



EDITOR

Brendan M. Laurs (blaurs@gia.edu)

CONTRIBUTING EDITORS

Emmanuel Fritsch, *IMN, University of Nantes, France* (fritsch@cnrs-imn.fr)

Henry A. Hänni, *SSEF, Basel, Switzerland* (gemlab@ssef.ch)

Kenneth V. G. Scarratt, *AGTA Gemological Testing Center, New York* (kscarratt@email.msn.com)

Karl Schmetzer, *Petershausen, Germany*

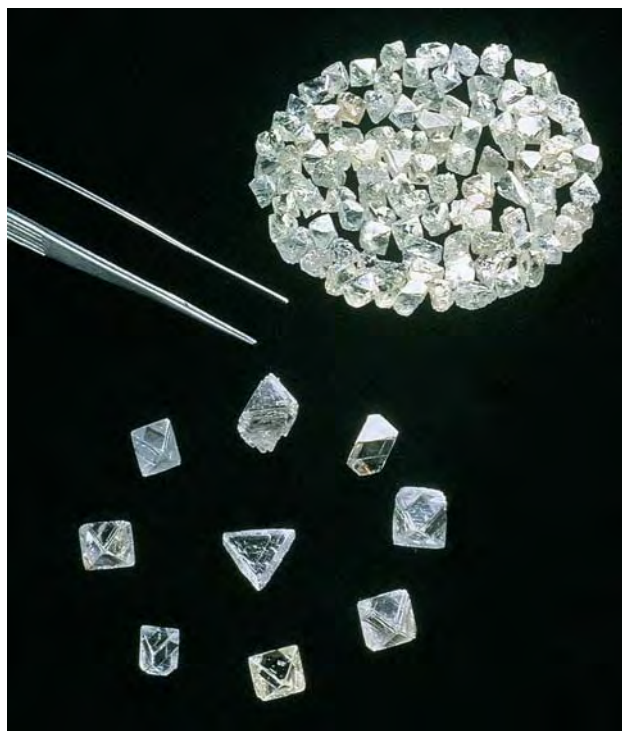
James E. Shigley, *GIA Research, Carlsbad, California* (jshigley@gia.edu)

Christopher P. Smith, *Gübelin Gem Lab, Lucerne, Switzerland* (cpsggl2@hotmail.com)

DIAMONDS

Report from the 2nd World Diamond Conference, Vancouver. On August 22 and 23, 2001, approximately 400 participants from 29 countries converged in Vancouver, British Columbia, Canada for the 2nd World Diamond

Figure 1. These rough diamonds were recovered during bulk sampling and evaluation of the A-154S pipe at the Diavik mine. Tiffany & Co. has already arranged to purchase some of the diamond production from this mine. Photo courtesy of Diavik Diamond Mines Inc.



Conference. GNI editor Brendan Laurs attended the conference and provided this report. The well-rounded program consisted of approximately 40 presentations from mining and exploration company executives, mining engineers, government officials and diamond valuers, financial analysts, and international financiers. **Chaim Even-Zohar** (editor-in-chief and publisher, *Mazal U'Bracha Diamonds* and *Diamond Intelligence Briefs*) was the moderator of the conference, which focused mainly on Canadian diamond production, now and in the future.

In his introductory presentation, Mr. Even-Zohar stressed that the industry is in transition due to major changes in the diamond "pipeline" caused by the evolving roles of the traditional major producers and the emergence of new industry leaders (e.g., BHP-Billiton and Rio Tinto) in both mining and merchandising. He introduced the phrase *committed rough* for diamonds (mined or unmined) with a predetermined manufacturing destination—such as, for example, the arrangement by Tiffany & Co. to receive diamonds from the forthcoming Diavik mine in Canada (figure 1). The recent restructuring of De Beers is having a profound influence on the pipeline, as reduction of their diamond stockpile in 2000 contributed to the current overstocking in both the cutting centers and the retail sector. Mr. Even-Zohar also explained the legal challenges facing De Beers's "supplier of choice" initiative to create demand at the consumer level.

Martin Rapaport (*Rapaport Diamond Report*) echoed Mr. Even-Zohar's contention that the industry is undergoing fundamental, and irreversible, structural changes as the result of a convergence of factors—in particular, a weak global economy, changes in De Beers, the branding movement, and "conflict" diamonds. He stressed that the future will hold greater market uncertainty in distribution and pricing, with rough prices determined by the prices of polished goods (a reversal of the situation in the past); consequently, rough-diamond producers must add value through marketing. Diamond branding was a recurrent



Figure 2. Construction of the Diavik mine is underway in anticipation of diamond production in early 2003. Three kimberlite pipes (A154N, A154S, and A418) are located beneath Lac de Gras in the foreground, and a fourth pipe (A21) is located under the lake on the far left of the photo. The prominent arcuate structure in the foreground is a rock dike (to be completed in fall 2001) that will be used to hold back the lake surrounding the A154N and A154S pipes to allow for open-pit mining. Silt from dike construction is carefully contained to minimize the environmental impact on the lake. The processing plant (also under construction) and camp are located in the background on the left. The disturbance in the center is a quarry that supplies rock for construction of the dike, and an airstrip is visible on the right. Photo by Jiri Hermann; courtesy of Diavik Diamond Mines Inc.

theme during the conference, and at least one ambitious strategy, still in the formative stage, was outlined in a stimulating presentation by **Lindsey Hughson** of Aurias Diamonds (a subsidiary of BHP-Billiton). He proposed a cooperative arrangement involving multiple suppliers to create consumer desire for diamonds through a carefully executed luxury branding campaign.

Conflict diamonds took center stage during a speech by Ohio Congressman **Tony Hall**, who emphasized that "This affects you." He reminded the audience that although the Clean Diamonds Bill enjoys widespread support in the U.S. Congress, it has yet to become law (as of October 12, 2001). He stated that the Kimberley Process—an international certification system for controlling the flow of rough—will be crucial to the bill's effectiveness. **Cecilia Gardner** (Jewelers Vigilance Committee) reviewed the "system of controls" that must be followed by countries exporting their rough under this bill. The full text of the pending legislation can be viewed on the Internet at <http://www.worlddiamondcouncil.org>.

Much of the conference was devoted to presentations by diamond explorers and producers, with an emphasis on activities in the world's most important emerging diamond frontier—Canada—which is projected to account for 12%–15% (by value) of world production by 2005. **Dr. Art Ettlinger** of Yorkton Securities estimated that between Can\$800 million and \$1 billion has been spent on diamond exploration in Canada in the last decade. Presentations by executives from several "junior" exploration companies were delivered with enthusiasm, despite uncertainties over the future of the rough diamond market and recent difficul-

ties in raising much-needed venture capital.

Kowie Strauss (BHP-Billiton) reviewed developments at the Ekati diamond mine, Northwest Territories (NWT), which has produced 7 million carats (Mct) of rough with an average value of US\$160/ct since it opened in late 1998. He also described continued exploration by his company for new diamond deposits in the NWT and other regions using "Falcon," a sophisticated airplane-based geophysical technique that can measure gravity, magnetics, radiometry, and digital elevation in the same survey. **Buddy Doyle** (Kennecott Canada Exploration, 100% owned by Rio Tinto) provided an overview on diamond exploration methodology and confirmed that the Diavik mine (a joint venture with Aber Diamond Corp.), also in the NWT, should become Canada's second diamond source by early 2003 (figure 2).

Tom Beardmore-Gray (De Beers Canada) stated that one-half of De Beers's diamond exploration budget has been allocated to Canada, with most attention focused on two projects, Snap Lake (a kimberlite dike) in the NWT and

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Victor (a kimberlite pipe) in the James Bay Lowlands area of Ontario. Snap Lake is expected to become Canada's third diamond mine, but during the conference De Beers's corporate headquarters announced a one-year delay in its development. When questioned by Mr. Even-Zohar, **Richard Molyneux** (De Beers Canada) cited two reasons for the delay: (1) the government permitting process will not be complete in time for De Beers to arrange for the transportation of heavy construction equipment and materials to the site along the winter 2003 ice road, and (2) unexpected variations in the morphology of the diamondiferous dike require more trial underground mining. Full production is now estimated to occur in 2006. The status of exploration at Gahcho Kué (also known as Kennady Lake) in the NWT, a joint project between De Beers and Mountain Province, was presented by **Jan Vandersende** (Mountain Province). Here, three kimberlite pipes are being evaluated, but it appears that a 15% increase in diamond prices would be needed to advance this project to the feasibility stage. In the territory of Nunavut, the Jericho project is undergoing a feasibility study, and **Joseph Gutnick** (Tahera Corp.) stated that it could supply 3 Mct/year of rough diamonds for eight years.

In addition to the NWT and Nunavut, diamond exploration and evaluation is occurring in other areas of Canada, particularly within the provinces of Alberta, Saskatchewan, Ontario, and Quebec. For example, kimberlites in Saskatchewan were reviewed by **William Zimmerman** (Kensington Resources Ltd.); Kensington and its partner De Beers are evaluating numerous kimberlites in the Fort à la Corne region. Although the inferred diamond grades are relatively low, the large size of the Saskatchewan kimberlites and good infrastructure in the area make them attractive for further evaluation. **Robert Boyd** and **Brook Clements** (Ashton Mining of Canada) provided an overview of their company's properties and aggressive exploration programs in the Buffalo Hills of northern Alberta, Otish Mountains in Quebec, and at Kikerk Lake and Ric in Nunavut. Of these, the K-252 pipe in the Buffalo Hills is most promising, with an estimated diamond content of 55 carats per 100 tonnes based on a 22.8 tonne sample collected in March 2001. **Jacques Letendre** (Majescor Resources) reviewed diamond-bearing rocks in Quebec, including the Otish Mountains and at Fortage, Torngat, and Wemindji. Several other companies (i.e., SouthernEra Resources, Navigator, Shear Minerals, and Shore Gold) presented the results of their current exploration projects, as well as plans for the future, in various parts of Canada.

A number of speakers described activities in other parts of the world. **Sergey Oulin** (Alrosa) predicted that in the next four years there would be significant expansion in prospecting, rough production, and vertical integration of the diamond industry in Russia, with a greater emphasis on manufacturing and retailing but less on the export of rough diamonds. **Howard Bird** (SouthernEra) described properties in Africa (Gabon, Angola, and South Africa) and western Australia (Yilgarn). Exploration activities at the Tsumkwe project in northeast Namibia were reviewed by

Nigel Forrester (Mount Burgess Mining).

Diamond valuation and government relations with diamond explorers were covered in several presentations, with emphasis on Canada and Africa. In South Africa, according to **Claude Nobels** (DVIC Valuations Ltd.), independent valuers help the government maintain its custodial role, so that the industry can operate with confidence and in an organized fashion. **Richard Wake-Walker**, whose company WWW International Diamond Consultants Ltd. holds a diamond-valuation contract with the Canadian government, explained how run-of-mine diamond rough from the Ekati mine is evaluated according to the market price set by other suppliers to ensure that correct royalties are paid. **Martin Irving** (Government of the Northwest Territories) described ambitious activities to support diamond manufacturing in that jurisdiction and to monitor the government's certification program for diamonds that are both mined and cut in the NWT.

The diamond industry in South Africa was described by **Abbey Chikane** (South African Diamond Board) and **Abe Mngomezulu** (South African Department of Minerals and Energy). A new Minerals Development Bill has been drafted to encourage mining and diamond trading in South Africa, especially on a small scale. Ministers responsible for the mineral industries in Namibia (**Jesaya Nyamu**), Angola (**Paulo Mvika**), and Tanzania (**Edgar Maokola-Majoga**) provided overviews of diamond production and outlined recent changes in royalty and/or mining regulations that should facilitate activities in their respective countries. **Luciano de Freitas Borges** (Ministry of Mines and Energy, Brazil) mentioned proposed changes to mining legislation in Brazil that are designed to help reduce bureaucracy and increase the attractiveness of this country's mining properties to foreign investors. He also described ongoing geologic mapping and geophysical surveys of prospective terrain for diamonds by the Brazilian Geological Survey, with computerized results available in GIS format.

In other presentations, **Colin Kinley** (Layne Christensen Canada) described developments in cost-effective bulk-sampling methods for diamonds using new hydraulic drilling technologies that reduce diamond breakage and allow rock samples up to 24 inches (61 cm) in diameter to be collected at depth underground. He predicted that, in the near future, new drilling technology will enable the subsurface recovery of bulk samples up to 60 inches (152 cm) in diameter from kimberlites covered with glacial till or other types of overburden. **Graham Popplewell** (Signet Engineering) described state-of-the-art computer-drafting and networking capabilities for the design of diamond ore-processing plants using remote workstations and password-protected Internet sites. **Frank Holmes** (U.S. Global Investors Inc.) and **Robert Bishop** (*Gold Mining Stock Report*) reviewed factors that affect the market price of diamond mining stocks for investors, including commodity price trends, political risk, mine "life cycle," and exploration funding.

The mood at the close of the conference was one of



Figure 3. A number of exploration trenches, similar to this one, have been dug for diamonds at Staggy Creek, Australia. Photo by Shane F. McClure.

anticipation, as participants absorbed the excitement of Canada's emergence as a major diamond player and the revolutionary changes that are taking place in the industry overall.

Diamonds from Copeton, Australia. Diamonds reportedly were first discovered in Copes Creek, Copeton, in 1872, and the major workings in nearby Staggy Creek began in the late 1880s. The Copeton area remained Australia's main producer of diamonds until the development of the Argyle mine in the early 1980s. Although production historically has been rather small, the Copeton diamonds are interesting because of their unresolved geologic origin and reports that they are harder than other diamonds (see, e.g., L. M. Barron et al., "Subduction model for the origin of some diamonds in the Phanerozoic of eastern New South Wales," *Australian Journal of Earth Sciences*, Vol. 43, No. 3, 1996, pp. 257–267). The deposits also are interesting because virtually all of the recovered diamonds are "gem quality," and apparently no micro-sized diamonds have been found there; the rough Copeton diamonds typically weigh 0.20–0.25 ct. Geologists continue to debate the geologic origin of these diamonds (see, e.g., the previous reference, as well as H. O. A. Meyer et al., "Unusual diamonds and unique inclusions from New South Wales, Australia," *Russian Geology and Geophysics*, Vol. 38, No. 2, 1997, pp. 305–331). Some researchers maintain that the deposits are alluvial in nature, as suggested by the abundance of round-

ed pebbles in the host tuffsite. Conversely, Peter Kennewell (managing director of Cluff Resources Pacific) thinks the deposit is primary.

As part of a trip arranged by Dr. Lin Sutherland of the Australian Museum in Sydney, these contributors visited some of the new diamond diggings in the Copeton area in May 2001 after attending the ICA (International Colored Gemstone Association) Congress in Sydney. At the time of our visit, Cluff Resources Pacific had excavated two tunnels. We visited the Streak of Luck tunnel (located on the southern side of Mount Ross), which has produced up to 8 carats of diamonds per 100 tonnes excavated. The tunnel has crossed a number of old shafts from earlier diggings, and then intercepted what appears to be a volcanic intrusion that thus far has not yielded any diamonds. We were unable to visit the Star tunnel (which reportedly produced the highest quality stones recovered by Cluff at Copeton), because it has been flooded since 1999 due to above-normal rainfall. Significant restoration will be necessary before this shaft and tunnel can be worked again.

Cluff also is investigating another site in the Copeton area known as Staggy Creek. Several exploratory trenches (figure 3) have yielded relatively low returns so far. A lamprophyre/dolerite dike runs through the center of this deposit, but it is barren of diamonds. The highest concentrations of diamonds are recovered from the adjacent tuffsite. According to Cluff's 1998 annual report, more than 3,000 diamonds (totaling over 400 carats) were recovered from the pits and trenches at Staggy Creek.

Cluff is also mining another, similar diamond deposit in Bingara, approximately 60 km west of Copeton. According to their 2000 annual report, the Monte Christo diamond mine produced almost 9,000 diamonds from September 1999 to December 2000, or an average of 9.94 carats per 100 tonnes of material mined.

CPS and
Shane F. McClure
GIA Gem Trade Laboratory, Carlsbad
smcclure@gia.edu

COLORED STONES AND ORGANIC MATERIALS

Maxixe-type green-blue beryls with eye-visible pleochroism.

In May 2001, the AGTA Gemological Testing Center in New York examined two large (30.67 and 23.64 ct) faceted oval beryls with a face-up color that resembled aquamarine (figure 4). Standard and advanced gemological testing revealed that both green-blue stones had properties consistent with Maxixe-type beryl. The color, which is caused by natural or laboratory irradiation, is due to an unstable color center that fades on exposure to heat or light.

Both of the samples examined had similar gemological properties with refractive indices of 1.572–1.580, a specific gravity of 2.71 (measured hydrostatically), and a uniaxial optic figure; all of these aided in the identification of the stones as beryl, possibly aquamarine. The stones appeared



Figure 4. Both of these beryls (30.67 ct and 23.64 ct) show a strong green-blue color when viewed face-up parallel to the optic axis (left). Strong pleochroism is evident when viewed from the side, where a greenish yellow color is seen perpendicular to the optic axis (right).

yellow when viewed with a Chelsea filter, and were inert to long- and short-wave UV radiation. Microscopic examination revealed long needles and growth tubes that reached from crown to pavilion, as well as internal growth zoning. These proved the stones' natural origin, which was confirmed by FTIR spectroscopy.

The most striking aspect in the visual examination of the two stones was the difference between the strong green-blue face-up color and the greenish yellow color seen from the side (again, see figure 4). Such strong dichroism in a natural-color or heat-treated aquamarine is suspect. In addition, the darker pleochroic color was visible looking down the optic axis (along the ordinary ray), and the lighter pleochroic color was observed perpendicular to the optic axis (along the extraordinary ray). This is consistent with Maxixe-type beryl, and is opposite the behavior shown by natural-color or heat-treated aquamarine (see Winter 1998 Lab Notes, pp. 284–285).

Using a desk-model spectroscope, we found that the 437 nm "iron" line that is typically observed in strongly colored aquamarine was absent. Instead, there was a series of lines throughout the green to red regions of the spectrum. These findings also aided in the identification of the two stones as Maxixe-type beryl (see, e.g., K. Nassau et al., "The deep blue Maxixe-type color center in beryl," *American Mineralogist*, Vol. 61, 1976, pp. 100–107). Visible spectra measured by a Zeiss MCS 501 UV-Vis-NIR spectrophotometer showed a series of absorption bands and peaks not seen in natural-color or heat-treated aquamarine (figure 5).

Another feature of natural or treated Maxixe-type beryl is the presence of cesium (Cs), which rarely is detectable in aquamarine (figure 6; see also W. A. Deer et al., *Rock Forming Minerals—Disilicates and Ring Silicates*, Vol. 1B, 2nd ed., The Geological Society, London, 1997, pp. 372–409). According to Webster (*Gems*, 5th ed., Butterworth-Heinemann, Oxford, 1994, p. 127), the original Maxixe beryls mined in Brazil contained small amounts of cesium and lesser amounts of boron. Using EDXRF spectroscopy, we found Cs in both of the green-blue beryls along with small

quantities of iron (Fe) and traces of manganese (Mn). This is consistent with other Maxixe-type beryls we have examined at the laboratory. By comparison, most aquamarine has much more Fe and less or no Cs (again, see figure 6).

In June 2001, we received a dark violetish blue beryl set in a pendant at our mobile laboratory at the JCK Las Vegas Show. Since Maxixe-type beryl does not come through the laboratory very often, we were surprised when this stone, too, proved to be Maxixe-type. To date, we have examined five Maxixe-type beryls over an eight month period, none of which exhibited any residual radioactivity. We indicated on their lab reports that the color is produced by irradiation and has been known to fade in light and heat. The trade should take note that these stones are currently on the market, and are sometimes misrepresented.

Susan Paralusz

AGTA Gemological Testing Center, New York
sparalus@msn.com

Coloration of morganite from Pala, California. Renewed gem mining in the historic Pala pegmatite district has recently produced some attractive gem tourmaline, as well as small amounts of kunzite and morganite (see "Recent gem discoveries..." below). Most of the facetable morganite from the district was recovered from the White Queen mine on Hiriart Mountain by the Dawson family in the 1960s and 1980s. Although the White Queen is not currently active, Bob Dawson of Temecula, California, recently brought two exceptional White Queen morganites to our attention that well illustrate the effect of sunlight exposure on the coloration of this beryl (figure 7). When mined, the typical color of morganite from this pegmatite is brownish pink. According to Mr. Dawson, after exposure to sunlight for about one week, the brown color disappears, resulting in an attractive pink to purplish pink that is stable under normal conditions of wear and care.

This simple process, capable of causing such a distinct color change in morganite, is not widely known. A similar color alteration due to sunlight is illustrated for Brazilian morganite in the Spring 1989 issue of *G&G* (see A. R. Kampf and C. A. Francis, "Beryl gem nodules from the Bananal mine, Minas Gerais, Brazil," pp. 25–29). According to Dr. George Rossman (as cited in the above-mentioned article), the brownish pink or orange color of the as-mined material is due to prolonged exposure to low levels of natural radiation in the pegmatite host rock. Exposure to sunlight (or mild heating) is generally sufficient to return electrons that were displaced by this radiation to their original sites in the morganite crystal structure, restoring the pink color.

Vanadium-colored beryl from China. An interesting green beryl crystal from a new locality, reportedly in the Guangxi Province of China, was recently sent to GIA by Jack Lowell of the Colorado Gem and Mineral Co. in Tempe, Arizona.

UV-Vis SPECTRA

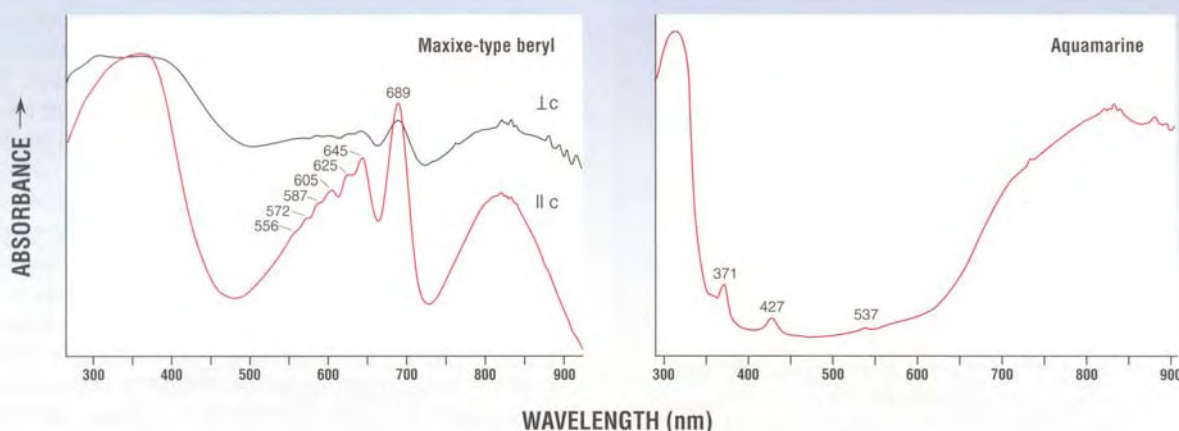


Figure 5. The polarized absorption spectra on the left depict the series of absorption peaks between 556 and 689 nm that were recorded in the green-blue Maxixe-type beryls. These peaks also are readily visible with a handheld spectroscope. In contrast, a typical absorption spectrum for natural-color aquamarine (right) shows strong “iron” lines at approximately 371 and 427 nm, and a small peak at 537 nm (which usually disappears after heat treatment).

The crystal, which was broken on both ends, measured 12.32 mm long and weighed 4.16 ct. The faces of the hexagonal prism were relatively flat and sharp edged, which indicates that the crystal was not recovered from an alluvial deposit. As shown in figure 8, the body color of the translucent crystal is a medium yellowish green, mottled with areas of white that are caused by dense clusters of light-scattering micro-fractures.

One of the flat prism faces yielded refractive indices of 1.575–1.581, with a birefringence of 0.006. A specific gravity of 2.69 was obtained hydrostatically. Microscopic examination revealed inclusions of tourmaline in the form of elongated individual rods, tight “nests,” and small clusters of needles. These inclusions show strong, very dark brown to light brown dichroism when examined with a single polarizing filter.

Figure 6. The EDXRF spectrum of one of the green-blue Maxixe-type beryls (left) shows small amounts of Cs, Fe, and Mn. The spectrum of a natural-color aquamarine (right) shows much more Fe and no Cs, although a minute amount of Mn may also be present. Heat-treated aquamarine generally shows an EDXRF spectrum similar to that of the natural-color aquamarine shown here. In both spectra, the peak at about 8.7 keV is an instrumental artifact.

EDXRF SPECTRA

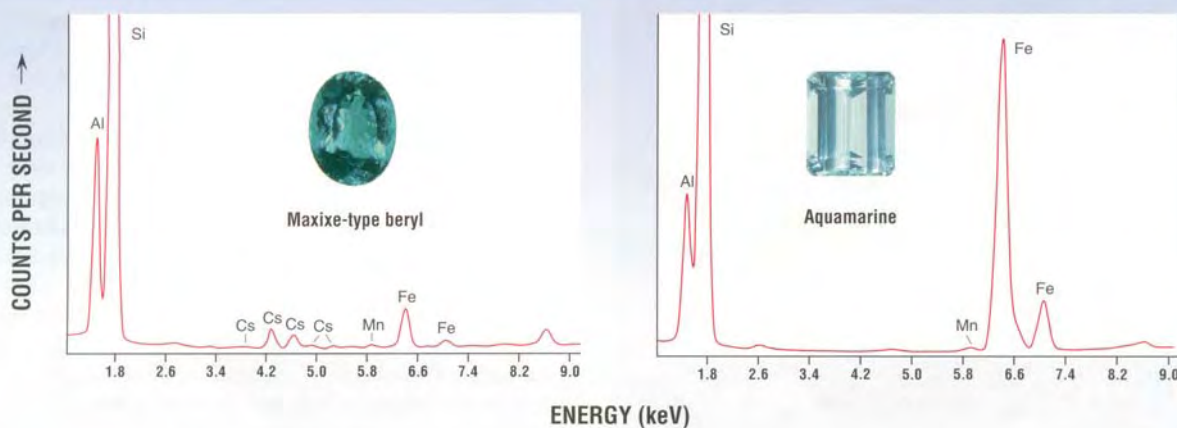




Figure 7. The 191.59 ct stone on the left shows the brownish pink color that is typical of morganite as it is mined from the White Queen mine in Pala, California. After exposure to sunlight for about one week, the brown color disappears, as shown in the 202.41 ct purplish pink White Queen morganite on the right. Courtesy of Bob Dawson; photo © Harold & Erica Van Pelt.

Figure 8. This 4.16 ct vanadium-colored beryl crystal reportedly was recovered from China's Guangxi Province. Photo by Maha Tannous.



The crystal was inert to both long- and short-wave UV radiation and showed no useful spectral features other than a moderate general absorption of the blue region when examined with a desk-model spectroscope. When the crystal was examined in transmitted light with a Chelsea filter, it took on the color of the filter itself, and no red transmission was observed.

EDXRF analysis revealed only the presence of vanadium and iron. No chromium was detected. The yellowish green body color of this crystal suggests that vanadium, and not iron, is the primary coloring agent, although the possible influence of iron cannot be ruled out. It is interesting to note that another relatively new locality for vanadium-bearing green beryl (which also contains some chromium) has been reported in China, in Yunnan Province (see F. Hongbin and L. Yongxian, "Mineralogical characteristics and exploitation perspective of emeralds in Yunnan Province," *Mineral Resources and Geology*, Vol. 12, No. 3, 1998, pp. 188–192).

Thus far most of the material recovered has been sold as "emerald" mineral specimens. According to Mr. Lowell, a few gems have been fashioned from these crystals, but they have been marketed only in China.

John I. Koivula, Maha Tannous,
and Sam Muhlmeister
GIA Gem Trade Laboratory, Carlsbad
jkoivula@gia.edu

Mini-faults in chalcedony. Disquieting earthquakes and spectacular volcanoes generally serve to remind us of the powerful and potentially destructive forces of nature. Even though these mega-forces may play a role in certain gem-forming processes, we rarely see any obvious evidence of their effect in the miniature world of gems. With this in mind, it was interesting to examine two polished slabs of patterned jasper (a variety of chalcedony) that showed sharp displacements in their layering (see, e.g., figure 9).

The two colorful samples were purchased at the 2001 Tucson show from West Coast Mining, College Place, Washington. The jasper samples were said to originate from Mexico (more specific locality unknown). We had them recut for photography by Leon Agee, of Deer Park, Washington, to 56.41 ct ($31.98 \times 30.59 \times 5.24$ mm) and 3.98 ct ($12.00 \times 11.39 \times 2.24$ mm).

Once the specimens were recut, the bedding planes and their displacement across miniature faults were even more apparent (figures 9 and 10). Standard gemological testing and observation confirmed their identification as jasper.

John I. Koivula and Maha Tannous

Recent gem discoveries in Pala, California. Granitic pegmatites in the Pala district are once again yielding significant finds of tourmaline, kunzite, and other gems. In the early 1900s, mines in Pala and the nearby Mesa Grande district (particularly the Himalaya mine, located 30 km southeast of the town of Pala) made Southern California a world-

renowned source of fine gemstones and mineral specimens. After decades of little or no production, recent finds have occurred at three historic mines: the Tourmaline Queen on Queen Mountain, and the Pala Chief and Elizabeth R on Chief Mountain. GNI Editor Brendan Laurs visited these mines in July–August 2001 for this update.

Renewed work at the Tourmaline Queen by mine owner Edward Swoboda of Beverly Hills, California, began in August 1996. This mine was the major producer of gem tourmaline in the Pala district in the early 1900s. After it was closed in about 1914, there was no organized mining until Mr. Swoboda purchased the property in 1970, more than 50 years later. The Tourmaline Queen was leased to Pala Properties International (a partnership between Mr. Swoboda and Bill Larson of Fallbrook, California) and mined during the period 1971–1978. That activity resulted in the discovery of some superb mineral specimens and pieces of gem rough, particularly in January 1972 when the miners found a large pocket that contained well-formed crystals of pink tourmaline with blue terminations (or “blue caps”; see B. Larson, “The ‘Queen’ reigns again,” *Lapidary Journal*, Vol. 26, No. 7, 1972, p. 1002 et passim). Specimens from this find can be seen in several major museums, such as the Smithsonian Institution in Washington, D.C. Since 1978, the property was leased for brief periods by various individuals, but for the most part remained inactive.

When Mr. Swoboda resumed mining at the Tourmaline Queen in 1996, he extended the underground workings to the west and south of the historic zone that yielded abundant tourmaline-rich pockets in the early 1900s. A few blue tourmalines were recovered from this area, but no significant pockets were found after excavating more than 100 m (328 feet) of tunnel over a period of two years. In 1997–1998, a portion of the underground workings was scanned with ground penetrating radar by Jeffrey Patterson and Dr. Fredrick Cook (both from the University of Calgary, Alberta, Canada) as part of their research to detect gem-bearing cavities within pegmatite. Although the instrument detected several anomalies, none turned out to be a gem pocket when excavated.

In October 2000, Mr. Swoboda signed an agreement with Scott Ritchie and Erik Cordova of Southern California Gem Industries, Torrance, California, for additional exploration and mining activities at the Tourmaline Queen. The team improved the rough four-wheel-drive roads that access the mine, and in July 2001 began open-cut excavations of the pegmatite with a large trackhoe. They exposed several hundred feet of the pegmatite where it crops out to the east and north, and made a large cut in the area where much of the historic production occurred (figure 11). Here, excavation exposed two old tunnels, and further mining in late July revealed several gem pockets.

The first pocket contained a blue tourmaline crystal that yielded two attractive cat’s-eye cabochons of 13.57 and 31.50 ct. Two pink cat’s-eye cabochons (7.30 and 7.95 ct) were cut from a crystal found in another pocket (figure

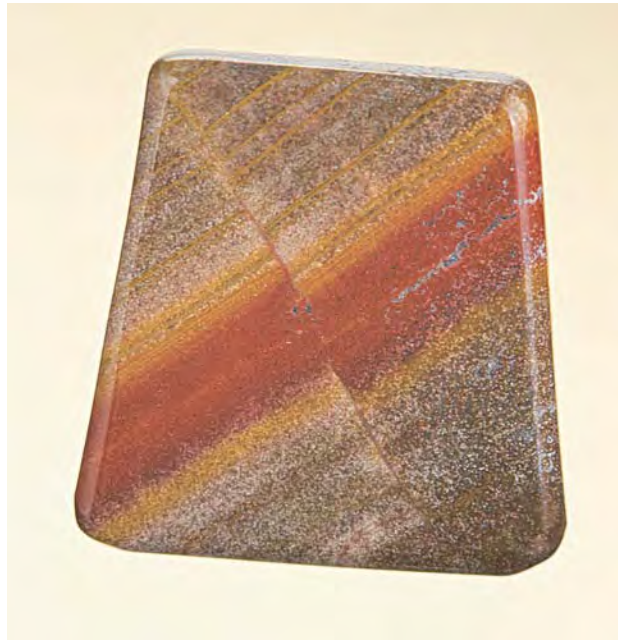


Figure 9. This 56.41 ct polished jasper shows an obvious displacement of the colorful bedding planes. Photo by Maha Tannous.

12). Chatoyant tourmaline from San Diego County is typically green—as found mainly at the Himalaya mine in Mesa Grande—so the blue and pink cat’s-eyes cut from material found in these new pockets are very unusual. Other cavities produced bright pink and bicolored pink-and-blue tourmaline rough, two of which have been pre-formed into stones that exceed 100 ct. Mr. Swoboda estimates that the recent finds have yielded several hundred carats of gem-quality tourmaline as well as several specimen-quality crystals (some with morganite). The open cut has now been mined out and filled in; future plans call for underground mining of several enriched sections of the pegmatite.

The historic Pala Chief mine is known mostly for its pink or “lilac” kunzite, in addition to fine tourmaline and

Figure 10. The high contrast of red and white layers in this 3.98 ct polished jasper makes the mini-faulting readily apparent. Photomicrograph by John I. Koivula; magnified 3×.





Figure 11. In July 2001, Edward Swoboda and partners used a large excavator to open-cut part of the Tourmaline Queen mine in Pala, California. Several pockets containing gem- and specimen-quality tourmaline were found after the cut was extended several meters into the pegmatite. Photo by Brendan M. Laurs.

morganite. The current owner, Bob Dawson of Temecula, California, purchased the property in the early 1990s. Mr. Dawson improved the roads and security in preparation for mining, and began extending one of the short tunnels in

Figure 13. At the Pala Chief mine, mine owner Bob Dawson found a gem pocket containing tourmaline and kunzite in November 2000. The pocket, which measured approximately 1 m long, was located in the pegmatite core zone next to the area with purple lepidolite to the left of Mr. Dawson; photo by Brendan M. Laurs. The inset shows the pocket as it was being excavated; the dark crystal on the lower right is tourmaline (6.3 cm across) on a matrix of quartz and cleavelandite feldspar that is attached to the top of the pocket. Photo by Bob Dawson.

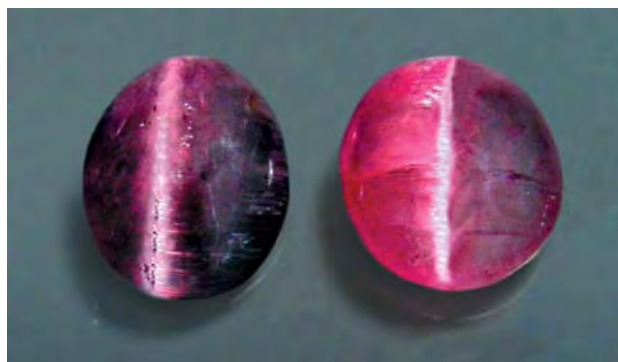
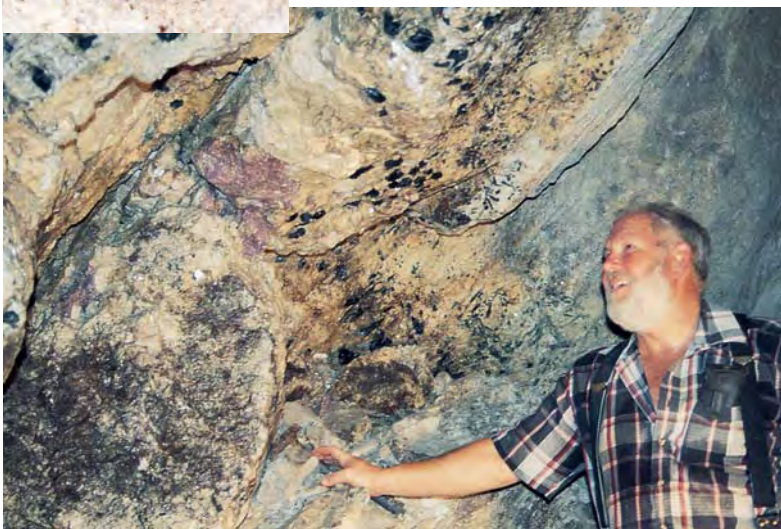


Figure 12. One of the gem pockets recently found at the Tourmaline Queen mine yielded a chatoyant tourmaline crystal that was cut into these two cat's-eyes (7.30 and 7.95 ct). Chatoyant tourmaline from San Diego County is typically green. Photo by Edward Swoboda.

October 2000. After drilling and blasting through about 3 m of pegmatite, he found a gem pocket approximately 1 m long $\times$ 0.5 m wide $\times$ 0.3 m thick in early November 2000 (figure 13). From this pocket, he recovered five well-formed crystals of pink tourmaline with flat pale blue-gray terminations (see, e.g., figure 14), as well as several pieces

Figure 14. This well-formed crystal of tourmaline (8.4 $\times$ 6.2 cm) was recovered at the Pala Chief mine in November 2000. Courtesy of Bob Dawson; photo by Maha Tannous.



of pink kunzite. The tourmalines formed stout prisms ranging from 6.1×2.3 cm to 8.4×6.2 cm, and the kunzites occurred as deeply etched, lustrous crystals up to 10.7×2.7 cm. Further mining has uncovered a few additional small pockets or “vugs” that contained crystals of pink or blue-gray tourmaline.

The Elizabeth R mine is not as well known as the other two, but it has been operated intermittently for nearly three decades by Roland Reed of El Cajon, California. The property was originally purchased by Mr. Reed as the Hazel W claim in 1974, and he renamed it Elizabeth R in 1980. In 1973, he purchased the adjacent Ocean View claim, from which he obtained large quantities of quartz and morganite in well-formed crystals (some of the latter bicolored with aquamarine) in 1974–1975 and 1982. In September 2000, Mr. Reed sold the Ocean View mine to a group headed by Jeff Swanger and Stephen Koonce Jr. of Escondido, California.

In July 2000, Mr. Reed started a new tunnel on the Elizabeth R property, and in November 2000 the tunnel penetrated the down-dip extension of the Ocean View pegmatite. He was surprised when he immediately encountered a mineralized quartz-spodumene core zone, in which he found several small clay-filled vugs that contained pink, blue, and bicolored pink–bluish green tourmaline and lavender kunzite (figure 15). As of August 2001, the new tunnel at Elizabeth R had produced several hundred carats of gem rough, and some had been faceted or cut into cabochons (see, e.g., figure 16). The tourmaline- and kunzite-bearing zone that Mr. Reed has uncovered is completely unlike the beryl-bearing areas previously known on the property; it more closely resembles the mineralization at the Pala Chief and Tourmaline Queen. As work continues at all three mines, more gems and mineral specimens will likely become available in the marketplace.

A statuette containing a large natural blister pearl. This past summer, the AGTA Gemological Testing Center

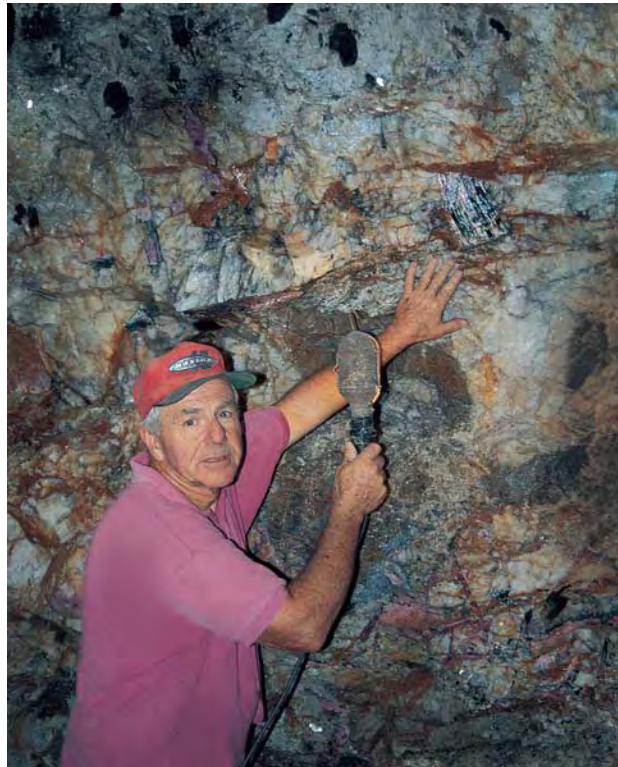


Figure 15. Beginning in November 2000, a new tunnel at the Elizabeth R mine in Pala penetrated a previously unknown pegmatite core zone that yielded several small clay-filled vugs with gem-quality tourmaline and kunzite. Mine owner Roland Reed is pointing to a large black-and-pink crystal of tourmaline that is “frozen” in the pegmatite. Photo by Brendan M. Laurs.

examined a large “pearl” set within a statuette of a centaur (figure 17). A centaur is a mythological creature with the head, arms, and chest of a man but the legs and lower half of a horse. Figurines that make use of oddly shaped pearls were particularly popular with artists during the Renaissance, when mythological themes were adopted for interesting ornaments, such as the circa 1560 Canning Jewel (in which a large natural pearl has been set as the

Figure 16. Several hundred carats of rough gem tourmaline and kunzite were recently recovered from the Elizabeth R mine. The faceted stones on the left (0.47–2.02 ct) show the range of color of the pink tourmaline. The middle photo depicts some unusual cat’s-eye tourmaline in blue, greenish blue, and bicolored pink-green colors (13.44–16.30 ct). The faceted kunzite on the right weighs 14.39 ct. Courtesy of Roland Reed; photos by Maha Tannous.

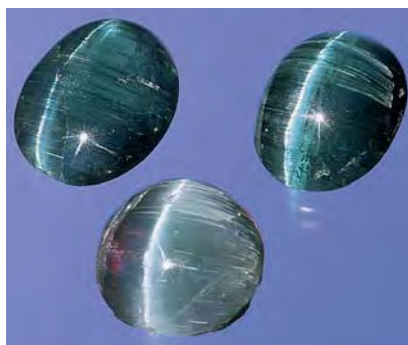




Figure 17. The torso of the centaur in this statuette is actually a natural blister pearl that weighs 856.58 ct. Photo by Kenneth Scarratt.

torso of a triton; see, e.g., figure 6 in D. M. Dirlam et al., "Pearl fashion through the ages," Summer 1985 *Gems & Gemology*, pp. 63–78). Although we had no information on the possible age of the statuette we examined in our lab, the practice of using oddly shaped pearls—both natu-

Figure 18. After being removed from the statuette, the 856.58 ct natural blister pearl could be examined from all directions. The back of the blister pearl (see inset) shows the banded structure of the shell from which it grew. Photos by Kenneth Scarratt.



ral and now cultured—in this manner has carried through to the present.

The centaur measures approximately 17 cm in height (excluding the base) and is about 15.5 cm long from tail to outstretched front hoof. The head and arms of the man and the entire horse portion are made of a yellow metal embellished with white, red, green, and black enamel work. Set at various points are old-cut diamonds with well-worn facet edges and foil-backed "red" corundum. The "saddle" is removable and facilitates the setting and unsetting of the "pearl." A yellow metal band wraps around the midriff and is similarly decorated with old-cut diamonds and foil-backed corundum.

The "pearl" is nacreous, and when removed from the setting it weighs 856.58 ct and measures $69.13 \times 48.97 \times 34.68$ mm. The color is purplish brownish gray on the convex front and dark gray to black on the concave back (figure 18). The back has the banded structure of the shell from which it grew, indicating that it is not a true, fully formed pearl, but rather is a blister pearl. X-radiography showed that the structure of the blister pearl is banded throughout and not concentric (figure 19). The lack of a bead nucleus or any other indication of cultured pearl growth confirmed that it is natural.

Most nacreous pearls of extraordinary size are, in fact, found attached to the inner wall of the host mollusk's shell. Hence, they are termed *blister pearls*. The Hope pearl, thought to be one of the largest of all nacreous pearls, with an estimated weight of 450 ct, is a natural blister pearl (see, e.g., S. Kennedy et al., "The Hope pearl," *Journal of Gemmology*, Vol. 24, No. 4, 1994, pp. 235–239). The Summer 2001 issue of *Gems & Gemology* (Gem News International, p. 158) described a natural pearl recently discovered in waters off the coast of Myanmar that, at a reported weight of 845 ct and measuring $62 \times 53 \times 30$ mm, was thought to be the world's largest (nacreous) natural pearl (U. T. Hlaing, "World's largest pearl," *Australian Gemmologist*, Vol. 21, No. 3,

Figure 19. This X-radiograph of the blister pearl shown in figure 18 reveals a layered growth structure, which confirms its identity as natural.



2001, p. 135). Although the reports thus far emerging from Myanmar do not confirm whether or not this is a blister pearl, the published images suggest that this may be the case. By comparison, the natural blister pearl set in the centaur statuette is about the same size and weighs slightly more than the Myanmar pearl. Certainly, both of these weigh more than the reported or assumed weights for such large, historically famous nacreous pearls as the 450 ct Hope pearl, the 605 ct Pearl of Asia, and the 575 ct Arco Valley pearl (G. F. Kunz and C. H. Stevenson, *Book of the Pearl*, Century Co., New York, 1908; J. Taburiaux, *Pearls—Their Origin, Treatment and Identification*, NAG Press, London, 1985, pp. 89-99).

In describing large individual natural or cultured pearls, and certainly when making claims regarding their relative sizes, it is important to note whether they are nacreous or non-nacreous (and, if possible, to state the type of mollusk from which they were recovered), as well as whether they have characteristics of blister growth. This allows for a clearer comparison to be made. *KVGS*

Exceptional carpet shell pearl. The “carpet shell” (or palourde) is a bivalve mollusk, very common off the coast of France, where it is much appreciated by shellfish enthusiasts for its flavorful yet subtle taste. Very rarely, it also produces small pearls (typically about 2 mm), which are generally very irregular and unattractive. Mrs. Gilberte Landré, janitorial manager at this contributor’s institute, nevertheless fished an exceptional specimen on October 17, 2000, from the Gois passage—the expanse of sand inshore of the French island of Noirmoutier that is covered by the sea only at high tide—south of Nantes (figure 20).

The pearl is almost perfectly round, with a diameter of 5.7–5.9 mm, and weighs 1.43 ct. It is nacreous and very lustrous, but without much orient. The pearl shows an even purple color; this hue is also present in a portion of the shell it came from, which is otherwise white and brown inside (again, see figure 20). There are several small, grayish blemishes on the surface. When exposed to long-wave UV radiation, the pearl luminesced a chalky whitish yellow, similar overall to the reaction of the inside of the shell (although the purple part of the shell is only weakly luminescent). The reaction was weaker to short-wave UV.

The sample was also examined with a JEOL 5800 scanning electron microscope (SEM) in the low-vacuum mode (no conductive coating necessary); a qualitative chemical analysis was obtained using a Princeton Gamma Tech detector with a high-resolution (115 eV) germanium crystal and an ultra-thin polymer window. This equipment ideally can measure elements as light as boron. The surface appeared granular at 1,500× magnification, with pits less than 1 mm in diameter evenly distributed over the area examined. As expected, the chemical analysis revealed mostly calcium, oxygen, and carbon (i.e., a calcium carbonate), with trace amounts of aluminum and sodium. *EF*



Figure 20. The “carpet shell” mollusk shown here was fished near the island of Noirmoutier off the coast of western France. It yielded this exceptional 5.8 mm purple pearl. Photo by Alain Cossard.

Tahitian “keshi” cultured pearls. Two “black” cultured pearls (figure 21), one near-round and the other oval (potato shaped), were recently submitted to the SSEF laboratory for identification. Both samples showed an uncommon surface feature: a small groove (or indentation) on the flatter side of the slightly button shape, which may correspond to internal growth inhomogeneities (see below). On closer examination, we saw that the samples were actually dark brown. Chemical analysis by EDXRF revealed a very low manganese content, which is typical of saltwater origin. We confirmed that the color was natural by measuring the reflectance spectra with a standard (Hitachi 4001) spectrophotometer. X-radiography showed multiple growth inhomogeneities that formed a typical pattern, but no evidence of a nucleus (figure 22). The shape of the cultured pearls as well as their typical irregular growth structures led us

Figure 21. These two samples (11 and 15 mm across) were found to be Tahitian non-nucleated cultured pearls (“keshi”). Photo by H. A. Hänni.



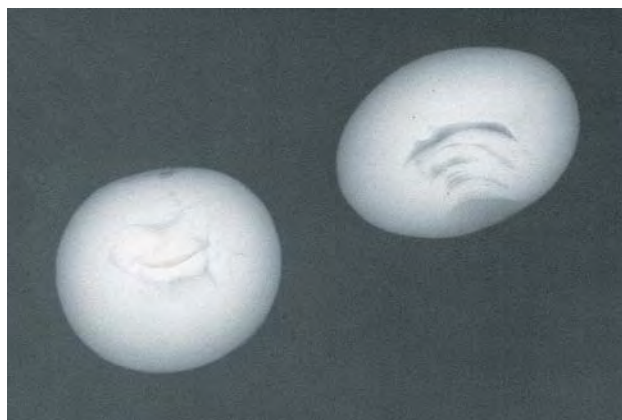
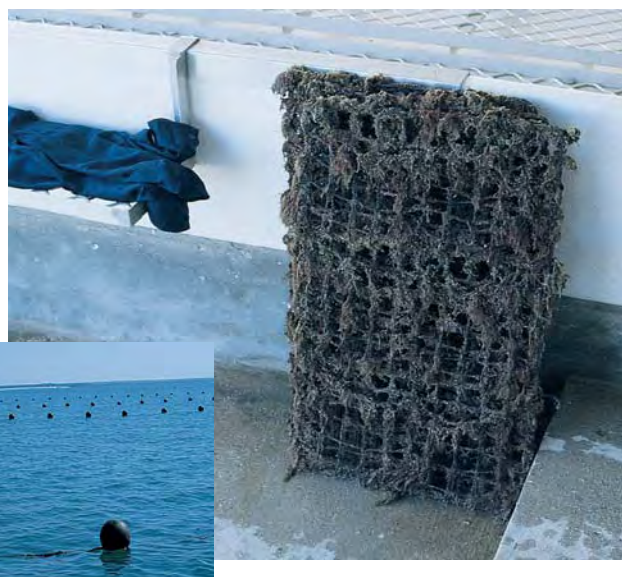


Figure 22. This X-radiograph reveals typical growth inhomogeneities within the two Tahitian "keshis" shown in figure 21.

to the conclusion that they are Tahitian non-nucleated cultured pearls (sometimes called "keshi").

When a bead-nucleated cultured pearl is removed from a pearl sac, the cultivator can insert a second bead of the same diameter as the cultured pearl just harvested, or leave the pearl sac empty and wait for the possible formation of a "keshi." However, this contributor suggests that these samples formed after rejection of the second bead, which would also result in a beadless cultured pearl when the pearl sac is filled with calcium carbonate from the mantle epithelium. "Keshi" cultured pearls are well known from Australia, but

Figure 23. At Bruce Brown's pearl farm at Cygnet Bay in northwest Australia, nucleated oysters are placed in wire cages such as this. They are cleaned every two weeks to remove the fast-growing weed that collects on them. The cages are suspended from 350 "lines" (see inset), and each line holds 400 nucleated oysters. Photos by Shane F. McClure.



Tahitian "keshi" cultured pearls are more of a novelty (see, e.g., Spring 2000 Gem News, pp. 70–71). According to cultured pearl experts Andy Muller and Robert Wan (pers. comm., 2001), a small quantity of black "keshis" were released into the pearl market last year. HAH

Pearl culturing in northwest Australia. In May 2001, these contributors visited Cygnet Bay Pearls, a cultured pearl farm at Cygnet Bay that is owned and operated by Bruce Brown. Located approximately 200 km north of Broome (about a one hour flight by small plane), Mr. Brown's farm was founded 40 years ago by his father and older brother. The farm now harvests 140,000 oysters in two-year cycles (typically every 20 to 24 months). In the main part of the bay, Mr. Brown has 350 "lines," each of which contains 400 nucleated oysters. To maximize cultured pearl growth, he has the oyster shells cleaned every two weeks to remove a fast-growing weed that collects on them (figure 23). This ensures that the oysters get the full benefit of the nutrients necessary to promote nacre growth. Typically the pearls achieve 2–4 mm of nacre growth per year (with the greatest amount when the mollusks are younger and progressively less as they get older). The farm uses beads made from Mississippi freshwater mussel shells, typically with a diameter of 6 mm to yield cultured pearls from 11 to 12 mm.

Most of the mollusk shells open slightly when taken out of the water for harvesting. A wooden peg is inserted to keep the shell open until just prior to the extraction procedure, when the peg is replaced by a clamp that further separates the shell and holds it open just wide enough to remove the cultured pearl without traumatizing the mollusk. Those few oysters that do not open their shells are returned to the water until the next harvesting cycle. As noted above in the entry by Dr. Hänni (and illustrated in the Summer 2001 S. Akamatsu et al. article on Chinese freshwater cultured pearls, p. 105), farmers will insert another bead (similar in size to the cultured pearl just harvested) into the vacant pearl sac, which typically will produce a 14–15 mm cultured pearl by the next harvest. If the bead is smaller than the cultured pearl that was extracted, the pearl sac collapses and produces button- or off-shape cultured pearls with irregular nacre thickness. After harvesting the oysters and re-seeding them, the cultivators wash the shells with fresh water to kill the bacteria that cause disease in the animals.

A few of the cultured pearls from Mr. Brown's farm are gray in color. He stated that when parasites drill through the shell, the oyster coats them with a black film to kill them. Sometimes the oyster also does this to the bead once it has been inserted. Subsequently, the coated bead is covered with nacre and the pearl develops as usual; however, the black film imparts a gray appearance to the resulting cultured pearl.

As a consequence of the culturing process, some non-nucleated ("keshi") cultured pearls also are produced. When these are detected during a routine X-ray of the shells to determine if nacre is forming on the beads, the mollusks are placed in a separate area of the farm for

further development without intervention. Although small amounts of “keshis” are harvested, they are not being sold at this time. The largest “keshi” they have produced to date is a baroque shape that weighs 4.75 momme (89 ct).

Mr. Brown’s farm is represented by the marketing arm of the Autore Group of Companies, which was founded in 1991 by Rosario Autore. The Autore Group acts on behalf of 11 pearl producers (from Western Australia, Indonesia, and most recently, Papua New Guinea) that specialize in fine-quality South Sea pearls. According to Mr. Autore (pers. comm., 2001), the Autore Group of Companies sells 30% of the Australian production of South Sea cultured pearls, second only to Paspaley Pearls (which has a market share of approximately 50%). The Autore Group separated from the South Sea Pearl Consortium approximately two years ago, to develop its own classification system, marketing strategy, and brand. One of these contributors (CPS) was shown a magnificent cultured pearl necklace consisting of 18–21 mm round cultured pearls of very good surface luster and few or no surface blemishes (figure 24).

CPS and Shane F. McClure

Green powellite from Chile. Powellite, CaMoO_4 , is one of the rarest gem materials. Transparent crystals suitable for faceting are known from India’s Maharashtra State, but only from one area, near Nasik, where they occur in basalt cavities with abundant zeolites. Indian powellite is colorless to yellow, and cut stones over 2 ct are very rare, although at least one attractive faceted stone over 50 ct exists (D. Blauwet, pers. comm., 2001).

Powellite from Chile has a completely different appearance. The locality is the Inca de Oro copper mine in the Atacama Desert, where powellite is found with a rela-

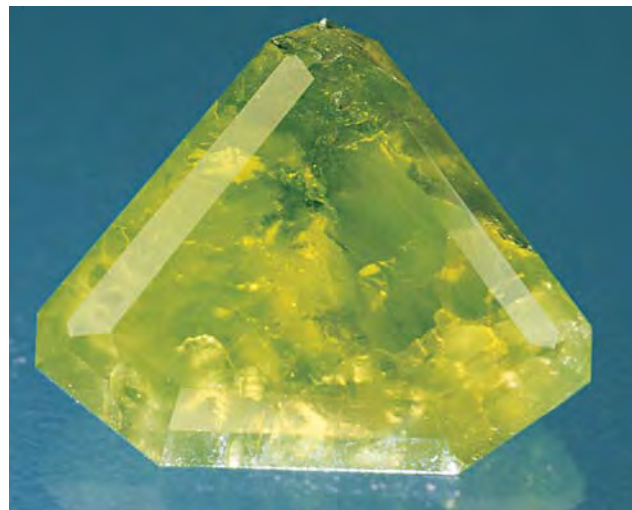
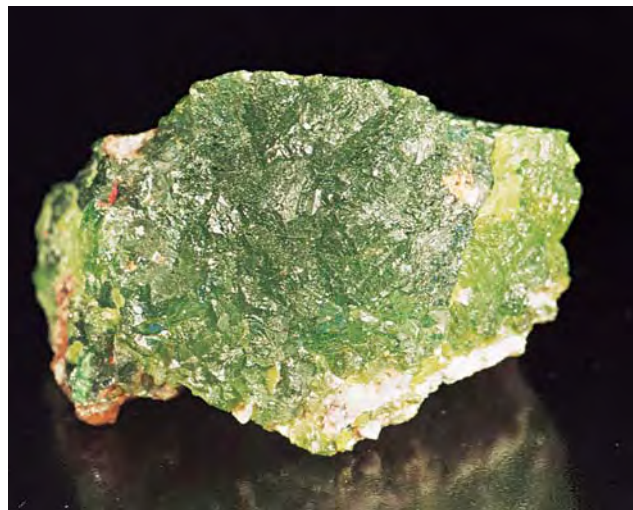


Figure 24. Bruce Brown’s pearl farm is a member of the Autore Group of Companies, which specializes in fine-quality South Sea cultured pearls from farms in Western Australia, Indonesia, and Papua New Guinea. The top-quality cultured pearls in this necklace range from 18 to 21 mm. Courtesy of the Autore Group of Companies.

tively new mineral, szenicsite, as described by C. A. Francis et al. (see “Szenicsite, a new copper molybdate from Inca de Oro, Atacama, Chile,” *Mineralogical Record*, Vol. 28, No. 5, 1997, pp. 387–394). This Chilean powellite occurs as yellow pseudomorphs after molybdenite, as small crystals and as very rare translucent green druses (figure 25); the drusy material has yielded a few interesting faceted stones. The most transparent gemstones range from 0.5 ct to 1 ct, but translucent stones can weigh more than 15 ct (again, see figure 25). However, powellite’s low hardness (3.5–4 on the Mohs scale) makes it unsuitable for jewelry, despite this interesting color.

This contributor studied 18 faceted powellites from Inca de Oro to document their gemological properties. These samples weighed 0.25–16.07 ct and were translucent to transparent. They ranged from yellow-green to green with weak pleochroism—in green and yellow-green.

Figure 25. The 4 × 3 cm sample of translucent drusy powellite on the left is from the Inca de Oro copper mine in the Atacama Desert, Chile. The faceted Chilean powellite on the right weighs 16.07 ct. Photos by J. Hyrs.



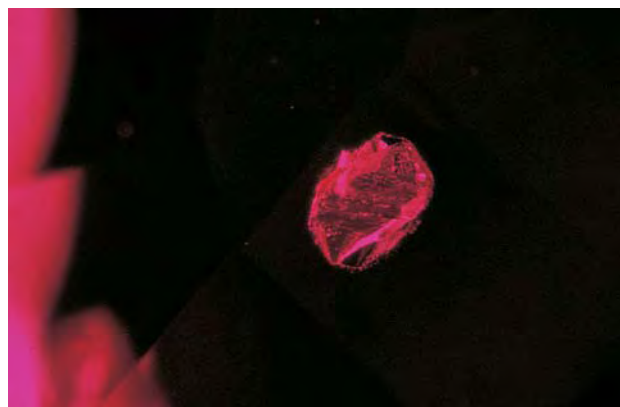


Figure 26. This colorless, roughly tabular inclusion in an unheated ruby from Myanmar was identified as anhydrite, which has not been identified previously as an inclusion in gem corundum. Photomicrograph by Christopher P. Smith; magnified 50×

The refractive indices were over-the-limits of a standard refractometer, and the specific gravity values were rather high at 4.17–4.22. When examined with a polariscope, powellite behaves as an anisotropic aggregate; only the smallest cut stones show normal extinction. Very characteristic is a bright yellow fluorescence to short-wave UV radiation, but the material is inert to long-wave UV. The spectrum seen with a handheld spectroscope exhibited complete absorption of the blue and purple regions, starting from about 460 nm. When viewed with a microscope, the samples showed a swirled structure, although one stone exhibited a layered agate-like structure.

Because of its unusual color, the Chilean material is sometimes described as “chrome-powellite.” However, the color is probably due to trace amounts of copper. In addition to calcium and molybdenum, Francis et al. (1997) reported 0.02–0.30 wt.% CuO in yellow, green, and brown powellite, with the greatest amounts measured in a dark green sample.

Jaroslav Hyrsl
Kolin, Czech Republic
hyrsl@kuryr.cz

Anhydrite inclusion in a ruby from Myanmar. As more advanced analytical techniques become commonplace in gemological laboratories, properties and features not reported previously will occasionally be encountered. Such was the case in the Gübelin Gem Lab (GGL) recently, when a 3.79 ct ruby was submitted for identification. The combination of inclusion features, internal growth structures, and chemical composition indicated that the ruby was unheated and originated from the Mogok stone tract of Myanmar. A crystalline inclusion situated just below the surface of the gemstone, however, had an unfamiliar appearance (figure 26). This colorless crystal had a roughly tabular habit with an irregular surface, and did not resemble any of the more common crystalline inclusions encountered in Burmese rubies, such as calcite, apatite, and sphene.

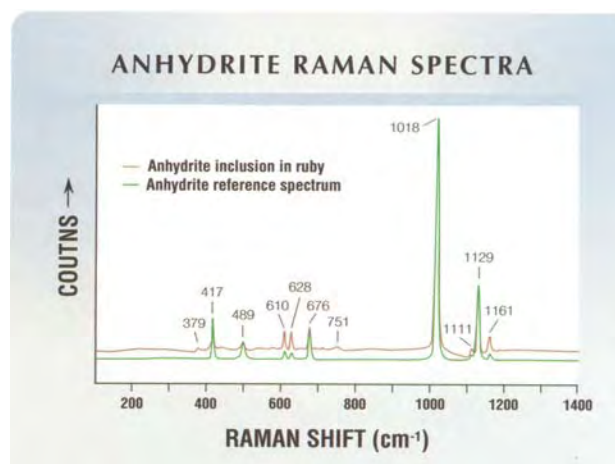
Analysis of the inclusion with a Renishaw 2000 Raman microspectrometer proved that the mineral was anhydrite, CaSO_4 (figure 27). To our knowledge at GGL, this is the first time that anhydrite has been identified as an inclusion in gem corundum from any source. Anhydrite, a relatively common rock-forming mineral, is a nonhydrated form of gypsum. It is often associated with gypsum, which is commonly derived from anhydrite by the process of hydration. Occurrences of anhydrite have been identified underlying thick layers of gypsum in northern Shan State (see, e.g., F. Bender, *Geology of Burma*, Gebrüder Borntraeger, Berlin, 1983), east of the Mogok stone tract.

CPS and Christian Dunaigre
Gübelin Gem Lab
Lucerne, Switzerland

Ruby and sapphire mining at Barrington Tops, Australia. In addition to diamond mining in the Copeton and Bingara fields (see the “Diamonds from Copeton...” entry above), Cluff Resources Pacific operates the ruby and sapphire deposits in Gloucester, in the Barrington Tops area of New South Wales (see also Winter 1995 Gem News, pp. 281–282). Additionally, they operate a joint-venture sapphire mine in central Queensland. As part of the trip arranged by Dr. Lin Sutherland, these contributors visited the Barrington Tops ruby and sapphire deposit in May 2001.

Apparently discovered by a prospector in the 1970s, the deposits occur along several river tributaries (principally from the Manning river) and are classified into three types (i.e., recent alluvials, middle terraces, and upper terraces). Corundum has been found throughout the flatland

Figure 27. The Raman spectrum of the crystalline inclusion shown in figure 26 clearly identified it as anhydrite, with the two primary peaks positioned at 1018 and 1129 cm^{-1} , respectively. Here, the Raman spectrum of the anhydrite inclusion is compared to that of an anhydrite reference spectrum in the Renishaw database. No peaks were recorded in the region 1400–1800 cm^{-1} .



region between the various tributaries. Managing Director Peter Kennewell believes that the entire region of terraces was formerly a swamp where gem-bearing basaltic eruptions deposited an extensive ash layer ranging from 1 to 2 m thick. Heavy minerals (including gems) in these deposits have been reworked into recent alluvial systems. The rubies and sapphires are apparently recovered mostly from these alluvial sediments (figure 28), together with gem-quality zircon and black spinel.

Cluff negotiated with the landowner to begin a bulk sampling program in 2000. To date, several trenches have been dug that are approximately 3–4 m wide, 4 m deep and up to 200 m long. The largest gem-quality ruby recovered weighed 5.8 ct. The company has established a laboratory and processing facility in Sydney, managed by Dr. Robert Coenraads, to begin developing a market for their gemstones. Dr. Coenraads has developed a classification system for the various colors of corundum (yellow through green, to blue, and parti-colors) that they produce. The faceted rubies and pink sapphires are graded into six color categories (red no. 1 and pink nos. 1–5) and four quality ranges (1–4; “clean” to heavily included). The company continues to cut and stockpile its stones in preparation for a major marketing campaign. As of August 2001, around 5,000 grams of ruby had been recovered during the exploration program, and about half of this was of cutting quality (R. Coenraads, pers. comm.).

Studies by Dr. Sutherland have shown that two types of corundum coexist in this vast region (see F. L. Sutherland et al., “Origin of chromium-colored gem corundums, Australia,” *Gemmologists Handbook*, International Gemmological Congress, 1999, pp. 37–39; G. Webb, “Gemmological features of rubies and sapphires from the Barrington volcano, eastern Australia,” *Australian Gemmologist*, Vol. 19, 1997, pp. 471–475). One type is chromium-bearing and is related to a metamorphic or metasomatic corundum-sapphirine-spinel source. The colors of these rubies and sapphires include red/pink through purple to violetish blue, and even pure blue. The other, smaller population consists of blue to blue-green sapphires that are related to a magmatic sapphire-bearing source. Sapphires of this type exhibit the typical surface corrosion features of corundum transported as xenocrysts in alkali basalts. This magmatic-type gem corundum is typical of many basalt-related deposits in eastern Australia, but the Barrington Tops area is unusual in that significant quantities of metamorphic-type ruby/sapphire gems are also present. Similar bimodal gem corundum associations have been recognized in other basaltic fields in eastern Australia, as well as in Cambodia (Pailin), Laos, and southern Vietnam.

Shane F. McClure and CPS

Renewed mining for rubies in Nanyaseik, northern Myanmar. Over the past few months, thousands of miners have converged on the Nanyaseik area of northern Myanmar, in a new “gem rush” for ruby and pink sapphires, as well as spinel. The area, also referred to as Nanyar Zeik



Figure 28. This equipment is used for washing the gem-bearing sediments in the Barrington Tops area of eastern Australia. Photo by Shane F. McClure.

(and various other spellings), is located in the Myitkyina district of Kachin State. This region is well known for the famous jadeite deposits near Hpakan, which are located approximately 30 km west of Nanyaseik. Rubies from this area have been described previously (see, e.g., H. Htun and G. E. Harlow, “Identifying sources of Burmese rubies,” Fall 1999 *Gems & Gemology*, pp. 148–149), but past production has been rather small and sporadic.

Thick vegetation and forests of tall trees have been cleared so that pits could be excavated to reach the gem-bearing alluvial layer (figure 29). The miners use traditional Burmese mining techniques: First, they dig a “lebin,” or square pit, and then they hoist the soil and gem-bearing material to the surface using a rope and a bucket. Washing of the gravels and initial processing of the ruby rough is performed on-site. Although most of the newly mined ruby is reportedly small, good-quality crystals up to 8–10 ct also have been found.

Overall, the faceted rubies appear very similar to Mogok material. The color typically ranges from pink and purple-pink to dark red, and the stones are usually very clean. During a recent visit to Bangkok, one of the contributors (CPS) examined 25 high-quality rubies that reportedly came from Nanyaseik. Observation with a microscope revealed planar and swirled internal growth structures. These non-heated rubies also had long, iridescent rutile needles as well as small “nests” of short rutile needles. Other mineral inclusions consisted of colorless calcite, rounded crystals of



Figure 29. The Nanyaseik area of northern Myanmar is producing ruby and pink sapphire, as well as spinel, from alluvial diggings such as this. The gem-bearing gravel has been hoisted to the surface from the pit on the lower left, and is being washed by the miners. Photo courtesy of Frederico Barlocher.

light yellow sphene, and dark orange rutile. All of the mineral inclusions were identified visually, based on features that are diagnostic of their appearance in Burmese rubies. EDXRF analyses of the Nanyaseik rubies revealed trace-element contents that are similar to those recorded for rubies from Mogok, with relatively high levels of vanadium and lower concentrations of iron, titanium, and gallium.

CPS and George Bosshart
Gübelin Gem Lab
Lucerne, Switzerland

Figure 30. "Spider" quartz has been mined in the Antsirabe region of central Madagascar for the past few years. The crystals shown here weigh 52.05 and 26.62 ct, and the faceted stone weighs 12.48 ct; courtesy of John I. Koivula and photo by Maha Tannous. The inset shows the interesting display created by the needle-like inclusions. Photomicrograph by John I. Koivula; magnified 10×.



"Spider" quartz. An attractive variety of colorless quartz with interesting inclusions has been mined in the Antsirabe region of central Madagascar for the past few years (figure 30). It contains small radiating sprays of black needles that measure up to a few millimeters across (again, see figure 30). The appearance of these inclusions has prompted the dealers to call it "Spider" quartz or "Microstar." Denis Gravier of Le Minéral Brut, St. Jean-le-Vieux, France, provided several specimens to this contributor in the hope that our research laboratory could identify the inclusions.

We broke open several rough samples and examined the fractures with a JEOL 5800 scanning electron microscope (SEM). One of the fractures revealed protruding needle-like crystals, up to 10 μm across (figure 31), that corresponded to an underlying "spider" inclusion. The chemical composition was measured with the EDX spectrometer of the SEM, although only a semi-quantitative analysis was possible because of the small size of the needles and the lack of a polished surface perpendicular to the beam. Nevertheless, we obtained several consistent analyses. These revealed that, in addition to oxygen (about 60 atomic percent, determined by stoichiometry), manganese was abundant (about 27 at.%), followed by barium (a little less than 4 at.%), iron (about 3.5 at.%), and aluminum (about 2.3 at.%); the remainder (about 3 at.%) consisted of lead and silicon. The major-element composition is consistent with the mineral hollandite, $\text{Ba}(\text{Mn}^{4+}, \text{Mn}^{2+})_8\text{O}_{16}$. Lead is probably an impurity in the hollandite, whereas silicon, iron, and aluminum may be contaminants related to the quartz (silicon) or possibly clay-like materials that coat the inclusions.

We confirmed the identification of these inclusions as hollandite by single-crystal X-ray diffraction analysis, using a curved-detector Linel diffractometer. The shape of the needles is consistent with the monoclinic pseudotetragonal crystal habit of hollandite. EF

Figure 31. This scanning electron micrograph of a broken piece of "Spider" quartz from Madagascar shows the fine needle-like inclusions that were identified as hollandite.



Blue-to-green tourmaline from Nigeria. In recent years, the Ibadan region of western Nigeria has become an important source of pink and bicolored (pink-green) tourmaline for the gem trade (see, e.g., Winter 1998 Gem News, pp. 298–299). According to Dudley Blauwet (Dudley Blauwet Gems, Louisville, Colorado) and Bill Larson (Pala International, Fallbrook, California), Nigeria recently produced some fine blue-to-green tourmaline (figure 32). Some of the rough appears as clean, elongate “pencils” that do not show evidence of alluvial transport, but alluvial material also is recovered. The first discoveries of these tourmalines were made late last year, from granitic pegmatite deposits. Nigerian dealers of rough have indicated that the mine is located in the Ilorin area of western Nigeria, and production has been sporadic.

Although production figures are not available, shortly before the 2001 Tucson shows Mr. Blauwet saw a parcel of rough that weighed 1,100 grams, and at Tucson he saw another parcel that weighed 400 grams. Most of the tourmaline in these parcels was blue and appeared dark, but some showed attractive colors. From a selection of 110 grams of rough, Mr. Blauwet obtained about 250 carats of faceted stones; most of these ranged from 1 to 7 ct. Pala International participated in the sale of a 3,500 gram parcel of this tourmaline in June 2001, from which two crystals (49.81 and 79.22 ct) were selected for chemical analysis. The saturated blue color shown by these unheated gemmy crystals resembled that of some copper-bearing “Paraíba” tourmaline from northeast Brazil (see also the following entry). EDXRF qualitative chemical analysis at the GIA Gem Trade Laboratory in Carlsbad revealed major amounts of Al, Si, and Fe, as well as traces of Ca, Mn, Zn, Ga, and Sn, in both crystals; however, no copper was detected in either crystal.

Nigeria as a new source of copper-manganese-bearing tourmaline. In August 2001, the Gübelin Gem Lab (GGL) received samples of tourmaline from firms in Idar-Oberstein, Germany (Gebrüder Bank, Wild & Petsch, and Paul Wild) that also reportedly were from a new deposit near Ilorin, Nigeria. We were informed by these suppliers that the tourmalines from this deposit are found in a wide range of colors, many of which are similar to those observed in “Paraíba” tourmalines from the São José da Batalha mine in Brazil. According to the suppliers, most of the Nigerian material—like the Brazilian tourmalines—is heat treated; after heat treatment, the majority of the tourmaline is sold in Germany and in Brazil.

The Nigerian tourmalines studied at GGL were submitted by the dealers before heat treatment, and consisted of a 22.98 ct violet gemstone (figure 33), six purplish pink to blue crystal pieces (0.69–1.44 ct; figure 34), and a 3.30 ct bluish green piece. Standard gemological properties obtained for the 22.98 ct stone were typical for gem tourmaline: R.I.— $n_o=1.620$, $n_e=1.638$; birefringence—0.018; optic character—uniaxial negative; and inert to short- and long-wave UV radiation. Internal features consisted of the typical liq-

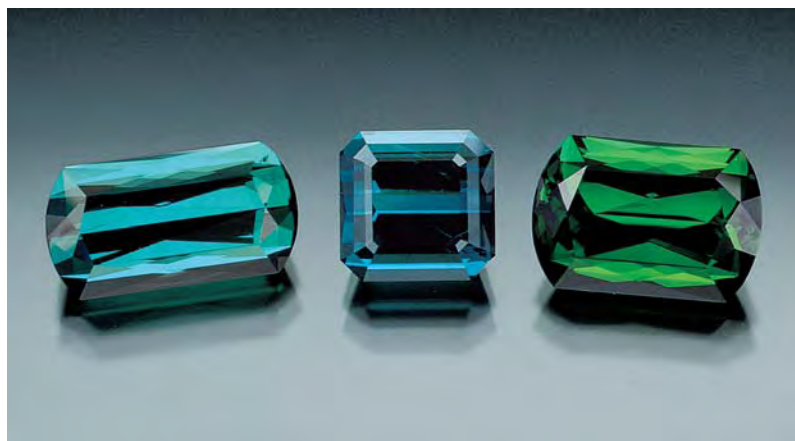


Figure 32. These three blue-to-green faceted gems (9.5, 7.0, and 9.5 ct) show the range of color seen in the tourmaline found recently in the Ilorin area of western Nigeria. Courtesy of Dudley Blauwet; photo by Jeff Scovil.

uid inclusions observed in tourmalines, some of which contained a secondary gas bubble. The gemstone displayed moderately strong pleochroism consisting of purple-violet parallel to the optic axis and slightly grayish violet-blue perpendicular to the optic axis. A distinct color change was visible when the stone was viewed in day- or fluorescent light (violet) and incandescent light (purple).

EDXRF qualitative chemical analysis of the violet gemstone and the purplish pink to blue pieces revealed the presence of copper, as well as manganese, iron, and bismuth, in varying relative intensities. The bluish green slice contained relatively high concentrations of iron and manganese, but no copper was detected.

Copper-manganese-bearing elbaite from Nigeria was

Figure 33. This 22.98 ct copper-manganese-bearing tourmaline comes from a new deposit in Nigeria, also believed to be in the Ilorin area. Some of the gems recovered from this deposit are similar in color to “Paraíba” tourmalines from Brazil. Photo by Franzisca Imfeld.



recently documented by J. W. Zang et al. ("Cu-haltige Elbaite aus Nigeria," *Berichte der Deutschen Mineralogischen Gesellschaft, Beihefte zum European Journal of Mineralogy*, Vol. 13, 2001, p. 202), who reported the source as the Edeko area, near Ilorin in western Nigeria. These authors obtained quantitative chemical analyses of three violet-blue samples (J. Zang, pers. comm., 2001) that are consistent with the results we obtained; using an electron microprobe and laser mass spectrometry, they measured 2.13–2.59 wt.% MnO, 0.51–2.18 wt.% CuO, 0–0.05 wt.% TiO₂, 0–0.02 wt.% FeO, and 0–0.02 wt.% Bi₂O₃, as well as other minor and trace elements. Prior to this new find, cuprian elbaite was known only from the Paraíba and Rio Grande do Norte states in northeast Brazil (see, e.g., E. Fritsch et al., "Gem-quality cuprian-elbaite tourmalines from São José da Batalha, Paraíba, Brazil," Fall 1990 *Gems & Gemology*, pp. 189–205; J. Karfunkel and R. R. Wegner, "Paraíba tourmalines—Distribution, mode of occurrence, and geologic environment," *Canadian Gemmologist*, Vol. 17, No. 4, 1996, pp. 99–106).

Tourmaline mining in the Edeko area is reportedly unorganized, with up to several thousand miners working the area. At this time, the amount of copper-manganese-bearing tourmaline produced from there is not known. Some reports indicate that over 100 kg of Edeko rough have been sent to Idar-Oberstein, but very little of the material is of high quality, and even less has enough copper to attain the intense "Paraíba"-like blue, blue-green, and "turquoise" colors (J. W. Zang, pers. comm., 2001).

CPS, George Bosshart, and Dietmar Schwarz
Gübelin Gem Lab, Lucerne, Switzerland

Figure 34. These six samples (0.69–1.44 ct) show a range of colors from the new tourmaline deposit in Nigeria. All of them were identified as copper-manganese tourmaline by EDXRF qualitative chemical analysis. Photo by Franzisca Imfeld.



More on liddicoatite from Nigeria. A report on an orangy pink crystal of Nigerian liddicoatite in the Summer 2001 GNI section (pp. 152–153) speculated that an untold amount of tourmaline from this country might be liddicoatite, which historically has been known primarily from Madagascar. More liddicoatite now has been identified from Nigeria, this time purplish red.

Last spring, John Patrick of El Sobrante, California, sent two purplish red tourmalines to GNI editor Brendan Laurs for examination after he noticed that they had a slight color shift between incandescent light and an Ott-Lite (which is represented as a "total spectrum light source"). The 8.64 ct oval brilliant and 6.89 ct cushion step cut were purchased about two-and-a-half years ago, and reportedly were mined in the Abuja area in central Nigeria (figure 35). Mr. Patrick also donated a 1.39 ct purplish red tourmaline crystal from the same parcel to GIA, one end of which we polished flat, perpendicular to the c-axis, for analysis.

The three stones were reddish purple when viewed with a daylight-equivalent fluorescent lamp, and their color appeared somewhat more brownish in incandescent light. This color behavior is quite normal, due to the different wavelengths of these two light sources, and it would not be considered a color-change phenomenon. Gemological properties were: R.I.— $n_o=1.621$, $n_e=1.639$; birefringence—0.018; S.G.—3.07–3.08; fluorescence—inert to long-wave UV radiation, and inert to very weak greenish yellow to short-wave UV. With the microscope, the oval-cut stone and the crystal revealed strong graining and tiny colorless crystals that appeared isotropic between crossed-polarizers. The grain lines were planar and intersected in angular or triangle-shaped patterns that were centered on the c-axis. Concentrations of graining along each triangular apex appeared in the shape of a Mercedes Benz symbol perpendicular to the c-axis of the crystal, but otherwise there was no evidence of zoning within this homogeneously colored tourmaline. The crystal also contained minute growth tubes parallel to the c-axis, some of which originated from the tiny included crystals.

The polished surface of the crystal was analyzed with an electron microprobe by Drs. William ("Skip") Simmons and Alexander U. Falster at the University of New Orleans, Louisiana, as part of an ongoing research project there on tourmaline composition. There was no systematic chemical zoning in five analyses that traversed a cross-section of the crystal. The sample proved to be liddicoatite, with average concentrations of 2.87 wt.% CaO and 1.44 wt.% Na₂O. Fluorine (1.35 wt.% F), manganese (0.20 wt.% MnO), and iron (0.09 wt.% FeO) also were detected; the latter two chromophoric elements are the likely cause of the purplish red color. Other elements known to influence the color of tourmaline (i.e., titanium, chromium, and vanadium) were not detected. Unlike the Nigerian liddicoatite reported in the Summer 2001 GNI section, this crystal contained very little bismuth—an average of only 0.03 wt.% Bi₂O₃. Traces of zinc (up to 0.09 wt.% ZnO), magnesium (up to 0.05 wt.% MgO), and potassium (up to 0.03 wt.% K₂O) also

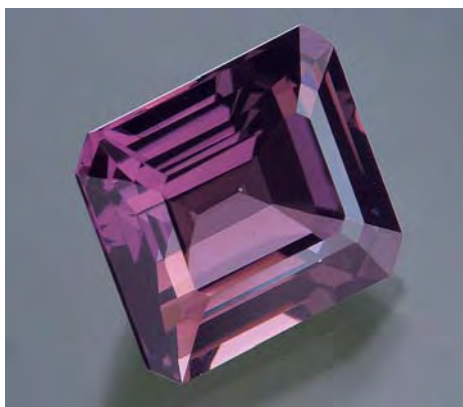


Figure 35. These 8.64 ct (left) and 6.89 ct (right) tourmalines were reportedly mined in the Abuja area of central Nigeria. The purplish red color is seen here as viewed with a daylight-equivalent fluorescent lamp. A crystal of identical color from the same parcel proved to be liddicoatite. Courtesy of John Patrick; photos by Maha Tannous.

were found in some analyses, whereas barium, lead, and chlorine were not detected.

SYNTHETICS AND SIMULANTS

Laboratory-grown orange-to-yellow “langasite.” Langasite is a transparent piezoelectric silicate of lanthanum and gallium ($\text{La}_3\text{Ga}_5\text{SiO}_{14}$) that is grown by the Czochralski method for technological applications. It has no natural counterpart. The name *langasite* is derived from its chemical components (La, Ga, and Si); it should not be confused with the unrelated natural mineral *langisite*, (Co,Ni)As. Langasite is one of about 100 compounds with the $\text{Ca}_3\text{Ga}_2\text{Ge}_4\text{O}_{14}$ structure that were first grown in Russia in the early 1980s (see B. V. Mill et al., “Synthesis, growth and some properties of single crystals with the $\text{Ca}_3\text{Ga}_2\text{Ge}_4\text{O}_{14}$ structure,” 1999 *Joint Meeting EFTF – IEEE IFCS, Extended Abstracts*, pp. 829–834). The high refractive indices, high dispersion, and hardness (reported as 6.6 on the Mohs scale) of langasite make it suitable for use as a gem material. It is currently produced in Russia, Japan, Korea, France, and the U.S., and is used in wireless and cellular communications and cable television. The color of langasite can vary, depending on growth conditions and added dopants. We know that orange to yellow crystals are grown in Russia, Japan, and France (see S. Uda and O. Buzanov, “Growth of 3-inch langasite crystal with clear faceting,” *Journal of Crystal Growth*, Vol. 211, 2000, pp. 318–324), and colorless crystals are reportedly produced in the U.S. (Prof. Y. Pisarevsky, pers. comm., 2001).

GIA recently used both standard and advanced gemological techniques to examine nine samples of langasite from Russia (see, e.g., figure 36). Three of the samples were faceted (4.59, 4.98, and 56.80 ct), and four were crystal fragments or oriented sections (up to 81.99 ct or $23.6 \times 19.8 \times 13.2$ mm). Detailed results of this examination will be published in *Vestnik Gemmologii* (*Gemology Herald*; T. Lu et al., “Langasite—A new man-made orange-to-yellow gem material,” Vol. 1, No. 2, 2001, in press), a new journal of the Gemmological Society of Russia in Moscow. The samples ranged from orange to yellow, with the larger samples having the greatest color saturation. The coloration was uniform, with no color banding observed. Moderate pleochroism (light yellow/orange) was seen with a polar-

iscope. All samples yielded a specific gravity (measured hydrostatically) of 4.65. The refractive indices of langasite are over-the-limits of a standard refractometer. However, on a sample of orange Russian langasite, Prof. Y. Pisarevsky (Institute of Crystallography Russian Academy of Sciences, Moscow, Russia) used the prism method to determine R.I. values of $n_o = 1.9099$ and $n_e = 1.9213$ (with 546 nm light), a birefringence of 0.0114, and high dispersion (0.035) with green and red dispersive colors.

None of the samples exhibited any twinning or fracturing. We observed triangular-shaped solid inclusions (oriented in linear arrays) in one faceted sample, and a large number of two-phase inclusions in the form of parallel needles in another faceted sample. The rough samples with crystal faces showed growth striations in oblique orientation to the optic axis direction.

Using a handheld spectroscope, we did not observe any absorption bands in the samples; nor did we observe any visible luminescence when they were held over the spectroscope lamp. All the samples were inert to short- and long-wave UV radiation.

The visible spectra (250–850 nm) of five orange-to-yellow samples showed gradually decreasing absorption from 350 to about 580 nm, and no absorption features from about 580 to 850 nm. The infrared spectra displayed a broad band centered at 5436 cm^{-1} , and weak sharper bands at 3405 , 2921 , and 2847 cm^{-1} . The Raman spectra showed peaks at 5280 , 5246 , 3472 , and 3223 cm^{-1} ; a broad peak centered at 4612 cm^{-1} ; and weak peaks at 3574 , 2654 , 2628 , 737 , and 704 cm^{-1} . EDXRF spectra showed the expected major elements (lanthanum, gallium, and silicon); no trace elements were detected. The color of the samples was stable when heated to 250°C . No data have been reported on the cause of the yellow to orange color.

Faceted pieces of this langasite could resemble other transparent orange or yellow gem materials. However, the properties of langasite permit easy identification by a trained gemologist with standard gemological instruments. The high refractive indices distinguish langasite from sapphire and spinel, and its double refraction differentiates it from optically isotropic gems such as diamond, cubic zirconia, YAG (yttrium aluminum garnet), and GGG (gadolinium gallium garnet).

The gem material that most easily could be confused



Figure 36. These two faceted samples of the synthetic material “langasite” ($\text{La}_3\text{Ga}_5\text{SiO}_{14}$) were grown in Russia by the Czochralski method. They weigh 56.80 and 4.59 ct. Photo by Maha Tannous.

with langasite is zircon. However, characteristic absorption lines seen with the desk-model spectroscope can separate the two materials. Also, the infrared and Raman spectra, as well as the EDXRF chemical analysis, of langasite and zircon are quite distinct. In addition, the crystal morphology of zircon is tetragonal, whereas langasite (which is trigonal) is grown in the form of hexagonal-shaped crystals.

Langasite-type compounds have received much attention in the optoelectronics industry. Several varieties have been grown as single crystals by the Czochralski method

Figure 37. This laboratory-grown 5.45 ct rectangular step cut ($11.1 \times 6.9 \times 5.1$ mm) was represented as “langasite.” Chemical analysis of the sample revealed a composition that is consistent with a theoretical formula of $\text{SrLaGa}_3\text{O}_7$, which differs from that of langasite, $\text{La}_3\text{Ga}_5\text{SiO}_{14}$. Photo by Alain Cossard.



(again, see Mill et al., 1999), and their gemological properties are likely to vary from what is reported here.

Taijin Lu and JES
GIA Research
tlu@gia.edu

Vladimir S. Balitsky
Institute of Experimental Mineralogy
Russian Academy of Science
Chernogolovka, Russia

Laboratory-grown pink $\text{SrLaGa}_3\text{O}_7$, a material related to “langasite.” Pierre Vuillet of Villards d’Heria, France, provided this contributor with a light pink 5.45 ct rectangular step cut represented as “langasite” by a crystal grower from the French Alps (who reported the chemical formula as $\text{SrLaGa}_4\text{O}_7$). Although the sample is light pink in daylight (figure 37), this color changes to light yellow with exposure to strong incandescent light. Unlike an alexandrite effect, however, the color change is not instantaneous—it takes several minutes. But like the alexandrite effect, the change in color is reversible. With a calibrated Sarasota Instruments reflectometer, a refractive index of approximately 1.82 could be measured. Observation with a polariscope revealed a fairly strong birefringence, but this could not be measured with the reflectometer due to the resolution (approximately ± 0.02) of the instrument. The sample was optically uniaxial, but no pleochroism could be seen, perhaps because of the very light color. The specific gravity was very high, at about 5.25. The sample fluoresced an intense green to long-wave UV radiation, and a weaker green to short-wave UV. The handheld spectroscope revealed a line in the blue region at about 485 nm and a doublet in the green region around 525 nm. There were many groups of inclusions, including whitish “breadcrumbs” and short cylindrical tubes that were interrupted in places and in a few instances originated at larger “breadcrumb” inclusions. Also observed were what looked like negative crystals, and a few small, irregular yellowish masses.

Analysis with the energy-dispersive X-ray spectrometer of a JEOL 5800 scanning electron microscope revealed the following chemical composition (measured in atomic percentage): 24.74 at.% gallium, 8.36 at.% strontium, 8.57 at.% lanthanum, and 58.34 at.% oxygen (determined by stoichiometry). This is consistent with a theoretical formula of $\text{SrLaGa}_3\text{O}_7$, which differs from the formula provided by the manufacturer by one less gallium atom per formula unit.

To investigate the origin of the pink color, a UV-visible absorption spectrum was recorded with a Unicam UV4 spectrophotometer in the range 350–700 nm. A number of sharp lines and doublets—with the major ones at 365, 380, 485–488, 520–523 and 648–653 nm—were superimposed on an absorption continuum that rose slowly toward the ultraviolet. This latter absorption may be enhanced by incandescent lighting, which shifts the color of the sample toward yellow over a period of minutes. These absorption features are consistent in general shape and position with those seen with the handheld spectroscope. They are

typical for erbium (Er^{3+}) in cubic zirconia (see, e.g., Kammerling et al., "An examination of nontransparent 'CZ' from Russia," Winter 1991 *Gems & Gemology*, pp. 240–246), as is the luminescence behavior. However, the erbium concentration was below the detection limit (which is estimated at approximately 400 ppm) using our SEM-EDX analytical technique under standard conditions.

Although this material is not langasite, which has a formula of $\text{La}_3\text{Ga}_5\text{SiO}_{14}$, its composition suggests that it could be part of the langasite family of compounds (see B. V. Mill et al., 1999, cited in the previous entry). EF

An unusual "crystal" of synthetic ruby from Sri Lanka. In December 1999, a friend of this contributor purchased a 9.56 ct specimen in Sri Lanka that was represented as ruby. The sample looked like a typical broken bipyramidal crystal with waterworn surfaces, and showed a saturated red color (figure 38). Examination with a handheld spectroscope revealed a typical ruby spectrum. With strong back-lighting, straight parallel zones perpendicular to the perceived optic-axis direction could be seen with difficulty; these appeared to result from the presence of inclusions.

The rough yielded a well-proportioned 4.17 ct pear shape. Prominent, eye-visible zoning appeared to be caused by dense concentrations of the "silk" inclusions that are typical of ruby (figure 39). When viewed with a microscope, however, slightly curved zones of tiny gas bubbles were seen. Between the zones of small bubbles were larger bubbles, some with a long attached channel (figure 40). Also present were abundant, curved hollow cavities that were very similar to the "trichites" seen in many tourmalines.

The gas bubbles proved that this sample was a flame-fusion synthetic ruby. However, this fake crystal was unusual in that it was fashioned from low-quality synthetic material containing abundant bubbles. While most gem

Figure 38. This 9.56 ct broken bipyramidal "crystal" was actually manufactured from low-quality flame-fusion synthetic ruby. Photo by Jaroslav Hyrsl.



Figure 39. The 4.17 ct pear-shaped synthetic ruby cut from the "crystal" shown in figure 38 appears to contain zones of "silk," which give it a natural appearance to the unaided eye. Photo by Jaroslav Hyrsl.

dealers are suspicious of high-quality rough *without* inclusions, few expect to see clever imitations of rough crystals made from lower-quality synthetics. Such mistakes can be very costly. Jaroslav Hyrsl

A rare medieval sapphire imitation. Gemstone imitation is an ancient practice, and some historic examples are very clever. One such imitation was recently documented by this contributor during a gemological examination of the medieval Ardennes cross at the German National Museum in Nuremberg. The gem materials in the cross were identified by a combination of optical properties (using a microscope, dichroscope, spectroscope, color filters, and sometimes a refractometer), as well as UV fluorescence, thermal properties, and (in rare instances) hardness.

The wooden cross measures 73 cm tall and 45 cm wide, and is covered by dozens of polished gems; one arm is

Figure 40. When examined with a microscope, the streaks of "silk" were revealed to be slightly curved zones of gas bubbles, which proved the ruby was synthetic. Photomicrograph by Jaroslav Hyrsl; field of view is 1.7 mm.





Figure 41. A gemological examination of the medieval Ardennes cross revealed red almandine garnet and glass or quartz imitations of more valuable gem materials. The wooden cross measures 73 × 45 cm; one arm is damaged, and the stones and metalwork are missing. Courtesy of Germanisches Nationalmuseum Nürnberg.

damaged and the stones are missing (figure 41). According to art historians, it probably was crafted in France in the second quarter of the ninth century. Most of the gems are set in their original mountings, although some were apparently added during restorations—these have a larger mounting and/or a different cutting style. On the basis of their optical characteristics, the gems were identified as red almandine garnet, green glass, rock crystal, and many unusually large samples that apparently served to imitate sapphires.

Three of the sapphire imitations are blue glass; these contain many gas bubbles and scratches on the surface, and one of them is drilled. Based on the criteria mentioned above, these appear to be replacements for the original gems. In addition, 15 of the large “sapphires”—all of which are believed to be original to the piece—are polished pebbles that have been drilled. They are colorless with a few blue spots (figure 42) and appear similar to Sri Lankan sapphires, which were available in Europe since at least Roman times. Microscopic examination of the colorless portions revealed fractures and two-phase inclusions, as are typical of natural stones. However, the blue spots contained tiny gas bubbles (again, see figure 42). Thermal con-

ductivity testing showed no reaction on the blue spots, but significant conductivity on the colorless areas. The colorless portion of one broken “sapphire” revealed a conchoidal fracture, which is typical of quartz or glass; a careful hardness test made while examining the sample with a microscope supported an identification as quartz, as did the presence of the two-phase inclusions.

These observations suggest that the 15 drilled sapphire imitations consist of quartz pebbles that were dipped into molten blue glass and then drilled and repolished. (Note that “gemstones” in ancient Sri Lanka were commonly used as amulets, and therefore almost all Roman and medieval sapphires are drilled.) These imitations are much more convincing than those made of blue glass, which are common to medieval as well as younger objects. Nevertheless, the gas bubbles seen with the microscope, and the relatively low hardness of the quartz, were key factors in recognizing these imitations.

Jaroslav Hyršl

ANNOUNCEMENTS

CONFERENCES/SHOWS

GAGTL Gem-A Conference 2001. The Gemmological Association and Gem Testing Laboratory of Great Britain will host its annual conference on November 4, 2001, at London’s Barbican Conference Centre. Presentations will cover HPHT-treated diamonds, heat treatment of rubies, and more. In conjunction with the conference, one-day GAGTL workshops will focus on pearls (October 31) and amber (November 6). Additional events include a guided tour of the geologic section of the Natural History Museum in London (November 2) and a visit to De Beers (November 5). For further information, visit <http://www.gagtl.ac.uk/gnews.htm>; contact Mary Burland at 44-20-7404-3334 (phone), 44-20-7404-8843 (fax); or e-mail gagtl@btinternet.com.

SimDesign 2001. The 1st Brazilian Symposium of Jewelry Design and Gemology will take place November 29–December 1 at the Marina da Glória Convention Center in Rio de Janeiro. The event will provide networking opportunities for designers, jewelers, and gemologists. For more, visit <http://www.simdesign2001.com.br> or e-mail info@simdesign2001.com.br.

Australian Diamond Conference. On December 4–5, 2000, this conference will take place in Scarborough, Perth, Western Australia. The program will feature presenters from several diamond explorers, as well as major industry analysts. A pre-conference tour of the Argyle diamond mine will occur on December 1. Contact Eleanor Dix at 61-8-9321-0355 (phone), 61-8-9321-0426 (fax), or e-mail at elle@louthean.com.au.

Visit Gems & Gemology staff in Tucson. *Gems & Gemology* editors Alice Keller, Brendan Laurs, and Stuart Overlin will join Subscriptions manager Debbie Ortiz at



Figure 42. Among the sapphire imitations in the medieval Ardennes cross were 15 drilled and polished pieces such as the 2.4-cm-long example shown on the left. The light-colored area crossing the length of the stone in the center is a drill hole. On the right, note the tiny gas bubbles in the blue glass areas, as well as the two-phase inclusions in the colorless portion, which was tentatively identified as quartz (field of view is 8.0 mm wide). Photos by Jaroslav Hyrsľ.

the *Gems & Gemology* booth in the Galleria section (middle floor) at the Tucson Convention Center for the AGTA show, February 6–11, 2002. Stop by to ask questions, share information, or just say hello. And take advantage of the many back issues—and special prices—we'll be offering, including a limited number of out-of-print issues that we recently acquired.

Following the AGTA show, the Tucson Gem and Mineral Show will take place on February 14–17. The theme of the show and of the 23rd Annual Mineralogical Symposium (February 16) will be *African Minerals*.

EXHIBITS

Jewels of the Nizam. The famed gem and jewelry collection of the Nizam of Hyderabad, valued at \$1.27 billion, is now on display to the public. The exhibit was inaugurated on August 29, 2001 by Indian prime minister Atal Bihari Vajpayee at the National Museum in New Delhi. The Indian government purchased the 173-piece collection from the trust of the last Nizam, as the feudal princes of the western Indian state of Hyderabad were known, after years of negotiations. The Nizams governed Hyderabad from 1712 until 1948, a year after the end of British colonial rule of India. After the last Nizam's death in 1967, the collection—which includes the 185 ct Jacob diamond as well as emeralds, pearl necklaces, and gem-encrusted turbans—was housed in the Reserve Bank of India in Mumbai. Beginning in November, the exhibition will be on display for six weeks at the Salar Jung Museum in Hyderabad. Visit <http://www.nationalmuseumindia.org>, or contact Mr. U. Das at 91-011-3018415 (phone) or rdchoudh@ndf.vsnl.net.in.

Gem museum in Sri Lanka. In March 1999, a new gem and mineral museum opened to the public in Mount Lavinia, Sri Lanka. Undertaken by lapidary and collector

Gamini Zoysa, the museum houses rare and unusual gemstones, organic gem materials, and specimens displaying optical phenomena from Sri Lanka and other countries. Also featured is a large collection of postage stamps depicting gemstones. Call 94-1-726796 or e-mail mincraft@slt.lk.

Pearls at the American Museum of Natural History. A comprehensive exhibition on pearls will take place at the American Museum of Natural History in New York until April 14, 2002. *Pearls* will then travel to Chicago's Field Museum, where it will be on view from June 28, 2002, through January 5, 2003. The exhibition showcases pearls and pearl-forming mollusks, including white and black pearls from marine *Pinctada* oysters of Japan and Polynesia, freshwater pearls from mussels found in the United States and China, pink conch "pearls" from the Caribbean Queen conch, and more. A section on the decorative use of pearls will feature a wide range of jewelry and *objets d'art*. Visit www.amnh.org, or call (212) 769-5100.

ERRATA

1. In the Summer 2001 article on Chinese freshwater cultured pearls by S. Akamatsu et al., line five of the abstract on p. 96 should have read "Zhejiang Province" (of which Hangzhou city is the capital). We thank Dr. Tian Lianguang for this correction.
2. In the abstract on synthetic corundum and spinel from Skawina, Poland (Summer 2001, p. 170), the Al_2O_3 that does not occur naturally and does not have a trigonal structure should have been reported as $\gamma\text{-Al}_2\text{O}_3$, not $\alpha\text{-Al}_2\text{O}_3$. The material described in the last sentence of the abstract also is $\gamma\text{-Al}_2\text{O}_3$. We thank Dr. W. Wm. Hanneman for bringing this error to our attention.