



GEM NEWS

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DIAMONDS

Indicators of additional diamond pipes in Australia.

Centenary International Mining Ltd. of Australia has announced the discovery of a potentially diamondiferous pipe zone at Giralia, north of Lake MacLeod in Western Australia. The joint-venture lease area is about 1,600 km (1,000 mi.) southwest of Argyle. Preliminary exploration revealed the presence of chrome spinels that, theoretically, could only come from a primary deposit similar to the Argyle pipe. Follow-up work will include detailed sampling of previously detected magnetic anomalies, as well as aeromagnetic, ground magnetic, and stream sediment sampling of the remainder of the lease area. (*Diamond International*, July/August 1992, pp. 33, 35)

"Presidential" diamond cavity. Anthony de Goutière, a gemologist and jeweler from Victoria, British Columbia, brought to the editors' attention a 0.33-ct round-brilliant-cut diamond with an exceptionally deep surface-reaching cavity. The cavity was open at the pavilion and, when viewed down its length, showed distinct trigons on its inner surfaces as well as a square cross-sectional outline. When viewed through the stone's crown, the cavity proved to be exceptionally deep (with an approximately four-to-one length-to-width ratio). Also evident was the remarkable resemblance of the cavity to a statue of the 16th president of the United States, Abraham Lincoln (figure 1). The exact cause of the cavity is not known. Similar features, however, have been described previously as "etched dislocation channels" (see Gem Trade Lab Notes, this issue).

An update on diamond research. In early September 1992, one of the editors (EF) attended the "Diamond 1992" conference in Heidelberg, Germany. He prepared the following report on recent progress made in diamond research.

Most research activity in the low-pressure growth of synthetic diamond (essentially chemical vapor deposition—or CVD—synthetic diamond) appears to be concentrating on refining current processes to achieve higher growth rates or fit specific applications. To demonstrate progress made in the growth of large (for this technique) gem-quality crystals by microwave CVD, Prof. Andresz Badzian of Pennsylvania State University exhibited a 2-mm-high pyramidal single crystal of synthetic diamond that, to the unaided eye, appeared to be transparent and colorless.

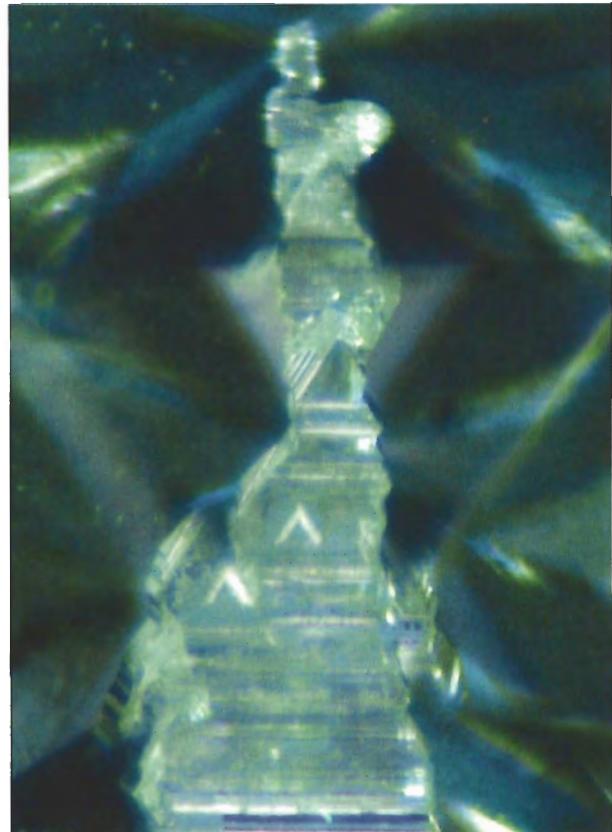


Figure 1. Viewed through the crown, this cavity in a diamond resembles a statue of 19th-century U.S. president Abraham Lincoln standing on a pedestal. Photomicrograph by Anthony de Goutière; magnified 18 \times .

As a result of research on high-temperature, high-pressure synthesis of diamond, Dr. Hisao Kanda, of the National Institute of Research on Inorganic Material in Japan, has produced yellow synthetic diamonds that contain A nitrogen aggregates (type IaA diamond) by treating type Ib yellow synthetic diamonds at high pressure. All of the synthetic yellow diamonds reported previously contained only dispersed (type Ib) nitrogen. The presence of nitrogen aggregates may dramatically affect the gemological properties of the stones

and would have important implications should they ever be made commercially available.

Dr. Alexander P. Yelisseyev, of the Institute of Mineralogy and Petrography in Novosibirsk, Russia, showed typical cubo-octahedral yellow gem-quality synthetic diamonds grown in Novosibirsk. These diamonds were grown at high pressures and temperatures in what is called a split-sphere apparatus, a technique that, Dr. Yelisseyev maintains, is less expensive than the classic belt method used by all other producers of high-pressure synthetic diamonds. It is interesting to note that some of these diamonds had been heat treated at high pressure, which resulted in a lighter, greener color. According to Dr. Yelisseyev, this green color is caused by nickel-related color centers formed during the treatment. The nickel impurity comes from the molten metal flux in which the synthetic diamond is grown.

The Drukker International booth in the industrial exhibit area featured a display of hundreds of large (0.5 to 8 ct) De Beers synthetic yellow diamond crystals. According to a Drukker representative, De Beers Industrial Diamond Division sells thin slabs (about 1 mm) of such synthetic diamonds for use as heat dissipaters. However, some slabs had fairly large surface areas (about 1 cm on an edge).

During an enlightening lecture on the geologic origins of diamonds, Dr. Jeff Harris, of Glasgow University in Scotland, reported that recent inclusion research has proved that some diamonds may form at much greater depths than previously thought. Most diamonds are now believed to have formed at depths between 180 and 450 km, but some rare crystals might have grown at a depth of about 670 km.

More exploration in Tanzania. The Tanzanian government has signed a number of exploration agreements with private firms. One such agreement, between the Tanzanian Ministry of Energy and Minerals and the firm Reunion Mining, is for diamond exploration in the Lake Victoria region. There is also reportedly some interest in prospecting for gems in the Tabora region. (*Mining Journal*, July 31, 1992, p. 72)

Zimbabwe diamond find. Australia-based Auridiam Consolidated reports that three months of test work at its pilot processing plant in Zimbabwe has yielded 5,000 ct of diamonds, including one 17-ct cutting-quality stone. The ore from which these stones were processed was recovered from the firm's River Ranch concession, located near the Limpopo River in the south of the country. Plans call for the plant to begin processing 200,000 m³ of ore per year. (*Mining Journal*, October 2, 1992, p. 233)

COLORED STONES

Agate and amethyst from Uruguay. Although Brazil is well known as a source of many varieties of quartz, neighboring Uruguay also has large, commercial deposits of, specifically, agate and amethyst. These are found in the northernmost department of Artigas. According to the August 14, 1992,

Country Supplement to *Mining Journal* (p. 7), annual production is approximately 150 tons of agate and 80 tons of amethyst, with a significant amount of the latter being shipped to Germany.

Amber from the Dominican Republic and the Baltic region.

At the June 1992 Vicenza trade fair in Vicenza, Italy, two of the editors (EF and RCK) noted the large amount of fine-quality amber on display. One dealer, Dr. Salvatore Greco, devoted a significant portion of his display area exclusively to rare blue amber from the Dominican Republic. Strong luminescence to visible light is said to produce the blue appearance of this material.

Sarunas Davainis—representing the firms Galeria No. 44, Gdansk, Poland, and Amber Ltd., Vilnius, Lithuania—provided an update on the amber industry in the Baltic region. He estimated that this region—specifically, Lithuania, Russia, and Poland—produces approximately 10 metric tons annually. The different types of deposits require different mining methods. In Russia and Lithuania, the amber-containing strata lie beneath 25–40 m of overburden. Explosives used in the recovery process damage the amber, producing a yield in finished goods of only 7% to 10% by weight. In Poland, however, the amber is closer to the surface, under roughly 12 m of overburden. Here, miners use the “floating” method: They inject saline solutions into the soils, thereby drawing the amber toward the surface. Near the city of Gdansk, Poland, some—usually top quality—amber is still found along the coast. Mr. Davainis indicated that he is exploring the possibility of “pumping” amber directly from the seabed. In a first experiment in the summer of 1991, he recovered some 160 kg of amber from the submerged former shoreline.

Unusual aragonite. Pectolite from the Dominican Republic is a visually distinctive material; it typically has a greenish blue body color and displays finely fibrous spheroidal aggregates in cabochons and polished slabs (for more information, see Woodruff and Fritsch, “Blue Pectolite from the Dominican Republic,” *Gems & Gemology*, Winter 1989, pp. 216–225). Until recently, the editors knew of only one material that might be confused with pectolite, an artificial glass marketed under the names: “Imori Stone” and “Victoria Stone.”

At the February 1992 Tucson Show, the editors saw for the first time another gem material with a striking resemblance to some Dominican pectolite (figure 2). Marketed under the trade name “Victorite” (after Victor Herrera, a friend of the mine owner, according to Eugene Mueller of The Gem Shop, Cedarburg, Wisconsin), this material comes from a copper-mining area approximately 3,000 to 4,000 m above sea level in the Department of Moquegua of southern Peru. Recovery is primarily from small seams, although the material mined to date ranges from a few grams to over 1 kg.

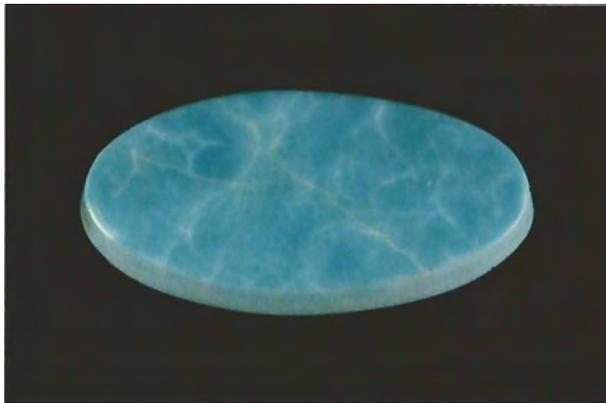


Figure 2. This 9.36-ct tablet ($22.51 \times 11.06 \times 4.10$ mm) is an impure form of aragonite from Peru. Photo by Maha Smith-DeMaggio.

We subsequently obtained three specimens of "Victorite," including a large unpolished piece donated by Mr. Mueller. Detailed testing on the 9.36-ct oval tablet shown in figure 2 revealed the following properties: color—variegated greenish blue and white; diaphaneity—semi-translucent; spot R.I.—1.52 to 1.66, with a strong "birefringence blink" indicating high birefringence (approximately 0.140). The material was inert to both long- and short-wave U.V. radiation, although two large fractures luminesced a weak, dull brownish orange. The tablet appeared green through the Chelsea color filter, showed no distinct absorption features when examined with a desk-model prism spectroscope, and had a specific gravity of 2.75, as determined by hydrostatic weighing. Magnification revealed a coarse microcrystalline structure.

Energy-dispersive X-ray fluorescence (EDXRF) analysis, performed by GIA Research, revealed the presence of calcium, copper, and strontium. X-ray powder diffraction analysis, carried out by Gus Calderon of the GIA Gem Trade Laboratory, produced a match with a standard pattern for aragonite. Although the S.G. is lower than that reported in the literature for aragonite (2.94+), the presence of impurities and/or cavities could account for the discrepancy.

On the basis of this information, the "Victorite" was identified as an impure form of aragonite. The blue coloration of this material (like blue pectolite) may also be due to copper. Although this aragonite may resemble pectolite, the much stronger birefringence of aragonite will easily separate the two. Note, too, that aragonite is not as durable as pectolite.

Color-change burbankite-related mineral from Mont St. Hilaire, Quebec. As reported in the Spring 1992 Gem News section, an unusual color-change gem, stated to be burbankite, was discovered in 1991 not far from Montreal at the Poudrette quarry, Mont St. Hilaire, province of Quebec,

Canada. Some good-size gem-quality crystals were found, and faceted stones as large as 6.62 ct have been cut. Burbankite $[(Na,Ca)_3(Sr,Ba,Ce)_3(CO_3)_5]$ is a hexagonal carbonate.

Recently, the editors examined a 3.18-ct cut-corner rectangular modified brilliant faceted from this material, which was loaned to GIA by Art Grant of Martville, New York. This stone exhibited a color change from very slightly greenish yellow in fluorescent lighting to slightly yellowish orange in incandescent illumination (figure 3). Gemological properties were determined by Gus Calderon and Shane McClure of the GIA Gem Trade Laboratory (GIA-GTL). Refractive indices of 1.630 and 1.632 yielded a birefringence of only 0.002, which is exceptionally low for a carbonate and also quite different from the published values for burbankite of 1.615 and 1.627. The stone showed no significant pleochroism, and the optic figure was pseudo-uniaxial. The specific gravity, determined by averaging three hydrostatic measurements, was 3.53 (as compared to 3.50 for burbankite). Microscopic examination revealed several narrow parallel growth tubes across the width of the stone. This stone proved inert to both long- and short-wave U.V. radiation, and showed no reaction (i.e., appeared green) through the Chelsea color filter. A handheld-type prism spectroscope revealed total absorption up to about 420 nm, with several sharp bands characteristic of a rare-earth spectrum; the strongest features were at approximately 452, 514 (strong doublet), 522, and 575 nm (several strong lines coalesced together).

EDXRF analysis performed by GIA Research identified strontium and calcium as major elements, with minor sodium, potassium, lanthanum, and cerium. Neodymium was also detected in trace amounts. This represented a departure from typical burbankite chemistry. In particular, no barium was detected, although lanthanum, neodymium, and potassium were also found in the specimens used for the original description of burbankite (Pecora and Kerr, *American Mineralogist*, Vol. 38, 1952, pp. 1169–1183). Subsequent X-ray diffraction and microprobe analyses on reportedly identical material (but not on this specimen) at the Canadian Museum of Nature in Ottawa, Ontario, identified their material as remondite-(Ce), a new mineral related to burbankite (and first described by Cesbron, Gilles, Pelisson, and Saugues in 1988, with the crystal structure determined by Ginderow, 1989; see *American Mineralogist*, Vol. 75, No. 3–4, 1990, p. 433). On the basis of this information and what we gathered, we believe the cut stone we examined is also remondite-(Ce).

To understand the color-change behavior seen in this gem, we recorded its ultraviolet-visible transmission spectrum. This revealed sharp lines at approximately 444, 488, 510, 522, and 578 nm, plus others at 626, 678, 740, 800, and 874 nm, as well as a series of broader absorption bands in the near infrared. We attributed the cutoff toward the ultraviolet to absorption by cerium (Ce^{4+}) and the sharp bands to neodymium (Nd^{3+}). Our own research has shown that Nd^{3+} produces a moderate bluish purple to reddish

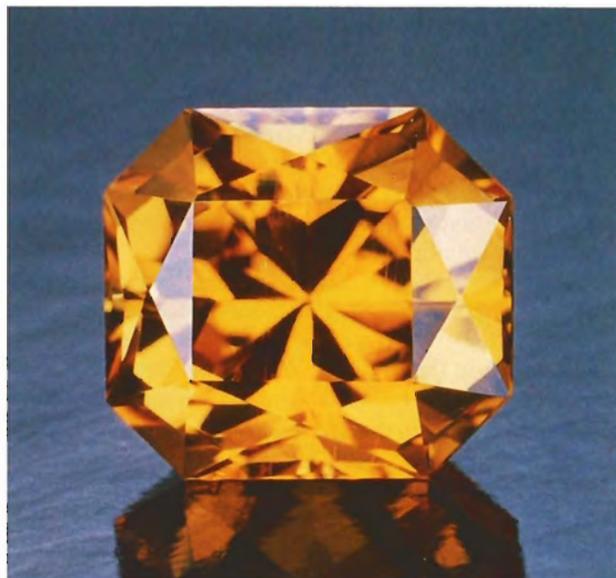


Figure 3. This 3.18-ct stone is believed to be remondite-(Ce), a new rare-earth carbonate related to burbankite. It exhibits a color change from slightly greenish yellow in daylight (left) to yellowish orange in incandescent light (right). Photo © GIA and Tino Hammid.

purple or purplish pink color change in YAG and cubic zirconia. Therefore, we believe that the color change in this sample is due to Nd^{3+} ; the colors seen are different from those observed in YAG and cubic zirconia because of the influence of the Ce^{4+} absorption. Mr. Grant informed us that not all specimens of this material that he has cut exhibit color change. We speculate that those that do not have little or no neodymium.

Dumortierite-in-quartz beads. The vast majority of the gem materials fashioned into beads are polished to produce a vitreous luster. Occasionally, however, we see beads on which the surface has intentionally been left rough to give a dull finish. At the Vicenzaoro trade fair this past June, two of the editors (EF and RCK) noticed some interesting beads at the booth of Gaetano Bazzi from Faenza, Italy. These large beads—roughly 18 mm in diameter—exhibited a violetish blue body color with mottled black veining (figure 4). The material had been represented to Mr. Bazzi as dumortierite from South Africa.

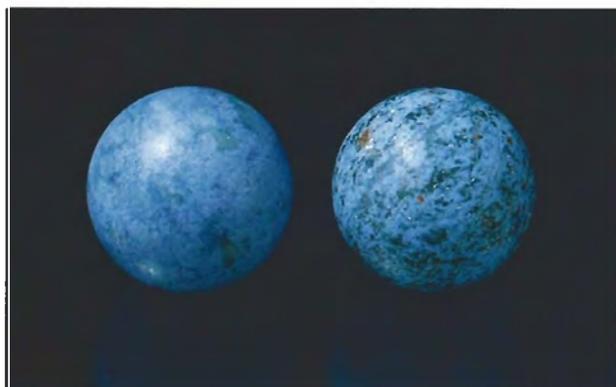
Two beads were donated to GIA for research. Subsequent testing revealed a vague spot R.I. of 1.55 and an S.G. of 2.95. The beads were inert to long-wave U.V. radiation, but the violetish blue areas luminesced a moderate, chalky whitish blue to short-wave U.V. (with the black areas remaining inert). Using a gemological microscope, we noted angular patches of a semitransparent, colorless mineral (probably quartz) interspersed with the violetish blue material. X-ray powder diffraction analysis produced a pattern matching a standard for dumortierite in quartz, that is, a superimposition of the patterns for both minerals.

Feldspar-and-amphibole gem from Egypt. The Sinai Peninsula of Egypt is well known as one of the earliest

sources of turquoise. In neighboring Israel, adjacent to the Sinai Peninsula, another semitranslucent to opaque, blue-to-green gem is found. Known in the trade as “Eilat stone,” this mixture of chrysocolla and malachite, like turquoise, is colored by copper. It was thus with interest that in Cairo this past year, one of the editors (RCK) saw some unusual, mottled cabochons with major areas of greenish blue, similar to “Eilat stone.” According to the vendor, small quantities of the material show up sporadically in the marketplace, having been collected by Bedouin tribespeople.

Two representative cabochons (a 7.05-ct pear shape and a 3.29-ct oval) were purchased and subsequently examined in detail. Both are semitranslucent and have a variegated, mottled appearance, with greenish blue and very dark green areas, the latter so dark in tone as to appear black in

Figure 4. These two rough-surfaced beads, approximately 18 mm in diameter, are dumortierite in quartz. Photo by Robert Weldon.



overhead illumination (see, e.g., figure 5). The greenish blue areas are highly fractured and veined; the dark green areas contain irregular inclusions with a metallic luster. We also noted small inclusions of a more saturated greenish blue color and lower diaphaneity, as well as areas of brownish red (limonitic?) staining.

Spot refractive-index determinations gave readings of 1.54. The stones appeared green through the Chelsea color filter. The more translucent areas fluoresced a faint yellowish green to long-wave U.V. radiation, but the stones were completely inert to short-wave U.V. Hydrostatic weighing produced specific-gravity values of 2.67 for the 7.05-ct pear-shaped cabochon and 2.74 for the 3.29-ct oval.

As the above data were inconclusive, X-ray powder diffraction analysis was performed on both the greenish blue and dark green areas. On the basis of the patterns produced, we determined that the greenish blue areas are a feldspar, whereas the dark green areas are an amphibole, although we could not determine the specific species. Therefore, we identified these stones as rocks consisting of feldspar and amphibole with possibly other, undetermined mineral components. EDXRF analysis revealed the presence of Al, Si, K, Ca, Ba, Mn, Fe, and Cu. We believe that the blue coloration is most likely due to the copper impurities.

Figure 5. Believed to be from the Sinai Peninsula of Egypt, this 7.05-ct cabochon consists primarily of greenish blue feldspar and an amphibole mineral. Photo by Maha Smith-DeMaggio.

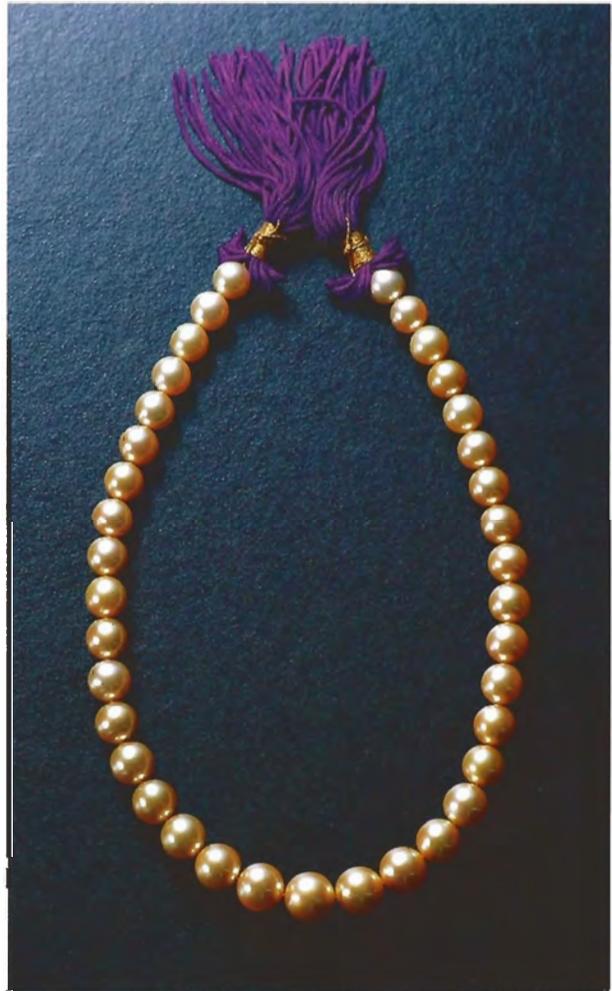


Figure 6. Okinawa is the reported source of this rare strand of 37 "golden" cultured South Sea pearls (11.2–14.1 mm in diameter), which are also notable for their high luster and absence of blemishes. Photo courtesy of René Hodel.

Update on golden cultured pearls. At the September 1992 Hong Kong Jewelry and Watch Fair, René Hodel of the firm Schoeffel in Hong Kong exhibited three strands of fine, rare "golden" cultured South Sea pearls, which ranged up to 18 mm in diameter (see, e.g., figure 6). Mr. Hodel reported that cultured South Sea pearls of this hue are actually accidents of the culturing process, representing a very small percentage of the harvest from the yellow- and white-lip oysters. According to Mr. Hodel, those with a "pure, dark gold" color are most valuable; any greenishness is considered detrimental.

The cultured pearls in these necklaces reportedly came from Okinawa, Japan. In the past, Burma (now Myanmar) was the principal source of golden cultured pearls. Today,

Figure 7. Small-scale mining operations continue in the Elahera gem field of Sri Lanka. This shallow circular pit is located along a tributary of the Mahaweli Ganga River. Photo by Shane F. McClure.



Indonesian pearl farms produce most of the golden cultured pearls in the marketplace, usually in sizes less than 15 mm in diameter. Top-quality larger (up to 18–19 mm) golden cultured pearls primarily come from Australia.

Sri Lanka: Current mining in Elahera. In August 1992, GIA-GTL's Shane McClure visited mining sites in Sri Lanka through the assistance of gem dealer M.H.S.M. Mahisukeen. One area visited was Elahera, in the center of this island nation (the subject of a Summer 1986 *Gems & Gemology* article by Gunawardene and Rupasinghe).

At the time of the visit, local inhabitants indicated that no large-scale mining had taken place for roughly four years. Individual miners, however, continue to operate in the area illegally and produce small quantities of sapphire, garnet, and various collector gems from the alluvial deposits. These operations are typically small pits dug into the banks of tributaries of the Mahaweli Ganga River (figure 7).

Sri Lanka: Update on gem production. Gordon Bleck of Radiance International, San Diego, California, has provided another update on gems and gem mining in Sri Lanka. He reports that a variety of factors have produced a general decline in gem production there. In the Okkampitiya area, one reason is the threat of terrorism by members of the Liberation Tigers of Tamil Elam. Also, this southeastern area of the country has been suffering through a drought so bad that drinking water has had to be trucked into some communities, so there has not been sufficient water to wash the gem gravels.

Good natural-color blue and yellow Sri Lankan sapphires are less plentiful than in previous years, although pink to purple sapphires appear to be slightly more available than in the past. Yellow sapphires of all qualities are reportedly being purchased in large quantities for heat or diffusion treatment. Mr. Bleck also noted the appearance on the market of a higher percentage of yellow sapphires that are unstable to daylight. Typically, sapphires turned yellow by exposure to X-rays fade to their original pale yellow or colorless state after a few hours in direct sunlight. Consequently, it is common practice for many buyers to expose yellow sapphires to daylight for one or two days prior to completing the purchase. According to Mr. Bleck, however, subjecting a sapphire to repeated irradiation and fading cycles may produce a color that will not discernibly fade for as long as 10 days in sunlight.

Similarly, some light pink sapphires are reportedly irradiated to produce a pinkish orange, "padparadscha" color. Because the yellow component of the color is unstable, the stones fade back to light pink after one to six hours' exposure to daylight. Therefore, it is strongly recommended that buyers expose "padparadscha" sapphires to direct sunlight for several hours to check color stability.

Some rare and unusual stones surfaced during the past year. One small pit in the Okkampitiya area has produced a surprising number of chatoyant kornerupines. Near Okkampitiya, in the small town of Passura, several chatoyant rutiles have been found. This material is very unusual (see also the entry in the Summer 1986 Gem Trade Lab Notes section, p. 111). Some of the almost two dozen cabo-

chons the editors examined (which ranged up to 3.5 ct) showed a very intense, sharp eye. Rutile from Karawita, near Ratnapura, has been faceted into small stones, in weights up to slightly over 1 ct. Most showed a very dark brown-red body color when illuminated with a strong light source, and were found (by EDXRF analysis in GIA Research) to contain impurities of iron, chromium, and niobium. One stone, however, a 1.08-ct oval shape, appeared dark violetish blue in the same lighting; it contained traces of niobium only, and displayed very strong electrical conductivity when tested with a gemological conductometer. Such conductivity behavior has been documented in blue synthetic rutile as due to a reduction of Ti^{4+} to Ti^{3+} (see, e.g., K. Nassau's *Gems Made by Man*, Chilton Book Co., Radnor, PA, 1980, p. 217). This reduction could have occurred in nature due to natural radiation, as many radioactive gemstones and other minerals are found in the same general area of Sri Lanka.

Mr. Bleck also showed us a remarkably large (114 ct; $38 \times 28 \times 12$ mm), slightly waterworn twinned crystal of yellow chrysoberyl (figure 8). According to the State Gem Corporation, it is the largest chrysoberyl recovered from Sri Lanka in recent years.

A brownish yellow-green 3.71-ct oval chrysoberyl revealed some unusual properties. Most notable were the indices of refraction—1.763 and 1.777—which are significantly higher than the expected values of approximately 1.746 and 1.755. However, the stone's X-ray diffraction pattern matched GIA's standard pattern for chrysoberyl. Energy-dispersive X-ray fluorescence analysis identified traces of titanium and gallium, as well as a very intense signal for iron. This high iron concentration is probably the cause of the unusually high R.I.

Figure 8. This 114-ct twinned chrysoberyl crystal is reportedly the largest recovered in Sri Lanka in recent years. Photo by Maha Smith-DeMaggio.



Large taaffeite. At the September 1992 Hong Kong Jewelry and Watch Fair, one of the editors (EF) saw an exceptionally large taaffeite. The 33.33-ct oval mixed cut displayed numerous eye-visible included crystals that, from their morphology, were possibly apatite. Like many taaffeites that we have examined, this gem displayed a slight color change, appearing purple under fluorescent lighting and a more reddish purple under incandescent illumination.

New joint venture in Vietnam. A new joint-venture company, Vietnam Gems Technology Co. Ltd. (GemTec), has been formed to process and trade in rubies and other gems mined in Vietnam. The firm, formed between Australian businessman Raymond Eaton (chairman of the Bangkok-based Export Development Trading Corp.) and the Electronic and Optical Instruments Corp., a subsidiary of the National Center for Scientific Research, will buy, fashion, and market the rubies. To this end, a factory and trading house with a staff of 120, plus a small gemological laboratory, are to be set up in Hanoi.

Update on Vietnam gems. In November 1992, *Gems & Gemology* editor Alice S. Keller and one of the Gem News editors (RCK) visited a number of gem localities in Vietnam. The trip was arranged through Savitech, a joint-venture between FINGEMS (a Swiss firm) and the State Bank of Vietnam, to prepare an update to Kane et al.'s "Rubies and Fancy Sapphires from Vietnam" (*Gems & Gemology*, Fall 1991, pp. 136–155) with one of the coauthors of that article, Saverio Repetto. Following are some of the highlights of the new information they gathered.

Mining for rubies and pink sapphires has been reactivated and accelerated at the original Vietnamese source, Luc Yen, in Yen Bai Province. The largest operation, a joint venture between state-owned Vinagemco and the Thai firm B. H. Mining, is a heavily mechanized open-pit mine, with four electricity-powered water cannons and a six-jig sluice. Geologist Nguyen Duc Khai, senior expert with the Council of Ministers in Hanoi, explained that the joint venture has a 12-year lease to work the area, and plans to work five open-pit mines total, one after the other. The Vietnamese army is also involved in mining in the Luc Yen area. We saw only one "independent" (illicit) mining operation, but were told that most of the illegal operations in this area are conducted at night.

Mining has also accelerated greatly at Quy Chau and neighboring Quy Hop, in Nghe An Province. Four companies—three controlled by the provincial government and one by the national Ministry of Heavy Minerals (in conjunction with Thai investors)—are authorized to mine in the Quy Chau area. To date, all of the mining has been open pit, into the gem-bearing gravels. The operations range from some that are highly mechanized, using bulldozers, water cannons, and diesel-powered jigs (to separate the gems), to many that are simple hand digging, with miners using shovels to remove the overburden and baskets to wash the grav-



Figure 9. At Ba Dan, in Binh Thuan Province, hundreds of predominantly shallow pits have been dug to reach the sapphire-bearing gravels. Photo by Robert C. Kammerling.

els. We saw significantly more independent mining in the Quy Chau area than in Luc Yen, although both areas had a strong police presence. Prof. Dr. Phan Truong Thi, chairman of the Vietnam Mineralogical Association, reported that a “good” 54-ct ruby had recently been found at Quy Chau. Most of the stones we saw at Quy Chau were small and highly fractured, with the characteristic blue zones in the pink to red material. We also saw significant amounts of what appeared to be flame-fusion synthetic rubies in both Luc Yen and Quy Chau, primarily in the provincial capitals of Yen Bai and Vinh and at some of the mining areas in Quy Chau.

Although fine blue sapphires have been known to come from the marble-related deposits in the Luc Yen area, most of the blue sapphires currently mined in Vietnam originate from alkalic basalts in the south of the country, in Lam Dong, Dong Nai, and Binh Thuan Provinces. We visited two localities in Binh Thuan Province: Da Ban and Ma Lain. Both were crude open-pit operations, where the miners dug into the alluvium (often less than a meter) to reach the gem gravels, which were then washed in nearby artificial ponds. At Ba Dan, hundreds of predominantly shallow pits appeared to have literally chewed up an area at least hundreds of meters long (figure 9). Reportedly, there had been as many as 3,000 people working this deposit in recent months, but the number was greatly reduced by government efforts to control the area and eventually systematize the mining. We saw more activity at Ma Lain, where we were told that approximately 400 people were still working the region, with an average yield of 100 stones per day. Most of these pits, too, were shallow, but we saw some as deep as 3 m. For the most part, the sapphires we observed from both localities were very dark blue to bluish green; most of the potentially gem-quality rough crystals were small, less than

3 ct. Mr. Nguyen Xuan An, general director of Vinagemco, indicated that lighter blue sapphires had been found at Lien Dam, near Di Linh, in neighboring Lam Dong Province.

Green zoisite from Pakistan. Recently, the editors examined two remarkably well-formed transparent crystals of green zoisite provided by Larry C. Winn of AJS Enterprises in Wheat Ridge, Colorado. Of great interest was the fact that the crystals (100.5 and 9.6 ct; figure 10), reportedly came from Skardu, Pakistan. At approximately the same time, we were also given two crystal fragments of green zoisite by Pierre Bariand, curator of the Sorbonne mineral collection in Paris, France. These, too, reportedly came from central Asia, although the exact source (Afghanistan or Pakistan) is not known. EDXRF and ultraviolet-visible spectroscopy showed that all four specimens, although not identical in appearance, had very similar spectra, which suggests a common origin.

When gemologically compared to the green zoisite recently described from Merelani Hills, Tanzania (Barot and Boehm, *Gems & Gemology*, Spring 1992), these new green zoisites have a slightly higher refractive index at 1.700–1.706. In addition, they show relatively strong absorption lines in the hand spectroscope, at 433 and 460 nm, and distinct pleochroism in bluish green, brownish orange, and yellow.

The two crystals obtained from Mr. Winn are slightly tapered prisms. The color seen through the two flatter prism faces is a medium dark, slightly greenish blue, whereas that seen through the other two prism faces is a slightly orangy brown. In addition to the constituents of zoisite detected (calcium, aluminum, and silicon), EDXRF analysis revealed traces of titanium; small amounts of vanadium, chromium, and strontium; and a comparatively large amount of



Figure 10. These two green zoisite crystals (100.5 and 9.6 ct) are reportedly from Pakistan, a new source for this material. Courtesy of AJS Enterprises; photo by Shane F. McClure.

iron. This is a significant difference from Tanzanian green zoisite, which has essentially no, or negligible, iron.

Ultraviolet-visible spectra taken in the orangy brown direction showed two intense, sharp bands at about 390 and 452 nm, with accessory peaks at 359 and 427 nm. These are typical of Fe^{3+} in octahedral coordination. In conjunction with a general increase of the absorption from the red toward the ultraviolet, they produce the orangy brown color seen in that direction. We also noted a weak, broad band with an apparent maximum at about 590 nm, very similar in shape and position to that responsible for the blue color of tanzanite; this has been correlated to vanadium (present only as a trace element in these specimens). In the near-infrared portion of the spectrum, we observed a broad band centered at about 1150 nm. Spectra taken in the "green" direction showed the same sharp bands at about 390 and 452 nm; in this direction, however, they were accompanied by a complex broad band causing absorption between approximately 600 and 850 nm, and the band at about 1150 nm was not present. These sharp and broad absorption features are also typical of Fe^{3+} . The pleochroism of these specimens

appears to be very similar to that observed in crystals of mixed epidote and clinozoisite from Gilgit, Pakistan (G. R. Rossman, pers. comm., 1992).

To our knowledge, green zoisite from Pakistan has not been reported previously.

ENHANCEMENTS

Filled diamonds marketed under new name. In the more than five years since the fracture filling of diamonds to enhance apparent clarity was first introduced in the trade, there has been considerable debate concerning proper nomenclature to describe diamonds that have been treated in this fashion. One of the newest twists to this issue of disclosure was just brought to our attention by a jeweler in Western Australia, who sent us a flier being used to promote such treated stones in Perth. According to this flier, "a diamond of a clarity of say Piqué 1 or 2 can be enhanced to become a *Genesis II Diamond* [editors' emphasis] of at least S1 [sic] or VS clarity." Referring to such treated diamonds by this name, without also clearly indicating that they are treated stones, could easily result in confusion in the marketplace.

Fracture filling of rough diamonds reported. *Diamond Intelligence Briefs* (September 24, 1992, p. 926) has warned that rough diamonds apparently are being clarity enhanced and then shipped to one or more African nations for marketing. These efforts appear to be aimed at defrauding subsequent purchasers of the stones.

As pointed out in ICA Laboratory Alert No. 52 and in a follow-up entry in the Fall 1992 Gem Trade Lab Notes section of *Gems & Gemology*, this enhancement cannot withstand the heat generated in cutting and polishing. Such deceptive treatment of rough would therefore certainly be discovered on the cutting wheel. Those who buy rough diamonds outside established channels are advised to check their stones carefully for evidence of fracture filling, such as the flash effect, trapped bubbles, or flow structure seen with magnification (see, e.g., Koivula et al., "The characteristics and identification of filled diamonds," *Gems & Gemology*, Summer 1989, pp. 68-83).

More on irradiated "black" diamonds. The Summer 1992 Lab Notes section included an entry on a green irradiated diamond with a color so dark that the stone appeared black to the unaided eye. In the trade, such stones are often described as black.

At the Vicenzaoro trade fair in Vicenza, Italy, this past June, one of the editors (EF) was shown several such "black" diamonds by Eddy Vleeschdrager, a cutter from Antwerp. Although Mr. Vleeschdrager indicated that these stones were not radioactive, he confirmed that similarly treated stones that were radioactive had recently been seen in Antwerp and Germany. According to Mr. Vleeschdrager, radioactivity was no longer present in the stones seen in Germany after they were subjected to prolonged boiling in

acid. This would indicate that the radioactivity was related to metallic polishing residues that had collected in the numerous surface-reaching fractures in these low-clarity stones. Irradiation in a nuclear reactor apparently produced radionuclides in these polishing residues. Acid boiling the stones (to remove the residues) before they are submitted for irradiation would appear to solve this problem in the future.

Interesting treated ornamental sandstone. On a recent trip to Asia, Ms. Eddie Decsi, of GIA Education, visited a factory in the town of Hualien, on the east coast of Taiwan. Hualien is a center for fashioning ornamental gem materials, especially marble, which is mined locally. In addition to marble, Ms. Decsi saw an attractive ornamental sandstone that was being fashioned into objects such as small teapots. Whereas some of the objects were marketed in their natural, light to medium brown color, others were treated to produce darker tones. The editors found it interesting that the "dye" used on these teapots was *tea*: The fashioned items were boiled in tea until the desired depth of color was obtained.

Ms. Decsi purchased one of these "dyed" teapots and provided it to the editors for examination (figure 11). Although no dye appeared on an acetone-dipped cotton swab when it was rubbed on an inconspicuous part of the carving, similar testing with dilute (2%) nitric acid produced a tell-tale discoloration on the swab.

SYNTHETICS AND SIMULANTS

Update on crystal growth. In August 1992, one of the editors (EF) attended the tenth International Conference on Crystal Growth in San Diego, California. Presented at this conference were advances in crystal-growth techniques as well as descriptions of new synthetic materials.

Most of the crystal-growth research of potential relevance to the gem industry is being conducted in the fields of laser and optical materials. Very few such materials are still grown using a classic flux technique or hydrothermal method (a major exception to the latter is hydrothermal synthetic quartz). Instead, most such crystals are being grown by pulling techniques, such as the Czochralski method, which is already well established for the production of such materials as synthetic corundum and yttrium aluminum garnet (YAG), as well as other so-called synthetic "garnets."

In the past, such methods required that the material melt congruently, that is, that the composition of the crystal formed by freezing must be identical to that of the melt. As this technique reached its maturity, new pulling techniques were developed that are now commonly used. In one such method, the composition of the melt is constantly adjusted by the addition of raw materials during growth. This has led to the production, for example, of fluoride crystals over 100 kg, a size that would be impossible with the classic Czochralski pulling method. Another technique,



Figure 11. Tea was used to color enhance this sandstone teapot (14.7 × 9.2 × 6.8 cm). Photo by Maha Smith-DeMaggio.

called top-seeded solution growth, combines flux and pulling methods. A seed starts to grow in a solution (typically referred to in gemology as a flux), and then is slowly pulled up during growth. The thermal geometry of this arrangement will allow for controlled nucleation and ensure the growth of a single, larger crystal than would be possible with either method alone.

New types of crystals being developed are yttrium silicates (Y_2SiO_5 , see entry below) and yttrium vanadates (YVO_4), as well as various types of apatite for laser applications. Colorful, rare-earth aluminates with perovskite structures, such as $LaAlO_3$, are also being grown for use as superconductor substrates. Neodymium (as Nd^{3+}) already has been reported to cause a pink-purple color change in materials such as YAG (Gem News, Spring 1992, p. 66) and cubic zirconia. Now, neodymium is being incorporated into a variety of color-change synthetic apatites, including fluorapatite and silicate-oxyapatites. A neodymium-doped fluorapatite grown by Dr. Bruce Chai, of the University of Central Florida Center for Research in Electro Optics and Lasers, exhibited a distinct color change, from blue in fluorescent lighting to violet in daylight and purple in incandescent illumination. EDXRF analysis by GIA Research revealed strontium as a constituent in the crystal.

Union Carbide, a well-known synthetics manufacturer, has shown interest in producing various crystals by the Czochralski method for the gem industry. Dr. Milan Kokta, from the firm's Washougal, Washington, facility, showed the editor a variety of corundum crystals doped with iron-titanium or cobalt (blue) and titanium (pink), as well as complex synthetic garnets with a beautiful green color. These crystals are grown specifically for the jewelry industry: Several nuances of blue color in synthetic corundum have been produced in response to market demands.

Attractive "gem construct." The term *assembled stone* is used in the trade to describe gems that have two or more

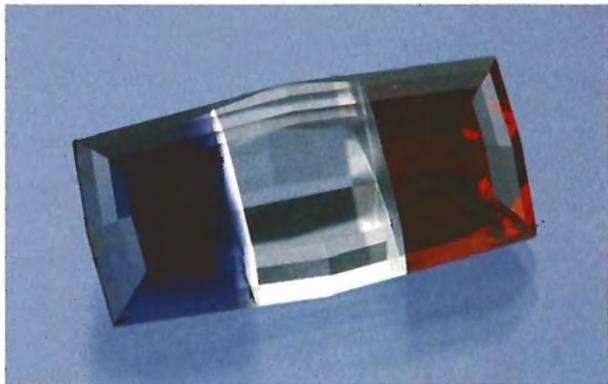


Figure 12. This 16.31-ct gem construct ($22.26 \times 10.65 \times 7.32$ mm) is composed of sections of rhodolite garnet, colorless topaz, and iolite. Photo by Maha Smith-DeMaggio.

components. Two pieces of material joined by a colorless cement are commonly referred to as *doublets*, whereas the term *triplet* is used to describe assemblages of three materials (or two sections joined by a colored cement, such as synthetic spinel triplets).

For the most part, assembled stones are produced either to imitate other gems or, as in the case of opal doublets and triplets, to use thin sections of a gem material that alone would lack sufficient durability for jewelry. In both cases, it is desirable that the assembled nature of the piece not be apparent. There is, however, another type of assembled stone that is less commonly seen in the trade, one that is constructed to accentuate the unique visual features of the components. One producer, Sid Berman, refers to these assembled stones as "gem constructs."

An attractive 16.31-ct "gem construct" was donated to GIA from the Josephine L. Scripps gem and mineral collection. The stone, which arrived in a container marked "Rhodiopaz," has distinct dark purplish red, colorless, and dark violet sections of approximately equal size (figure 12). Gemological testing indicated that the name was not inappropriate, as the components were identified as rhodolite garnet, iolite, and colorless topaz.

Extremely small synthetic melee. In June 1992, at a trade show in Vicenza, Italy, two of the editors (EF and RCK) spoke with Mario Tiedemann, marketing director of Durafourg, a major producer and manufacturer of melt-grown synthetic gem materials that is based in Lausanne, Switzerland. Mr. Tiedemann noted that his firm produces large quantities of flame-fusion synthetic corundum and synthetic spinel each month, as well as very large quantities of cubic zirconia. Of particular interest is the small size of some of the stones fashioned in their cutting facilities. We were shown faceted CZs that weighed approximately 0.002 ct each, that is, almost 500 stones per carat.

Synthetics preset in findings by "automation." Also at the Vicenza trade show, we visited the booth of Bifra, a Vicenza-based firm that markets synthetic gem materials preset in various types of gold findings. The firm's Mr. David indicated that the findings with prong-set stones can be produced using virtually any stone shape and that the bezel-set stones include rounds, ovals, squares, and marquises.

Mr. David reported that the setting process is fully automated, with the findings machined from small blocks of gold rather than from gold tubes. About 3,000 pieces are produced per day. We were told that the product is particularly popular in Japan, which has high labor costs: Rather than set the stones individually, the jewelry manufacturer simply solders the gem-set finding onto the piece of jewelry being produced.

Large hydrothermal synthetic ruby. One of the most striking synthetic gem materials displayed at the International Conference on Crystal Growth [see summary entry above] was a 386-g (1,930-ct) hydrothermally grown synthetic ruby crystal (figure 13). This and smaller crystals, all exhibited by Dr. Roch Monchamp of Goleta, California, were grown about 1966, when synthetic ruby was the foremost laser material and the subject of much research. This large crystal, possibly the largest hydrothermal synthetic ruby ever produced, represents a failed attempt to synthesize a one-pound (2,268 ct) ruby.

According to Dr. Monchamp, the crystal was grown with the necessary ruby constituents in a concentrated potassium-carbonate solution in a silver-lined vessel, at a pressure of 20,000 psi and a temperature of 540°C. Veils of fluid inclusions throughout the crystal are quite apparent to the unaided eye and form a roughly hexagonal honeycomb-

Figure 13. The hydrothermal method was used to synthesize this extremely large (1,930 ct; $95.30 \times 55.05 \times 19.78$ mm) ruby crystal in the mid-1960s. Courtesy of Dr. Roch Monchamp; photo by Shane F. McClure.



like structure. Dr. Monchamp indicated that these veils and the corresponding structure (which the editors have seen in other pink-to-red synthetic corundum crystals produced around the same time) are typical of the rapid growth conditions. Although smaller crystals were grown with fewer such inclusions, these crystals tended to develop color banding due to uneven chromium distribution.

This large synthetic ruby crystal was subsequently loaned to GIA for characterization. The gemological properties were generally typical of synthetic ruby: R.I.—1.760–1.768; birefringence—0.008; red appearance through the Chelsea color filter; and an absorption spectrum typical of ruby, both natural and synthetic. When exposed to long-wave U.V. radiation, the crystal luminesced a very strong orangy red; the reaction to short-wave U.V. was a moderate purplish pink with a whitish surface luminescence. It was interesting to note that the fluid-filled cavities luminesced a moderate greenish yellow to long-wave U.V. and a weak greenish yellow to short-wave U.V.

Chemical analysis by EDXRF found (in addition to aluminum and chromium) impurities of iron, potassium, titanium, copper, and traces of chlorine, calcium, and arsenic. Quantitative measurements revealed approximately 0.04 wt. % Cr₂O₃ and roughly 0.01 wt. % each of TiO₂ and FeO.

Assembled imitation watermelon tourmaline. Recent Gem News entries have described a number of novel tourmaline imitations, including a glass imitation of indicolite (Summer 1992), a glass composite resembling watermelon tourmaline (Fall 1992), and a tourmaline-glass assemblage (also Fall 1992).

Bill Larson of Pala International, Fallbrook, California, has since brought to our attention the most complex tourmaline imitation we have seen to date. The large (667.74 ct; 65.3 × 42.2 × 37.7 cm) "crystal" section superficially resembled the watermelon variety (figure 14).

Detailed examination, however, revealed that the specimen was actually a complex assemblage. The outermost layer consisted primarily of a veneer of long, narrow slices of a gem material—two of which were dark blue, while the others were dark yellowish green. All of the slices appeared finely striated parallel to the length of the "crystal." Although the striations made refractometer testing very difficult, a spot R.I. reading taken on one yellowish green section produced a value of 1.63 and a weak "birefringence blink." Examination with a desk-model prism spectroscope revealed a very weak absorption line at 460 nm. Magnification showed that these outermost sections contain fluid inclusions and internal fractures running parallel to their length.

The next layer, which was semitranslucent, appeared to be an assemblage of very small mineral fragments (including, perhaps, colorless quartz and mica?) held together by a



Figure 14. This 667.74-ct imitation watermelon tourmaline "crystal" specimen is actually a complex assembly of several materials. Photo by Maha Smith-DeMaggio.

transparent, colorless cementing agent that contains numerous gas bubbles. The large transparent core of the specimen at first appeared to be pink. However, illumination with a fiber-optic light pipe revealed that it was actually colorless with a dark pink surface coating. The colored coating was clearly visible in areas near either end of the specimen, where the ground-matter-and-cement layer failed to completely cover the core. Polariscope testing showed this innermost section to be doubly refractive, and microscopic examination revealed what appeared to be fluid inclusions. X-ray powder diffraction analysis conclusively identified the core as quartz.

On the basis of these tests, we determined that the specimen was actually a complex assemblage that consisted of, from core to periphery: a large section of rock crystal quartz, a coating of dark pink coloring agent, and a layer of mineral fragments in cement—all housed within slices of tourmaline.

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