart confirmed recent reports of another ruby occurrence and placed it in southern Laos. He added that it is not the same as the corundum deposits recently detected in Vietnam along the Laotian border.

ENHANCEMENTS

Durability of polymer-impregnated (B-type) and natural jadeite. C. M. Ouyang, of the Hong Kong Gems Laboratory, reported on an "aging" test that she had performed on six natural jadeites and at least four polymer-impregnated (B-type) jadeite samples. Each jade sample was cut into pieces, with one piece of each retained for "before-and-after" comparisons. Samples were exposed to four types of durability tests: soaking in detergent, heating in an 80°C oven, exposure to a 40W daylight-equivalent light source, and exposure to ultraviolet radiation. After 90 days of each treatment, none of the natural

Figure 17. Part of the Guarrazar Treasure, this 11-cm-diameter gold crown has five sapphires and one iolite as drops. Photo © Patrimonio Nacional, Spain.

jadeites was affected; the B-jade samples were not affected by the lighting or UV radiation tests, were slightly affected by the heating tests, and were significantly affected by soaking in detergent.

For the detergent test, the B-type jadeites were soaked in a detergent solution (one part "washing" liquid to five parts water) for up to 90 days. The solution was stirred twice daily, and the material was examined at about two-week intervals. Surface polymer layers showed partial-to-nearly complete dissolution at the first examination (15 or 16 days); the boundaries between crystal grains became evident at 35 or 54 days (two samples); and two B-type jade samples appeared cracked at 40 and 73 days. Ms. Ouyang calculated that this corresponded to cracks appearing after 10 and 19 years' wear, respectively, if one submerged the jade in quarter-strength detergent solution (that is, one part detergent to 20 parts water) for one hour daily.

One of the four B-type jadeite samples exposed to heat showed a burn mark after 24 days at 80°C, but the others showed no change after 55 days of heating. In previous studies, Ms. Ouyang had found that B-type jadeite turns brown at 250°C, brownish black at 350°C, and "charcoal black" at 400°C (natural jadeite is unchanged by heating to these temperatures). None of the samples was affected by the tests for prolonged exposure to light or UV radiation, although more powerful sources might have produced different results.

INSTRUMENTATION

Infrared spectroscopy of Thai rubies and sapphires. Wilawan Atichat, from the Thai Ministry of Industry, examined FTIR spectra in transmission mode of 38 corundums from Chanthaburi-Trat and Kanchanaburi, in Thailand. She found seven different types of mid-infrared spectra for these samples, depending on the regions from which they came. Morphological and visual-characteristic studies of the inclusions were also correlated to the FTIR spectra. In fact, the variations present in the FTIR spectra were due mostly to inclusions (type, variety, size, shape, number, and assemblage), and were affected by the corundum chemistry to a lesser degree. With inclusion and chemistry information, these FTIR spectra could be used to determine the location from which the stones were derived.

Infrared spectroscopy distinguishes synthetic from natural emerald and quartz. In two presentations, Pierre Zecchini, of the Crystallography and Mineral Chemistry Laboratory at the University of Franche-Comté, Besançon, France, and co-workers explored the use of infrared spectroscopy to distinguish synthetic from natural materials. In the first of these talks, they asserted that spectroscopy of reflected IR radiation can be used to determine whether emeralds crystallized in nature or in the laboratory, and to separate emeralds from green beryls. Transmitted IR radiation can confirm the results from the reflected method, and it may also be used to determine whether an emerald has been impregnated.

Also covered was how infrared spectroscopy can separate natural from synthetic amethyst, citrine, and quartz of other colors. Each variety has its own typical spectra for natural and artificial crystallization; hence, the IR spectrum acquired for an unknown quartz example must be compared with standard spectra for the same variety (for instance, amethyst with amethyst; not citrine or some other variety with amethyst). Another part of this presentation concerned ametrine: Differences were seen between the compositions of the purple and yellow regions of natural ametrine. However, natural ametrine could not be clearly differentiated from ametrine obtained by heating natural amethyst.

MISCELLANEOUS

Gems from archeological excavations in Rome (Crypta Balbi) . . . Dr. Georgio Graziani, of the University of Rome, described his investigation with G. B. Andreozzi and L. Sagui of 28 gems coming from "Crypta Balbi," a Roman archeological site dating to the 7th century B.C. The identification of the materials was made more difficult by the fact that the samples had been poorly preserved and by the need for completely nondestructive (and, within limits, noninvasive) tests. Still, enough information was obtained to hypothesize about origin. The samples included a blue sapphire from Sri Lanka, an emerald from Egypt, and a piece of amber from the Baltic area. Also identified were quartz varieties (including rock crystal, carnelian, and sardonyx), as well as garnets, lapis lazuli, and corals.

. . . and gems in a Visigoth treasure. Cristina Sapalski, of the Instituto Gemológico Español, in Madrid, discussed gems from the Guarrazar Treasure. This hoard of 7th-century jeweled votive crowns (see, e.g., figure 17) and crosses was discovered in 1858 in the province of Toledo, Spain. The part of the hoard that was studied by Ms. Sapalski and her associate, Juan S. Cozar, included 243 blue sapphires, three cordierites (iolites; probably thought to have been sapphires), 14 emeralds, one aquamarine, two moonstones, nine rock-crystal quartzes, six blue chalcedonies, 21 amethysts, 169 pearls, 154 pieces of mother-of-pearl, 110 glass "stones" (green, blue, orange-brown, and of indeterminate color owing to later devitrification), and many small garnet fragments. All the sapphires had been polished, some were partially faceted, one was cut as a hollow cabochon, and one was engraved. The sapphires' gemological characteristics suggest that they came from the old Ceylon (now Sri Lanka) deposits.

ANNOUNCEMENTS

Treasures of Mexico exhibit at the Houston Museum. The Houston (Texas) Museum of Natural Science is hosting an exhibit of minerals, gems, and precious metals until September 8, 1996. "Mineral Treasures of Mexico: the Romero Collection of Gems and Minerals," includes over 200 pieces, most of which have never been seen outside Mexico. More information is available through the museum's World-Wide Web site, http://www.hmns.mus.tx.us.