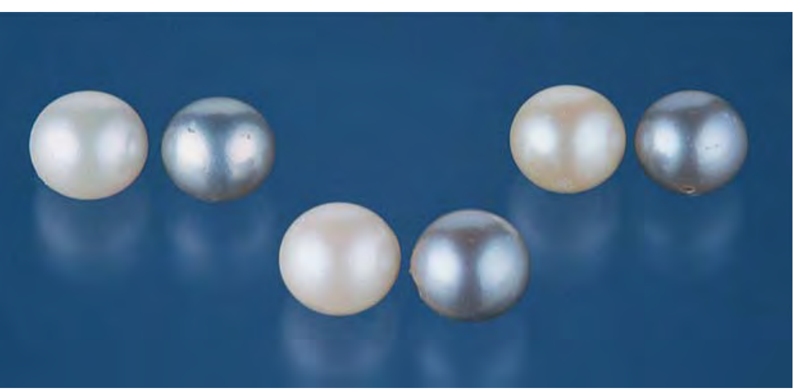
GEM NEWS International

SPECIAL REPORT

U.S. Postal Service irradiation process may affect some gemstones. The jewelry industry relies heavily on the USPS to ship gems and jewelry throughout the United States. As most are aware, the recent incidences of people being infected by anthrax spores sent through the mail has caused the postal service to seek ways to protect their employees and the public from this potential threat. One part of this effort is to use a technique that actually kills anthrax spores (and other biological agents) in the mail as it is being processed.

One company with which the postal service has contracted, SureBeam (a subsidiary of Titan Corp.), makes equipment designed to destroy food-borne pathogens such as salmonella. SureBeam uses a type of linear accelerator that creates a beam of high-energy electrons. This is the same type of ionizing radiation that is often used intentionally to change the color of some gem materials—and could produce an undesirable result as well. We at GIA and others in the trade immediately recognized the potential impact of this development on the jewelry industry and the consuming public, so we decided to test the effect of the proposed postal irradiation process on several gem materials.

Figure 1. All of the white cultured pearls turned gray with irradiation. One in each of these pairs of bead-nucleated saltwater cultured pearls (approximately 6.5 mm) was irradiated, while the other was retained as a control sample. Photo by Maha Tannous.



The Process. For these initial tests, we chose gem materials that, based on our many years of experience and discussions with experts in the field, we know may be significantly affected by irradiation. This group consisted of two types of cultured pearls plus 14 gem varieties from eight different gem species—all of which were natural—for a base of 16 sample types (table 1). We also included a 14 karat yellow gold ring, to reassure the industry that gold jewelry would not retain any residual radioactivity from this process.

We made up three sets of this sample group and placed them in boxes that were packaged in the same manner that we routinely use to ship gems from the GIA Gem Trade Laboratory. Because stones are often shipped through the mail more than once (e.g., sent out on memo, returned or sent to a manufacturer for mounting, and then returned or sent to someone else), we asked to have one package scanned just once, another scanned twice, and the third scanned four times—to see if the cumulative effect of multiple scans caused any significant difference.

The contents of the boxes were identical, except that there was only one heavily included gray diamond. We placed this in the package that was to receive four scans to determine whether it would retain any residual radioactivity, as is often detected in irradiated black diamonds.

A spokesman for SureBeam told us that the dosage being used by the postal system is 56 kilograys (kGy), which is equivalent to 5.6 megarads. This figure was later confirmed by Laura Smith, quality assurance manager for Titan Scan Technologies, another Titan Corp. subsidiary, who agreed

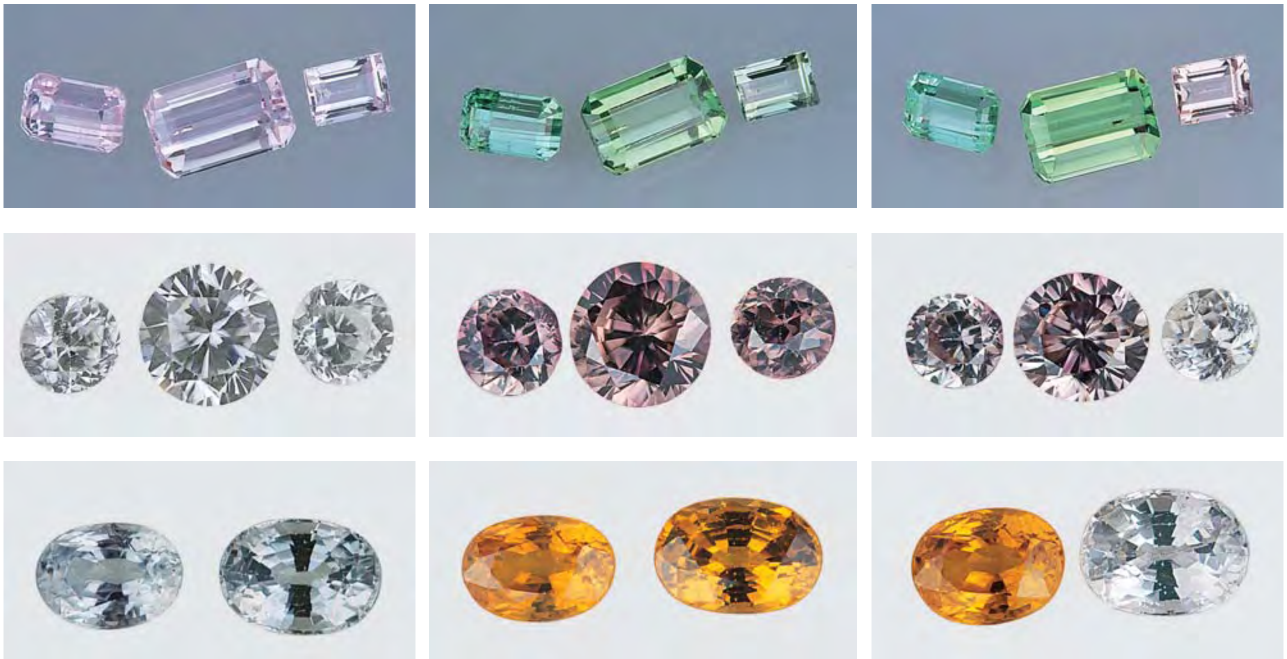


Figure 2. Distinct changes were seen in the color appearance of spodumene (top row, 1.13–4.24 ct), zircon (middle, 0.51–1.39 ct), and sapphire (bottom, 0.60 and 0.72 ct) following simulated USPS irradiation and subsequent fade-testing experiments. For each gem variety, the photo on the left shows the material before irradiation, the middle photo was taken after irradiation, and the image on the right shows the final result of fade testing (far right stone only). Photos by Maha Tannous.

TABLE 1. Gem materials exposed to irradiation conditions used by the USPS.

Gem material	Before	After
Diamond	Near colorless	Near colorless; *no change*
Diamond	Gray (due to inclusions)	Gray; *no change*
Spodumene	Pink (kunzite)	Green
Beryl	Brownish orangy pink (morganite)	Yellow
Cultured pearl: bead-nucleated saltwater	White	Gray
Cultured pearl: tissue-nucleated freshwater	White	Gray
Quartz	Colorless	Brown
Quartz	Yellow (citrine)	Brown
Sapphire	Light blue	Yellowish orange
Topaz	Colorless	Brown
Tourmaline	Near colorless	Light pink
Tourmaline	Light pink	Darker pink
Tourmaline	Bicolored green and pink	Green; *no change* Pink; darker
Zircon	Colorless	Pinkish brown
Zircon	Yellow	Yellowish brown
Zircon	Green	Greenish yellowish brown

to run tests for us under the same conditions being used by the U.S. Postal Service. Ms. Smith confirmed, however, that the figure is approximate, as our three packages were exposed to the following doses:

Package A – one scan – 51.0 kGy
Package B – two scans – 113.5 kGy total
Package C – four scans – 251.7 kGy total

Results. After we retrieved the packages, we first checked for the presence of residual radiation with a Victoreen model 290 radiation survey meter. No residual radiation was detected from the unopened packages or any of the individual samples.

Next, we examined each stone for obvious changes in appearance. (Changes in absorption spectra and analytical data will be addressed in future research.) All of the gem materials other than diamond showed a dramatic change in color (see table 1; figures 1 and 2).

***Editorís note:** Bylines are provided for contributing editors and outside contributors; items without bylines were prepared by the section editor or other G&G staff. All contributions should be sent to Brendan Laurs at blaurs@gia.edu (e-mail), 760-603-4595 (fax), or GIA, 5345 Armada Drive, Carlsbad, CA 92008.*

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For most of the samples, the changes were just as dramatic in the box that went through only one scan as in the box that went through four. However, the degree of change was different for some stones. For example, the colorless quartz in the box that was scanned once came out a medium brown; a similar sample in the box scanned twice turned dark brown; and the third sample, scanned four times, became almost black.

Some of the color changes produced by radiation exposure are known to be unstable to light or heat. (For more on the color stability of irradiated gems, see K. Nassau, *Gemstone Enhancement*, 2nd ed., Butterworth-Heinemann, Oxford, 1994.) Therefore, we performed some simple experiments on selected samples to try to return them to their original, pre-irradiation color. The stones included sapphire, kunzite, and (originally colorless) zircon. In each case, we tested one of the three irradiated samples and saved the others for comparison.

In an attempt to fade these stones under realistic conditions, we taped them to a south-facing window on a sunny day in December, and checked their color periodically. After approximately 2.5 hours, the green color that had been induced in the kunzite and the pinkish brown in the zircon had completely disappeared, and the stones had returned to essentially their original colors. It is interesting to note that the other two zircons showed noticeable color fading even though they had been kept in the stone paper and were removed only briefly for photography.

The sapphire slowly lost color and became more yellow than orange. After 36 hours, the stone had faded to light yellow and was removed from the window to be photographed. In an attempt to return the stone to its original light blue color, we gently heated it in the flame of an alcohol lamp. This method was successful in removing the remaining yellow color. However, the original blue hue did not return, and the stone was left colorless (again, see figure 2). According to Dr. John Emmett (pers. comm., 2002), if the stone were heated to significantly higher temperatures in a reducing atmosphere, the blue color should be restored.

Implications for the Future. Currently, the USPS is scanning only a small portion of the mail and only letters and flat envelopes. John Dunlap, manager of Materials Handling and Deployment for the USPS Engineering Group (pers. comm., 2001), which oversees mail sanitization operations, told us that "Probably nothing will be done to packages that are sent registered or certified [the preferred method for the jewelry industry], since we now require information from the sender." Other postal authorities have commented that the cost and time required to sanitize all mail would be prohibitive.

We also contacted the U.S. Customs Service, Brinks, Malca Amit, UPS, and FedEx, and learned that no irradiation procedures were being used or were planned by them at this time. Nevertheless, it is important that members of the trade and the consuming public alike be aware that some gem materials could be affected by the procedure, and every effort should be made to ship such materials by methods that are not likely to be exposed to the irradiation process.

We recognize that other gem species or varieties, including ruby and emerald, may be affected to lesser degrees by this radiation dosage. Also, not all members of the same species or even the same variety should be expected to react similarly. For example, according to Dr. George Rossman of the California Institute of Technology (pers. comm., 2001), it is less likely that blue sapphires from basaltic deposits (e.g., Thailand or Australia) will show a change in color. In the second phase of our testing, which is already underway, we will investigate these and many more questions about this newest concern to the gem industry.

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CONFERENCE REPORTS

28TH INTERNATIONAL GEMMOLOGICAL CONFERENCE

Held in Madrid, Spain, on October 8–12, 2001, the 28th IGC attracted 38 delegates and 25 observers from 22 countries. The participants consisted of gemologists (laboratory and academic), gem cutters and dealers, geologists, archaeologists, instrument designers, museum curators, physical scientists (e.g., spectroscopists), synthetics manufacturers, editors, educators, and more. An abundance of information was exchanged, and new ideas were germinated that should help advance many aspects of gemology, from exploration for new deposits to new approaches to protecting the consumer.

The IGC is a biennial event, and this year's conference was organized by the Instituto Gemológico Español, with Cristina Sapalski as the executive secretary. The 51 presentations (44 oral and seven posters) covered a variety of topics. This report, prepared by IGC participants Dr. Alfred A. Levinson, Robert E. Kane, and Michael E. Gray, is a summary of selected presentations that provide a significant amount of new information for *G&G* readers.

Update on Piteiras emeralds, Minas Gerais, Brazil. Dr. Jan Kanis, a consulting geologist from Veitsrodt, Germany, provided an update (as of May 2001) on the exploration, geology, and recovery of emeralds at the Piteiras property, which is part of the Itabira emerald belt (see Spring 2001 GNI section, pp. 68–69). A 140-m-long tunnel with a 12% decline has been completed to access the emerald-bearing zones, from which further bulk sampling is taking place. An automated plant is used to process the emerald-bearing schist and associated quartz-feldspar veins, and 24 workers hand-pick the emeralds from the concentrate along three conveyor belts. Fine facet- and cabochon-grade rough has been recovered, and most of the stones range from 3 to 12 mm. However, some large (more than 2 kg), mostly non-gem-quality emerald crystals also have been recovered (figure 3). Electron microprobe analysis of four emerald crystals revealed an average of 0.60 wt.% FeO, 0.33 wt.% Cr_2O_3, and 0.03 wt.% V_2O_3.

Update on jadeite mining in Myanmar. In February 2000, Robert E. Kane of Fine Gems International, Helena, Montana, visited the Nansibon jadeite mines in northern Myanmar (see also R. W. Hughes et al., "Burmese jade: The inscrutable gem," Spring 2000 *Gems & Gemology*, pp. 14–15). These mines are located within the Hkamti region, which is arguably the most important source of green jadeite in the world today. The two main mining areas—Natmaw and Nansibon—are separated by about 32 air km (20 miles).

At Natmaw, the jadeite occurs in two types of deposits: (1) primary—as dikes and veins in serpentinite, and (2) secondary—as jadeite pebbles and boulders in conglomerate. The primary deposits are mined using conventional pneumatic drilling and blasting; the pebbles and boulders found usually come from the Natmaw River. At Nansibon, an area of jadeite-bearing conglomerates is divided into nearly 175 one-acre cooperative joint-venture mining claims that are worked by both traditional hand methods and modern mechanized mining techniques (figure 4).

The Myanma Gems Enterprise, a subsidiary of the government's Ministry of Mines, oversees jadeite mining in the Nansibon and Natmaw areas, and has a valuation facility in the town of Hkamti. The jadeite is categorized according to three grades: (1) Gem Quality, (2) Commercial, and (3) Utility. Valuation is based on standardized pricing guidelines. After valuation, the jadeite is sent to trading and cutting centers directly or via Mandalay.

Figure 3. This large (18 × 9 cm) emerald crystal was recently recovered from the Piteiras property in Minas Gerais, Brazil. Photo courtesy of Jean-Marc Lopez.

Figure 4. The Nansibon region of northern Myanmar is an important source of fine-quality Imperial jadeite. This is the largest jadeite mining operation in the area, the Hjar Maw joint venture. Photo by Robert E. Kane.

The structure of opals. The structure of play-of-color opal of sedimentary origin (e.g., Australia) is classically described as a three-dimensional stacking of silica (SiO_2) spheres. However, Dr. Emmanuel Fritsch of the University of Nantes, France, explained that this is an over-simplification applicable only to highly porous, hydrophane opal. In opals typically encountered in the gem trade, the spheres coalesce to the point that the structure is best described as a network of holes (i.e., the spaces remaining between the spheres) in a solid silica matrix.

In opals of volcanic origin (e.g., Mexico), no such spheres are observed on freshly broken surfaces of play-of-color material. Only after etching with dilute hydrofluoric acid is a network of spherical holes observed. These holes are about 200 nm in diameter, in a residual "honeycomb" composed of small siliceous grains (20–40 nm each). These grains appear to be the true elementary building blocks of many opals. Because of their small size, they are best observed with an atomic-force microscope (figure 5). In volcanic opals without play-of-color, these small grains are disordered. They sometimes coalesce to form fibers (in pink opal) or platy crystals of disordered cristobalite in opal CT (in most volcanic opals). The ~200-nm-diameter spheres observed in play-of-color sedimentary opals from Australia or Brazil are on rare occasions built of concentric layers of small grains.

Transparent green orthoclase feldspar from Vietnam. Dr. Johann Ponahlo of the Natural History Museum, Vienna, Austria, described green orthoclase that first appeared in gem markets at Luc Yen, in northern Vietnam, in 1997. The material is predominantly opaque, but some translucent and transparent pieces have been sold as polished gems, represented as jadeite or amazonite. Mineralogical studies have established that the material is orthoclase

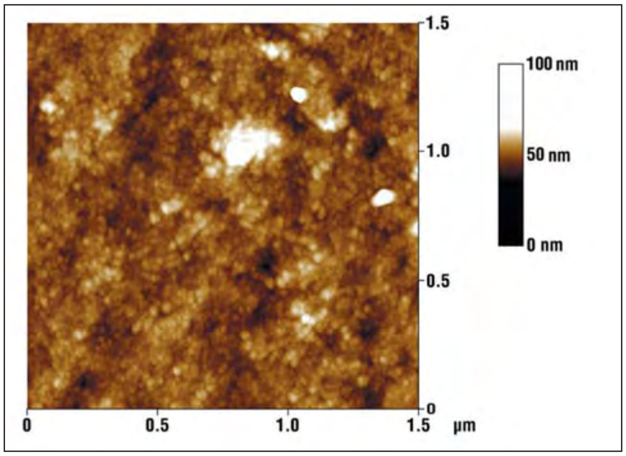


Figure 5. Atomic-force microscopy of the freshly broken and etched surface of a volcanic fire opal from Kazakhstan shows that it is composed of an agglomeration of small silica grains that are typically about 20 nm (0.02 µm) in diameter. The field of view is 1.5 × 1.5 m m, and the colors correspond to the topographic relief of the broken surface. Micrograph by David Albertini.

because it is a monoclinic K-feldspar (amazonite is a green Pb-bearing triclinic K-feldspar). Unique to this locality, the orthoclase contains inclusions of small ruby crystals, which were identified by their strong red cathodoluminescence (CL) and characteristic CL spectrum. A strong CL band at 822–834 nm also is characteristic of orthoclase from this locality. The green color is attributed to an unusually high lead content (0.5 wt.% PbO), which is also unique to orthoclase from the Luc Yen area.

Cultured mabe pearls from North Queensland, Australia. Dr. Grahame Brown of Brisbane, Australia, reviewed the culturing process, production, and quality characteristics of the bead-nucleated mabes that are cultured by Indian Pacific Pearls Ltd. in subtropical waters off Orpheus Island, 80 km north-northwest of Townsville. When they reach approximately 120 mm long, one-year-old *Pteria penguin* oysters (also known as penguin or black wing oysters) are implanted with five polymer nuclei of various shapes. After 18 months the mabes are harvested, with a nacre thickness of ~0.5 mm. After processing, about 40% of the cultured mabes are marketable (figure 6).

The cultured mabe pearls are 12–16 mm in diameter. Their nacre is highly iridescent, in colors that range from white-"silver" to "silver"-brown, and a most desirable slightly brownish "gold." Some are attractively patterned by the intergrowth of black calcite that lines the outer margin of the mollusk's shell. When exposed to long-wave UV radiation, the white to "silver" nacre fluoresces a strong blue and the brown and black material is inert.

"Young" and "old" sapphires from Australia and Southeast Asia. Australia and Southeast Asia have been the sources of large amounts of sapphire associated with basaltic rocks. It is universally accepted by geologists that the sapphires did not crystallize directly from the basalts; rather, the basalts merely were the transporting mechanism that brought the sapphires to the surface. Over the past decade, two types of sapphires associated with basalts from these areas have been recognized, based on variations in their trace-element contents. Dr. F. L. Sutherland of the Australian Museum, Sydney, postulated that sapphires with a Cr_2O_3/Ga_2O_3 ratio less than 1 crystallized from a magma, whereas those with a Cr_2O_3/Ga_2O_3 ratio greater than 1 formed by a metamorphic process.

To help prove this hypothesis, Dr. Sutherland and coworkers have obtained information on the age of sapphires from both inferred origins. Sapphires of such different geological origins should show discrete differences in their crystallization ages. Syngenetic zircon inclusions (figure 7) in both types of sapphire were dated by uranium-lead isotope methods. Vastly different ages (ranging from 2.8 to 900 million years) were obtained in a study of Australian sapphires of both types, from Queensland and New South Wales. The younger ages correspond to sapphires with a magmatic origin, while the older sapphires have trace-element ratios that indicate a metamorphic origin. The youngest ages obtained so far (1.1–1.5 million years) were found in magmatic-type sapphires from Laos.

Spanish gem deposits. Cristina Sapalski gave an overview of gem and mineral localities in Spain (see also J. C. Guinea and E. G. Huertos, "Mapa Gemológico y Previsor de España," Instituto Gemológico Español and Instituto Geológico y Minero de España, Madrid, 1986). These include: sapphire and spinel in marble deposits at Villanueva de Bogas (Toledo); cinnabar and mercury at the world-famous Almadén deposits; topaz from greisens at the Valle de la Serena mine (Badajoz); hematite and mala-

Figure 6. These cultured mabe pearls were harvested from Pteria penguin *oysters near Orpheus Island, North Queensland, Australia. Photo by Grahame Brown.*

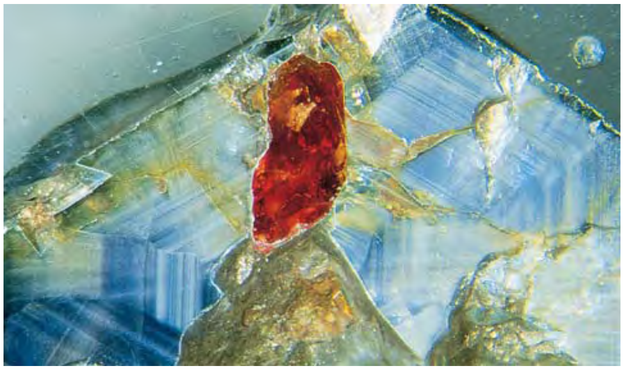


Figure 7. Uranium-lead isotopic dating of this 3-mm-long red-orange zircon inclusion in an Australian sapphire from Lava Plains, Queensland, suggests a crystallization age of 3 million years and a magmatic origin. Photo by Gayle Webb, Australian Museum.

chite at the Jayona mine; scapolite, sphene, and other minerals in skarns at Burguillos del Cerro and Jeréz de los Caballeros (Badajoz); turquoise from hydrothermal veins at Valdeflorez (Cáceres); rose quartz from a pegmatite at Oliva de Plasencia (Cáceres); goshenite in cavities within the Pereña pegmatite; and variscite at Palazuelo de las Cuevas. Currently, there is little or no commercial production of gem-quality material from these occurrences.

Tsavorite from Tanzania and elsewhere. Menahem Sevdermish of the European Gemological Center and College, Ramat Gan, Israel, reviewed currently known localities for tsavorite and recounted the cutting of a 192 ct piece of tsavorite that was recovered from the tailings of the old Titus tsavorite mine in Tanzania (see Spring 2001 GNI, pp. 72–73). Tsavorite was originally found and described from the Tsavo National Game Park in Kenya. However, over the last few years Tanzania has surpassed Kenya in production of this gem. Today, there are five main sources of tsavorite in Tanzania (see figure 8), each of which produces gems with slightly different color characteristics. However, their gemological characteristics (e.g., R.I. and S.G. values) are essentially identical.

Advanced spectroscopic methods applied to gem materials. Drs. Jean-Marie Dereppe and Claudette Moreaux of the University of Louvain, Belgium, reviewed a variety of nonconventional spectroscopic methods such as neutron activation analysis (NAA), Mössbauer spectroscopy, nuclear magnetic resonance (NMR), and X-ray photoelectron spectroscopy (XPS, also called electron spectroscopy for chemical analysis [ESCA]). These different methods can be used to help determine the locality of origin of natural gemstones and detect new synthetics or treatments.

Synthetic and enhanced gems from Russia. An update on synthetics, simulants, and gem treatments from Russia was provided by Dr. Vladimir S. Balitsky of the Institute of Experimental Mineralogy, Russian Academy of Science, Chernogolovka, Russia. Several government institutes and about 30 companies have succeeded in manufacturing almost all known gems, whether their natural counter-

Figure 8. This map shows the five major tsavorite-producing localities in Tanzania (Komolo, Merelani Hills, Ruangwa, Tunduru, and Umba) and one in Kenya (Voi, near the Tsavo National Game Park). The characteristic colors of the tsavorites from each locality also are illustrated. Courtesy of Menahem Sevdermish.

Figure 9. Russian gem treaters are experimenting with surface-coloring technologies using a high-temperature process in the presence of cobalt and other metals and their oxides. This 1.17 ct reddish orange sapphire and 2.62 ct orangy yellow topaz were treated in this fashion. Courtesy of Vladimir S. Balitsky; photo by Maha Tannous.

parts are abundant (e.g., some varieties of synthetic quartz) or relatively uncommon (e.g., synthetic alexandrite, morganite, and moissanite), and representing a broad value range (e.g., synthetic emerald, play-of-color opal, malachite, and turquoise). In some cases, they are being manufactured in huge amounts—such as a few thousand kilograms annually of synthetic amethyst, ametrine, ruby, and sapphires of various colors—by every major method of synthesis (including hydrothermal, flux, Czochralski, and floating zone). Also being manufactured are large quantities of simulants, such as YAG, GGG, and CZ.

The Russians are enhancing the appearance and/or physical characteristics of several natural gems, including: agate, amazonite, amber, charoite, corundum, danburite, demantoid garnet, heliodor, lazurite, nephrite, quartz, topaz, and turquoise. A variety of techniques are used, such as heat treatment, impregnation, and dyeing. Gem treaters are also developing new surface-coloring technologies. For example, they are using a high-temperature process that chemically alters the surface of stones to turn colorless and pale-colored sapphires an attractive blue. Quartz and topaz are also enhanced by this process (see, e.g., figure 9).

The future will likely see increased production of larger and better synthetics (e.g., diamonds), as well as advances in enhancement techniques. Clearly, Russia is a leader in these fields.

Recent observations at CISGEM. Dr. Margherita Superchi of the Centro Informazione e Servizi Gemmologici (CISGEM), Milan, Italy, focused mainly on the recent discovery of gem-quality rhodizite from Antetezantsio in central Madagascar, which she compared to the new gem mineral londonite, $(Cs,K,Rb)Al_4Be_4(B,Be)_{12}O_{28}$. The latter was discovered at nearby Antsongombato (see W. B. Simmons et al., "Londonite, a new mineral species: The Cs-dominant analogue of rhodizite from the Antandrokomby granitic pegmatite, Madagascar," *Canadian Mineralogist*, Vol. 39, 2001, pp. 747–755). The Antetezantsio rhodizite ranges from colorless to yellow-green or very light bluish green (figure 10). Preliminary chemical data reveal a relatively high content of rubidium.

Dr. Superchi also discussed a new bead that is being manufactured in Australia for pearl culturing. The bead is made from sintered dolomite, $CaMg(CO_3)_2$, and spheres from 13 to 15 mm in diameter have been used to nucleate South Sea cultured pearls on at least one Indonesian farm. The material has an S.G. of 2.84 and is opaque to X-rays.

A code of ethics for gemologists and jewelers. Dr. Roger Harding of the Gemmological Association and Gem Testing Laboratory of Great Britain (GAGTL), discussed an important matter for gemologists and jewelers—a general code of practice and behavior in business. This topic has particular relevance today because business practices have changed significantly in recent years. For example, via the Internet, traders are more often dealing with people they do not know. Also, the need to disclose enhancements and synthetics is more important than ever before to safeguard the future of the gem and jewelry industry.

Dr. Harding reviewed the codes of conduct, practice, and/or ethics, as well as disciplinary procedures and remediations, of four professional organizations in Great Britain: the National Association of Goldsmiths, the Geological Society, the Registered Valuers, and the London Diamond Bourse and Club. He noted large differences, especially in detail, among them, even though all operate within the same region. Based on these preliminary findings, Dr. Harding concluded that it would be difficult to compile a detailed "code of practice" that would be both applicable and acceptable to all segments of the gem and jewelry industry. Accordingly, GAGTL is considering a general code of conduct, and would welcome input from similar organizations worldwide.

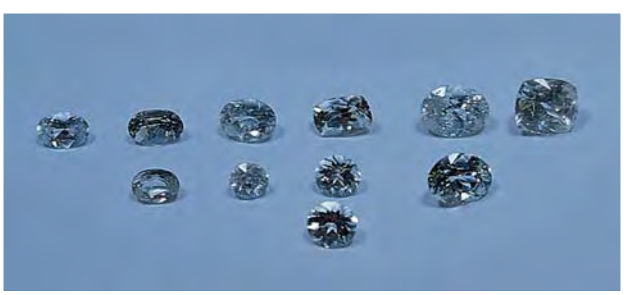
Hardness testing of gemstones. It is well known that some gems show variations in their hardness according to crystallographic orientation. For example, the Mohs hardness of kyanite ranges from 4.5 to 7, and diamond must be oriented in specific directions during cutting. Michael Gray of Coast-to-Coast Rare Stones Intl., Missoula, Montana, reported that *every* mineral species should have some variation in hardness according to crystallographic orientation. Hand-held testers have been developed that use traditional (scratch) techniques to accurately measure hardness in a matter of seconds. These instruments could be used to help confirm the identity of gem materials, even when mounted, because the mark they leave is imperceptible without magnification. Mr. Gray proposed using this technique to reexamine the accepted hardness of various mineral species; to determine if there are differences in directional hardness between heat-treated gems (such as corundum) and synthetics, as compared to their natural counterparts; and to investigate whether gems from different localities show differences in hardness.

Diamond presentations at the annual AusIMM and Australian Diamond Conferences. The annual Australasian Institute of Mining & Metallurgy (AusIMM) meeting, held November 6–8 in Melbourne, was attended by 650, down from 2,000 the previous year. Meanwhile, attendance at the Australian Diamond Conference, held December 3–4 in Perth, was 240, which exceeded the attendance three years ago at 180.

Many presentations at the two meetings overlapped. The highlight of both conferences was the address given by Miles Kennedy, chairman, and David Jones, exploration manager, of Kimberley Diamond Co. (KDC), which in 2000 purchased the mining rights to the Ellendale project in the West Kimberly region of Western Australia. The area contains two large (78 and 45 ha) diamondiferous lamproites, and evaluation by KDC has shown that parts of their western peripheries have enriched surface zones down to 3 m (10 feet) that contain 470,000 tonnes at 26 carats/tonne (pipe 4) and 500,000 tonnes at over 12 carats/tonne (pipe 9). During evaluation, good-quality diamonds weighing 8.04 ct, 7.90 ct, and 6.88 ct were found. Mining is scheduled to start in April or May 2002. With a projected production of 400,000 carats per year, Ellendale will be Australia's third diamond mine after Argyle and Merlin.

Gordon Gilchrist, managing director of Argyle Diamonds, remarked that diamonds now comprise about 10% of Rio Tinto's business. With the recent completion of development work for enlarging the open pit at Argyle, annual production will climb back to 30 million carats (Mct), up from its present 24 Mct. The Merlin mine produces 70,000 carats annually, and Canada's Diavik mine will go on-line in mid-2003 with 2.6 Mct projected for the year. Diavik's planned full production of 7.8 Mct annually will be reached in mid-2005. Other Rio Tinto projects include the Murowa pipes in Zimbabwe, which may start production in 2003 with an initial output of 400,000 carats per year, and an unnamed venture in Brazil.

Figure 10. The Rb-rich rhodizites shown here (up to 1.15 ct) were recently mined from the Antetezantsio pegmatite in central Madagascar. Courtesy of Margherita Superchi.



Bill McKechnie, group manager of exploration for De Beers South Africa, gave a diamond industry overview from the De Beers perspective. Production among the three largest producers stands as: De Beers—31% by weight, 44% by value; Russia—18% by weight, 20% by value; and Rio Tinto—43% by weight, 4% by value. De Beers's new producers will be Snap Lake, starting in 2005 with 1.7 Mct annually; the new small pipe east of Orapa (Botswana), starting in 2002 with 170,000 carats per year; Mwadui (Tanzania) redeveloped and in full production in 2003 at 250,000 carats per year; and the Premier C-cut (South Africa), in full production by 2008 at 3 Mct per year. The company's exploration in Canada centers on three areas: the Victor pipe in the James Bay Lowlands (with diamonds valued at US$160/ct), the Fort à la Corne area in Saskatchewan, and the Kennady Lake area in the Slave province of the Northwest Territories (NWT).

Elsewhere in Canada, Tahera Corp.'s Joseph Gutnick described the discovery of the new Coronation district of diamondiferous kimberlites, 120 km northwest of the company's Jericho project in Nunavut. Jericho may become Canada's third diamond mine, ahead of De Beers's Snap Lake.

Stephen Cooper, Wolf Marx, and Leon Daniels of Orogenic Exploration and Tawana Resources discussed the Flinders Island prospect off the west coast of South Australia, where drilling will begin in January 2002. Linda Tompkins, technical director of Elkedra Diamonds, outlined the geologic merits of exploring the Altjawarra craton in the southeastern part of the Northern Territory. Various companies presented case histories of discovery, sampling, and exploration at other Australian projects, but they did not include any new mine feasibility studies.

Presentations on diamond projects elsewhere included: Namakwa Diamond Co.'s development of onshore diamondiferous beach deposits, 12–47 km north of the Olifants River in Namaqualand, South Africa; African Mining & Petroleum Resources' Bobi diamond project in the Ivory Coast, which aims to start mining an alluvial deposit in January 2003 at a rate of up to 50,000 carats per year of diamonds valued at US$100/ct; and an alluvial deposit in Brazil's Abaete River that is shared by Australia's Kimberley Diamonds and Black Swan Minerals of Toronto. Namibia's mining minister, Jesaya Nyamu, pointed out that the country has profited from developing its own diamond cutting and polishing industry. Richard Russell, speaking for Mount Burgess Mining, announced the intersection of kimberlite at their Tsumkwe prospect, in northeastern Namibia. The contributor of this GNI entry, acting as technical director of Australian Indian Resources, indicated that there are still many undiscovered diamond deposits in India.

In other presentations, David Fardon, manager of polished sales at Argyle Diamonds, showed the variations in color and intensity of pink diamonds. Garry Holloway of

Precious Metals discussed how small manufacturers and retailers can shorten the pipeline by making direct arrangements with producers and establishing their own brand.

The atmosphere in Melbourne among the metal miners and explorers was subdued, but in Perth the mood was different. Despite the present poor economic climate, diamond explorers remain optimistic. The success of the initial prospectus offer for Elkedra Diamonds showed that it was still possible to raise capital for a new project. Many junior diamond exploration companies are still venturing into Africa and India. Rio Tinto and De Beers are each investing millions annually for exploration in Australia and Canada. The biggest challenge will be to increase demand for diamonds in order to keep up with increasing production.

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COLORED STONES AND ORGANIC MATERIALS

Figure 11. Even in times of war, Afghanistan has produced an abundant supply of gems, such as this tourmaline (12.1 cm tall, with stilbite and cleavelandite) from a pegmatite in Paprok, Nuristan Province. Courtesy of Steve Neely; photo © Jeff Scovil.

Gem resources of Afghanistan. If wars and tribal conflicts were not tearing the country apart, Afghanistan could produce as much as $300–$400 million in colored gemstones yearly, according to *Gems & Gemology* author Gary Bowersox, of GeoVision Inc., Honolulu, who has been working with Afghan miners and dealers for 30 years. Bowersox says the country could be a major source for numerous gemstones, including emerald, aquamarine, morganite, tourmaline, kunzite, pink sapphire, ruby and, of course, lapis lazuli.

As Mr. Bowersox indicated in the Winter 1985 issue of *G&G* ("A Status Report on Gemstones from Afghanistan," pp. 192–204), most of the country's gem deposits are located in the eastern region within the Hindu Kush Mountains, relatively close to the border with Pakistan. Many of the mines are in remote, mountainous areas, and some are accessible for only a few months of the year. Since miners have already exploited the surface deposits, now they must go deeper to find the gems, which will require more sophisticated equipment than the primitive digging and blasting typically used there.

Mr. Bowersox feels that the strongest potential is for emeralds from the Panjshir Valley, which was also the home base of the recently assassinated Northern Alliance leader General Ahmed Shah Massoud, who was heavily involved in emerald mining. Mr. Bowersox maintains that the best gems are "comparable to the finest emeralds of the Muzo mine in Colombia." Despite the primitive mining methods, as much as $10 million worth of emeralds have been produced annually since 1994.

Pegmatite gems (see, e.g., figure 11) are mined in the Nuristan-Laghman region, which is east of the main emerald deposits. In his 1985 *G&G* article, Mr. Bowersox wrote that since the early 1970s "literally hundreds of thousands of carats of gem-quality tourmaline and fine kunzite" had been cut from this area. Morganite and large aquamarine crystals have been mined in the same region. The ruby and sapphire deposits are the most accessible, located near the road between the capital, Kabul, and the city of Jalalabad to the east. Because this has been one of the country's most embattled areas, production has been sparse, although Mr. Bowersox believes it could be a major deposit.

Lapis lazuli, for which Afghanistan is the primary source, has been mined for centuries in Badakhshan Province, north of the country's other gemstone deposits. In July–August 2001, Mr. Bowersox escorted a film crew to the lapis mines. Although there was little activity or production at the mine, the group saw more than 18 tons of lapis lazuli for sale in Peshawar, Pakistan. Apparently the miners were occupied with the war against the Taliban, as numerous lapis veins could still be seen in the mine tunnels.

Mr. Bowersox is optimistic that, if peace and stability return to the country (which has known neither for some 20 years), "gems from Afghanistan will be flowing onto the market for many years to come."

Update on amethyst, citrine, and ametrine from the Anahí mine, Bolivia. Since the publication of "The Anahí ametrine mine, Bolivia" by P. M. Vasconcelos et al. (Spring 1994 *G&G*, pp. 4–23), there have been some significant changes in the processing and marketing of gem material from this mine. The following update was provided by Ramiro Rivero, owner of Minerales y Metales del

Oriente S.R.L. (Santa Cruz, Bolivia), which has mined the deposit since 1990.

The company currently employs a full-time team of three mining engineers and geologists, as well as more than 120 miners. Exploration is conducted simultaneously with mining to help assure a steady supply of material in the future. They are now exploiting seven areas within the Anahí mining concession (see, e.g., figure 12), in search of cavities that are lined with the amethyst-citrine crystals. The miners extract about 30–40 tonnes of amethyst, citrine, and ametrine (bicolored amethyst-citrine; see figure 12 inset) every month, which is processed at the company's facility in the city of Santa Cruz (figure 13). The processing plant employs approximately 60 workers, who are involved in washing, cobbing, sawing, and pre-forming the rough. Calibrated pre-forms are sent to Hong Kong for faceting—together with examples of finished gemstones with the desired proportions and facet designs—and the polished gems are then returned to Santa Cruz for sorting and quality control before distribution to the international market.

To avoid problems created by the widespread practice of mixing synthetic quartz into parcels of amethyst, citrine, and ametrine, the company sells about 80% of their gemstones directly to overseas jewelry manufacturers. Sales of rough material to selected high-end designers and cutters will continue at the Tucson gem show. The company aims to maintain the combined production of faceted material (sold directly and cut from rough) at 3 million carats per year, as they have since 1998. The proportion of each gem variety produced is adjusted according to market requirements; today it is approximately 40% amethyst, 20% citrine, 20% ametrine, and 20% "anahite" (pale amethyst with no brown overtones). Every year, about 100 tonnes of nonfacetable material is sold to manufacturers of spheres, cabochons, and beads in Brazil and Hong Kong. The company also sells about 10 tonnes of mineral specimens annually.

Research and development on gem cutting and jewelry manufacturing is ongoing. The company is investigating the logistics of developing large-scale lapidary capabilities in Santa Cruz, and they are test marketing silver jewelry that is being manufactured in Bangkok.

"Copal" resin from Madagascar. In recent years, attractive polished specimens sold as copal from Madagascar have become widely available. The material's transparency, interesting inclusions, and availability in large sizes and quantities have contributed to its popularity. GNI editor Brendan Laurs recently received some information on the origin and characteristics of this Malagasy "copal" from Dr. Federico Pezzotta, of the Museo Civico di Storia Naturale, Milan, Italy.

Dr. Pezzotta has followed this attractive resin since 1994–95, when the first production arrived in the capital city, Antananarivo. At that time, the material was scarce, commanded high prices, and was sold as amber. Soon buyers classified it as "copal" when they realized that it was of recent origin. In fact, this material should actually be called *resin*, since it is generally just several years (or tens of years) old, according to Dr. Pezzotta. (Conversely, *copal* is defined

Figure 12. A miner uses a wheelbarrow to remove material from the Anahí mine in Bolivia; photo courtesy of Ramiro Rivero. The free-form ametrine carving in the inset is by Michael Dyber and weighs 25.60 ct; photo by Sena Dyber.

Figure 13. At a processing facility in Santa Cruz, Bolivia, mine-run material from the Anahí mine is washed, cobbed (center and right side), sawn, and pre-formed (left side). Courtesy of Ramiro Rivero.

as "barely fossilized tree resins between 100 and 1,000 years old," according to GIA's *Colored Stones* course.) The hard resin is collected in rain forests that lie principally along the east coast of the island; it is taken directly from certain trees or from the ground beneath them. Dr. Pezzotta reported that the resin forms on the trees annually, and he has seen masses weighing several kilograms on the market, with part of the wood still attached in some cases.

In 1997–98, large stocks of medium- to low-quality "copal" showed up in gem markets in Antananarivo and Antsirabe, and local dealers began working with the material—in a process that involved controlled heating of the surface during polishing—to produce attractive transparent forms that contained spectacular inclusions. Dr. Pezzotta has seen not only a wide variety of insect species in the hardened resin, but also small lizards (including chameleons), leaves of various trees, and even feathers (see the following entry for more detail on these inclusions). It is not known if all of these inclusions were trapped in the resin naturally.

The stability of the resin is unknown at this time. From 1996 to 1998, Dr. Pezzotta collected a significant number of polished samples with interesting inclusions for his museum, and some of these have started to develop a network of thin cracks on the surface. The stability may depend on the age, location, or species origin of the resin, or it may be influenced by the polishing procedure used.

More interesting inclusions in copal resin from Madagascar. In the Spring 2000 Gem News section (pp. 67–68), one of these contributors (JIK) documented some unusual fluid inclusions in what was represented to him as copal from Madagascar. This attractive resin was widely available at the 2001 Tucson gem show, and Le Minéral Brut (Hauterive, France) had a good selection of well-polished specimens that contained a wide variety of arthropod inclusions such as ants, spiders, beetles, termites, and two- and four-winged flies, as well as plant matter. Some of these polished pieces were more than 25 cm long and weighed several hundred carats. The clarity of the resin and the high quality of the polish provide an excellent showcase for viewing the various inclusions (figure 14).

Figure 14. A variety of arthropods, plant matter, and fluid inclusions can be found in "copal" resin from Madagascar. This polished specimen is 130.38 mm long and weighs 306.72 ct. Photo by Maha Tannous.

One of these contributors (JIK) obtained a sample that contained a spider, a large beetle, and several small flies, as well as a number of bubbles trapped along a flow plane. Microscopic examination of the bubbles revealed a watery liquid of low viscosity, possibly encapsulated droplets of rain or dew; most of the bubbles also contained a small gas phase (figure 15). In a few of these fluid inclusions, the gas bubbles moved freely.

The variety and type of inclusions, together with the apparent quality of the resin, make this material interesting to anyone who appreciates nature. According to the literature provided by the dealer, the resin comes from *Hymenaea verrucosa* trees in forests on the northeastern part of the island.

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Iolite and corundum in Wyoming. In 1995, this contributor led the Wyoming State Geological Survey (WSGS) field reconnaissance for gems in the central Laramie Range of southeastern Wyoming, at which time he discovered samples of cordierite (iolite) and corundum—many of gem quality—in the Palmer Canyon area west of Wheatland. Recently, some Palmer Canyon iolites and pink to purplish pink sapphires were cut by claim owner Vic Norris of Lyons, Colorado, as part of ongoing investigations into the commercial viability of the deposit. These samples were provided to the WSGS and examined by Elizabeth Quinn at the GIA Gem Trade Lab in Carlsbad for this report.

The iolite is hosted by quartzofeldspathic gneiss that crops out over a distance of 60 m and averages about 3 m wide (W. D. Hausel, "Field reconnaissance of the Palmer Canyon corundum-kyanite-cordierite deposit, Laramie Mountains, Wyoming," *WSGS Mineral Report* MR98-1, 1998, 7 pp.). This outcrop disappears under soil, and the presence of detrital iolite up-slope suggests that the deposit may exceed 500 feet (152 m) in length. The iolite typically forms rounded transparent to translucent grains or larger nodules. Samples of fractured iolite as large as 600 grams, with areas that could cut jewelry-quality stones, were collected from the gneiss during the initial field investigation. A similar piece found recently measures 10.8 × 6.4 × 3.2 cm, and is believed to be the largest iolite known from Wyoming.

The three samples (0.36–1.33 ct; see figure 16) examined at GIA had the following properties: color—grayish violet to violet, with moderate to strong pleochroism in violet and very light brownish yellow; R.I.—from 1.531–1.533 to 1.540–1.542; birefringence—0.009; S.G.—

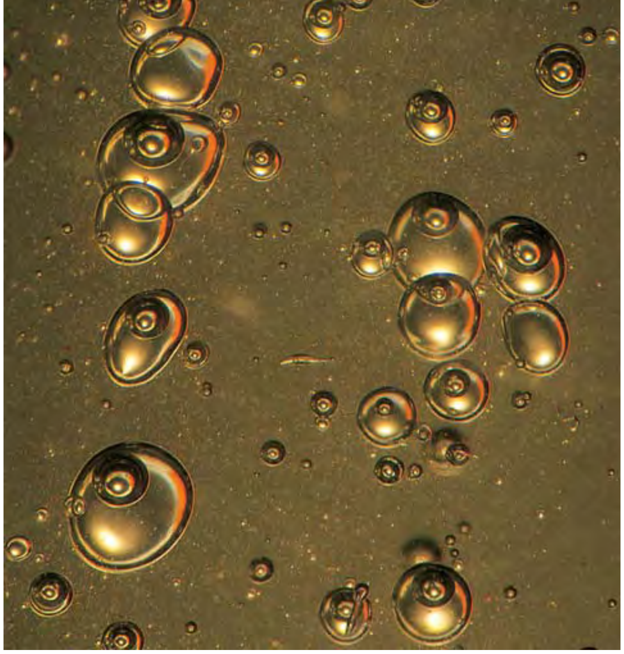

Figure 15. The bubbles in this resin, trapped along a flow plane, are partially filled with a watery fluid; several also contain free-floating gas bubbles in the fluid portion. Photomicrograph by John I. Koivula; magnified 10×.

2.59–2.60; inert to long- and short-wave UV radiation; and no features visible with the desk-model spectroscope. These properties are consistent with those reported for iolite in the literature (see, e.g., R. Webster, *Gems*, 5th ed., revised by P. G. Read, Butterworth-Heinemann, Oxford, 1994). Microscopic examination revealed dark hexagonal crystals (probably biotite), colorless and milky-looking crystals, fractures (some partially healed), patchy clouds, and broken lines of "silk."

The corundum from Palmer Canyon is found near the iolite occurrence in chlorite-biotite schist and mica-kyanite gneiss that has been traced for nearly 300 m (see Hausel, 1998, cited above). The corundum forms hexagonal prisms and platelets that are locally abundant in the schist. The crystals are translucent to transparent, and vary from white to pink to (less commonly) purplish pink. Most crystals average about 1 cm long and 0.5 cm in diameter; the largest specimen collected thus far measures 2.5 × 0.7 cm.

Ms. Quinn examined a 1.15 ct transparent faceted purplish pink sapphire and a 1.47 ct opaque brownish purplish pink sapphire cabochon from Palmer Canyon (again, see figure 16). The faceted sapphire showed the following properties: pleochroism—moderate, in purplish pink and orangy pink; R.I.—1.760–1.768; birefringence—0.008; S.G.—3.99; fluorescence—moderate orangy red to long-wave, and very weak red to short-wave, UV radiation; and chromium lines and a 470 nm doublet visible with the desk-model spectroscope. Microscopic examination revealed fractures (most partially healed), twin planes, white needles (probably boehmite), colorless crystals, and fine "silk" composed of minute short needles, stringers, and clouds. No evidence of heat treatment was observed. The following properties were recorded for the cabochon: no pleochroism observed; R.I.—1.76 (spot method); S.G.—3.89; fluorescence—very weak red to long-wave and inert to short-wave UV; and chromium lines in the red region plus absorption due to iron around 450 nm in the blue region. Microscopic examination revealed numerous needles (probably rutile) and reddish orange crystals, abundant twin planes and fractures, and a yellowish substance in some fractures.

Several other minerals with potential as gems or ornamental materials have been identified in Wyoming, many within the last two to three decades. These include diamond, aquamarine, chrome diopside, jade, labradorite, peridot, opal, pyrope garnet, variscite, and many unusual agates and jaspers (see W. D. Hausel and W. M. Sutherland, *Gemstones and Other Unique Minerals and Rocks of Wyoming—A Field Guide for Collectors*, WSGS Bulletin 71, 2000, 268 pp.). Further field investigations will likely lead to additional gem discoveries in the Cowboy State.

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Green kyanite from Bahia, Brazil. Although kyanite is typically blue (see, e.g., Spring 1999 Gem News, pp. 51–52), recently a large discovery of green material was made in Bahia, Brazil. According to Steve Perry of Steve Perry Gems, Davis, California, the find occurred in March–April 2001. Last June, he saw 16 kg of rough in Governador Valadares. Lightly to moderately included faceted gems averaging about 6–10 ct (and up to 30 ct) were also seen by Mr. Perry in Brazil. Many of the stones contain a blue stripe that appears similar to material mined in Brazil's Goiás State about 13 years ago. The blue area is variable in width and ranges from very pale to saturated.

Figure 16. The iolites (0.36–1.33 ct) and pink sapphires (1.15 and 1.47 ct) shown here are from the Palmer Canyon area in the central Laramie Range of southeastern Wyoming. Courtesy of Vic Norris; photo by Maha Tannous.

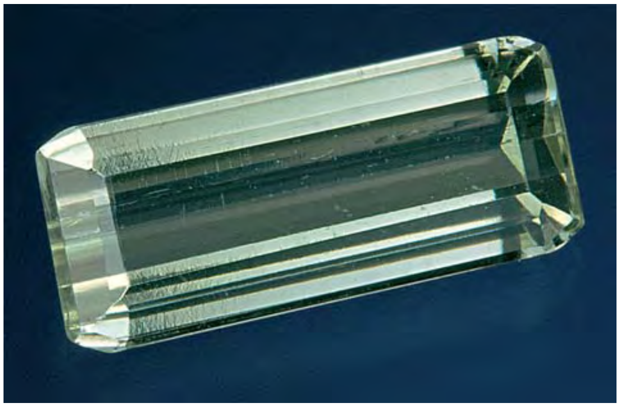

Figure 17. This 3.45 ct kyanite was reportedly mined in spring 2001 in Bahia, Brazil. Courtesy of Steve Perry; photo by Maha Tannous.

Mr. Perry sent a 3.45 ct light yellowish green kyanite (figure 17) to GIA for examination. Cheryl Wentzell of the GIA Gem Trade Lab in Carlsbad recorded the following properties: R.I.—1.711–1.739; birefringence—0.019; S.G.—3.69; fluorescence—inert to short- and long-wave UV radiation; and two absorption bands in the blue region at approximately 435 and 445 nm. Microscopic examination revealed minute crystals and pinpoints, and a cluster of tiny cleavage breaks. The properties are consistent with those reported for gem kyanite, except that this stone showed a larger range in R.I. values and a greater birefringence (compare to n=1.716–1.731 and d=0.012–0.017 reported in the *GIA Gem Reference Guide*). Raman analysis gave a perfect spectral match for kyanite.

"Ruby Rock" cabochons. In early 2001, this contributor first saw cabochon doublets that were created by attaching quartz domes to thin slices of Ruby Rock from New Zealand. Also referred to as goodletite, this ornamental stone comes from the Southern Alps (near the coastal town of Hokitika on the South Island), and is composed of ruby or pink-to-blue sapphire with green chromian mica or tourmaline (see, e.g., G. Brown and H. Bracewell, "Goodletite—A beautiful ornamental material from New Zealand," *Journal of Gemmology*, Vol. 25, No. 3, 1996, pp. 211–217). Microprobe analysis of the tourmaline in one sample at the University of Manitoba in Winnipeg proved that it was chromian dravite, with 1.90 wt.% Cr_2O_3 (Dr. F. Hawthorne, pers. comm., 2001).

According to Gerry Commandeur of New Zealand Ruby Rock Ltd., Hokitika, all of the Ruby Rock found to date has been in glacial moraine; none of the material has been found *in situ*. In thin slices, the material becomes translucent and shows vivid red and green colors that mingle in a variety of patterns. Some of the doublets have been set in jewelry to make distinctive pendants and rings (see, e.g., figure 18).

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Figure 18. The vivid colors in "Ruby Rock" from New Zealand are due to ruby and green chromian mica or tourmaline. The Ruby Rock doublet in this pendant has a quartz dome. Courtesy of Gerry Commandeur.

A new find of tourmaline in Warner Springs, California. An unusual discovery of pink tourmaline was made recently at the Cryo-Genie mine, approximately 3 km northwest of Warner Springs in north-central San Diego County (see map accompanying the spessartine article in this issue, p. 280). Formerly known as the Lost Valley Truck Trail prospect, the pegmatite was first located in 1904, and has been worked in a series of trenches, small pits, and short tunnels. In 1974, the property was claimed as the Cryo-Genie mine by Bart Cannon of Seattle, Washington, who worked it occasionally until the mid-1980s. Since 1994, the claim has been held by Dana Gochenour of Tustin, California, and worked intermittently by the Gochenour family and their associates. The main production from the pegmatite has consisted of mineral specimens of beryl (morganite and aquamarine), tourmaline (green and, rarely, pink or blue), and typical associated pegmatite minerals. GNI editor Brendan Laurs visited the mine in October 2001 for this report.

In spring 2001, the Gochenours intensified their mining activities, bringing in additional partners and investors including Jim Clanin (El Cajon, California), John Klenke (Las Vegas, Nevada), Cal Kalamas (Eugene, Oregon), and others. The group excavated the entire outcrop with a backhoe and extended the main tunnel in the central-eastern part of the pegmatite by drilling and blasting. A series of cavities or gem "pockets" encountered along this tunnel contained nonfacetable blue-to-green and pink tourmaline.

In early October, however, Ken Gochenour recovered some large, well-formed crystals of pink tourmaline from a pocket measuring 1.2 × 1.0 × 0.4 m (figure 19). The largest crystal weighed 2.2 kg (16.3 cm tall), and had both prism terminations intact (figure 20). Two other notable crystals approached 17 cm in length and up to 10 cm in diameter, with distinctly flared pinacoidal terminations. The crystals are predominantly of carving quality, but contain small transparent areas that are facetable. However, most will be sold to collectors as mineral specimens, since the crystals are unusual for their size and color, as well as their morphology. Large pink tourmalines (similar in color to those found in the famous Pala pegmatite district 45 km to the west) were previously unknown from the Warner Springs area, and the flared shape is not typical of tourmalines from any of the southern California pegmatites. Rather, the shape resembles that of some tourmalines from east-central Afghanistan.

Figure 19. In October 2001, large crystals of pink tourmaline were found at the Cryo-Genie mine, near Warner Springs in San Diego County, California. Jim Clanin, a partner in the mining project, displays one of the crystals in front of the large cavity from which it was mined. Photo by John Klenke.

Figure 20. This doubly terminated 16.3-cm-tall crystal is the largest of the tourmalines recovered recently at the Cryo-Genie mine. Photo © Jeff Scovil.

SYNTHETICS AND SIMULANTS

Synthetic topaz crystals. Topaz is one of the few popular gems that—until recently—had not been grown successfully in the laboratory. This is undoubtedly because topaz has few physical properties that make it industrially useful, and there is an adequate supply of gem-quality brown ("smoky"") or blue topaz for the jewelry market. In addition, topaz is difficult to grow by ordinary hydrothermal growth techniques. In early 2000, however, synthetic topaz was successfully manufactured at the Institute of Experimental Mineralogy in Chernogolovka, Russia, by one of these contributors (VSB). The experiments were undertaken to gain a better understanding of the crystal morphology, color formation, and crystal growth mechanism of natural pegmatitic topaz. The growth technique, experimental conditions, and gemological properties of the synthetic topaz crystals are reported here.

The hydrothermal growth method used a supercritical fluoride-bearing aqueous fluid under conditions of a direct thermal gradient (see V. S. Balitsky and L. V. Balitskaya, "Experimental study of coincident- and opposite-directed simultaneous transfer of silica and alumina in supercritical aqueous-fluoride fluids," *High Pressure Research*, Vol. 20, 2001, pp. 325–331). The growth experiments were carried out at temperatures of 500°–800°C and pressures of

20–200 MPa, using an autoclave made from a heat-resistant Cr-Ni alloy with a volume of 100 cm^3.

The autoclave was heated in a vertical electric furnace with two independent heaters. Water with added AlF_3 was used as a solvent. The resulting acidic fluoride-bearing aqueous fluid had a pH of 1–2, as measured after the experimental run. A mixture of equal quantities of crushed natural quartz and topaz was placed in the upper zone of the autoclave in a perforated basket. Topaz seed plates were suspended in the lower zone of the autoclave; they were separated from the perforated basket by a diaphragm. The seed plates were cut in a rectangular shape with a ZX-orientation (i.e., the plate was elongated in the prism [110] direction). The temperature difference between the upper and lower zones of the autoclave ranged from 20° to 100°C. The duration of the experimental runs was between 20 and 30 days.

Light gray to near-colorless single crystals of synthetic topaz were grown in dimensions ranging from 2.5 to 4.0 mm thick, 20.1 to 40.8 mm long, and 8.0 to 15.0 mm wide; they weighed up to 20 g. About half of each crystal consisted of the seed, with the other half formed by the synthetic topaz overgrowth. Growth rates varied depending on crystallographic orientation, characteristics of the seed plate, and the growth conditions used. The maximum growth rate of a few tenths of a millimeter per day occurred in the [101] direction, while the minimum rate of a few thousandths of a millimeter per day occurred in the [001] direction.

Various heating and irradiation experiments were performed to alter the color of the synthetic topaz crystals. As is the case with natural topaz, the synthetic material can be changed from light gray or near-colorless to "smoky" brown by gamma-ray irradiation (figure 21), and to light blue using high-energy electron irradiation and heat treatment. The stability of the brown color in the synthetic topaz has not been investigated yet. In one of the synthetic topaz crystals, one of us (VSB) observed a narrow zone of red-violet color along the seed plate. This coloration could be related to the presence of a chromium impurity from the autoclave walls that was captured during growth.

The two synthetic topaz crystals in figure 21 (23.66 and 27.48 ct), were examined at GIA by one of these contributors (TL) and Dino DeGhionno of the GIA Gem Trade Lab in Carlsbad. Three colorless crystal sections of synthetic topaz cut perpendicular to the c-axis and mount-

Figure 21. These synthetic topaz crystals were grown at the Institute of Experimental Mineralogy, in Chernogolovka, Russia. The semi-transparent light gray crystal weighs 23.66 ct (36.40 × 12.90 × 3.92 mm), and the semi-translucent brown crystal weighs 27.48 ct (36.70 × 11.52 × 4.41 mm). The latter has been treated by gamma-ray irradiation. Photo by Maha Tannous.

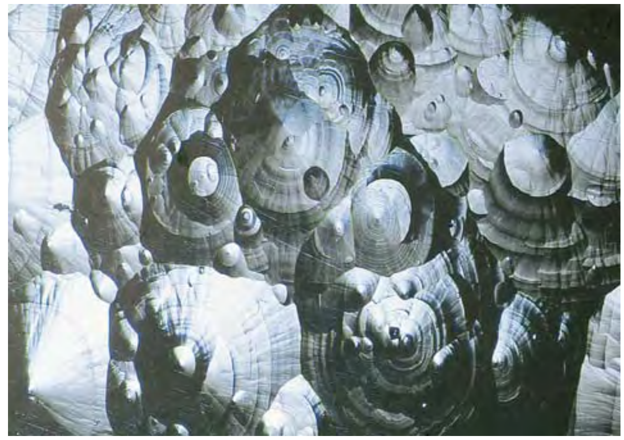
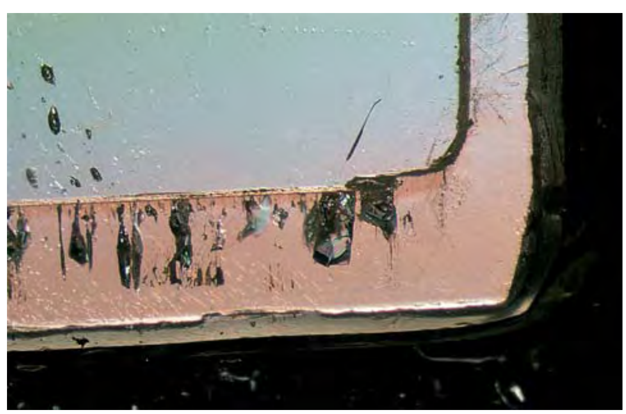


Figure 22. Conspicuous growth hillocks were observed on the as-grown surfaces of the synthetic topaz crystals. Photomicrograph by Taijin Lu; magnified 50×.

Figure 23. Two-phase inclusions were observed in the synthetic topaz, along the boundary with the seed plate, as shown in this crystal section. The synthetic topaz overgrowth is on the bottom and right, and the seed plate is on the upper left. Photomicrograph by Taijin Lu; magnified 10×.



ed on a glass slide also were examined. The light gray crystal was as-grown, while the brown one had been treated by gamma-ray irradiation. The morphology of these synthetic crystals resembled that of natural topaz, although a more detailed crystallographic study is underway. The crystal faces were well developed and had abundant concentric growth hillocks (figure 22). These hillocks often contained tiny black spots (possible impurities) at their centers. There was a roughly proportional relationship between the sizes of the growth hillocks and the sizes and numbers of these black spots. In addition, the larger the growth hillocks were, the more irregular their shapes were. The largest growth hillock was 3 mm in diameter.

The refractive indices of the two crystals ranged from 1.610 to 1.620, which is slightly lower than the values seen for typical pegmatite-derived topaz. Specific gravity (measured hydrostatically) was about 3.57 for these samples (which still contained portions of the steel wires used to suspend the seed); this value is slightly higher than that of natural OH-poor topaz. In addition to the steel wires, two-phase inclusions and fractures were observed. The two-phase inclusions were usually distributed in the region close to the boundary with the seed plate, and were typically elongated along the growth direction (figure 23).

The FTIR and Raman spectra of the synthetic overgrowths were very similar to those of natural topaz. Sharp absorption peaks in the near infrared were found at 2317 cm^{-1} and in the range of 3478–3680 cm^{-1}, together with a small peak at 4798 cm^{-1} and a broad peak around 3970 cm^{-1}. Qualitative chemical analysis by EDXRF spectrometry detected traces of iron, nickel, and germanium in the two synthetic topaz crystals.

Although the basic growth technology for synthetic topaz has been developed, more work is needed before production becomes commercially viable. Research is ongoing to refine the growth technique and find the appropriate conditions for producing pink and yellow-orange colors.

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EXHIBITS

A visit to the Pearls exhibit at AMNH. What has been described as the most comprehensive exhibition ever presented on pearls opened at the American Museum of Natural History in New York on October 13, 2001. The dazzling display (see, e.g., figure 24) includes all types of natural and cultured pearls, as well as calcareous concretions. Among the most interesting in the latter category are the multitude of conch and melo "pearls," including an enormous (27 mm) red conch "pearl" in a tarantula brooch. Other stand-outs include a collection of American freshwater pearls used by the Native American Hopewell culture, which date from 200 B.C. to 500 A.D. A later addition to the exhibition was perhaps the most famous single pearl, "La Peregrina." Currently owned by Elizabeth Taylor, its lineage has been traced back to Mary Tudor (1516–1558), daughter of England's King Henry VIII.

Figure 24. The Queen Victoria Brooch is one of the historic pieces featured at the AMNH "Pearls" exhibit. This gold brooch (approximately 6.4 × 4.4 cm), an 1843 anniversary gift from Prince Albert to Queen Victoria, is set with four Scottish freshwater pearls and accented by amethyst, garnet, and chrysoberyl. On loan from the collection of Mr. and Mrs. G. C. Munn; photo by Denis Finnin, © American Museum of Natural History.

Lead Curator Dr. Neil Landman and his staff have done exceptionally well in covering the entire scope of pearls. In an informative display on pearl formation, the exhibit traces the growth and harvesting of many varieties of cultured and natural pearls. Their historic use in decorative and religious objects is well illustrated, and several magnificent pieces, both jewelry and art, are shown. An interactive display allows visitors to observe the surface features of four specimens, as seen with a scanning electron microscope.

A comprehensive 232 page book has been prepared by Mr. Landman and coauthors to accompany the exhibit, called *Pearls: A Natural History* (reviewed in this issue of

G&G). The exhibit runs through April 14, 2002, and will move to the Field Museum in Chicago from June 28 to January 5, 2002.

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Gems at the Bowers Museum. "Gems! The Art and Nature of Precious Stones" will be on display at the Bowers Museum of Cultural Art in Santa Ana, California, February 16–May 12, 2002. Curated by museum president Dr. Peter Keller together with Mike Scott, this exhibit will feature extraordinary gems such as a 480 ct golden sapphire, a 10 ct Burmese ruby, a 60 ct blue sapphire, a 250 ct tanzanite, and a 5,500 ct star rose quartz (figure 25). The show will answer basic gemological questions, present a variety of rare gems, and portray gemstones as art. Featured artists include Bernd Munsteiner and Gerd Dreher of Idar Oberstein, John Marshall of the U.S., and several Asian master carvers. Visit www.bowers.org or call 714-567-3600.

Figure 25. "Dynamic Symmetry," by John Marshall (1990), features a 5,500 ct star rose quartz; note the 1 ct diamond placed to the right of the base for scale. Photo © Erica & Harold Van Pelt.

GIA Museum exhibits. The Museum Gallery at GIA in Carlsbad is featuring "The Glitter Merchants" photo essay of diamond cutters and dealers, and an educational display about GIA's role in the diamond industry titled "From Trading to Grading"; both exhibits will be on display through May 2002. In the rotunda at GIA in Carlsbad is "Jeweled Zoo," a fascinating array of more than 100 pieces of animal-motif jewelry, on display through March 2002. Contact Alexander Angelle at 800-421-7250, ext. 4112 (or 760-603-4112), or e-mail alex.angelle@gia.edu.

ANNOUNCEMENTS

GIA's new Graduate Retail Management program. GIA has launched a new business-oriented diploma program called Graduate Retail Management. Available at GIA's Carlsbad campus, it consists of three 60 hour courses in Retail Management, Marketing, and Entrepreneurship that integrate jewelry-industry specifics into fundamental business practices. The courses are taught over 10-week terms, and students may take them concurrently or individually. The interactive format will include guest speakers, panels, and video presentations, and students will develop practical, industry-related term projects. In 2002, the program will be offered in a Summer Quarter (May 30–August 9) and a Fall Quarter (October 10–December 20). Enrollment is limited and on a first-come, first-served basis. For details, contact Taryn Reynolds at 800-421-7250, ext. 7306 (or 760-603-4000, ext. 7326), or visit www.gia.edu/education.

Trip to Idar-Oberstein, Germany. On April 21–27, 2002, the Gemmological Association and Gem Testing Laboratory of Great Britain will lead their eighth trip to Idar-Oberstein. Highlights will include visits to mineral and gem museums, historic and modern gem-cutting facilities, and a mine with agate and amethyst. Visit www.gagtl.ac.uk/gidar.htm or contact Douglas Garrod at 44-0-20-7404-3334 (phone), 44-0-20-7404-8843 (fax), or e-mail gagtl@btinternet.com.

CONFERENCES

International Bead Expo 2002. This show will celebrate its 11th year in Santa Fe, New Mexico, March 6–10. Expanded bazaar locations, additional workshops, and a multitude of educational events will be offered for an estimated 6,000 artists, scholars, vendors, and buyers. The 65 workshops will cover a variety of media, techniques, and skill levels. "Glass Beadmaking Through the Ages" is the Expo theme, with morning lectures and afternoon discussions scheduled March 8–10. Visit www.beadexpo.com, e-mail info@beadexpo.com, or call 800-732-6881.

PDAC 2002. The annual convention of the Prospectors and Developers Association of Canada will take place March 10–13, in Toronto, Ontario, and will include presentations on diamonds from Canada and Brazil, as well as diamond pricing. Visit www.pdac.ca, or call 416-362-1969, fax 416-362-0101, or email info@pdac.ca.

19th Colloquium of African Geology. Held in El Jadida, Morocco, March 19–22, 2002, this colloquium will include a symposium titled *Ore Deposits and Gem Minerals.* Visit www.ucd.ac.ma/geologie/cag19.html.

Basel 2002. The World Watch, Clock, and Jewellery Show will be held April 4–11 in Basel, Switzerland. GIA will host GemFest Basel 2002 from 4:00 to 6:00 p.m. April 6, which is open to the public and will highlight critical issues in the gem and jewelry trade in a panel discussion and keynote speech on "Doing Business in a Changing Economy." A presentation of GIA's latest research activities will round out the program. During the show *Gems & Gemology* editor Alice Keller will be available at the GIA booth in Hall 2, Stand W23. Visit http://www.baselshow.com or call 800-357-5570.

Workshop on Diamond and Diamond-like Carbon. On April 8–10, 2002, this workshop will be held in Brighton, U.K., during the Institute of Physics' Annual Congress. Topics will include the nucleation, growth, and characterization of diamond, diamond-like carbon, and other "high performance" crystals. Visit http://physics.iop.org/IOP/Confs/Congress/Diamond or e-mail registrations@iop.org.

Global Exploration 2002. As a sequel to their 1993 conference, the Society of Economic Geologists will convene Global Exploration 2002—Integrated Methods for Discovery, on April 14–16, in Denver, Colorado. The technical program will include presentations on diamond exploration, and post-meeting activities will include a workshop "Diamonds—from Source to Sea" (April 17–18) and a field trip to the Kelsey Lake diamond mine in the State Line kimberlite district of Colorado (April 19). Visit www.seg2002.org, call 720-981-7882, fax 720-981-7874, or e-mail SEG2002@segweb.org.

AGS Conclave. On April 24–27, the 2002 AGS International Conclave will take place in Vancouver, British Columbia, Canada. Several high-profile speakers have been scheduled, including De Beers's Nicky Oppenheimer. Visit http://www.ags.org.

Gemmological Association of Australia conference. The Queensland Division of the GAA will present the 56th Annual Federal Conference May 16–19, 2002, in Brisbane, Queensland. Invited speakers will cover Australian gem and pearl sources; the geology of Australian opals; inclusions in agates; Aurias diamonds; sapphires from Subera, Queensland; rhodonite from Broken Hill, New South Wales; and quartz coloration. The program also will include a Raman spectrometer workshop and presentation of the *Australian Gemstones in Jewellery Design* awards at the Queensland Museum. Visit www.gem.org.au/news, or contact Hylda Bracewell at 07-3355-5080 (phone), 07-3355-6282 (fax), or hyldab@gil.com.au.

Santa Fe Symposium. The 16th annual Santa Fe Symposium will take place May 19–22, 2002, in Albuquerque, New Mexico. Presentations will cover cutting-edge jewelry manufacturing technology, business acumen, and gem treatments. Visit www.santafesymposium.org, call 505-839-2490, or fax 505-839-3248.

GAC–MAC Saskatoon 2002. The joint annual meeting of the Geological Association of Canada and the Mineralogical Association of Canada will take place May 27–29 in Saskatoon, Saskatchewan, Canada. A session on diamondiferous kimberlites from central Saskatchewan and elsewhere in Canada will be followed by a one-day workshop with Canadian kimberlite drill core. Visit www.usask.ca/geology/sask2002, call 306-966-5708, fax 306-966-8593, or e-mail karen.mcmullan@usask.ca.

16th Australian Geological Convention. The Geological Society of Australia is presenting this conference in Adelaide, South Australia July 1–5, 2002. Gems will be discussed in a symposium titled "World-Class Australian Ore Deposits," and a pre-conference excursion—"Kimberlites and Diamonds in South Australia"—will take place June 26–30. Visit www.16thagc.gsa.org.au or call 618-8227-0252, fax 618-8227-0251, or e-mail 16thagc@sapro.com.au.

IAS2002 Congress. The 16th International Sedimentological Congress will take place July 8–12, in Johannesburg, South Africa. Diamonds will be included in a special session on placer sedimentology and a short course titled "Modern and Ancient Placers—Sedimentological Models for Exploration and Mining." A pre-meeting field trip (June 29 to July 7) will follow diamonds from Kimberley (South Africa) to the Namibian coast, with several stops along the Orange-Vaal drainage system. Visit http://general.rau.ac.za/geology/IAS2002, or contact Dr. Bruce Cairncross at 27-11-489-2313 (phone), 27-11-489-2309 (fax), or e-mail bc@na.rau.ac.za.

8th International Conference New Diamond Science and Technology 2002. On July 21–26, at the University of Melbourne in Victoria, Australia, this conference will cover all aspects of diamond science and technology including growth and processing, characterization, and methods of detecting HPHT diamonds in gemology. Visit www.conferences.unimelb.edu.au/icndst-8, call 61-3-8344-6389, fax 61-3-8344-6122, or e-mail icndst-8@unimelb.edu.au.

ERRATA

1. In box B on p. 176 of the Fall 2001 article "Modeling the Appearance of the Round Brilliant Cut Diamond: An Analysis of Fire, and More About Brilliance," the acronym AGA should have referred to Accredited Gem Appraisers, a subsidiary of D. Atlas & Co., Inc. We thank David Atlas for bringing this error to our attention.
2. In the Fall 2001 Gem News International entry "Vanadium-colored beryl from China" (pp. 226–228), the location of the deposit should have been reported as Yunnan Province. We thank Ron Tsai for this correction.
3. Harold Dupuy (Baton Rouge, Louisiana) and Johanne Jack (Algarve, Portugal) were inadvertently omitted from the list of 2001 Challenge Winners in the Fall 2001 issue (p. 220). We apologize for this error.