

Editors • Mary L. Johnson, John I. Koivula,
Shane F. McClure, and Dino DeGhionno
GIA Gem Trade Laboratory, Carlsbad, California

Contributing Editors
Emmanuel Fritsch, IMN, University of Nantes, France
Henry A. Hänni, SSEF, Basel, Switzerland
Karl Schmetzer, Petershausen, Germany

DIAMONDS

Can Angolan diamonds be identified by country of origin?

There have been a number of reports recently on the sale of diamonds to fund long-running civil wars in Africa, particularly in Angola and Sierra Leone (see, e.g., P. Hawthorne, "Diamonds in the rough," *Time*, December 6, 1999, pp. 64–65). After visiting these troubled areas in December, two U.S. Congressmen, Tony Hall (D–Ohio) and Frank Wolf (R–Virginia), have sponsored legislation (H.R. 3188) requiring disclosure of where diamonds are mined, so that a ban on diamond trade with the rebels in these areas can be enforced. Considering the geology of the Angolan diamond deposits, and of diamond deposits in general, how accurate could such an origin determination be? What scientific tests might be used to establish where a diamond is mined? How practical would it be to attempt such an identification?

Some indications can be gathered from the world of colored stones, where country-of-origin determination has become a popular laboratory service for important rubies and sapphires. In a recent lecture, Ken Scarratt of the AGTA Gemological Testing Center described the many kinds of data his lab needs to determine conclusively the origin for, at most, 90% of the gemstones they are asked to test (T. Novellino, "AGTA lab explains gem origin determinations," *National Jeweler*, December 1, 1999, p. 22). He went on to explain that the gathered data must then be compared to a large database made from observations of rubies or sapphires known by other means to be from a specific location in order to reach a conclusion. Such testing can take hours to days per stone.

A large database of diamond properties applicable to geographic origin determination does not exist. However, on a statistical basis, diamonds from certain countries and specific mines do have distinctive features. For example, cubic diamonds are common from the Democratic Republic of Congo (formerly Zaire) but relatively rare elsewhere; a high proportion of the world's rare type IIa diamonds come from South Africa (the Premier mine); diamonds with a green skin are abundant

in Botswana (the Jwaneng mine); Australia's Argyle mine yields diamonds with highly saturated pink and dark brown colors; and gem diamonds from Russia are commonly flat-faced octahedra with sharp edges. However, many of these characteristics are not applicable to faceted diamonds, and none of these features is exclusive to a specific locality when the stones are considered on an individual basis. Tests such as analysis of the inclusions or physical properties of the diamond (e.g., with cathodoluminescence or infrared spectroscopy) also fail to yield results that are specific, conclusive, or unequivocal with regard to origin determination.

Some reasons for the lack of diagnostic inclusions or physical properties are found in the geologic origin of diamonds. Because diamonds form deep in the earth's mantle (at about 125–150 km) and are transported to the surface by volcanic processes (kimberlite or lamproite magmas), stones that crystallized in the same area of the mantle conceivably can be found in diverse geographic localities. Such diamonds could contain similar inclusions and other characteristics, regardless of where they were ultimately emplaced at the earth's surface. Further, the diamond-bearing magmas might have sampled more than one mantle source area during their rise toward the earth's surface, so a single source area can contain diamonds with

Editor's Note: Information for Gem News is provided by members of the gemological community as well as by the editors and contributing editors. Credit is given in the entry to people who provide specimens and specific information to the editors; bylines (or initials, in the case of a contributing editor) are given at the end of each entry that is prepared by individuals other than the editors. Anyone interested in contributing a Gem News entry should follow the procedures listed in the Gems & Gemology "Guidelines for Authors," which can be obtained at www.giaonline.gia.edu, or by contacting senior editor Brendan Laurs at blaurs@gia.edu (e-mail), 760-603-4503 (phone), or 760-603-4595 (fax).

Gems & Gemology, Vol. 35, No. 4, pp. 208–223

© 1999 Gemological Institute of America

different formation characteristics. The situation is further complicated in Angola by the fact that most of the diamonds are being mined from alluvial deposits; that is, they were transported from kimberlite pipes elsewhere in Angola or nearby countries in Africa.

Because mineral inclusions in diamonds tend to fall into one of two broad groups (eclogitic and peridotitic), reflecting their mantle source region, it is not likely that such inclusions would be diagnostic regarding the country of origin, even with a study of their trace elements, isotopic signatures, or other characteristics. With current technology, such studies require direct access to the inclusion within the diamond, which is inevitably destructive for stones with non-surface-reaching inclusions. Furthermore, many gem diamonds do not contain mineral inclusions at all. Trace elements in diamond itself have been studied by neutron activation, but this method produces some residual radioactivity in the diamond so that, after measurement, it must be held at a licensed facility before it “cools” enough to be released for sale. Other potentially relevant geochemical methods are also problematic. For example, measuring carbon or nitrogen isotopes to indicate a geographic source has not been shown to yield definitive answers.

Assuming that a database of characteristics for diamonds from different deposits was created, and that some diagnostic properties were identified for the deposits of interest, testing diamonds quickly enough would still be a Sisyphean task. Approximately 10 million diamonds of 0.50 ct or more, of all qualities, are cut annually worldwide. Even with multiple graders in multiple venues, a massive and expensive effort would be required. Given these constraints, it is unlikely that analytical testing of diamonds to determine their place of origin can be made practical—either immediately, as Congressmen Hall and Wolf are proposing, or in the foreseeable future.

*Dr. A. A. Levinson
University of Calgary, Calgary, Alberta, Canada
Dr. Ilene Reinitz
GIA Gem Trade Laboratory, New York*

A visit to Venezuelan diamond mines. While traveling in Venezuela in late 1998, GIA Distance Education instructor Ric Taylor had an opportunity to visit the alluvial diamond mining region of Guaniamo, in the state of Bolivar in central Venezuela. The following report is based on this visit.

Miners in Guaniamo use water cannons to wash the soil from the hillsides into pits (figure 1), from which it is pumped into rocker boxes or sieves. After washing, the gravel remaining in the bottom of each box is hand-sifted to recover the diamonds. The rough diamonds typically weigh 0.20–0.70 ct; they range from near colorless to intense yellow, with some brown and reddish brown (figure 2). About 20% of the diamonds are suitable for faceting.



Figure 1. Water cannons are used to mine diamonds near the Quebrada River in the Guaniamo region of Venezuela. Photo by Ric Taylor.

According to Venezuelan government records, in 1980 the Guaniamo area produced more than 75% of the country's rough diamonds. The neighboring towns of La Salvación and Milagro are in the center of the diamond-mining area. The towns lie along the Quebrada River, the alluvial distribution system in Guaniamo. In La Salvación, the miners have washed away the ground right up to the edges of buildings; in a few areas, buildings have been undermined and are falling into the artificial lakes created by the diamond-mining operation.

Diamond production appears to have decreased significantly in recent years. For example, according to engineer

Figure 2. These well-formed diamond crystals from Venezuela weigh 0.07–1.03 ct. Courtesy of Ric Taylor; photo by Maha Tannous.





Figure 3. These “Aggos”—thin slices of matte-finished Montana agates—were fashioned to bring out their colors and patterns. The shield shapes measure 24 x 22 x 0.8 mm. Courtesy of LS Enterprises/Montag Mfg.; photo by Maha Tannous.

Figure 4. These two slices of Montana agate (27 x 13 x 0.9 mm) have been set with similarly colored Montana sapphires. Courtesy of LS Enterprises/Montag Mfg.; photo by Maha Tannous.



Tiso Campo of the Asociación Cooperativa Mixta La Salvación (which manages the mining area of La Salvación), the cooperative produced 9,930 carats in 1997, down from 32,393 carats in 1994. After watching several miners walk away from the cooperative’s official buyer, unhappy with the prices they were offered, one might suspect that the diamonds are being sold through other, more profitable channels; this would account for the decrease in official production figures. During my visit to La Salvación and Milagro, however, I saw evidence that the population of the two towns had dwindled. Some stores had closed and others, although still open with sparsely stacked shelves, were for sale. This observation was reinforced when I talked to long-time residents of the two towns. Apparently, there was wealth at one time, but now everything seems to be a struggle. Nevertheless, new miners move into the area regularly, with the ever-present dream of waking up poor and going to bed rich.

An international mining concern, Cantreras el Toco, has been surveying and exploring in La Salvación for more than 10 years. More information on diamond mining in Venezuela can be found on the Web site <http://ganoksin.com/orchid/archive/9711/msg00333.htm>.

Ric Taylor, GIA Education

COLORED STONES AND ORGANIC MATERIALS ■

Matte-finished Montana agates. Nature is an artist, as beautifully evidenced by the patterns and colors of many agates. To showcase Nature’s talent, Montana photographer John Schlosser has fashioned agates from the Yellowstone River in eastern Montana into thin slices called “Aggos” that are cut to maximize the artistry of the patterns (figure 3). The slices are polished to a satin (low-luster matte) finish to bring out the color and patterns; they are fashioned with a “radiused” edge (a semi-circular cross-section) for better edge-strength than a conventional cabochon would achieve. The agates are cut in thin slices so the patterns are sharper, and so pieces can be matched for use in suites of jewelry. Montana sapphires are set into some “Aggos” as accent stones (figure 4).

“Aggos” are marketed by LS Enterprises/Montag Manufacturing of Billings, Montana. We have seen them in the trade since the 1997 Tucson show, when *Gems & Gemology* technical editor Carol M. Stockton first called them to our attention.

Dickite: Consider the odds. There are currently more than 3,500 known minerals, and the list continues to grow. Although some minerals occur as isolated single crystals (as is the case with most gem rough), the majority occur only as components of rocks. When rocks are used as ornamental materials, they generally are carved or fashioned into beads.

As a gift, GIA graduate Kelly Huang, an octogenarian gem carver and jewelry designer in Malaysia, sent GIA

chairman Richard T. Liddicoat a printing block carved with Mr. Liddicoat's likeness (figure 5). The approximately 61 x 41 x 11 mm block was composed of a semi-translucent white to very light brown aggregate material. The contours of the carving were highlighted with black dye or ink. There were also red ink stains on the surface, which were the result of previous inking of the block before it was sent to GIA. When Mr. Liddicoat transferred the piece to GIA's gem collection, curator Jo Ellen Cole asked the Gem Trade Laboratory to identify the material for archival purposes.

The surface was too rough to obtain a refractive index. Since the block did not appear to be porous, a specific gravity of 2.61 was determined hydrostatically. No other gemological properties useful for identification could be obtained. Now that GIA has ready access to laser Raman microspectrometry, we turned to that technique for a possible identification. In preparation for analysis, the surface of the block was cleaned with alcohol to remove any grease. Using the 514 nm argon ion laser, we obtained spectra from three spots on the front and three on the back. All matched that of the mineral dickite in the Renishaw digital spectral library.

Named for British mineralogist A. B. Dick in 1930, dickite is a monoclinic mineral in the kaolinite-serpentine group. It has the chemical formula $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$, and is polymorphous with three other minerals (halloysite, kaolinite, and nacrite). For this reason, and because the Raman library does not contain spectra for all of the members of this large group, we have only tentatively identified this printing block as a rock composed of massive member(s) of the kaolinite-serpentine group, which has the Raman spectrum of the end-member mineral dickite.

Note, however, that this is not the first time that we have encountered dickite in a gemological sample. It was previously identified as a component of the Chinese carving material known as "chicken-blood stone" (see Wang Fuquan and Guo Jingfeng, "Chicken-blood stone from China," *Gems & Gemology*, Fall 1989, pp. 168-170).

To many of his friends, Richard Liddicoat goes by the nickname "Dick." What are the odds that, out of all of the possible known minerals and rocks, a printing block carved in his likeness would turn out to give us a Raman spectrum for dickite?

Star ekanite. Recently, a 161 ct cabochon of dark green ekanite from Sri Lanka was loaned to this editor (KS) for examination. This unusual cabochon displayed an eight-rayed star that consisted of two four-rayed stars, one of which was more intense than the other (figure 6). (For a similar case of a double-rayed star, see the Summer 1999 Gem News item "Twelve-rayed star sapphire from Madagascar," p. 148.)

A rare mineral, ekanite is one of the few species that was first described as a gemstone (taaffeite is another). It was discovered in 1953 and described as a new mineral



Figure 5. Raman spectra taken on this printing block "stone" carving of GIA Chairman Richard T. (Dick) Liddicoat, Jr. matched that of the mineral dickite. Photo by Maha Tannous.

Figure 6. This 161 ct (33 x 25 x 20 mm) oval cabochon is an eight-rayed star ekanite from Sri Lanka. Photo by M. Glas.





Figure 7. These five yellow and orangy yellow opals are from Nevada. The cabochons weigh 1.36 ct (yellow) and 1.73 ct (orangy yellow). The largest piece of rough weighs 4.57 ct. Courtesy of Richard Shull; photo by Maha Tannous.

in 1961 (B. W. Anderson et al., "Ekanite, a new metamict mineral from Ceylon," *Nature*, Vol. 190, No. 4780, p. 997). Today, gem-quality ekanite occasionally is found at Eheliyagoda, Sri Lanka. It still is considered quite rare, and four-rayed star ekanite is among the rarest of gemstones (see, e.g., J. E. Arem, *Color Encyclopedia of Gemstones*, 2nd ed., Van Nostrand Reinhold, New York, 1987, p. 86; M. Sevdemish and A. Mashia, *The Dealer's Book of Gems and Diamonds*, Kal Printing House, Israel, 1996, p. 284).

Chemically, ekanite is a thorium-bearing silicate that also may contain significant amounts of uranium; the original analysis by Anderson et al. revealed 2.1 wt.% UO_2 . Ekanite from Sri Lanka is commonly metamict due to lattice damage by natural radioactivity. (A metamict mineral is one that has become virtually amorphous due to the breakdown of the original crystal structure by internal bombardment with alpha particles emitted by radioactive atoms within the mineral.) Asteriated ekanite from Sri Lanka typically reveals a weak four-rayed star, which echoes the tetragonal symmetry of the mineral prior to metamictization. The inclusions in asteriated ekanite were described by E. Gübelin ("Ekanite, another new metamict gem from Ceylon," *Gems & Gemology*, Vol. 10, No. 6, 1961, pp. 163–179, 191; and *Gemmologist*, Vol. 31, No. 373, 1962, pp. 142–157, and No. 374, 1962, pp. 165–169).

Microscopic examination of the eight-rayed star ekanite revealed a network of tiny elongated particles. At present, the nature of these inclusions, which are undoubtedly responsible for the unusual star pattern, is unknown. The only other reference to eight-rayed star

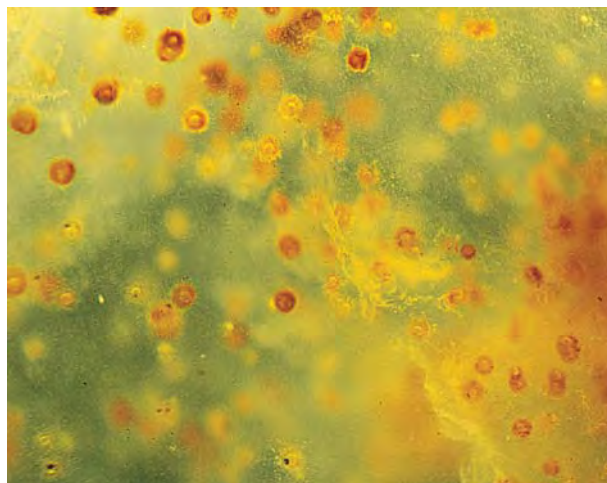


Figure 8. The iron-stained spherical inclusions in this 1.73 ct opal cabochon resemble fish eggs. Photomicrograph by John I. Koivula; magnified 20x.

ekanite is a recent review by W. L. D. R. A. Kumaratilake ("Gems of Sri Lanka: A list of cat's-eyes and stars," *Journal of Gemmology*, Vol. 25, No. 7, 1997, pp. 474–482), in which it was noted that the eight-rayed stars were associated with four sets of oriented inclusions intersecting at 45° to one other. KS

"American Golden opal" from Nevada. Richard Shull of Out of Our Mines, Arcata, California, provided the Gem News editors with several samples of rough and cabochon opal (figure 7) from a deposit in Nevada. The material is yellow in bodycolor and transparent to translucent. When we examined the more transparent material with a microscope, we saw round inclusions, some of which were iron stained (figure 8). In a number of samples, the iron-stained inclusions were so prevalent that the overall appearance was reminiscent of amber rather than opal (again, see figure 7). The two cabochons (1.36 and 1.73 ct) had refractive indices of 1.475 and 1.465, respectively; the five samples (rough and cut) had specific gravity values (measured hydrostatically) between 2.11 and 2.17. All were inert to both short- and long-wave UV radiation. None of the opals showed any play-of-color.

The formation of white zones in Mexican opals during fashioning. Natural opal can be frustrating for both the lapidary and the jeweler, as some opal is not stable during fashioning and normal conditions of wear and care. Often the surface develops fine cracks, a condition known as "crazing." In the case of some Mexican fire opals recently seen by this editor (EF), a different type of degeneration occurred.

The five opals examined ranged from 2.00 to 6.58 ct. Two independent cutters—Alexandre Wolkonsky of Paris and Denis Gravier of Le Minéral Brut, St. Jean le Vieux, France—mentioned that during or immediately following cutting (within one day), these opals developed

somewhat spherical, opaque whitish internal zones that rendered the material inappropriate for gem use (figure 9). Thus, the alteration in these fire opals was quite fast and dramatic in contrast to crazing, which typically develops over months (sometimes years) in some opals (G. Tombs and M. Duncan, "Australian opal—stable or unstable," *Transactions of the 26th International Gemological Congress*, Paris, France, 1993, pp. 257–259).

The shape of the white zones roughly followed the shape of the fashioned pieces—that is, the zone looked elongated in the pear shape, round in the round stone, and triangular in the triangular piece. This suggests that the mechanical strain introduced by cobbing, preforming, or faceting is a major factor in the development of this type of alteration.

Both cutters pointed out that, with careful examination of the rough using intense fiber-optic illumination, they could identify pieces that might alter in this way by the presence of a roughly egg-shaped, slightly white area approximately in the center of the piece (figure 10). It was not visible with typical transmitted ambient lighting. According to Gem News editor John Koivula, opals with such zones also are found *in situ* in the mines; the zones occur in all degrees of transparency, from barely discernible with transmitted sunlight to opaque. The opals in which these zones are obvious probably are rejected at the source.

Mr. Wolkonsky told us that, in his experience, a small percentage of the fire opal rough delivered to him in the last 20 years has changed with time or fashioning. In addition to the white zones described above, he has also seen the development of a spherical fracture, or of a white outer area surrounding a transparent gem nodule in the center. In at least one case, he observed the development of a white zone in a piece of Mexican opal that showed play-of-color. EF

An update on the John Saul ruby mine. Dr. John Emmett provided the following update on mining and production at the famous John Saul ruby mine in Kenya, which was reopened by Rockland Kenya Ltd. in August 1995. The mine is located in the Tsavo West National Park in southern Kenya, on a flat, semi-arid plain. The history of this mine is perhaps as colorful as the gems it produces. Discovered in 1973 by two geologists, John Saul and Tim Miller, it rapidly became coveted by the family and friends of Jomo Kenyatta, then president of Kenya. The predictable result was that the two geologists lost control of the mine. For the next 20 years, mining was sporadic at best. In 1989, mining operations in the national parks were terminated by Richard Leakey, Kenya's director of Wildlife Conservation at that time. It seems that poachers of elephant and rhinoceros in the game parks were posing as miners to avoid discovery. By 1991, ownership, mining rights, and permits had finally been secured by Rockland Kenya Ltd., led by Johnson Muthama. Mining at the site resumed in 1995.

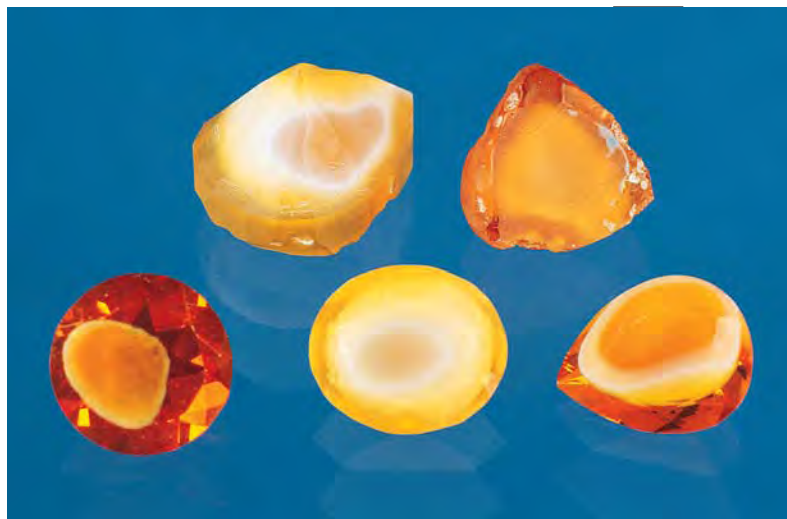


Figure 9. In these five Mexican opals (preformed or fashioned; 2.00–6.58 ct), white zones formed after fashioning had begun. Photo by Alain Cossard.

According to Cedric Simonet, chief geologist for Rockland Kenya, the ruby deposits at the John Saul mine are associated with the contact zone of a rounded ultrabasic body within the Kurase Group of country rock. In this locality, the Kurase Group consists primarily of metasediments such as marbles, graphite gneisses, and quartzites. The ultrabasic body appears almost white in color and is composed of magnesium-pyroxenes, magnesium-amphiboles, carbonates, and talc. Although several types of ruby mineralization are exhibited in different

Figure 10. A roughly egg-shaped white area, visible only with intense fiber-optic lighting, may be seen in the center of some Mexican opals that will later develop opaque white zones. This example weighs 2.09 g; photo by Alain Cossard.

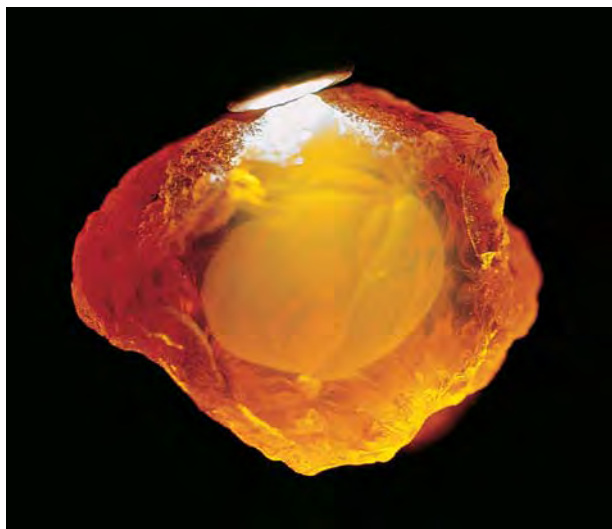




Figure 11. Note the high concentration of ruby in this 45 cm (18 inch) long portion of the ruby-bearing vein in the Kimbo pit. Photo © John L. Emmett.

portions of the John Saul mine, only two are responsible for significant ruby production. In the “Main pit,” which was the first portion mined in the 1970s and 1980s, ruby was recovered from pegmatite-like veins inside the ultrabasic body. These veins are comprised of mica, tourmaline, and ruby. In the “Kimbo pit,” ruby occurs at the interface of the ultrabasic body with the country rock. This interface is comprised of plagioclase, magnesian muscovite, green tourmaline, ruby, and minor amounts of graphite and monazite. The vein averages 1.2 m thick, although in some areas it reaches 2.5 m thick. A portion of that vein is shown in figure 11.

Today, Rockland Kenya is exploiting the Kimbo pit as their primary ruby production source. The broad ruby-bearing zone is mined by open-cast methods, as mineralization is present close to the surface. The removal of the barren host rock is a highly mechanized operation. Security at the mine is extremely tight and very professionally managed. At present, the pit is approximately 30 m deep. The mineralized zone, which was exposed to about 60 m from the surface, has widened to about 90 m at depth, extending southward. With increasing depth, both the color and clarity of the ruby improves, along with some changes in the mineralogical characteristics of the vein.

Much of the facet-quality ruby is recovered from alluvial gravels on the surface. The gravels are passed through a trommel to remove the fine-grained material and then are processed with a heavy-media concentrator. The specific gravity cut is made at about 2.9 so that chrome tourmaline—which is also present in the gravels—can be recovered as well.

Since the opening of the Kimbo pit in 1995, production at the John Saul mine has averaged well in excess of 100 kg of ruby per month. Of this, about 60% is cuttable, with 5%–10% representing top-quality material. The



Figure 12. These cabochons (8.67–17.85 ct) were fashioned from ruby that was recovered from the Kimbo pit. Photo by Maha Tannous.

great majority of the ruby produced is of cabochon quality (figure 12); only rarely is facetable rough recovered. Some crystals are quite uniform in color, while others exhibit strong color zoning (see figure 13). The lack of transparency is due primarily to the large number of “fingerprint” inclusions and feathers. Polysynthetic twinning also is very common. Fine rutile needles, presumably exsolved during cooling, are typical and of sufficient density in some pieces to produce good stars. Among the other inclusions are large rutile grains and various micas including fuchsite (chromium-rich muscovite), although a definitive inclusion study remains to be done.

The iron content of the John Saul rubies is very low, typically 0.01% as Fe_2O_3 . As a result, they fluoresce a very strong red, much like the famous rubies from the Mogok district of Myanmar. While the color of much of the material is also reminiscent of Mogok rubies, heat treatment is often used to improve it further by reducing or eliminating a slight blue hue to produce a purer red.

Figure 13. Strong color zoning is common in the rubies from the John Saul mine, as this basal section of a stone from the Kimbo pit illustrates. Photo © John L. Emmett.



Heat treatment of John Saul ruby also melts any micaeous inclusions, which sometimes flow to the surface of a stone. The glassy melt droplets that result may be easily confused with the residual flux inclusions typically observed in heat-treated Mong Hsu rubies (see, e.g., figure 1 on p. 90 of the Fall 1999 issue of *Gems & Gemology*).

While the John Saul ruby mine is already the stuff of legends, it would appear that it is only beginning its productive life.

*Dr. John L. Emmett, JLE Associates
Brush Prairie, Washington*

Ruby from Songea, Tanzania. In mid-1998, Randy Wiese of Michael Couch and Associates, Fort Wayne, Indiana, sent us a parcel of seven faceted rubies and three ruby slabs (figure 14), which are representative of material recently mined near Songea, Tanzania. He reported that most of the ruby rough from that area would cut half-carat stones, but some pieces were as large as 4–5 ct. The stones were recovered from an alluvial deposit about 30 km south of the city of Songea, along the Ruvuma River.

The seven faceted stones were transparent and somewhat brownish red to purplish red. They ranged from 0.37 to 1.17 ct, with the largest measuring 6.47 x 5.96 x 3.68 mm. The stones were pleochroic in yellow-brown and brownish red. Refractive index values ranged from 1.763 to 1.772, and specific gravity (measured hydrostatically) ranged from 4.00 to 4.01. A handheld spectroscope revealed features representative of both chromium and iron in corundum. The seven stones were inert or fluoresced very faint red to long-wave UV radiation, and were inert to short-wave UV. With magnification, we observed the following inclusions in the faceted stones: transparent dark brownish red rounded crystals, probably rutile; one metallic crystal with a large metallic halo, probably pyrite; and some black rounded and melted-appearing inclusions. Some of the inclusions had associated partially healed fractures (fingerprints).

The three flat, semi-translucent slabs weighed 5.73, 6.80, and 8.11 ct, with the longest 17.13 mm in maximum dimension. The gemological properties, where measurable, were comparable to those of the transparent stones, with a slightly lower R.I. (1.762–1.770) and broader S.G. range (3.99–4.01). With magnification, we again saw pyrite and rutile crystals; in addition, we could see distinct, eye-visible, hexagonal zoning.

Because we had not yet documented rubies from this locality, we asked GIA Gem Trade Laboratory research associate Sam Muhlmeister to measure the chemical compositions of three of the faceted samples (0.65, 0.70, and 1.04 ct) using energy-dispersive x-ray fluorescence (EDXRF). The three rubies contained 0.24–0.42 wt.% Cr₂O₃, 0.99–1.23 wt.% FeO, and up to 0.94 wt.% CaO (possibly due to apatite inclusions, since phosphorus also was detected in each sample and EDXRF is a bulk method of analysis). Small amounts of titanium

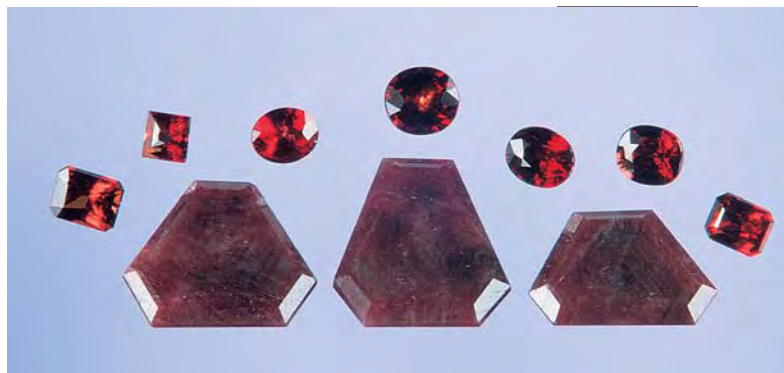


Figure 14. These 10 ruby samples came from the Songea area in Tanzania. The slabs weigh 5.73–8.11 ct; the faceted stones are 0.37–1.17 ct. Courtesy of Randy Wiese; photo by Maha Tannous.

(0.01–0.05 wt.% TiO₂) also were detected and may have been due to rutile inclusions.

Because of recent trade concerns about radioactivity (see, e.g., “Radioactive rubies,” Fall 1998 Gem News, pp. 227–228), we checked all 10 stones with a handheld Geiger-Muller counter. None showed any evidence of radioactivity.

Another source for bicolored sapphire: Tunduru, Tanzania. Bicolored corundum (pink sapphire or ruby on one side, blue sapphire on the other) has been reported in *Gems & Gemology* from two sources: Nepal (C. P. Smith et al., “Rubies and fancy-color sapphires from Nepal,” Spring 1997, pp. 24–41) and Vietnam (Spring 1998 Gem News, pp. 51–52). Last year, Stephen Avery, a gem dealer in Lakewood, Colorado, showed us six bicolored sapphires obtained in 1995 that reportedly came from Tanzania’s Tunduru region: two fashioned gems (0.64 and 1.97 ct; figure 15); three preforms weighing 0.73, 1.41, and 2.07 ct; and a 4.16 ct crystal. The crystal and the 1.41 ct preform showed potential for cutting bicolored corundums with blue sapphire as well as ruby zones, but the other samples were pink-to-purple in their reddest areas. Along with these sapphires was a 4.01 ct pale purplish pink spinel crystal with a dark blue rim that also could be fashioned into a bicolored gem.

Gemological properties of the two fashioned gems were measured by staff gemologist Maha Tannous and Gem News editors John Koivula and Dino DeGhionno. These were as follows (for the smaller stone first, where different): color—roughly half purplish pink (purple-pink) and half dark violetish blue; optic character—uniaxial; Chelsea color filter reaction—orangy red in the pink areas, inert in the blue areas; R.I.—1.760–1.769 and 1.760–1.768; S.G. (measured hydrostatically)—4.05 and 4.02; typical ruby absorption spectrum seen with a handheld spectroscope. The two stones fluoresced moderate-to-strong orange, with uneven distribution and medium chalkiness, to long-wave UV radiation; they were inert to short-wave UV. The 0.64 ct stone contained small transparent birefringent crystals



Figure 15. These two fashioned bicolored purplish pink to purple-pink and blue sapphires are reportedly from Tunduru, Tanzania; they weigh 1.97 and 0.64 ct. Courtesy of Stephen M. Avery; photo by Maha Tannous.

(possibly zircon); the 1.97 ct stone contained exsolved rutile and (probably) ilmenite "silk" in distinct zones. Both showed color zoning with sharp-edged regions; there was no sign of diffusion of color. The fact that the crystals and silk were intact, together with the sharp-edged color zoning, provided evidence that these sapphires had not been subjected to heat treatment.

Although mining at Tunduru has diminished greatly this year (as workers moved to the new tsavorite workings in Tanzania; see, e.g., Summer 1999 Gem News, pp. 151–152), in the past its gem gravels have produced a broad range of exciting material (see, e.g., the Gem News

Figure 16. These spessartine garnets are from a new deposit in Nigeria, near the village of Iseyin. The spessartine rough sometimes occurs as well-formed crystals up to 2 cm in diameter, as shown here. Photo by Joachim Zang.



items in Summer 1995, pp. 133–134, and Spring 1996, pp. 58–59). The gem potential of this region is probably far from being exhausted.

Spessartine from Nigeria. In April 1999, some highly saturated orange-yellow spessartine garnets appeared on the market in Idar-Oberstein, Germany, reports Dr. Joachim Zang and colleagues. By mid-summer, several dozen kilograms of rough spessartine from this source, mostly of lower quality, had arrived in Idar-Oberstein. African dealers reported the source as a mining area near the village of Iseyin, a three-hour drive northwest of Ibadan, Nigeria.

From a study of both crystals and fashioned stones (see, e.g., figures 16 and 17), we determined refractive index (measured with a Topcon refractometer) values of greater than 1.790 and specific gravity (measured hydrostatically) values ranging from 4.19 to 4.23. These measurements are consistent with near-end-member spessartine, which has an R.I. of 1.800 and an S.G. of 4.19. Absorption spectra exhibited typical spessartine features, plus local maxima at 469 nm and 527 nm (due to Fe^{2+}) and at 482 nm (due to Mn^{2+}). Most of the rough occurs in rounded shapes, although we saw a few crystals up to 2 cm in diameter (again, see figure 16). The largest clean faceted stone examined weighed more than 23 ct (again, see figure 17).

Semi-quantitative chemical analysis with a scanning electron microscope (EDAX system) gave the following composition (weight percent, normalized to 100%, all Fe reported as Fe^{2+} ; values for pure spessartine are given in brackets for comparison): $\text{SiO}_2 = 36.1$ [36.41], $\text{Al}_2\text{O}_3 = 21.4$ [20.60], $\text{FeO} = 0.64$ [0.00], $\text{MnO} = 40.6$ [42.99], $\text{MgO} = 0.94$ [0.00], $\text{CaO} = 0.27$ [0.00]. With a combination of physical and chemical techniques, the samples were determined to be nearly pure spessartine (up to 94 mol.%), with lower contents of almandine (from 1.5 to 11 mol.%) and pyrope (around 3.5 mol.%).

Dr. Joachim Zang, Klaus Schoder,
and Dr. Michael Luhn
Idar-Oberstein, Germany

Figure 17. These faceted spessartines are also from the new Nigerian deposit. The spessartine on the left weighs more than 23 ct. Photo by Joachim Zang.





Figure 18. These five spessartine garnets (2.15–11.03 ct) come from the Lundazi area of Zambia. Courtesy of Marc Sarosi; photo by Maha Tannous.

Spessartine from Zambia. At the 1999 Tucson shows, we saw orange spessartine from many sources, including several localities in Brazil (see, e.g., Spring 1999 Gem News, p. 55) and some sources in Africa. Marc Sarosi of the Marc Sarosi Company, Mill Valley, California, kindly loaned us five fashioned spessartines from the Lundazi region in Zambia (figure 18). According to Mr. Sarosi, a fair amount of orange garnet has been found in the country rock (decomposed granite) in the area, but very little of it is clean (less than 1 kg so far). The largest fashioned garnets weigh over 10 ct.

All five stones (2.09–11.03 ct) we examined were orange with even color. None showed any reaction to a Chelsea color filter. Refractive indices were in the narrow range of 1.799 to 1.800, but specific gravity values (measured hydrostatically) extended from 4.20 to 4.25, an unusually high value. All five were inert to both long- and short-wave UV radiation. They had a typical spessartine absorption spectrum when viewed with a handheld spectroscope, with a lower wavelength cutoff at 435 nm; bands at 460, 480, and 530 nm; and a weak 504 nm line. When viewed with a microscope, they showed typical garnet growth bands and fluid-filled “fingerprint” inclusions (figure 19). Based on these gemological properties, this is also nearly pure end-member spessartine.

Because some of the samples had high S.G. values, we analyzed two of them using EDXRF spectroscopy. Although these two samples had different S.G.’s (4.20 for the 11.03 ct stone and 4.23 for the 2.15 ct stone), research associate Sam Muhlmeister found similar chemical compositions for both samples, with major amounts of aluminum, silicon, and manganese, and trace quantities of iron, zinc, calcium, and gallium.

The Lundazi area also produces tourmaline (see, e.g., “Multicolored bismuth-bearing tourmaline from Lundazi, Zambia,” by M. L. Johnson et al., *Gems & Gemology*, Fall 1997, pp. 204–211) and aquamarine. Mr. Sarosi believes that this area shows considerable promise as a source for gems.

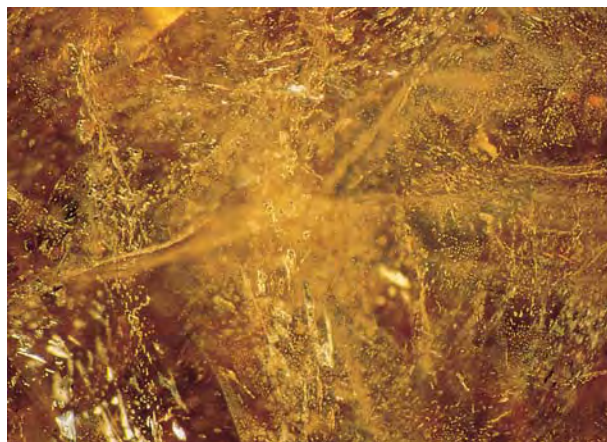


Figure 19. The Zambian spessartines typically had fluid-filled “fingerprint” inclusions, as seen here in the 11.03 ct modified triangular brilliant. Photomicrograph by John I. Koivula; magnified 30x.

Tremolite rock from China, represented as “Longxi Jade.” Professor Zhang Ru bo of the Department of Geological Science, Chengdu Institute of Technology in Chengdu, Sichuan Province, China, sent the following information to Dr. James E. Shigley of GIA Research. Professor Zhang and colleagues Zhang Yu Yu and Yang Da Xiong had examined a deposit of tremolite rock near Longxi Village, Wenchuan, in Sichuan Province, about 230 km north of Chengdu. The material was first discovered by villagers in the 1940s; based on its presence, the Guanxi Jade Carving Factory was founded, and the tremolite was marketed as “Guanxi Jade.” This source of carving material was no longer economic by the early 1980s, so the factory carved other materials (i.e., “Nanyang Jade” and “Xu Jade”). (The reader is reminded that *jade* is an inexact translation of the Chinese term *yu*, which refers to any hard stone that can be carved. In



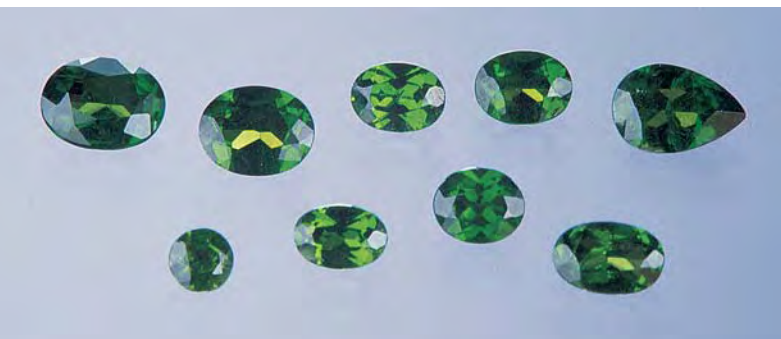
Figure 20. A semi-transparent tremolite rock forms stratified layers in the metamorphosed limestone at Longxi. Photo courtesy of Zhang Ru bo.

contrast, Western usage restricts the term *jade* to jadeite and nephrite. For more on this, see “Standards issued for the jewelry industry in China,” Fall 1997 Gem News, pp. 229–230.)

The Chinese team visited the locality in summer 1997, and determined that the source was not yet depleted. The mine is actually located several kilometers from Longxi, near the hamlet of Majia, at an altitude of 2,500 feet (760 m). At the time of their visit, there was a horizontal adit about 9 m deep and a 15-m-square open area for stacking the ore blocks.

The massive tremolite formed as layers up to 2 m thick (although typically 10 to 50 cm; figure 20), within

Figure 21. These nine tsavorite garnets (0.15–0.67 ct) are reportedly from a new deposit in southwestern Madagascar. Courtesy of Allerton Cushman & Co.; photo by Maha Tannous.



an anticline. The material in the mine pit was yellow, “golden” yellow, green, and yellow-green. The tremolite apparently formed by metamorphism of dolomitic limestones, with no evidence of metasomatic fluids; the tremolite only occurred in specific layers in the metamorphosed rock. Consequently, the authors predicted that large reserves of “Longxi Jade” will not be found at this deposit.

Professor Zhang and his colleagues determined the following gemological properties on representative samples of “Longxi Jade”: color—gray-white, light yellow, and yellow-green; diaphaneity—semi-transparent to opaque; hardness—5.5 to 6 on the Mohs scale; specific gravity—2.95 to 3.01. In thin section, the rock appeared to be composed of fibrous tremolite with small amounts of talc and carbonates. R.I. values of 1.595 and 1.625 were determined on the tremolite in the thin section. Chemical analysis revealed a composition that is quite close to end-member tremolite.

The finest-quality tremolite rock from the deposit is suitable for fashioning into cabochons. Some cabochons show a cat’s-eye effect and resemble cat’s-eye chrysoberyl.

Tsavorite from Madagascar. Tsavorite garnet from Madagascar was first called to our attention by Samir-Pierre Kanaan of Paris in mid-1997. In March 1999, Tom Cushman of Allerton Cushman & Co., Sun Valley, Idaho, showed us a suite of nine green garnets (0.15 to 0.67 ct) from southwestern Madagascar (figure 21), which also proved to be tsavorite; to the best of our knowledge, this is the first location outside of Kenya or Tanzania to produce commercial quantities of tsavorite. The parcel also included six chrome tourmalines that had been represented as tsavorite, and Mr. Cushman reported that green diopside also is recovered from the same area. The tsavorite is mined from a primary deposit; “intermittent production” typically yields faceted stones that do not exceed 1 ct.

Gemological properties of the garnets were as follows: color—green; optic character—singly refractive with weak anomalous double refraction; Chelsea color filter reaction—weak orange; refractive index—1.740 to 1.742; birefringence—none; specific gravity (measured hydrostatically)—3.63 to 3.66. The stones were inert to both long- and short-wave UV radiation. When viewed through a handheld spectroscope, they showed a typical tsavorite spectrum: 470 nm cutoff, absorption band between 580 and 620 nm, and vague absorption between 620 and 700 nm. With magnification, needles, small crystal inclusions, and “fingerprints” were seen. EDXRF analysis of two stones by research associate Sam Muhlmeister revealed major aluminum, calcium, and silicon, with traces of titanium, vanadium, chromium, manganese, iron, yttrium, and zirconium. All these properties are consistent with the tsavorite variety of grossular garnet.

TREATMENTS

The chemistry of emerald fillers. In the course of GIA's ongoing study of emerald treatments (see M. L. Johnson et al., "On the identification of various emerald filling substances," Summer 1999 *Gems & Gemology*, pp. 82–107), we investigated the possibility of using trace elements to identify fillers by means of energy-dispersive X-ray fluorescence (EDXRF) spectroscopy, using a Tracor Northern Spectrace 5000 instrument. A limitation of this system is that elements lighter than sodium cannot be detected; this includes the main constituents of the organic fillers (i.e., carbon, hydrogen, and oxygen). However, many of the 26 fillers we studied with this technique did contain heavier elements.

We examined fillers in the following substance categories: eight essential oils/natural resins, four other oils, seven epoxy prepolymers, two UV-setting prepolymers, and five solid polymers. The liquids were poured into the EDXRF sample holders for analysis, and the solid fillers were examined as blocks. Each sample was run at 15 and 20 kV (at 0.35 mA) in a vacuum, and at 30 kV (at 0.35 mA) in air.

Results are presented in the table. Only one essential oil (synthetic cinnamon oil) showed a distinct "heavy" element peak (zinc [Zn]). Of the other oils, Joban oil contained iron (Fe), copper (Cu), and calcium (Ca); azeite de dende (palm tree oil) contained chlorine. Six out of seven epoxy prepolymers (all except Epo Tek 314) contained chlorine (Cl), and all the solid polymers contained Cl. The two UV-setting artificial resins, in both liquid and solid form, contained many discernible elements: Epo Tek UVO114 contained silicon (Si), phosphorus (P), sulfur (S), Cl, and antimony (Sb); and the Norland Optical adhesive contained S and tin (Sn).

The next question was: How useful is this information for the identification of substances *within* emeralds? Most of the elements we identified also could be found naturally within an emerald, given the gem's common inclusion of brines (Cl and perhaps P) and sulfides (Fe, S, and perhaps Cu and Zn); so the best "test cases" to see if fillers produced elemental signatures were Sb or Sn. We therefore compared the EDXRF spectrum of a known natural emerald from Muzo, Colombia, with that of a 1.12 ct emerald that—after cleaning—we had filled with a significant amount of Norland Optical Adhesive type 65. The 5.01 ct unfilled emerald revealed major amounts of Si and aluminum, as well as trace amounts of S, Cl, K, Ca, titanium, vanadium, chromium, Fe, and gallium. The 1.12 ct emerald filled with Norland 65 contained the same elements (except gallium), and did not reveal detectable amounts of Sn. As other experiments described in the above-mentioned *Gems & Gemology* article found that less than 0.001 ct of filler is needed in an emerald of this size, the inability to detect the tin was not surprising. This

EDXRF results for 26 possible emerald fillers.

Substance category	Filler ^a	Elements identified with EDXRF ^b
"PRESUMED NATURAL" SUBSTANCES		
Essential oils		
Essential oils or natural resins	Cedarwood oil for clearing (Merck)	None
	Cedarwood oil for immersion (Baker)	Ca (?), Fe (?)
	Cedarwood oil for immersion (Merck)	W (?)
	Canada balsam (natural resin)	Zn (?)
	Clove bud oil	None
	Clove oil	None
	Cinnamon oil (synthetic)	Zn, Fe (?)
	Cinnamon oil (cassia)	None
Other oils		
Mineral oils	Mineral oil	None
	Paraffin oil	None
Vegetable oil	Azeite de Dende	Cl, K (?), Ca (?)
Mineral (?) oil plus vegetable (?) dye	Joban oil	Ca, Fe, Cu, Cl (?), K (?)
ARTIFICIAL RESINS		
Epoxy prepolymers		
	Araldite 506	Cl
	Araldite 502	Cl
	Araldite 6005	Cl
	Araldite 6010	Cl, K (?)
	Epo Tek 301	Cl
	Epo Tek 302-3M	Cl
	Epo Tek 314	None
Other prepolymers		
UV-setting	Epo Tek UVO114	Si, P, S, Cl, Sb
	Norland Optical Adhesive type 65	S, Sn
Polymers		
UV-setting	Opticon Resin 224 (cured)	Cl, Fe (?)
	Permasafe	Cl, Ca (?)
	Super Tres	Cl, Ca (?)
	Epo Tek UVO114 (cured)	Si, P, S, Cl, Sb
	Norland Optical Adhesive type 65 (cured)	S, Sn

^aFor sources, see M. L. Johnson et al., "On the identification of various emerald filling substances," *Gems & Gemology*, Vol. 35, No. 2, pp. 82–107.

^bAll EDXRF analyses were performed on the loose fillers (i.e., as "pure" substances, not in an emerald). "None" means that no element heavier than neon was detected. Peaks definitely identified (trace level) are given as, for example, "Fe"; those that were tentatively identified (i.e., a small peak was seen, but its signal was not significantly above the background level) are given as, for example, "Fe (?)."

research shows that it is not feasible at this time to identify the filler in an emerald with EDXRF.

MLJ and Sam Muhlmeister,
GIA Gem Trade Laboratory
Shane Elen, GIA Research

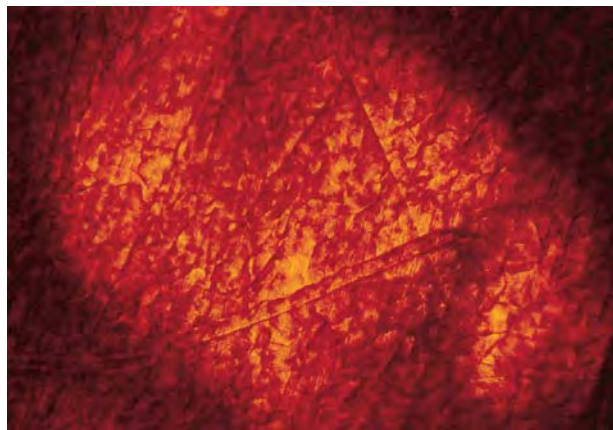


Figure 22. The heat-treated portion of this 5.60 ct almandine-spessartine garnet (left) developed a dark gray metallic coating that was identified as hematite. Photo by Maha Tannous.

Hematite coating on heat-treated garnet. After publishing the Winter 1997 Gem News item “Heat treatment of garnets” (p. 308), the Gem News editors carried out an experiment to determine the nature of the metallic coating that develops on certain garnets with heating. Such a coating has been noted when iron-bearing garnets (such as almandine) are heated in air to temperatures above 900°C, as previously determined by Gerhard Becker of Idar-Oberstein, Germany.

For our experiment, we chose a 5.60 ct transparent, dark orange-brown, oval modified brilliant cut. It was reportedly from Orissa, India, and contained only minimal inclusions (so few that they were unlikely to cause

Figure 23. The semi-transparency and mottled, uneven appearance of the hematite coating on the heat-treated garnet is visible in strong transmitted light. Photomicrograph by John I. Koivula; magnified 40x.



damage during heating). The garnet had an R.I. of 1.756, an S.G. of 3.91, and a mixed almandine-spessartine absorption spectrum. EDXRF analysis of the stone prior to heating showed the presence of aluminum, calcium, iron, magnesium, manganese, and silicon, with iron appearing to be slightly more abundant than magnesium, manganese, or calcium. The stone’s bodycolor, relative elemental peak heights, and the strength of the almandine visible-light absorption spectrum, suggested that there was more almandine component than spessartine.

For the experiment, the garnet was cut into two pieces, so that half the stone could be retained as an untreated (control) sample. The other half was placed in a muffle furnace, heated in air to 920°C, and then allowed to cool slowly. As expected for this iron-bearing garnet, the heat treatment produced an obvious dark gray metallic coating on the surface (figure 22).

We then retested the gemological properties on the heated half. Because of the metallic coating, we could not obtain an R.I. value. The 3.93 S.G. was slightly higher than that obtained before heating. Once again, the absorption spectrum was mixed almandine-spessartine, although it was much darker because the metallic coating interfered with the stone’s transparency. When examined with magnification in strong transmitted light, the coating was semi-transparent and had a mottled, uneven appearance (figure 23).

Using Raman analysis on the treated half, we identified the coating as hematite. This was not surprising, considering the high iron content of the garnet. We believe that iron at the surface of the garnet oxidized to form hematite (Fe_2O_3).

Factors in the heat treatment of corundum. At the 25th International Gemmological Congress (October 1995) in Rayong, Thailand, Dr. Varunee Thiramongkol of the Department of Science Service, Bangkok, gave a presentation on corundum heat treatment. She kindly provided the Gem News editors with the following update on her research in this area at the Third International Gemological Symposium last June.

Dr. Thiramongkol discussed oxidation conditions as an important factor in the heat treatment of corundum varieties. Corundum is oxidized in oxygen-rich environments, and reduced in hydrogen-rich, organic-rich, or inert environments. Oxidizing conditions cause rubies from Mong Hsu, Trat (Thailand), and Africa to become “purer” red; greenish blue sapphires to turn green; and dark blue-to-black sapphires to lighten. Reducing conditions make rubies from Mong Hsu, Trat, and Africa become more purple; and cause silky, milky, or yellowish blue sapphires to become blue. Pale yellow sapphires from Sri Lanka and Kanchanaburi turn intense yellow when heated in oxidizing conditions, but they become light blue when heated in nitrogen gas; the same stone can have its color “reversed” several times by changing the atmosphere in which it is heated.

Another factor that is sometimes important in heat treatment is the local "micro-environment" during heating: Light-colored stones may be stained blue in patches by proximity to dark blue or black sapphires, or they may be stained pink to brownish red if they are heated with rubies.

SYNTHETICS AND SIMULANTS

Manufactured products imitating charoite. One would not consider charoite a likely candidate for imitation, although a possible charoite (or sugilite) simulant (a dyed rock consisting of massive beryl and quartz) was described in the Summer 1992 Gem News section (p. 135). In the past three years, however, we have come across two manufactured products intended to simulate charoite. The first, marketed in 1996 as "Royal Russianite" by Marchant Enterprises of Anchorage, Alaska, was obtained as a bracelet of 20 round beads averaging 8.1 mm in diameter (figure 24). The second imitation, obtained in Tucson in 1999 by GIA Education product manager Philip York, consisted of a 2.90 ct rectangular bead.

Both samples were purple, opaque, and unevenly colored; both had a (spot) refractive index value of 1.55; and both burned, giving off an acrid odor, when exposed to a thermal reaction tester (hot point). (These properties were sufficient to identify these beads as manufactured products, probably comprised of or containing a significant amount of plastic.) It was not possible to measure the specific gravity of the round beads without dismantling the bracelet; however, the rectangular sample revealed an S.G., measured hydrostatically, of 2.67. The round beads were inert to long- and short-wave UV radiation, but the rectangular bead fluoresced uneven faint blue to long-wave UV radiation and uneven faint yellow to short-wave UV.

Figure 25. The "Royal Russianite" imitation charoite was mottled in light and dark tones of purple when viewed with magnification. Photomicrograph by John I. Koivula; magnified 15x.

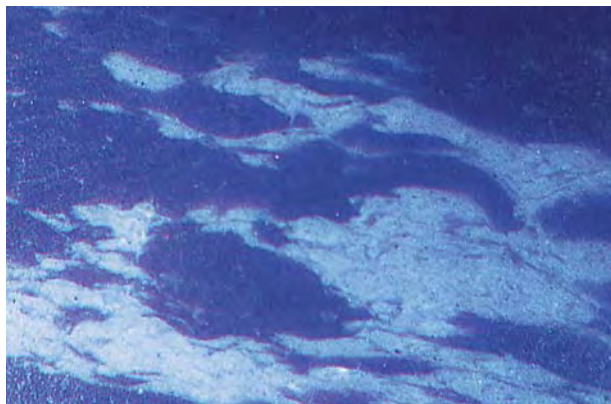


Figure 24. This bracelet of 8 mm imitation charoite beads was purchased in Alaska. Photo by Maha Tannous.

When examined with magnification, the two imitations looked quite different. The surface of each round bead showed a swirled mass of opaque purple layers in light and dark tones (figure 25), with no white or colorless areas. In contrast, the rectangular bead consisted of many translucent to opaque white blocks held together by purple, black, or even blue dye/bonding agents (figure 26). Through the microscope, the second was therefore the more convincing imitation of a charoite-bearing rock, but the first was more convincing to the naked eye.

In the course of editor MLJ's trip to Alaska, she saw other interesting imitations, including "Arctic Opal" (not an opal, but malachite/azurite or an imitation of it), "Glacier Pearl" (abalone shell, not pearl), and the familiar

Figure 26. The rectangular bead imitation of charoite was composed of white blocks and swirls of varying concentrations of purple (or blue, or black) colored matter. Photomicrograph by John I. Koivula; magnified 10x.

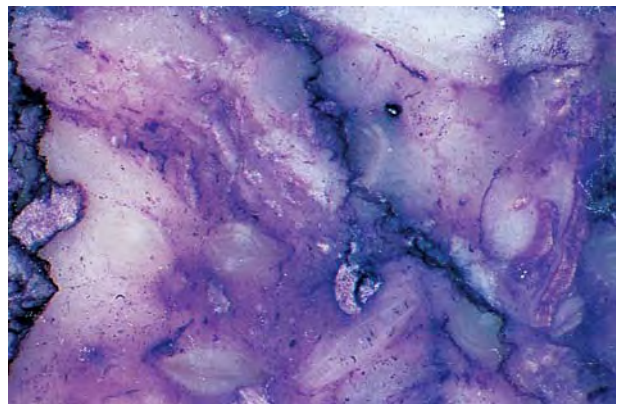




Figure 27. The words in this 42-mm-long synthetic quartz crystal were inscribed completely internally by a laser technique. Photo by Maha Tannous.

"Alaska Black Diamond" (hematite or a hematite imitation, but not diamond). Tourist beware!

MISCELLANEOUS

More on "internal" carving: Now done to synthetic and natural quartz. We first reported on the use of lasers to produce three-dimensional images inside of glass in the Winter 1996 Gem News section ("Completely internal 'carving' of glass," p. 292). In that entry, we mentioned that we saw no impediment to applying this technology to isotropic gem materials (such as CZ or diamond). This year, we discovered that this technology has gone beyond our predictions, as the uniaxial mineral quartz also is being internally inscribed in this fashion.

Utah Mineral and Fossil, of Bountiful, Utah, markets hydrothermal synthetic quartz crystals that have been laser inscribed near the surface (figure 27). We looked through the microscope at a sample inscribed beneath one prism face and observed sharp parallel fractures, such as those seen in the glass sample we observed in the Winter 1996 Gem News entry. We looked for evidence of dispersion of the laser beam, such as a broadening of the fissures in the deepest part of the inscription that might have been due to splitting of the beam by quartz's two refractive indices; however, we saw no such evidence.

Another firm has taken quartz carving a step further. At Tucson in 1999, Tom Harrelson of The Gemologist, Bellevue, Washington, showed *Gems & Gemology* senior editor Brendan Laurs a partially polished piece of natural quartz in which a stag had been internally engraved using a laser technique (figure 28). By March 1999, his firm had experimented with 17 quartz samples, including the varieties rock crystal, ametrine, rose quartz, and amethyst. Six of these samples sustained moderate to heavy damage

from stress cracking by the laser process, but designs were successfully produced in the other 11 with, reportedly, "good to excellent" image resolution. The laser inscriptions were produced in the U.S. using a proprietary computer software program that reduces the internal stress on the gem material caused by the laser. Mr. Harrelson also noted that any stress cracking in the gem material is produced at the time of inscription; no cracking has been observed to form later.

Several firms in Russia currently produce internal laser inscriptions, mainly in glass but also (reportedly) in cubic zirconia. The engravings are made with computer-controlled lasers and CAD-CAM programs; the images still consist of series of dots inscribed at specified positions in three dimensions. As the resolution gets finer (i.e., the number of "pixels" increases), the image quality improves.

ANNOUNCEMENTS

Basel 2000. The World Watch, Clock and Jewellery Show will be held March 23–30 in Basel, Switzerland. In conjunction with Basel 2000, on March 25 GIA will host GemFest Basel 2000 and the GIA Reception and Alumni Reunion, both sponsored by Messe Basel. GemFest, which is open to the public, will highlight critical issues in the gem and jewelry trade and host an open forum similar to the popular "War Rooms" at the 3rd International Gemological Symposium last June. For more information on Basel 2000, call 41-61-686-2020 or visit the Web site www.messebasel.ch. For details on GemFest, e-mail Cindy Campman at ccampman@gia.edu or call 760-603-4150. *Gems & Gemology* representatives will be available at the GIA booth in Hall 201, Stand 311.

International Rough Diamond Conference. The Israeli diamond industry and government will co-host the 2nd International Rough Diamond Conference March 21–23, 2000, at the Hilton Hotel in Tel Aviv. The conference will serve as a strategic forum between corporations involved in diamond mining, exploration, manufacturing, and financing, as well as government delegates from producing countries. Attendance will be free of charge to qualified members of the international rough diamond community, but space is limited. For details, contact the conference secretariat at 972-3-5410004 (phone), 972-3-5140044 (fax), or visit the Web site www.diamonds.org.il.

ISA personal property appraisal courses. The International Society of Appraisers (ISA) will offer its Core Course in Appraisal Studies February 26 through March 5, 2000, in Los Angeles, California. The course will focus on the broad issues of appraisal principles, including valuation theory, market research and analysis, identification and authentication, ethical standards, tax regulations, report writing, legal issues, basic appraisal techniques, and the Uniform Standards of Professional Appraisal Practice (USPAP). For more information, contact ISA at 888-472-



Figure 28. The stag was engraved completely within this natural quartz sample using laser technology. Courtesy of Tom Harrelson; photo by Maha Tannous.

4732, e-mail ISAHQ@isa-appraisers.org, or visit the Web site www.isa-appraisers.org.

Kremlin Gold at the Houston Museum of Natural Science. Presenting more than 140 gold relics, jeweled masterpieces, and precious art objects, *Kremlin Gold: 1000 Years of Russian Gems and Jewels* will be featured at the Houston (Texas) Museum of Natural Science from April 15 to September 4, 2000. On display will be works by Russian master goldsmiths dating back to the 4th century, a select number of Fabergé Imperial Easter Eggs crafted at the turn of the century, and award-winning contemporary works from the last half of the 20th century. For more information, call 713-639-4629 or visit the Web site www.hmns.org/hmns/kremlin.

Treasures from Topkapi Palace. Istanbul's Topkapi Palace has for centuries housed imperial jewels and other treasures from the Ottoman Empire. More than 200 objects from this palace will be on display in a new exhibition, *Palace of Gold & Light: Treasures from the Topkapi, Istanbul*. The exhibition will debut at the Corcoran Gallery of Art in Washington, DC, March 1–June 15, 2000, and will later appear at the San Diego Museum of Art July 14–September 24, 2000, before completing its tour at the Museum of Art in Fort Lauderdale, Florida, October 15, 2000–January 14, 2001. To contact the Corcoran Gallery, call 202-639-1700; for the San Diego Museum of Art, call Mindy Riesenbergl at 619-696-1946.

West Coast Antique & Period Jewelry Seminar 2000. This second annual seminar will be presented by the Center for Jewelry Studies on April 14–16 at the Sheraton Suites Fairplex in Pomona, California. Elise Misiorowski, Ginger Moro, Peter Shemonsky, Janet Zapata, and Christie Romero will lecture on topics ranging from

turn-of-the-century and later jewelry styles, American jewelers, diamonds and colored gemstones, the American crafts movement, and costume jewelry. To request a brochure, or for further information, call 714-778-1828 or e-mail CR4jewelry@aol.com.

Gemstones at upcoming scientific meetings. Special sections applying to gemstones will be offered at these upcoming meetings:

- A session on *Gemstones of the Pacific Rim* will take place at the Geological Society of America 96th Annual Meeting, Cordilleran Section, in Vancouver, British Columbia, Canada, April 27–29, 2000. For more information, visit the Web site www.eos.ubc.ca/cordgsa2000.
- A thematic session on *Diamond-Host Rocks: New Exploration Targets and Scientific Insights* and a one-day short course on *Kimberlites and Their Indicator Minerals* will be held at the joint meeting of the Canadian Geophysical Union and GeoCanada 2000 in Banff, Alberta, Canada, May 23–27, 2000. For details, visit the Web site www.acs.ucalgary.ca/~cguconf/main.html.
- Symposia on the *Geology of Gemstone Deposits*, *Applied Mineralogy: Ceramics and Gem Materials*, *Synthetic and Treated Gem Materials*, and *Petrogenesis of Carbonatite, Kimberlites, Lamproites and Related Rocks* will be included in the 31st International Geological Congress on August 6–17, 2000, at the Riocentro Convention Center in Rio de Janeiro, Brazil. Field trips to colored gemstone deposits of Minas Gerais and to diamond placers in the southern Espinhaço Mountain Range are also planned. For more information, contact FAGGA Eventos (phone 5521-537-4338, fax 5521-537-7991, e-mail geoexpo@fagga.com.br), or visit the Web site www.31ligc.org.