GEM NEWS INTERNATIONAL

Contributing Editors
Gagan Choudhary, *Gem Testing Laboratory, Jaipur, India* (gagan@gjepcindia.com)
Christopher M. Breeding, *GIA, Carlsbad* (christopher.breeding@gia.edu)
Guanghai Shi, *School of Gemmology, China University of Geosciences, Beijing* (shigh@cugb.edu.cn)

TUCSON 2022

Sellers and buyers alike were delighted to be back at Tucson for the show season after a two-year absence. As the world enters a new phase of the pandemic, the gem and jewelry industry is also preparing for the post-pandemic era. Attendees embraced precautions such as social distancing and face coverings (figure 1). Although social gatherings were much less crowded than usual, the atmosphere and business at the shows were as strong as before, if not better.

Due to travel restrictions, the international presence was down, but that did not affect vendor attendance at the main AGTA GemFair at the Tucson Convention Center, where the majority of exhibitors had strong U.S. representation. The Gem & Jewelry Exchange (GJX) show was slightly affected, with some booths left empty by foreign dealers who could not make it to Tucson this year. Vendor attendance in the satellite shows outside of the convention center area remained strong, as observed by the authors at

Figure 1. Customers select goods at the AGTA GemFair. Photo by Tao Hsu.

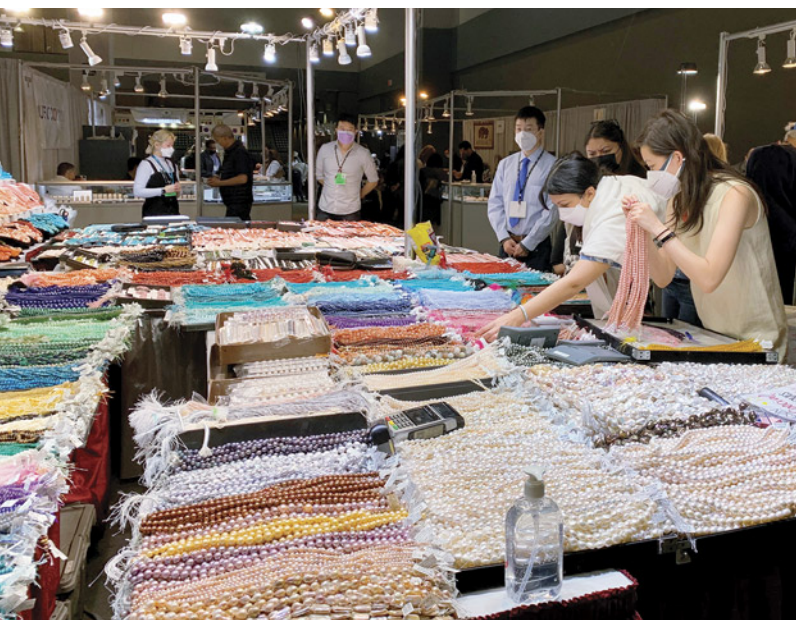


Figure 2. A stone decor dealer's booth at the Kino Gem & Mineral Show. Open to the public, the show saw steady foot traffic. Photo by Tao Hsu.

Editors' note: Interested contributors should send information and illustrations to Stuart Overlin at soverlin@gia.edu or GIA, The Robert Mouawad Campus, 5345 Armada Drive, Carlsbad, CA 92008.

Gems & Gemology, Vol. 58, No. 1, pp. 80–136.

Figure 3. Left: The Pueblo Gem & Mineral Show was an ideal place to source rough gems of all kinds. Right: Cutting services were provided at multiple shows open to the public. Photos by Tao Hsu.

the Pueblo Gem & Mineral Show, the Kino Gem & Mineral Show (figure 2), and the 22nd Street Mineral, Fossil, Gem & Jewelry Show.

Many exhibitors felt that while foot traffic was lighter than usual, buyers were focused on purchasing targeted goods to restock inventory. Meanwhile, the pandemic's influence on the supply side of the value chain was just starting to show. Therefore, this Tucson show season provided a very good opportunity to prepare for a potential shortage in the coming months (figure 3).

The variety of gems and jewelry traded at the shows remained consistent with previous years. The "big three"—ruby, sapphire, and emerald—still dominate the market (figure 4), with the intake at the GIA Show Service Lab reflecting this. Collector minerals and gems such as meteorite, gahnospinel, fluorite of various colors, opalized fossils, cerussite, and colemanite continued to attract a niche market clientele (figure 5). Also in high demand were fantasy cuts, rose cuts, briolettes, and mineral or rock slices. Jewelry designers on a mission to fulfill special orders sourced gems such as Montana sapphire, Oregon sunstone, Arizona turquoise, Washington nephrite jade, and other American gems.

Vendors have never been more creative in terms of their products and business savvy. To fulfill the ever-growing demand for one-of-a-kind creations, gem cutters, carvers, and jewelry manufacturers have put more thought and individuality into their pieces (figure 6). Products manufactured with a high level of sophistication such as inlaid jewelry or gems were prominent at the show (figure 7). Many vendors have shifted more business online over the past two years to combat limited foot traffic in stores. Newly formed companies, meanwhile, have often started completely online or done most of their business online.

Figure 4. An 8.23 ct star ruby cut by David Nassi. Photo by Robert Weldon; courtesy of 100% Natural Ltd.

Figure 5. A 45 ct green fluorite from New Mexico. Dealers carried fluorite of all colors and cutting styles at both the AGTA and GJX shows. Photo by Emily Lane; courtesy of Barker & Co.

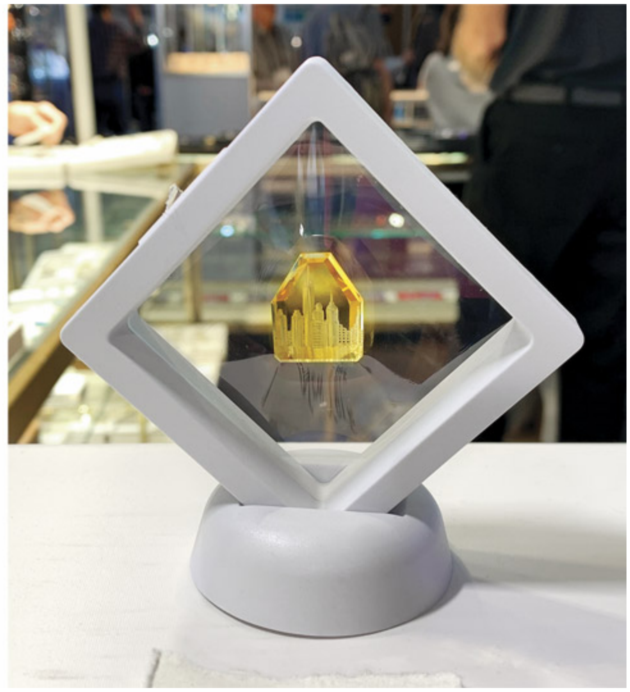


Figure 6. Left: Rock and metal wall decor in combination with metal art at the Kino show. Right: A 22.93 ct carved citrine crafted in Jaipur, India; courtesy of Artisav Jaipur. Photos by Tao Hsu.

GIA relished in the much-anticipated return to Tucson this year, enthusiastically gathering the latest from the shows to share in this report. Our coverage includes market updates, interesting and noteworthy finds, and uplifting accounts from dealers, cutters, designers, and more.

The following contributed to this report: Erin Hogarth, Erica Zaidman, Robert Weldon, Albert Salvato, Wim Vertriest, Lisa Neely, and Nathan Renfro.

Tao Hsu and Lisa Kennedy
GIA, Carlsbad

Figure 7. Gemstone-inlaid bangles from David R. Freeland Jr. Designs at the Pueblo Gem & Mineral Show. Photo by Lisa Kennedy.

COLORED STONES AND ORGANIC MATERIALS

Large, rare faceted collector gems. Barker & Co. (Scottsdale, Arizona) exhibited remarkable stones at this year's AGTA show, including some extremely fine, rare gemstones for collectors. Two of their collector stones, colemanite and phosphophyllite, stood out for their record-breaking size.

The colorless colemanite in figure 8, a modified triangular brilliant weighing 7.36 ct, is believed to be one of the largest faceted examples of its kind. Colemanite is known

Figure 8. A 7.36 ct colorless, modified triangular brilliant-cut colemanite displayed at the AGTA show. Photo by Emily Lane; courtesy of Barker & Co.

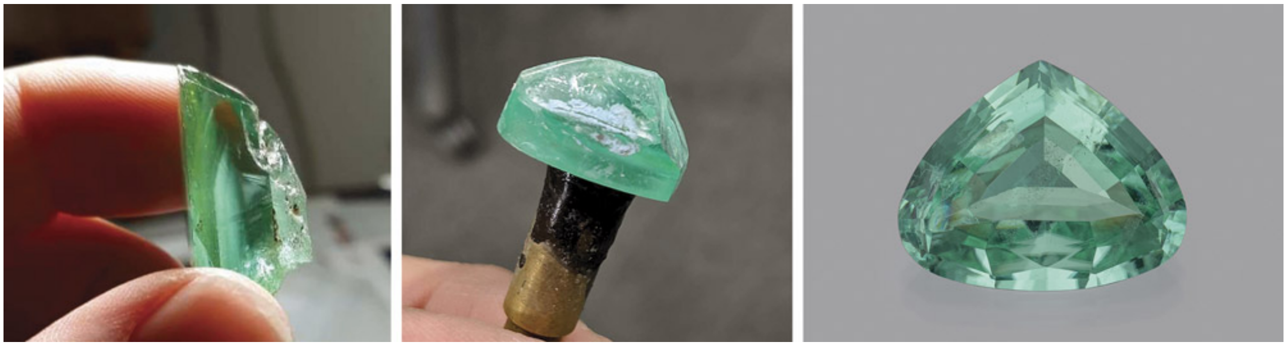


Figure 9. The evolution of a 45.42 ct rough phosphophyllite in the hands of Stacy Whetstone (left). It took four weeks to cut and finish the stone due to its heat sensitivity (center). The finished 17.52 ct bluish green, modified triangular brilliant-cut phosphophyllite was displayed at the AGTA show (right). Left and center photos courtesy of Barker & Co.; right photo by Emily Lane.

to fluoresce a strong yellow under ultraviolet light and phosphoresce green.

The strongly saturated bluish green hue of a 17.52 ct phosphophyllite echoed that of some of the finest hues of Paraíba tourmalines, though the stone is very different both structurally and chemically. Phosphophyllite was named in 1920 as a homage to its phosphate composition and perfect leaf-like cleavage (from the Greek *phyllon*, meaning "leaf"). Ann Barker of Barker & Co. explained that this particular phosphophyllite has a significant provenance. Once owned by author and renowned mineral collector Dr. Peter Bancroft, it was mined in the famed Potosí mine of Bolivia in 1958. Many years later, prize-winning gem cutter Stacy Whetstone took the striking 45.42 ct rough and expertly faceted the material into the finished 17.52 ct rounded trillion (figure 9). Given phosphophyllite's considerable heat sensitivity, the gem took four weeks to cut and finish.

Colemanite and phosphophyllite, like other collector stones, are seldom faceted due to their low hardness (4.5 and 3–3.5, respectively) and durability issues. As collector stones, they hold a unique position in the gem and jewelry industry, valued for expanding private collections. In recent years, with the help of a little luck and a lot of talent, collector stones are being seen more in jewelry.

Lisa Kennedy and Tao Hsu

Custom knives by Loren Feldman. Some of the most interesting discoveries in Tucson came courtesy of Loren Feldman (Feldman Custom Knives, Gold Canyon, Arizona). His knives are works of art constructed from some of the rarest materials on Earth—and other planets. A visit to Feldman's booth is a fascinating walk through history that reveals geological treasures such as *Tyrannosaurus rex* bones, woolly mammoth tusks, and meteorites that fell to the earth millions of years ago.

Remarkably, Feldman has only been making knives for seven years. He describes his introduction to the craft and training as pure luck. Collecting rocks and minerals since he was a young boy, Feldman impressed custom knife maker Robert Stratton with his enthusiasm at the 22nd Street show in Tucson. After a fourth visit to the booth, Stratton generously offered to teach Feldman everything he knew about the craft. At the end of the training, he allocated part of his Tucson booth space to help Feldman get his start in the business. Feldman said that after his apprenticeship, "it took me about two years full-time to consider my work what I considered good. It took me about three years to pay all my bills. And seven years later, it's the happiest I've ever been as far as a profession."

Feldman's knife handles are crafted from minerals, gems, and fossilized dinosaur bone. One of his favorites is a knife made of gem dinosaur bone from nine different dinosaurs (shown on the cover of this issue). He explained that only 1/20 of 1% of all dinosaur bone turns into gem, describing it as a miracle of nature because it is only created under very specific conditions. During this process, the dinosaur bone undergoes a transformation that leaves the bone with a beautiful pattern of color and texture (fig-

Figure 10. Loren Feldman holds a piece of gem dinosaur bone, displaying the variety of colors and textures he can choose for his knives. Photo by Robert Weldon; courtesy of Loren Feldman.

Figure 11. Feldman studies a piece of gem dinosaur bone he cut, contemplating how to incorporate it in the knife handle. Photo by Robert Weldon; courtesy of Loren Feldman.

ure 10). Of all the materials he uses, he gets the most excited about gem dinosaur bone because it's so scarce and highly coveted (figure 11). Feldman also makes his handles from rare gems and minerals from all over the world, such as charoite from Siberia, Ammolite from Alberta, green jade from British Columbia, black jade from Western Australia, dumortierite from Mozambique, lapis lazuli from Afghanistan, labradorite from Madagascar, and agate from Northern Mexico.

Equally impressive are Feldman's blades. Made of fine American Damascus steel, the blades are one of three types: carbon, stainless steel, or mosaic. Feldman also crafts blades from iron meteorites that fell to the earth millions of years ago (figure 12). Feldman noted that while rare and expensive, meteorite has been used to make knives throughout history, adding that at least one meteorite blade was found in King Tut's tomb.

Feldman purchases some of the material he uses but also does his own exploration and digging. Each summer, he visits a friend's ranch in Montana to dig for dinosaur bone, and any bone recovered is sent to a lab for identification. He recently found enough *T. rex* bone to make a knife. Feldman noted that he's never seen another knife maker incorporate *T. rex* bone.

Each knife comes with a sheath made of premium leather or exotic skin such as alligator, snake, or elephant—"all legally obtained," Feldman said. About half of Feldman's customers also purchase stands, which are crafted with the same rare materials, including dinosaur bone, woolly mammoth tusk, and fine gemstones, and are often chosen to coordinate with the materials in the knife.

When asked what he enjoys most about his business, Feldman revealed that his favorite part is attending the shows and talking with customers. "Doing these events and meeting the collectors, the hunters, the scientists, museum curators, and the professors. I love learning more about the products I sell. Just about everything that I share with my customers, I learned here at this very show."

Figure 12. A finished six-inch knife featuring a meteorite blade and gem dinosaur bone handle. Photo by Robert Weldon; courtesy of Loren Feldman.

For Feldman, business is better than ever. The pandemic has increased the demand for his handmade creations. He explained that customers have been treating themselves during a time when they've been deprived of so much. His clientele, which includes collectors, investors, ranchers, hunters, and culinary artists, has kept him busy for the past two years.

Erica Zaidman
GIA, Carlsbad

Social media success for Black Opal Direct. At the GJX show, Justin Thomas (New South Wales, Australia) told us about Black Opal Direct's success on social media during the pandemic, his efforts to share opal knowledge, and a black opal with a special story. Founded in 1961 by Thomas's father, Jurgen, and owned and operated by Thomas and his wife, Ruth, Black Opal Direct specializes in black opal from Lightning Ridge.

Thomas said most of their customers come from YouTube and Instagram. In the last three years, their YouTube subscriber count has increased from 30,000 to 170,000. He said views fluctuate between 500,000 and 3 million a month, averaging about a million. This led to a tripling of sales over the last two years, though their business has now returned to normal. "It was a dream run," Thomas said. "I believe those days are over." He acknowledged that they have been fortunate in a time when many businesses around the world failed due to the pandemic. Without YouTube, he said, they would have weathered the last two years but would not be doing nearly as well.

Black Opal Direct began selling on eBay more than a decade ago. They determined that a million people per month were searching the Internet for the word "opal." Within a few months of starting to sell rough on eBay, sales were strong; then they built their website and brought their eBay customers to it. Thomas created a YouTube channel (figure 13) around the same time as the eBay store, but it was only three years ago that he started posting videos more frequently.

"As the channel grew, it started to morph into more entertainment videos, showing them how fun it is to cut an opal, and my funny side, so they can see my personality," he said. "I think in social media you have to show a lot more and a little bit of vulnerability. If you can connect in that way, in the heartstrings way, people will trust you a lot more and are much more likely to buy from you."

Thomas believes his videos are helping the whole industry because he does not push sales. "I don't even give the link to my website very often," he said. "It's all about the love of opal, how to cut it, how to mine it. It also helps the world understand opal."

According to Thomas, the opal industry is very secretive, and he is probably the first person to share so openly through social media how to cut opal. He said many had thanked him at the show, saying they learned how to cut opal from his videos and in some cases quit their jobs to go into the opal business. "I think it's awesome to be able to share that abundance," he said.

Thomas learned to cut opal from his father, who moved to Australia from East Germany in the '60s and began mining in Lightning Ridge. Jurgen Thomas's tools included a pick, shovel, and candle. When he began cutting, he used a manual Singer sewing machine that he converted by adding a corundum grinding wheel. "He's passed away now, and all that knowledge is only with me," Justin Thomas said. Despite the positive response of those learning from his videos, he said, many cutters are unhappy because he's giving away prized secrets. "That knowledge—if that's gone with my dad, and it goes with me, and my son never takes it up, it's wasted," he said. "Why let it go?"

Thomas emphasizes the quality of social media followers over the number. "Even if you've got a hundred followers, they could be a hundred genuine followers because they genuinely like you," he said. "Say up to five percent of those people may buy. You grow from that."

When Thomas cuts a highly valuable opal from rough on camera, he often does a dance. "They love it," he said. "There's always a comment before they watch a video: 'I

Figure 13. Black Opal Direct's YouTube channel helped dramatically increase sales during the last two years.

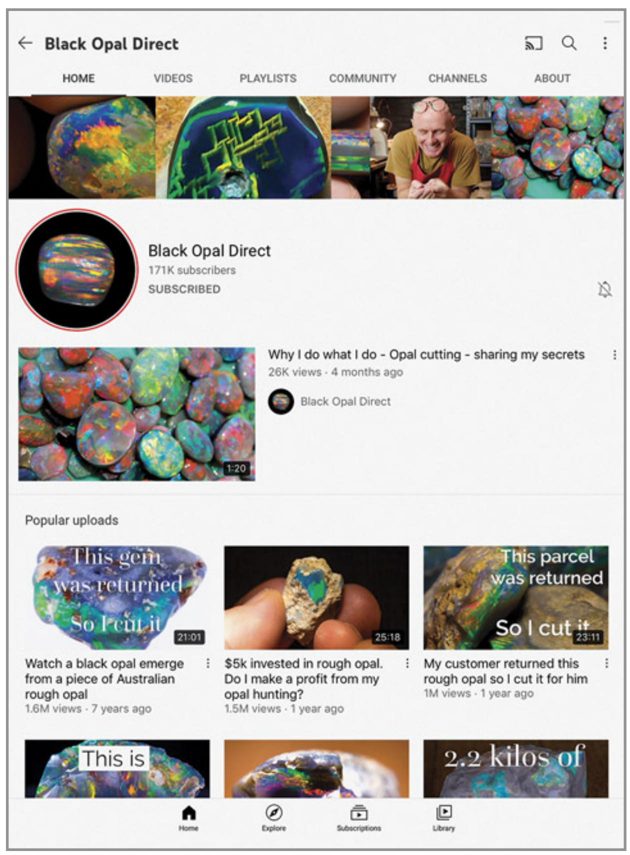


Figure 14. A 10.65 ct black opal found in Lightning Ridge by one of Jurgen Thomas's friends, at a location almost directly under where Jurgen lived nearly 60 years ago. Shown in diffused (left) and direct (right) lighting. Photos by Robert Weldon; courtesy of Black Opal Direct.

hope this one gets a dance!'" He has also been testing TikTok. "I always make jokes so they can see that I'm human, I'm personable, I can make an idiot of myself. I thought TikTok could be a good place for me to concentrate on those parts of my videos. I had a lot of followers quickly, who want to see me dancing."

Some competitors have tried to copy him—unsuccessfully, according to Thomas, because "their heart's not in it." Some also criticize his style. "I get lots of people saying 'You're an idiot' or 'You're a clown' or 'Why are you dancing?' Water off a duck's back. I try to focus on all the people that love me."

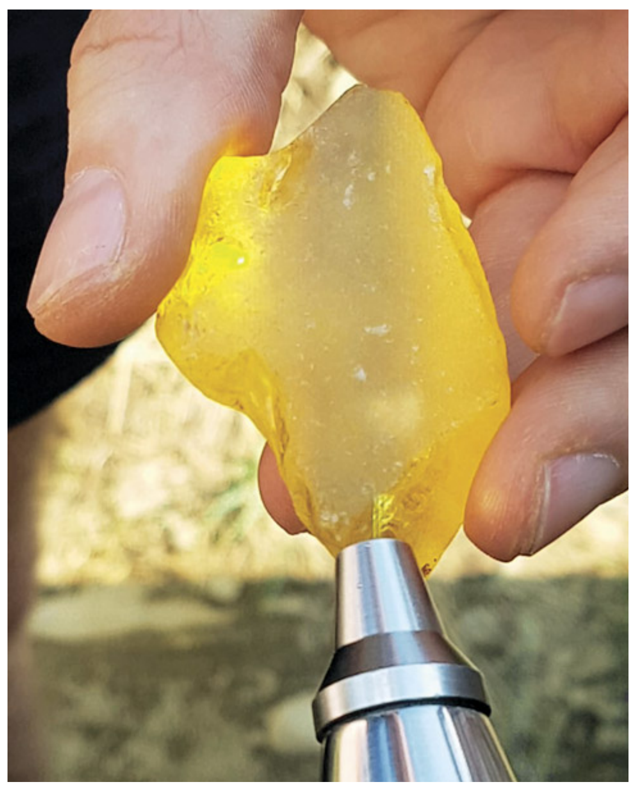
After years of working out of their home, the Thomases recently purchased a warehouse and built a cutting workshop there. Thomas said their subscribers have loved watching the small business grow. "I love this industry so much and I love what I do so much that it's addictive," he said. "Giving more and more to the subscribers and to my followers, going to the next level. So watch this space."

Thomas showed us a 10.65 ct black opal (figure 14), which he calls "the ultimate black opal." Its vivid colors, patterns, and strong play-of-color make it extraordinary. One of his father's friends, who mined with him at Lightning Ridge in the '60s, brought it to Thomas two years ago after finding it almost directly under the shed his father lived in back then.

Erin Hogarth
GIA, Carlsbad

Spectacular yellow sapphire from Sri Lanka. A return to the Tucson shows meant the opportunity to see the latest findings and designs from the Kreis family—stunning yellow sapphire from Sri Lanka. As *G&G* has reported in previous Tucson reports from 2014, 2015, and 2017, father Stefan buys the rough, mother Sonja designs the jewelry, and Alexander cuts the gems for the family business (Kreis Jewellery GmbH, Niederworresbach, Germany). Locating the sapphire rough in Sri Lanka required a combination of planning and luck, relying on the family's previously established network while also acting on rumors of possible sources. Two successful trips in 2020 and 2021 yielded five exceptionally large rough stones from five different deposits in the area surrounding Ratnapura, Sri Lanka (figure 15).

Figure 15. This 160 ct yellow sapphire rough was found in a deposit outside of Ratnapura, Sri Lanka. Photo courtesy of Kreis Jewellery GmbH.



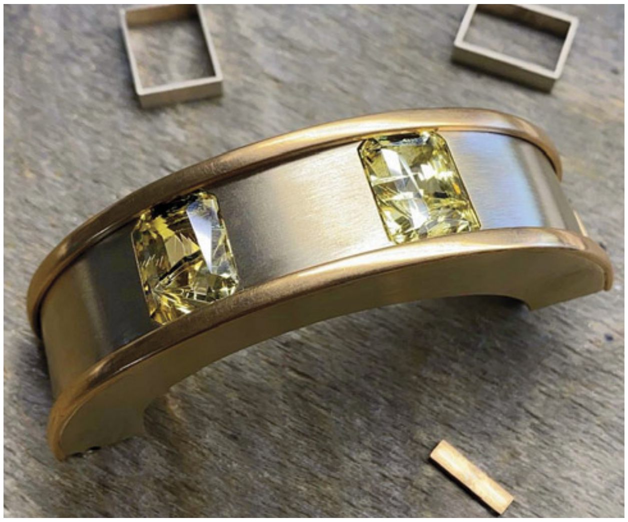


Figure 16. The yellow sapphires faceted by Alexander Kreis were set in a bracelet designed by Sonia Kreis. Photo courtesy of Kreis Jewellery GmbH.

Back in Germany, Alexander cut the five rough stones, and Sonja designed an exquisite bracelet (figures 16 and 17) to complete a suite of jewelry for a private collector. (Her previously designed pieces included a pendant, brooch, ring, necklace, and earrings.) The family aimed to create a harmony between the gems and the materials used, concentrating on gold colors that would not overshadow the sapphires. Alexander opted for a traditional cut for the outer shape but faceted the back to allow for more cross-reflection, mimicking this faceting in the diamonds that appear on the side of the bracelet. The creative combination of faceting and design perfectly captures the sunlight, creating magnificent reflections for the admirer. With an impressive total weight of 168.27 carats (containing 50.33, 32.80, 33.70, 23.98, and 27.46 ct sapphires), the bracelet is truly a breathtaking sight.

Erica Zaidman

Figure 17. The stunning finished bracelet features five yellow sapphires from Sri Lanka with a total weight of 168.27 carats. Photo courtesy of Kreis Jewellery GmbH.

Gray "spinel sisters." At the AGTA show, 100% Natural Ltd. (New York) took center stage with some large, extremely rare gemstones spared of treatments of any kind. Two stones that caught the authors' attention were a pair of exceptionally cut and nearly loupe-clean gray spinels weighing 69.96 ct (figure 18) and 11.78 ct (figure 19). There has been an increase in demand for gray spinel the past few years (Spring 2019 GNI, p. 130). Supply has remained relatively consistent, but larger, fine-quality stones are still quite rare.

Both of the gray spinels were cut from the same rough, weighing just over 220 ct and mined in Myanmar. Though famed for its rubies, Myanmar also produces equally fine red and pink spinel, as well as a range of other colors, including gray.

Master lapidarist and AGTA Spectrum Award winner David Nassi of 100% Natural Ltd. explained that gray spinel can appear lifeless and overly dark if cut poorly. His decision to create two "spinel sisters" from the same rough resulted

Figure 18. David Nassi's 69.96 ct antique cushion-cut, loupe-clean gray spinel. Prized in the trade for its metallic-like sheen, gray spinel of this size, quality, and color is extremely rare. Photo by Robert Weldon.

Figure 19. The finest gray spinel is a pure neutral gray, without a blue or violet secondary color component, as exemplified by this 11.78 ct antique pear shape expertly cut by David Nassi. Photo by Robert Weldon.

from a fissure running through the large piece of rough (figure 20). The 11.78 ct stone provided more of a challenge, as the shape of the rough piece was a bit flat and asymmetrical when sawn from the larger stone. Inspired by a large Mozambique stone he cut many years ago, Nassi expertly fashioned this piece into an antique pear shape, perfectly complementing the larger 69.96 ct antique cushion cut (to watch video of the "sister spinels," visit www.gia.edu/gems-gemology/spring-2022-gemnews-gray-spinel-sisters).

Nassi and the authors agree that gray spinel has been an underappreciated treasure in the trade for a while now. Its presence at the AGTA show gives us hope that gray spinel is gaining the popularity it deserves.

Lisa Kennedy and Tao Hsu

Michael Traurig: An opal dealer's battle with COVID-19. At the AGTA show, Michael Traurig (Jayson Traurig Bros. of Australia—Phoenix, Arizona, and Sydney, Australia) told us about his hospitalization for COVID-19 in Phoenix beginning in June 2020. "I went into shutdown," he said. "Heart, lungs, kidneys. I was on dialysis. I was on a respirator. I became diabetic."

Doctors put him on a life-support machine that acts as the heart and lungs outside the body. He said that up until that time, few people in the world with COVID-19 had survived the procedure. He was taken off and put back on the machine several times and visited by top doctors in the Phoenix area. "The ICU nurses called me magic because they put you on the machine to die basically," he said. After 30 days, he was sent to a rehab facility in order to free the hospital bed. "I coded one more time in rehab and they jumpstarted me," he said. "A few days later, everything started working again." Today he is no longer diabetic.

At a second Phoenix hospital, where Traurig underwent surgery to remove the dialysis tubes, the staff had heard his story. "The head OR nurse looked at me and said, 'Oh, you're the one.' I was the hope shot for the nursing staff because nobody else had lived through it."

Traurig went home in September, more than two months after he was admitted. He had lost 70 pounds. "I couldn't stand up," he said. "I was jelly. I had to learn to walk. So I got a dog. And she walked me every day, twice a day."

"It's worth sharing my story if I can get even one person to put on a mask," he said.

Before contracting COVID-19, Traurig had a successful show in February 2020. But a month later, 85% of the sales hadn't been paid for, and he got the stock back. "Because everybody's business shut down," he said. He had used most of his funds to buy stock for Tucson because his business had changed in recent years due to changes in the industry and in the company. "I ended up mostly broke," he said.

After his hospital stay, people began calling him and finding out what had happened. "They started throwing me a few bones," he said. "And I started getting some business. They've been kind." When he made his first purchase in months, a large batch of loose opals from a supplier in

Figure 20. The large rough gray spinel before (left) and after being sawn (right) because of a fissure in the rough. Not pictured is an additional small chipped-off piece weighing 3.32 ct, leaving open the possibility of a future third spinel sister. Photos courtesy of David Nassi.

Figure 21. A selection of opals at Jayson Traurig Bros. of Australia's booth at the AGTA show. Photo by Erin Hogarth.

Australia, they let him pay it off over time. "There's never credit given normally when you buy opals," he said. They sent him more shortly before this year's show. He had several displays of opal at the booth (figure 21) but said he had not yet been able to buy enough stock to make a living. "But it's okay," he said. "You realize who the friends are."

Figure 22. Cover of the Summer 1988 issue of G&G *featuring the 26 ct "Jason" boulder opal, which has since been sold. Photo © Harold & Erica Van Pelt; opal courtesy of Jayson Traurig Bros. Pty. Ltd.*

Traurig's father, John, and uncle, Tom, began working in the opal business in 1969. Jayson Traurig Bros. was the only non–North American member when AGTA was founded in 1981, the same year Michael bought into the business (Jayson = J's son). In 1988, one of their boulder opals—which was later sold—was featured on the cover of *G&G*'s Summer issue (figure 22).

Traurig and his father are both red-green colorblind. He said they had both learned to compensate and that lighting makes a difference. During GIA's Gem Identification course in the '70s, John was given permission to ask what color a stone was because he couldn't identify alexandrite's color change. "I remember him coming home and laughing," Traurig said. "During the exam he never asked the question. He said, 'If I had to ask, I knew it was alexandrite.'"

Traurig spoke about how the opal business and his business have changed in the last 20 years. More dealers have joined the industry, and older miners have stopped mining. He noted that there are far fewer mining concerns today. In the '80s and '90s, they used to have three people to work the booth. "There were people who were trying to always be next to us because of the overflow. We were the draw. We stopped being the draw. It's okay."

Traurig also visited Tucson last April. "It was my tour of 'I'm alive, I'm here, and I can walk,'" he said. "People were really welcoming and wonderful."

Erin Hogarth

Conversation with True Blue Opals and Gems. At the AGTA show, we spoke with Natassa Patel, who along with her mother, Salma, owns and operates True Blue Opals and Gems (Tucson and Gold Coast, Queensland, Australia). While they typically specialize in black opal from Lightning Ridge (figure 23), the closure of Australia's state bor-

Figure 23. A 13.12 ct black opal from Lightning Ridge, 19.7 × 14.4 × 7 mm. Photo by Robert Weldon; courtesy of True Blue Opals and Gems Inc.

Figure 24. A Yowah boulder opal or "Yowah nut" weighing 312.6 ct and measuring 74.6 × 67.3 × 22.6 mm (detail on the right). Photo by Robert Weldon; courtesy of True Blue Opals and Gems Inc.

ders during the pandemic prevented them from traveling there. Canceled trade shows and the inability to see clients face-to-face also limited business, but their online sales increased and they began sourcing from Queensland's Yowah and Koroit boulder opal fields. The majority of the stones at the booth were Yowah and Koroit boulder opal, with only one showcase of black opal.

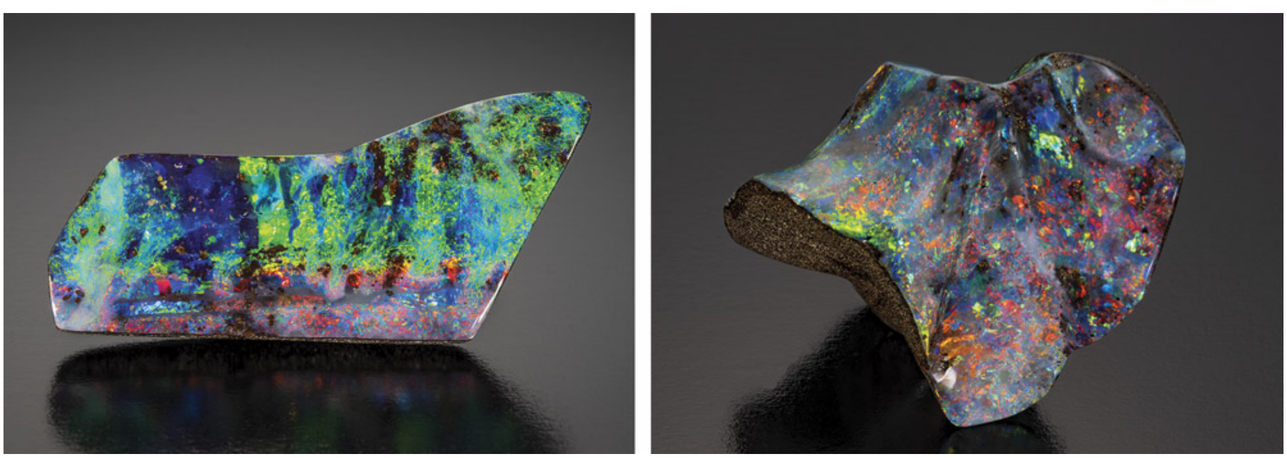
"Circumstance made us specialize in Yowah and Koroit," Natassa said. "I think my mom has taught me that, to make the opportunity. We could have just left it at home because everybody's chasing black opal, but we didn't. We believe in it."

According to Natassa, buyers don't want "generic" stones anymore, and opal is "very non-generic." She said boulder opal (figures 24 and 25) is "like a bouquet of flowers" with its immense variety of colors and patterns. "I think it appeals to the uniqueness we all want to feel, with our imaginations running wild in trying to see landscapes and faces and paintings that are so prevalent in the patterns of boulder opals," she said.

Natassa said that despite the common belief that anticipating customer demand is the way to success, it's important to her and her mother "to stay true to ourselves and sell what we like." She added that if you focus on persuading people by sharing knowledge rather than on trends, you can create a trend. "I like to pave the road. I don't like to follow: I want to go first."

When True Blue began exhibiting in Tucson in the early 2000s, they often had to educate customers on black opal. Natassa estimated that the number of opal dealers at the

Figure 25. Boulder opals: "Rainbow Jungle" (left), 73.53 ct and 52 × 25 × 7 mm, and "Red Lantern" (right), 188 ct and 54.8 × 41.4 × 22.0 mm. Photos by Robert Weldon; courtesy of True Blue Opals and Gems Inc.



Tucson shows has increased perhaps tenfold since, which has increased customer understanding of the gem. Boulder opal has become more popular, but they still have to inform people about Yowah and Koroit boulder opal.

"No matter if we sell one stone or a hundred stones, the focus, for me, should still be the same," Natassa said. "To bring something new, to educate people. What's the point of doing all this, if people still misunderstand opal or they don't see the value in it?"

Natassa noted that while many more designers use opal now, customers are still coming to terms with pricing. She attributes this to a lack of understanding of opal mining: The cost of opal is difficult to standardize because there are too many variables in its mining. "If you find one pocket in five years, and you've spent half a million dollars in mining, then that parcel is half a million plus," she said. "And sometimes there's a drought—no water to wash the dirt to see if there's opal trace."

True Blue celebrated their 20th anniversary last year, but Salma's passion for opal goes back further. After the Patels moved from Vanuatu to the Gold Coast in 1988, Salma was free to wander the shops while Natassa and her siblings were in school. She became fascinated with the black opals that were so different from the familiar gold and diamonds. After learning they were from Lightning Ridge, she traveled there with an opal dealer friend in the early 1990s. "I think it's something that she was called to," Natassa said. "I think what happened to her was what happened to me."

In 1995, Salma bought a small store on the Gold Coast, initially focusing on small parcels. Natassa helped her mother on nights and weekends while attending university, although she wasn't interested in gemstones at first. "I'm assertive, but I'm not aggressive," she said. "I didn't know how to push them."

Salma's first visit to Tucson was in 1995, and a few years later she exhibited at the Globex Gem and Mineral Show (now held at the Red Lion Inn). In 2002, after Natassa finished her master's degree, she went to live with family in New Jersey and look for a job in finance. Salma asked her to help at that year's show, but Natassa was still reluctant about selling. Salma promised she only had to stand behind the booth and rely on set prices. Natassa made a good salary based on commission over the two-week show. "It took her a while, but she convinced me to join the business," she said.

Soon Natassa started going to the opal fields with Salma and doing the smaller trade shows in Tucson. "I'm a good listener, I think," Natassa said. "And I believe I'm a good observer. So I learned quickly. It just kind of started rolling off my tongue eventually."

Since then, Natassa has only missed the Tucson shows twice, once while completing the Accredited Gemologist program at the Asian Institute of Gemological Sciences (AIGS) in Bangkok. "I felt that opals weren't in the mainstream," she said. "There was so much misinformation." She wanted to be able to explain opal in gemology terms "because it's this mysterious stone to most people." She found she loved gemology and being in the lab. "I love the microscope," she said. "It's pretty cool to see opals under microscopes."

True Blue's first AGTA show was in Las Vegas in 2005. Natassa got a call on opening day offering them the booth of an exhibitor who hadn't showed. "Back then we didn't have any money," she said. "We used to put stuff on credit cards." The cost of the booth was $7,000—the cost of the entire trip. "I'm thinking, how are we going to do these two booths? Is there enough stock to spread around? Plus seven grand. Plus it's already opening. Then we said okay—we'll just do it." Their first big sale that day wasn't an opal but a giant clam (*Tridacna gigas*) pearl they'd bought a few days prior, for which another exhibitor paid $10,000 cash. "So we covered our booth," Natassa said.

"We're blessed, because there have been difficult times for us personally and financially over the last 28 years," Natassa said. "For my mum, even more so because she was on her own before me. All these things I've learned from her, day in, day out."

Natassa recalled that in the early years some customers, expecting a male dealer, would ask where the owner was. "They just assumed that we weren't. A client would say, 'Go ask your boss if I can get a better deal on this.' I'd say, 'Well, I am the boss, and this is the price.' It's easier now."

Natassa and Salma try to find niches in the local market, such as opal beads (figure 26), which they began selling in the late 2000s. The beads use the precious part of the opal as well as the potch. "The really dark potch is jet black," Natassa said. "If you can wear a black spinel strand, you can wear a potch opal strand."

Natassa revealed that she never intended to stay in the opal business this long. "But I think it's God's plan for me," she said. "I don't think I could do anything else." She hopes

Figure 26. Faceted beads of black opal from Lightning Ridge totaling 45.15 carats. Each bead is 4 × 4 × 3 mm. Courtesy of True Blue Opals and Gems Inc.

Figure 27. Salma and Natassa Patel of True Blue Opals and Gems at their AGTA show booth. Photo by Erin Hogarth.

someone in the family will take over and operate True Blue when she and her mother no longer can.

The Patels (figure 27) have been discussing what to do when they return to Australia. They have considered splitting their stock fifty-fifty between black and boulder opal. "Black will always be king of all opal," Natassa said. "That's our favorite. We grew up on black opal, so we can't help ourselves."

Erin Hogarth

Washington Jade update. At the AGTA show, Rod and Nathaniel Cook of Washington Jade (Edmonds, Washington) told us about shifting their focus to cat's-eye blue and bluish green nephrite jade (figure 28). (We first spoke with them in 2019—see Spring 2019 GNI, pp. 124–125.) They initially intended to concentrate on the mid-tier jewelry market, but the non-chatoyant nephrite was not valuable enough to be cost-effective. About two years ago, they saw that two small pieces of chatoyant nephrite were drawing the most attention. This year, they cut 100 chatoyant stones from rough.

"It was a matter of finding something unique to our deposit that was a high enough grade of material that it would have broad market appeal," Nathaniel said. "People seem to really like not necessarily the really sharp eyes, but the really strong eyes, even if it's sort of a broad eye that moves across the stone. They're very charismatic and sort of bold."

Rod said they find better material each year. "The blue sort of validated the whole operation," he said. "We have pretty good demand emerging for the rough. Partially because around the world, supplies are down. We hear rumors that Siberia is not producing like it used to, that the surface material is pretty much gone—and going underground is to be avoided." The host material is also selling very well for high-end lapidary work.

Nathaniel has been cutting the rough since 2019. Orienting it for cutting can be tricky, he said, but understanding how it forms has shown him how to orient and process it. He first locates the line between the two dark sides of the nephrite (the directions where the eye moves back and forth), which he calls the "axis of chatoyance." Then he starts slabbing the stone parallel to this axis. Some adjustment is required within the slabs to ensure correct orientation of the finished stone. To cut cabochons, he pays attention to the direction of the cat's-eye and cuts calibrated sizes and shapes either parallel or perpendicular to that alignment.

Nathaniel explained that the material requires slightly different tools than most lapidaries use because of its variable hardness: The ends of the axis of chatoyance are very hard, but around it is much softer. After some trial and error, he began using inflatable sanding drums for much of the shaping process because they are gentler.

Processing the material also informs how they harvest it with their low-impact mining methods. "Nathaniel is integrating all the way from harvesting to finished stones," Rod said. "With that information, we can go up there and selectively harvest. It's like noninvasive surgery. We can essentially find the critical stuff."

According to Rod, many carvers are accustomed to materials like quartz, which is very hard and uniform in all di-

Figure 28. A chatoyant bluish green nephrite ring: 3.14 ct marquise cabochon (10.92 × 7.65 mm), 0.1 carats of round diamonds, and 14K yellow gold. Photo courtesy of Washington Jade.

rections. He said educating the market on chatoyant nephrite will take a few years. "We've realized in this industry it's not something you can throw money at and make it happen. It's pretty much listening to customer wants."

Rod showed us a piece of rough with a striking banded chatoyant pattern that resembles New Zealand's rarest, most prized jade. The New Zealand material has cultural significance and is often called *pīpīwharauroa* jade because its pattern is reminiscent of the breast feathers of the pīpīwharauroa (shining bronze cuckoo) bird. The claim contains a lot of the material, but they have not yet processed much of it. So far most of what they have found is unstable due to fractures, but they are looking into stabilization and may still find larger quantities of stable material. Rod expects to have more at next year's show.

"Our strategy is organic growth over the next few years using AGTA as the high end, and it appears that's enough to get people showing up and buying rough," he said. "So stay tuned."

[Editor's note: The term "cat's-eye jade" is a trade term and a misnomer. Although this material falls within the mineral series that constitutes nephrite jade, nephrite is characterized by its fibrous, interlocking felted structure, which gives it the toughness that is so important to jade. The cat's-eye material is made up of parallel fibers, which is why it has an eye. However, this structure does not possess the toughness required for a jade. The GIA laboratory would refer to this material as "cat's-eye actinolite."]

Erin Hogarth

Figure 29. This specimen of wavellite in matrix shows the mineral's characteristic radiating pattern. Photo by GIA.

Many faces of wavellite. A well-known collector mineral, wavellite ($Al_3(PO_4)_2(OH)_3 \cdot 5H_2O$), is named after its discoverer, British surgeon Dr. William Wavell. Wavellite mineral specimens seen on the market often occur as botryoidal aggregates. The crystal clusters are usually spherical in appearance. When the spheres are broken open, the cross sections show their signature radiating pattern formed by acicular-shaped crystals (figure 29).

Wavellite is not a gem material renowned for its brilliance or breathtaking colors, but its unique appearance does trigger curiosity and creativity. At the AGTA show, James Carpenter of Unconventional Lapidarist (Hot Springs, Arkansas) showed the authors a variety of wavellite cabochons and slabs and shared how he stabilizes the material for jewelry use.

All wavellite carried by Unconventional Lapidarist is sourced from Arkansas, one of the well-known sources for this gem. When used in jewelry, wavellite must be stabilized (figure 30) to make the piece durable. This is due to both the relatively low hardness of the material (3.5–4) and

Figure 30. Left to right: Wavellite rough before treatment, stabilized rough, a slab of stabilized rough with all the waste host rock trimmed off, and two pieces of polished stabilized wavellite cabochons (89 and 405 ct, respectively). Photo by Tao Hsu; courtesy of Unconventional Lapidarist.

Figure 31. This wavellite cabochon is of high quality. Some of the spheres were sliced open to show the radiating pattern, while others were left untouched. Wrapped in gold-plated wires, the cabochon weighs 150 ct, with a blue apatite mounted at the top. Photo by Tao Hsu; courtesy of Unconventional Lapidarist.

its occurrence in the host rock. Arkansas wavellite formed in veins cementing together brecciated sandstone/chert host rock. Therefore, the majority of wavellite specimens occur as very thin slabs or small spherical bodies.

Carpenter noted that 99% of the production needs stabilization for the materials to withstand further processing. He developed his own resin for this stabilization process. This resin is hydrophobic, meaning it is water resistant, and environmentally and biologically friendly. The material is impregnated with this resin in a vacuum under very high pressure and then cured and sliced. Slicing helps reveal where the wavellite is embedded in the host rock. Host rock that bears no wavellite is trimmed off before further polishing. Restabilization is sometimes necessary, especially when cabochons are to be made, to ensure the finished product is durable when set in jewelry. The yield of this process is only about 15%, with 85% waste.

Stabilized wavellite can then be polished to cabochons (figure 31) and mounted in jewelry, with high-quality material revealing an attractive botryoidal structure of rounded segments and/or radiating patterns with beautiful colors. The slab can also be utilized without much polishing (figure 32, left). The latter option works perfectly for stones showing the botryoidal exterior. When one turns this type of cabochon on its side, some of the broken spheres clearly show the radiating pattern, adding appeal to the jewelry piece (figure 32, right). Wavellite can be collected as mineral specimens or used as decor and jewelry material.

Tao Hsu and Lisa Kennedy

CUTS AND CUTTING

Stephen M. Avery: Celebrating half a century in gem cutting. Approaching his 50th anniversary in the business, Stephen M. Avery (Lakewood, Colorado) reflected on his journey to becoming an award-winning lapidary artist, detailing his signature cuts and gem sets and offering advice to up-and-coming gemstone cutters. Since starting his career at the age of 17, Avery has accumulated a remarkable amount of cutting experience. But even after all this time, the part he enjoys most is continuing to find new challenges.

Figure 32. Left: This piece of wavellite slab kept the original look of the rock with its botryoidal habit. Right: The view from the side reveals the radiating pattern on the cross sections of sliced-open spheres. Photos by Tao Hsu; courtesy of Unconventional Lapidarist.

Figure 33. With names like "Flaming Comet" and "It's a Zoisite Party," Avery's gem sets have enchanted for decades. This three-piece set consists of a 6.22 ct golden tourmaline flanked by two aquamarines, 5.14 carats total. Photo by Sara Rey; courtesy of Stephen M. Avery.

Figure 34. When skill and experimentation combine, something as brilliant as Avery's signature Triopp cut is born. This stunning example is a 9.79 ct chrome tourmaline measuring 14.5 mm. Photo by Sara Rey; courtesy of Stephen M. Avery.

Avery was not born into the business and began his career by enrolling in the American School of Diamond Cutting. He learned the foundations of diamond cutting from the prestigious diamond cutter Leonard Ludel. A few years later, he found himself working for Stradley Lapidary in Colorado, where he made the instinctual move from diamonds to colored stones. He describes this as a moment of clarity, as he was bored with the lack of creativity in cutting standard round brilliant diamonds. Avery noted that at the beginning of his career in the late 1970s, he was "bringing something unknown to the colored stones business: diamond cutting quality to colored gemstones."

Avery started to create gem sets—suites of intricately cut gemstones that fit perfectly together (figure 33)—about 40 years ago. He describes them as something that started experimentally and has exploded in popularity. When it comes to creating his gem sets and sourcing the right stones, he has learned that patience pays off. He explained that some colors will negatively impact other colors, and some colors when paired will read neutral. The most gratifying outcome occurs when all the gemstones used look better when they're together.

Throughout his career, Avery has fashioned numerous signature cuts. His very first signature cut was a Portuguese-cut trilliant, which took three years to design. Another early signature cut was the Triopp cut (figure 34), a triangular cut born out of anger when the perfect trillion preform had an inclusion in the corner. He ground it out, only to discover a completely new concept in faceting. He then went on to create the OVOB cut, an oval opposed bar cut, and most recently the Diamondback, a recreation of the checkerboard cut to fit elongated pieces of gem rough (figure 35).

His exquisite attention to detail and understanding of color and light enable Avery to cut award-winning, one-of-a-kind faceted gemstones. The majority of his pieces require designers to create custom settings. He has relationships with several skillful designers who allow him to share his

Figure 35. Avery's Diamondback cut is a blessing to stones longer than 50 mm. This 73.22 ct tourmaline measures 11.1 × 79.3 mm. Photo by Sara Rey; courtesy of Stephen M. Avery.

Figure 36. 2019 AGTA Spectrum Award–winning earrings designed by Adam Neeley with a pair of indicolite tourmalines cut by Stephen Avery, weighing 41.45 carats total. Other stones are tsavorite garnets (3.34 carats total) and diamonds (2.42 carats total) set in purple titanium, 14K white gold, and green VeraGold. Photo by Sara Rey; courtesy of Stephen M. Avery.

vision for the piece and then take it from there. His talent, in combination with the talent of these designers, has earned him many "Best Of" titles in the AGTA Spectrum Awards. Avery cut a matching pair of Afghanistan indicolite tourmalines that were 2018 AGTA Cutting Edge Awards first-place winners in Pairs and Suites. The following year, those same tourmalines won yet again in the Spectrum Awards, in earrings designed by Adam Neeley (figure 36).

Avery shared his advice for emerging gem cutters: "Learn all the techniques, then challenge the rules. If you want to do something and you don't have the technique, you're going to have to invent it. And that's okay—it just hasn't been done because you didn't do it yet."

To see an interview with Avery, visit www.gia.edu/gems-gemology/spring-2022-gemnews-stephen-avery.

Lisa Kennedy and Tao Hsu

Skull carved of meteorite. At the AGTA show, Nature's Geometry (Tucson) had on display a life-sized skull carved of meteorite (figure 37). The skull, "Gaia," was a collaboration between Lee Downey of Artifactual Studios (Tucson and Bali, Indonesia) and Balinese artist Ida Bagus Alit. It was carved from two pieces of the Gibeon iron meteorite, which landed in prehistoric times after bursting into pieces upon coming through the atmosphere. Its fragments are scattered over a large area in Namibia. Based on radiometric dating, the meteorite is estimated to be around four billion years old. Long before Westerners documented it in the early 1800s, the Nama people used pieces of it as weapons and tools.

Downey and Alit worked on the carving from March 2015 to January 2020 in the workshop Downey shares with Ratu Pedanda Manuaba, a high priest of Bali. In Balinese culture, meteorites are seen as powerful, and meteorite iron is used to make traditional *keris* (daggers) for ceremonial use.

The Gibeon meteorite's makeup is about 90% iron and 8% nickel, with small amounts of cobalt and phosphorus. Downey said the material is somewhat soft and sticky. The critical aspects were maintaining the proportions and watching for potential imperfections in the material. "Cracks and pockets of odd space junk can pop up," he said. "Luckily Gaia was basically flawless. She was difficult but forgiving."

The work was done using hacksaws, steel grinders, and rotary carving setups. Protective gear was required when using cutting burrs because the tiny shards coming off the skull were "like little razor blades flying around." Based on models of the human skull, a sphere-shaped piece of the meteorite was carved for the upper cranium and a block for the jaw, which is articulated and removable. Roughly 159 lbs. (72 kg) of material were cut and ground away to form the 39 lb. (18 kg) skull. After carving, the skull was fully polished to a chrome-like finish.

The final step was etching with a weak acid to reveal the meteorite's fine octahedrite structure, visible in the pattern on the skull's surface. The pattern, known as a Widmanstätten pattern or Thomson structure, is composed of interwoven bands of kamacite and taenite (iron-nickel alloys) and develops over millions of years of very slow cooling. It is revealed only through cutting, polishing, and etching.

The brown line on top of the skull is an inclusion of tridymite, a silica polymorph. Tridymite is also found on Earth, the moon, and Mars, and in planet-forming disks of dust and gas around stars.

Downey has previously described the human skull as "undeniably sure to register emotions in all of us. It has all the fear of death, the reminder of being alive, and the possibility of something greater in store…out there in the mysterious beyond."

Figure 37. A skull carved from the Gibeon meteorite, which landed in Namibia in prehistoric times. The brown line is a tridymite inclusion. Exhibited by Nature's Geometry at the 2022 AGTA show in Tucson. Photo by Robert Weldon; courtesy of Lee Downey.

"The intense gravity of this extraterrestrial metal is itself a mystery of life," he said. "Four billion years old and counting, the long travel to arrive on Earth, the rare beauty of the crystal patterns that can only form in the vacuum of space. The symmetry of the entire tale is beyond human comprehension."

Erin Hogarth

Puzzle-like gemstone designs. At the AGTA show, Rare Earth Mining Co. (Trumbull, Connecticut) offered a vast array of fine and unusual gem materials unavailable anywhere else in the trade. Among the opalized wood, Tiffany stone, honeycomb petrified wood, and many other varieties was one of the most expansive Steve Walters collections seen at Tucson (figure 38).

While Walters himself did not attend the show this year, Rare Earth Mining Co. was eager to detail his work for us. A master gemstone carver specializing in one-of-a-kind gemstone designs in Utah, Walters has been in the business for more than 50 years. He creates his carvings for jewelry designers, to help them achieve a unique look.

Walters's designs feature a perfect mix of traditional and exotic gemstones, expertly paired and carved to create a dramatic shape and color story. All done by hand, Walters uses titanium to bridge together and inlay the different gemstones.

Among the wide variety of gemstones used in Walters's carvings were onyx; chrysocolla; tourmalinated and rutilated quartz; amethyst, citrine, and ametrine with striking color zones; rock crystal quartz backed with onyx and gold foil; lapis lazuli; various agates; Australian and pink opals;

Figure 38. Trays of Steve Walters's unique gemstone carvings displayed at the 2022 AGTA show in Tucson. Photo by Tao Hsu; courtesy of Rare Earth Mining Co.

Figure 39. Left: This citrine "flame" top is connected to a chrysoprase "main body." Next to the chrysoprase is a portion made of a black chalcedony backing, covered by 24K gold leaf and capped by rock crystal quartz. The piece is completed with a freeform ametrine. Right: All pieces have a mother-of-pearl backing with Steve Walters's signature. Photos by Kevin Schumacher.

and meteorite. Every piece is finished with a mother-of-pearl backing with his signature (figure 39), ready to be set into a showstopping piece of jewelry.

Lisa Kennedy and Tao Hsu

JEWELRY DESIGN

One-of-a-kind designs from Zoltan David. 2022 marks the 42nd year in the industry for iconic jewelry designer Zoltan David (figure 40). At the AGTA show, the authors had an opportunity to converse with David about his passion, career, and inspired jewelry creations.

Curiosity and the drive to create led David to his career in metalsmithing. For David, creativity can be furthered by an in-depth understanding of the materials and skillful maneuvers. While modern technology allows for efficient jewelry sketching and design, the lack of knowledge about metals—base or precious—limits the execution of a great design or even the creativity of the design itself. David's jewelry pieces reflect this philosophy. Each of his creations is a three-dimensional "architecture," which must be viewed from multiple directions to fully appreciate its beauty.

The "Time" pendant (figure 41) is David's most recent award-winning design. In 2020, this piece won second place in the Business/Day Wear category of the AGTA Spectrum Awards. This pendant features a 19.54 ct fantasy-cut citrine as the center stone, surrounded by eight suspended metal elements forming two circles. The metal elements are made of iridescent blue and purple steel with

Figure 40. Zoltan David working at the bench in his studio, located in his store in Austin, Texas. Photo by Patti David.

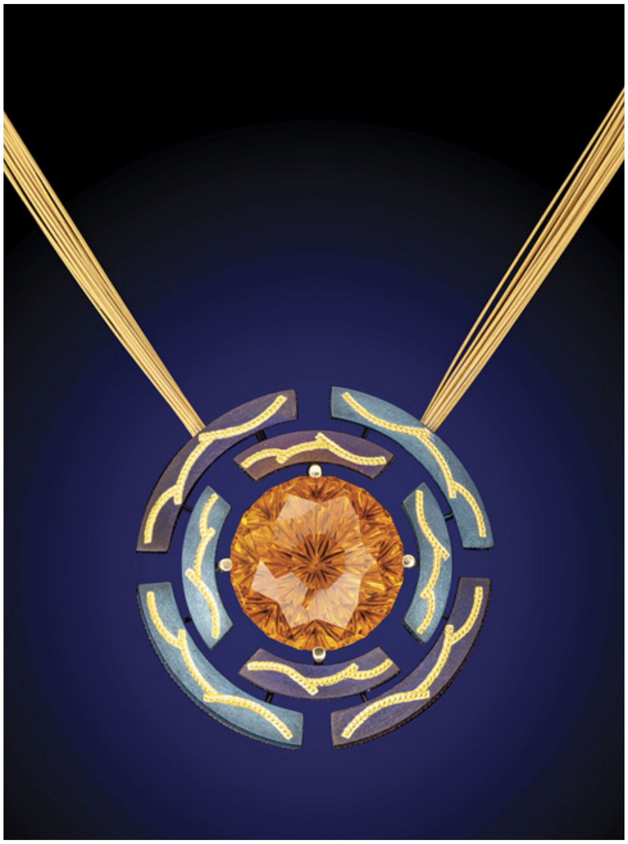


Figure 41. Exotic metals such as the iridescent blue and purple steel in the "Time" pendant are Zoltan David's signature. 24K gold inlay is also a Zoltan David distinction. This piece features a 19.54 ct citrine. Photo by Robert Weldon; courtesy of Zoltan David.

Figure 42. Zoltan David's "Mirror Mirror" pendant combines multiple innovative techniques and materials. The piece features platinum inlays in the mother-of-pearl surrounding the pink opal center stone, highly polished surgical steel as the base frame (left), a leaf wreath made of green gold wrapping around the outer edge of the whole piece, and diamonds mounted in the steel base (right). Photos by Robert Weldon; courtesy of Zoltan David.

24K textured yellow gold inlays, a signature patented technique invented by David. In addition, all these metal elements are suspended and well connected with each other. David wanted to create a sense of rotation with this design: All elements rotate around the center of the universe, trying to find the perfect balance.

More than four decades of knowledge building and practice have made David's jewelry pieces the perfect combination of metal art and architectural construction. The "Mirror Mirror" pendant (figure 42) represents the continuous exploration and technique refinement by the master designer. To fully understand this piece, one needs to carry out a jewelry "anatomy." Starting from the center of the pendant, an elongated oval pink opal is encased by a cut piece of mother-of-pearl, which was carved and inlaid with beaded pure platinum. The mother-of-pearl is surrounded by polished surgical steel and inlaid with 24K engraved and shaped rose gold. All of these elements are nestled in a framework of green gold leaves. From the side view, diamonds mounted in the surgical steel layer are exposed through the space between the green gold leaves (figure 42, right).

Although renowned for his metalsmithing, David is also drawn to spectacular colored stones. The "Ruby Flight" ring (figure 43), a piece from the Duchess collection, features a 2.45 ct Burmese ruby. The ruby is held by 18K gold prongs between two platinum wings inlaid with 24K gold. The engraved and shaped gold inlays form patterns on both sides of the wings. The interior walls of the wings are set with melee diamonds in between the gold inlays, while the exterior walls are set with melee rubies along the inlaid lines. More than 300 melee rubies also decorate the edges of the wings. The shank of the ring is also one of a kind, made up of three components: a melee diamond stud band sandwiched by the bottom of the two wings.

Figure 43. The "Ruby Flight" ring is representative of Zoltan David's stone selection and construction of a complex jewelry piece. Photo by Robert Weldon; courtesy of Zoltan David.

From the start, David has been an eager learner and has never stopped his exploration of the metalsmith profession. He is involved in all aspects of his business: designing, crafting, and trading each one of his creations. As David said, he would like to keep traveling along this journey by continuously surpassing himself.

To see interviews with David, visit www.gia.edu/gems-gemology/spring-2022-gemnews-zoltan-david.

Tao Hsu and Lisa Kennedy

Figure 44. An inrō *dating back to eighteenth-century Japan with gold* maki-e *and mother-of-pearl inlay. Courtesy of Getty Images.*

Old techniques reimagined: *Maki-e* pearls. At the AGTA show, Eliko Pearl (New York) exhibited a series of unusual cultured pearls, many of which were worked after culturing to create unique pieces of art. Among these, *maki-e* pearls caught the authors' attention.

Maki-e is an ancient Japanese lacquer technique that translates to "sprinkled picture" and is said to have originated more than 1,200 years ago. A fine brush is used to paint a design with lacquer, which is then sprinkled with gold powder before the lacquer dries. More lacquer may then be painted again over the design and polished. For centuries, the meticulous technique has been used to decorate screens, *inrō* (a type of small case worn in traditional Japanese culture; figure 44), Japanese letter boxes, and other vessels, and it has now been adapted for use on pearls.

A representative from Eliko Pearl explained that each pearl is decorated by hand using a combination of *urushi* lacquer and 24K gold powder overlay, with abalone shell inlay (figure 45). The natural lacquer is derived from the sap of the urushi tree, which is native to Japan, China, Vietnam, and Southeast Asia. Sap can be harvested from a single tree for 14 to 15 years, during which the tree only yields about 200 grams of material. The sap also goes through a lengthy treatment process before it can be used as a lacquer. After application, the urushi lacquer must cure in a high-humidity environment (70–90%) in a series of thin layers. The time-consuming and laborious process of harvesting, processing, and applying the lacquer on pearls makes urushi lacquer a costly material, but the finished maki-e pearl is a treasured piece of art.

Figure 45. A pair of Tahitian pearls decorated with 24K gold maki-e and abalone shell inlay (left). A single near-round Tahitian pearl, decorated by the same technique in a flower motif (right). Photos by Emily Lane; courtesy of Eliko Pearl.

The décor adorns Tahitian pearls predominantly and can be found on matching pairs as well as single pieces. Prices vary from piece to piece based on the detail of the design and the size and shape of the pearl, with the most expensive shape being round (figure 46).

Lisa Kennedy and Tao Hsu

Blue sapphire *Lord of the Rings* pendant. At the AGTA show, Jeffrey Bilgore of New York exhibited a sapphire, diamond, and platinum pendant (figure 47) inspired by *The Lord of the Rings*. From initial inspiration to delivery of the just-finished pendant midweek at the show, the piece was 15 years in the making.

"I read it in high school," Bilgore said of the beloved trilogy. "I read it again in college. Then I read it to my son when he was little, and when he was older he read it to me."

The 19.30 ct unheated light blue Sri Lankan sapphire briolette rotates within the platinum setting, accented by 177 round Flawless to VVS round brilliant diamonds (0.86 carats total). The pendant is modeled after the Phial (vial) of Galadriel, which the elf queen Lady Galadriel gives to hobbit Frodo Baggins for light and protection during his journey to Mordor. The vial contains water from her fountain, which holds the light and power of the elves' cherished star Eärendil.

"The Star of Eärendil is the North Star at night and the star you see in the dawn," Bilgore said. "It gives you hope in the darkness and brings you strength." He said the pendant

Figure 46. Trays of Tahitian maki-e pearls offered by Eliko Pearl at the 2022 AGTA show in Tucson. Available in a range of sizes in matching pairs and single pieces. Photo by Lisa Kennedy; courtesy of Eliko Pearl.

Figure 47. Platinum pendant with a 19.30 ct unheated light blue Sri Lankan sapphire briolette and 177 round brilliant diamonds, 0.86 carats total. Photo by Robert Weldon; courtesy of Jeffrey Bilgore.

"symbolizes all the good energies of hope and faith that add light to the world and protect those that it shines on."

The concept for the pendant came to Bilgore when he bought a diamond briolette in 2004, a year after establishing his own business. Prior to that, he spent 16 years as the primary gem buyer for Oscar Heyman. He began sketching the design but then sold the diamond. Over the next decade, he continued to refine the design. He eventually acquired a pair of light blue sapphires and began developing the piece with a jeweler about five months before the AGTA show.

"*The Lord of the Rings* is a story about our world, the power of faith, and good vs. evil," Bilgore said after the show. "Today, with all that is going on in Ukraine, it seems even more meaningful. The story shows how wars destroy everything and put groups against groups for no good reason. That only trust and faith in each other and in the positive powers of love and respect can conquer all." He added that the story—with its elves, dwarves, hobbits, and other beings—is also about diversity. "No matter your size, shape, color, or type, everyone has value and strengths."

"Others have attempted to replicate the Phial of Galadriel, but not quite like this," he said. "If you have anything going on in your life, put it around your neck and you'll be protected. You'll get through it."

Erin Hogarth

Figure 48. Sapphire ring designed by Rachel Chalchinsky: 5.18 ct heated mixed-cut pink sapphire (11.0 × 9.4 mm), 1.24 carats of diamonds, 0.36 carats of no-heat padparadscha sapphires, and 0.65 carats of orange sapphires, set in 18K rose gold. Photo by Robert Weldon; courtesy of Color Source Gems.

A pink sapphire ring with a message. At the AGTA show, Rachel Chalchinsky (Color Source Gems, New York) showed us a triple-halo ring (figure 48) designed to commemorate surviving breast cancer. "It's hard to live with it and go on," she said, "but once you do, you feel powerful." After her diagnosis in August 2018 and finishing chemotherapy in January 2019, she wanted to "replace" the tumor with "something good and positive."

Chalchinsky had three requirements for the center stone: that it be pink, for breast cancer awareness; the same size as the tumor (11 mm); and heated, to symbolize the radiation treatments she received in March 2019. After nearly three years of searching, she found a 5.18 ct heated mixed-cut pink sapphire measuring 11.0 × 9.4 mm.

"I used to have very big curly red hair, and I wanted to represent that in the ring," she said. "Now I have grayish hair. So I put orange sapphire around the outside. Then on the inside, I used white diamonds to represent gray hair. And on the side of the ring, I used the breast cancer ribbon. I had that graduated to fit on the sides of the band and set it all in rose gold."

When people admire the ring, Chalchinsky often tells them the story behind it "to bring awareness that people need to get their diagnostic tests and not wait." She noted that delaying or avoiding her annual mammogram and ultrasound could have resulted in a more serious prognosis. Chalchinsky said her story compels people to share their experiences with cancer. "It becomes almost like a bonding because we've all been through these emotional journeys."

Chalchinsky also uses Instagram to share the message. During Breast Cancer Awareness Month in October, she posts photos of pink stones, sometimes in pairs, asking people to get checked and make sure their loved ones do so as well. "I'll say, 'Ask your mom. Ask your loved ones. Nag them—take them by the hand to go with them.'"

Chalchinsky recognizes she is fortunate to have had excellent healthcare and supportive family and friends—and that many women undergo more invasive surgery or have a worse outcome. In 2021, Color Source Gems donated funds to White Plains Hospital in Westchester County, New York, to cover 10 mammograms for uninsured women.

"In Judaism they say that if you can rescue one person, you're saving the world," Chalchinsky said. "I really feel that is extremely important—that we all help each other."

Erin Hogarth

MARKETING

Market reaction to the pandemic: Insights from exhibitors. When COVID-19 evolved from a regional crisis to a global pandemic, the gem and jewelry trade abruptly paused for a short period and then gradually recovered to the pre-pandemic level. To investigate the trade's reaction, the impact on business, and market trends over the past two years, the authors took advantage of the Tucson show to survey the exhibitors.

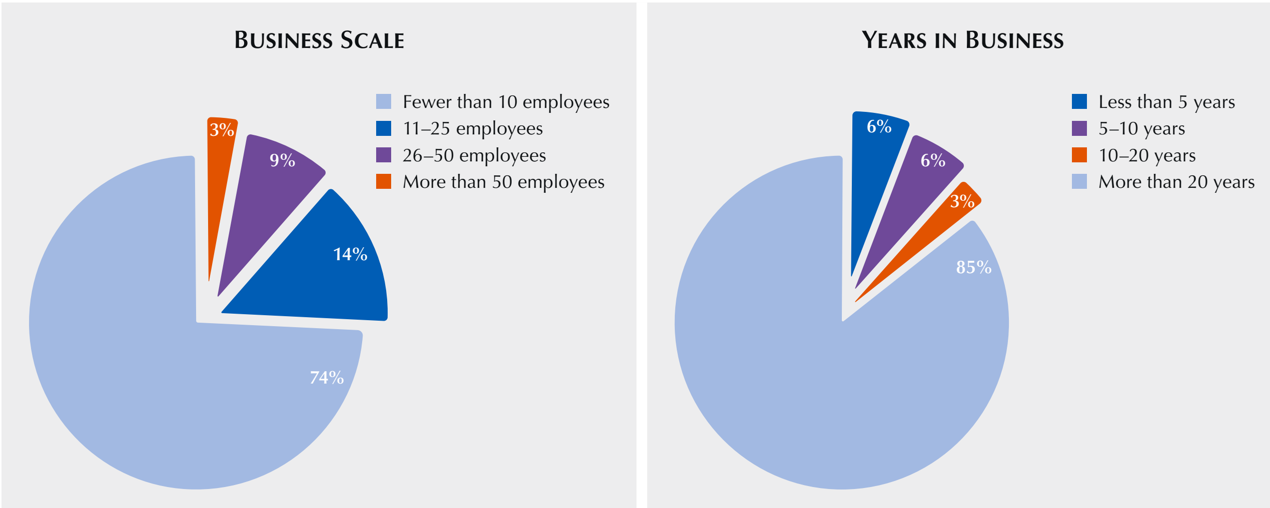


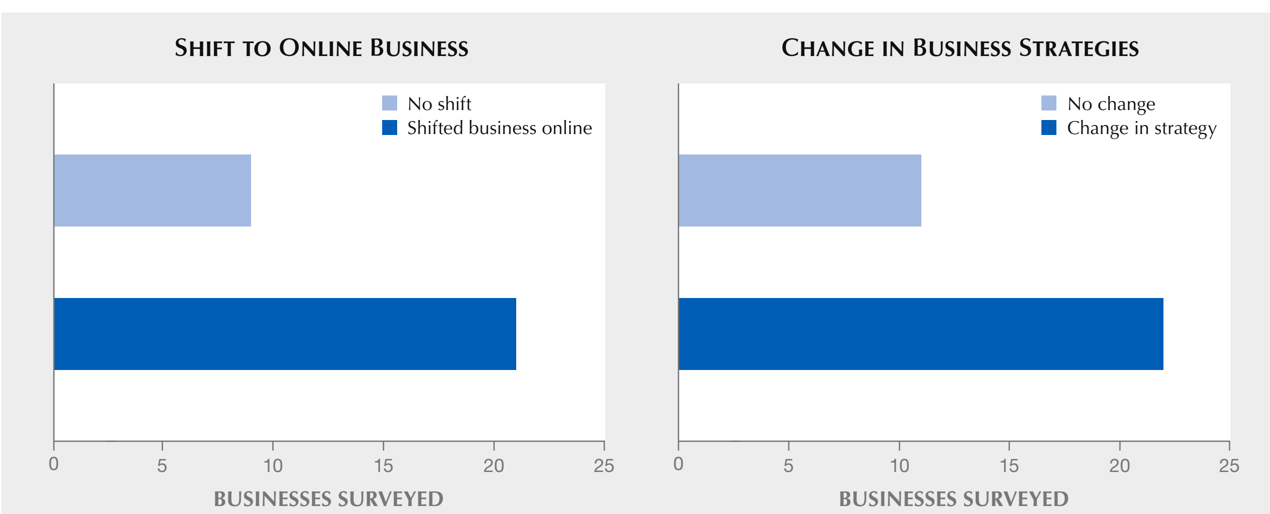
Figure 49. The majority of the 35 exhibitors surveyed have a small-scale business and more than 20 years in the industry.

This brief report presents outcomes from written surveys conducted with 35 randomly selected AGTA and GJX show exhibitors. The survey consists of two portions: general information about the business, and six pandemic- and market trend-related questions. All 35 exhibitors based their responses on their own experiences, with a very limited number of "not applicable" answers that were not included in the findings.

Nearly all respondents identified themselves as wholesalers, with a couple of exceptions as designers or miners. The authors noticed that some exhibitors played multiple roles: wholesaler, retailer, and sometimes even designer. While traditional roles in the gem and jewelry industry still carry on, the boundaries between them have become blurred. More than 70% of the exhibitors surveyed have fewer than 10 employees, and 85% of them are industry veterans with more than 20 years' experience in the trade (figure 49). Although the pool is small, it aptly reflects the nature of the gem and jewelry business in general, with small-scale business as the majority, but often with generations of commitment to the industry.

When asked about the impact of the pandemic on their business, most responded that it was most impactful at the beginning of the crisis, but recovery has been quite smooth since then. Some did express concern about the post-pandemic supply issues. Two-thirds of the interviewees stated that more business shifted online over the past two years, resulting in marketing and selling strategy changes (figure 50).

Figure 50. Due to mobility restrictions caused by the pandemic, most companies have shifted at least some business online to adapt to the new normal. This often required changes in sourcing, marketing, and selling strategies.



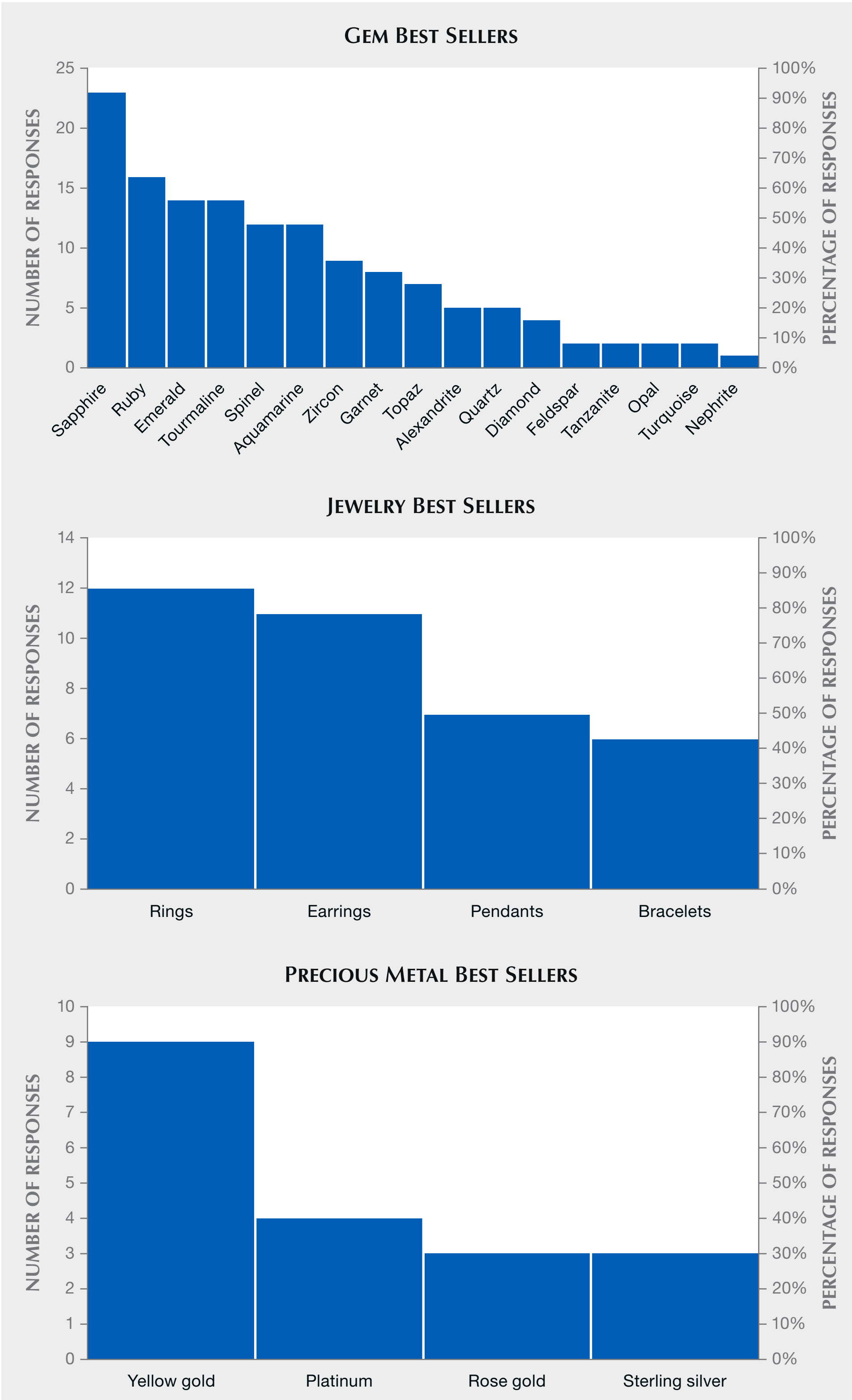


Figure 51. The best sellers over the past two years during the pandemic, according to gemstone species, jewelry type, and precious metal type.

Notably, the relatively new businesses, many with less than five years in the trade, often started with more business online than offline. Though sellers mostly embraced online trading of gems and jewelry, some had difficulties capitalizing on it, particularly with colored stones since buyers still prefer to check the quality in person.

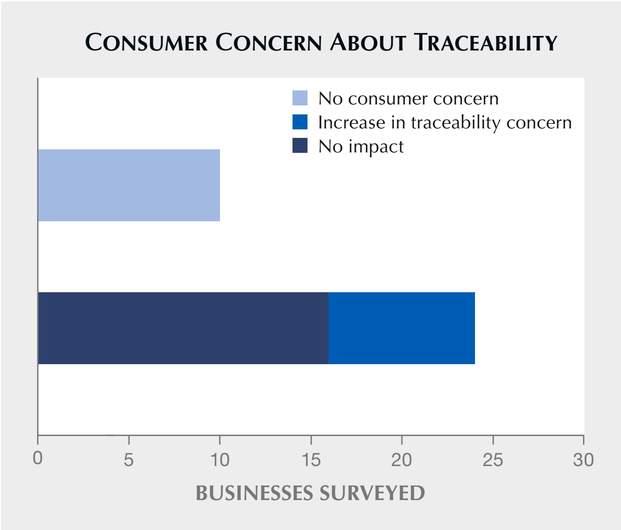


Figure 52. Many of the exhibitors surveyed noticed an increase in consumer concern about traceability, but the majority of them said it does not impact their business.

To investigate the types of stone and jewelry sales over the past two years, the authors asked the selected exhibitors to circle the corresponding items, with many circling multiple answers in each category. These questions covered gemstone species, jewelry, precious metal, and pearl types, with the understanding that while diamond sales continue to dominate the market, they are not the focus for the exhibitors surveyed. Not surprisingly, the "big three" still dominate sales, with sapphire leading the trend (figure 51, top), and tourmaline and spinel immediately following the big three. As for jewelry types, rings and earrings lead the way (figure 51, middle). Yellow gold still sells the best, with platinum as the second best seller (figure 51, bottom). Several pearl dealers circled their best sellers, but the authors found that overall sales were quite evenly distributed among the four major cultured pearl types.

As traceability is a hot topic in the trade, the authors also asked two related questions about whether respondents noticed increased consumer concern on traceability. If they answered yes, they were asked whether it affected how they do business. The result shows that about two-thirds of them noticed the concern, and two-thirds of those who noticed the concern did not feel that it affected their business (figure 52).

As the world enters the post-pandemic era, it is worthwhile to continue monitoring how the market reacts to the changes and how tradespeople adapt to the new normal.

Tao Hsu and Lisa Kennedy

RESPONSIBLE PRACTICES

Mercury Free Mining pilot program. In late 2021, Mercury Free Mining (MFM), the Alliance for Responsible Mining (ARM), and GIA joined with Peruvian artisanal and small-scale gold miners (ASGM) to launch a new program intended to find alternatives to mercury in gold mining. The partners are bound in recognizing the reliance on artisanal and small-scale gold mining to produce major quantities of an extremely valuable commodity. This situation unfortunately perpetuates the leading cause of anthropogenic mercury pollution. The pilot program aims to proactively develop mercury alternatives in two gold mines, increasing their sustainability, building a traceable ASGM gold supply, and acting as a major leap in the MFM research team's understanding of how we can ultimately eradicate mercury in gold mining.

Mercury Free Mining, the program lead, is a nonprofit organization founded by Toby Pomeroy, a lifelong goldsmith, jeweler, and passionate advocate for responsible sourcing. Founded in 2019 with the mission of eradicating mercury, MFM has been building a community of jewelers supporting efforts to provide the nearly 20 million ASGM with efficient and nontoxic mercury alternatives where presently unavailable.

MFM's research and deployment team, led by the author, a geometallurgist, fosters novel sociotechnical solutions to address the issues facing ASGM with a focus on finding suitable mercury alternatives. This is a challenge. Gold is nonreactive to most chemicals (mercury being one of the only exceptions) and coincides with dense black sands that are difficult to mechanically separate (figure 53).

Figure 53. Gold and dense black sands in a traditional wooden batea, shown by a Colombian miner at Oro Verde. Typically, mercury is used to separate the two materials. Photo courtesy of Toby Pomeroy.

Figure 54. In this photo from November 2020, Kenyan miners in Kakamega County press amalgam in a pan to remove excess water. Amalgam is a mixture of mercury and gold produced by adding mercury to concentrated gold ores. This method puts miners in direct contact with mercury, a potent neurotoxin that can be absorbed through the skin. Photo courtesy of Ruth Epwoka.

The team's methodologies rely upon the miners' desire to maximize earnings by recovering more gold from the raw ores while also minimizing harmful social, health, and environmental side effects. Currently, reliable information about implementing mercury alternatives that are more effective and less harmful is scarce. Without this, miners have no choice but to rely upon a multi-generational neurotoxin in order to earn an income (figure 54).

Figure 55. Miners wash the gold ores and use a sluice to collect gold within the slurry. Sluices are one of the most common tools used in artisanal and small-scale mining to concentrate gold. This simple configuration can capture ~20–70% of gold based on ore type, water flow, feed rate, and other specifications geometallurgists determine through research. Photo courtesy of Ruth Epwoka.

GIA granted $50,000 to jumpstart the pilot. Since then, MFM has collaborated with ARM engineers and Peruvian miners to collect representative mineral samples for use in testing a suite of innovative gold concentrators. MFM is partnering with six mineral processing experts to evaluate their respective technologies based on key performance indicators such as throughput, gold recovery, and concentration ratio. Spread across three continents, the testing will evaluate a large swath of potential mercury alternatives, helping to gather critical information on how different processors are suited for various gold ores (figure 55). This stage of the project will draw from advanced engineering and science to perform thorough analyses in an accurate and timely manner.

Following the testing, the results will be holistically synthesized by the MFM research team with respect to the many complexities of the miners' unique situations. This will include a mercury comparison to understand the true viability for the miners to adopt an alternative. Stakeholder discussions will then determine whether the miners ultimately decide to adopt one of the mercury-free technologies. If so, the team will help implement the transition to mercury-free methods and conduct observational research to better define the impact on the health of miners and their communities.

The completion of this pilot program in 2022 will mark a turning point in MFM's ability to minimize the global impacts of mercury by having a tested and verified framework that can translate to additional mercury elimination projects as MFM expands. Following the pilot, the MFM team will publicly release the first report documenting the research process and results in complete detail. This and future reports can be used freely by miners and organizations to enhance the ability to safely source gold. For those interested in learning more, collaborating, or using these methods elsewhere, please contact the author.

Caelen Burand (caelen@mercuryfreemining.org)
Mercury Free Mining
Tucson

TREATMENTS

Sugar/heat-treated opal. Treatments can cause harm when they are not disclosed properly, but without treatments, fewer gem resources would find their usage in the jewelry trade. At the AGTA show, the authors had the rare opportunity to talk with James Carpenter from Arkansas-based Unconventional Lapidarist about sugar/heat treatment on porous rough opal.

Sugar and acid treatment is one of the most commonly used methods to enhance opal. In the trade, this treatment is usually applied to matrix opal from Andamooka, Australia, a particularly porous material. The finished product is often referred to as "Andamooka matrix opal" or "Andamooka rainbow matrix opal" by the trade. This treatment was presented as a hot sugar bath followed by a hot acid bath (G. Brown, "Treated Andamooka matrix opal," Summer 1991 *G&G*, pp. 100–106). The chemical reaction between sugar and acid then deposits carbon to the porous structure of the opal as black dots. The treatment darkens the background color of the opal and therefore makes the play-of-color stand out more.

Carpenter revealed that he treated the opal without using acid to gain a similar result. The opals, either slices

Figure 56. From left to right: rough Andamooka matrix opal, a slice after treatment, and a 72 ct finished freeform cabochon. Photo by Tao Hsu; courtesy of Unconventional Lapidarist.

Figure 57. The winning design from the 2021 Gianmaria Buccellati Foundation Award for Excellence in Jewelry Design, created by Meghan Simmons, a Carlsbad graduate of the GIA Jewelry Design program.

or cabochons, were first soaked in a hot 50% sugary water solution for 6 to 9 hours. After cooling down from the hot sugar bath, the pieces were patted dry and then tightly wrapped in aluminum foil. Carpenter emphasized that tight wrapping is especially important because a loose wrap causes the sugar to sweat out and possibly generate more cracks in the material. The well-wrapped materials were then heated in a toaster oven at 450–500°F for about 4 hours. After the final cooling, the materials were polished to finished products or retreated if necessary, revealing a dramatic change from start to finish (figure 56).

Tao Hsu and Lisa Kennedy

ANNOUNCEMENTS

Fifth annual Gianmaria Buccellati Foundation Award winner. Meghan Simmons, a graduate of GIA's Jewelry Design program at the Carlsbad campus, received the fifth annual Gianmaria Buccellati Foundation Award for Excellence in Jewelry Design. The award was presented at the GIA Alumni Collective's "Night at the Museum" event held during the AGTA GemFair Tucson. One of 11 finalists, Simmons competed against more than 80 students from GIA's seven campuses. Her winning earring design (figure 57), inspired by the abstract artist Wassily Kandinsky, emphasizes the use of line and shape with gold, diamonds, and blue sapphires.

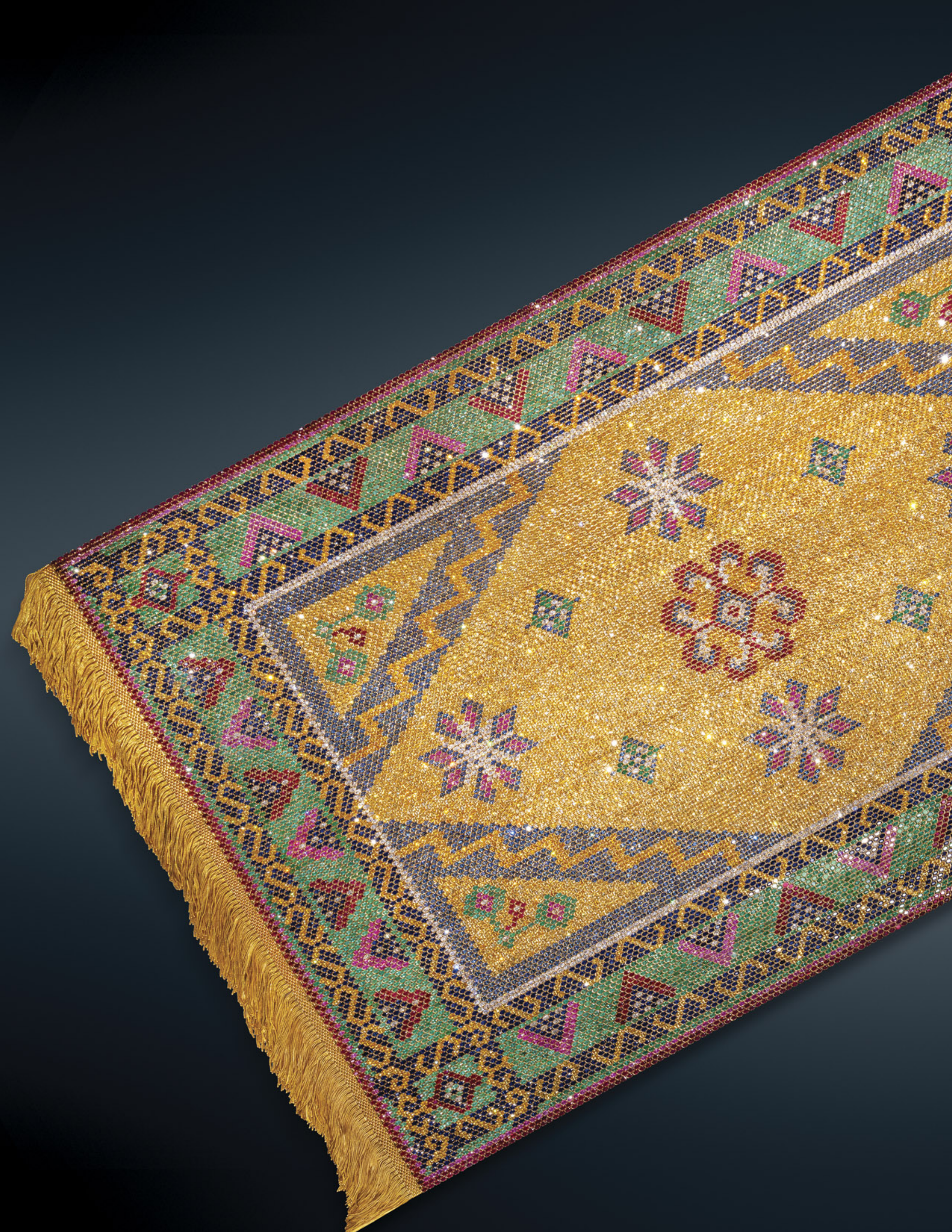
Simmons will spend a week in Italy, traveling from Florence to Venice to Milan, and will meet with a representative from the foundation.

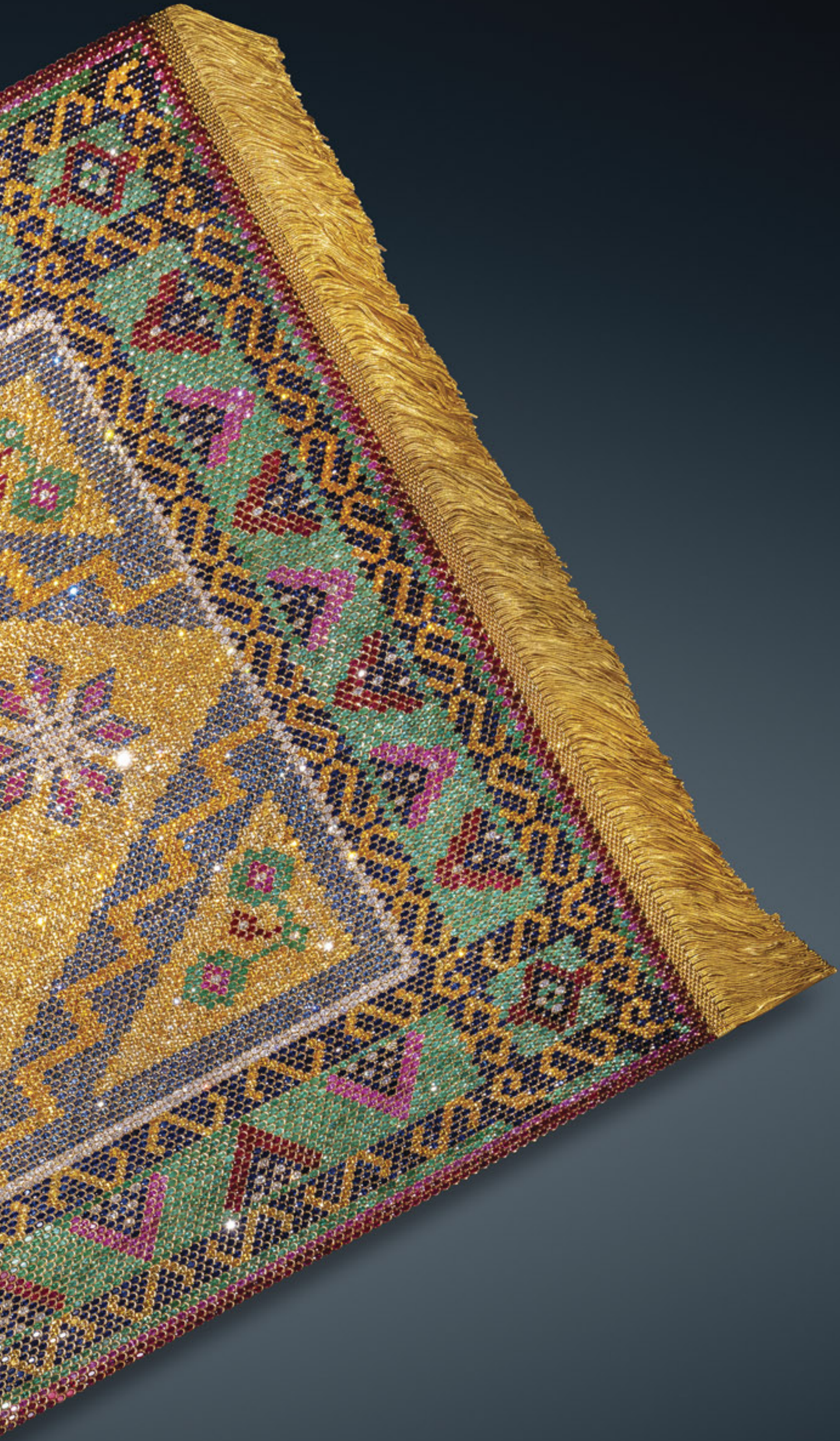
Larry French, chief officer of North American strategies for the foundation, said, "This competition was born out of the life and work of Gianmaria Buccellati. We congratulate not only all the students who participated in this year's design competition but also the talented instructors from GIA who guided the students on this beautiful art."

The 2022 Gianmaria Buccellati Foundation Award for Excellence in Jewelry Design competition is underway and open to students in GIA's Jewelry Design courses who meet the eligibility requirements. For more information, visit gia.edu/buccellati-foundation-award-jewelry-design.

2022 Tucson Photo Gallery

Helen Serras-Herman's "Pluto & Persephone—Rulers of the Underworld" carving features a 59.98 ct Oregon sunstone from the Dust Devil mine and a 280 ct gem-quality silica chrysocolla and quartz with malachite. The piece is 110 × 55 × 38 mm, with a base carved in wax and cast in sterling silver. The silver faces depicted represent the spirits of the underworld, with the Greek gods Pluto and Persephone sitting above them. Courtesy of Helen Serras-Herman.





"The Royal Tapestry," created by Parisian jeweler Cristofol, contains 26,649 individual gems—emerald, ruby, sapphire, and diamond—set in 18K gold. A team of more than 10 artisans spent more than 16,000 hours to complete it, in addition to the five years needed to source, cut, and calibrate the gems. The 122 × 71 cm tapestry has more than 100,000 gold prongs and weighs over 40 lbs. Owned by a private collector, this piece is on display at the new Alfie Norville Gem and Mineral Museum in Tucson.

Corundum crystals often exhibit growth features such as these eye-visible trigons. Helen Serras-Herman, best known for her carving expertise, left these crystals intact to emphasize the natural growth features as design elements, with simple gold wire turning them into pendants. Courtesy of Helen Serras-Herman.

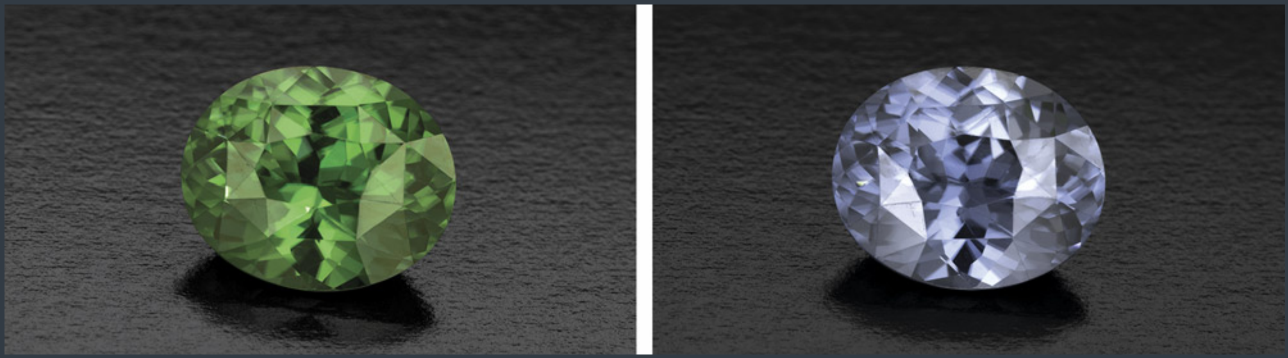
These sugarloaf cut gems, a 5.62 ct sapphire and a 9.00 ct emerald, are of excellent color and clarity. Courtesy of Crown Color.

A 234 ct cat's-eye topaz from Mozambique. Courtesy of Meg Berry.

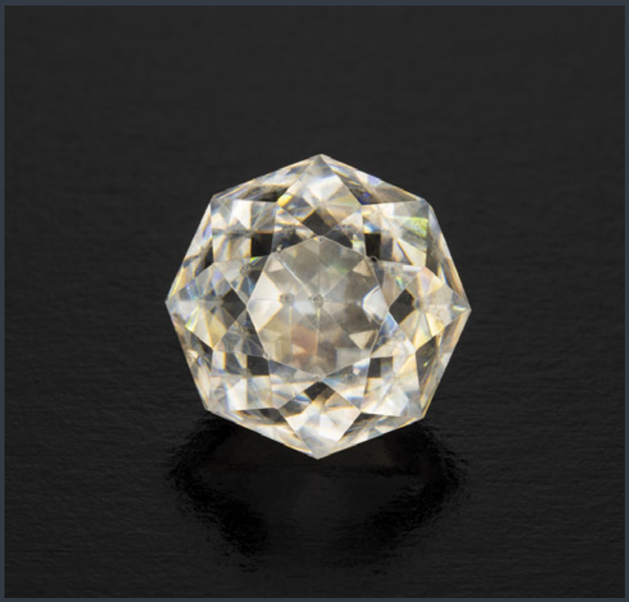
Inspired by the beautiful geometry of the Art Deco era, Zoltan David's "Deco Drama" pendant features a 4.30 ct tourmaline along with 24K gold inlay and diamonds totaling 0.44 carats. Courtesy of Zoltan David.

Zoltan David's "Twilight" pendant is inspired by the colors of the evening sky. It features a 24.06 ct Ethiopian opal set in titanium, inlaid with 24K gold, and accented with diamonds, blue sapphires, pink sapphires, tsavorite garnets, and spessartine garnets on a multi-strand steel chain. Courtesy of Zoltan David.

This functioning compact powder box and lipstick set, with a hand-engraved floral motif, is encrusted with emeralds, rubies, sapphires, and diamonds. Fashioned in gilded silver, the set was made in Russia circa 1930. Courtesy of Jewelerette & Co.



This 14.62 ct color-change zircon (believed to be from Sri Lanka or Myanmar) was fashioned in Thailand. The gem appears bright green in incandescent light, changing to violet in daylight. Courtesy of Bryan Lichtenstein, 30/90.



Although cerussite is rarely faceted due to its softness (3–3.5 on the Mohs scale) and distinct cleavage, this 2.65 ct faceted gem exhibits remarkable dispersion. Courtesy of Gembridge.

Opals are generally one-of-a-kind gemstones and rarely found as a matching pair, even as doublets. These 7 cm Australian opal doublets, set in 18K recycled rose gold earrings, were inspired in form and texture by the Azores island chain. Courtesy of Eve Streicker, Original Eve.

This fully terminated rhodonite crystal from the Conselhero region of Minas Gerais, Brazil, weighs 133.5 g and measures 52 × 33.9 × 29.4 mm. The 46.19 ct oval gem is of remarkable clarity and quality for rhodonite, which is generally used for ornamental carvings and cabochons. Courtesy of Jean Claude Nydegger.

Coveted by the Indian Mughal emperors during the seventeenth and eighteenth centuries, Colombian emeralds were often allowed to retain their hexagonal outline and then carved and fashioned using Golconda diamond tools. This 49.08 ct emerald exhibits a floral motif. Courtesy of a private collection.

This superb 50.09 ct color-change sapphire from Sri Lanka goes from purple to blue in incandescent and daylight, respectively. Courtesy of Pioneer Gems.

Jewelry clients increasingly seek gold that is equitably mined and not harmful to the environment. This 18K yellow gold "Oasis Medallion" pendant uses recycled gold and features F-color, VS_2 diamonds (0.17 carats total) and a 2.41 ct blue sapphire from Sheehan Sapphires, Sri Lanka. Made of Fairmined 18K yellow gold, the ring contains 0.09 carats of diamonds and a 2.19 ct pink sapphire. Courtesy of Lester Oehler and Juleia Dooley of Toby Pomeroy.

All photos by Robert Weldon.

REGULAR FEATURES

COLORED STONES AND ORGANIC MATERIALS

Cuprite and malachite in agate from the Yanyuan region, Sichuan. The Yanyuan region in China's Sichuan Province is rich in agates known for their vibrant colors, including pink, purple, and green. Dendritic inclusions are common in agates from many areas but rarely seen in agates from Yanyuan. Recently, our interest was drawn to a 9.40 g gray-purple carved pendant submitted for identification (figure 58) that displayed peculiar dendritic inclusions. The piece was reported by the client to be from Yanyuan.

Standard gemological testing of the pendant yielded a spot refractive index of 1.54, and Fourier-transform infrared (FTIR) spectroscopy was used to confirm the identity of the pendant. Microscopic observation revealed a blue-green spherical mineral surrounded by copper-red dendritic inclusions (figure 59), which appeared to have a metallic luster under reflected light.

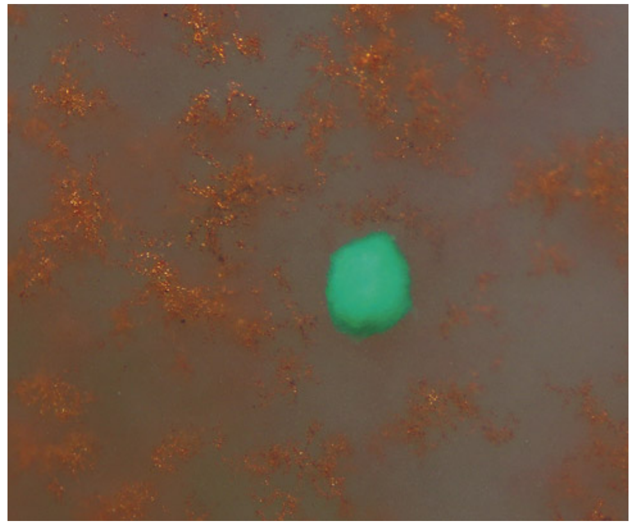


Figure 59. Microscopic observation of the pendant revealed copper-red dendritic inclusions and a blue-green spherical inclusion. Photomicrograph by Su Xu; field of view 1.5 mm.

The red inclusions in the exposed surface and the blue-green inclusion nearby were analyzed with Raman spectroscopy. The analyses showed that the red inclusions were cuprite (Cu_2O) and the blue-green sphere was malachite ($Cu_2(CO_3)OH_2$), both of which were confirmed by energy-dispersive X-ray fluorescence (EDXRF) testing (figure 60). In the Raman spectra of the inclusions, the peak at 464 cm^{-1} was assigned to the agate host (figure 60).

Figure 58. This 9.40 g gray-purple pendant was identified as agate. Photo by Su Xu.

While copper inclusions have been previously reported in purple chalcedony (Spring 2019 *G&G* Micro-World, p. 111) and chrysocolla chalcedony (M. Ye and A.H. Shen, "Gemmological and mineralogical characteristics of chrysocolla chalcedony from Taiwan, Indonesia and the USA, and their separation," *Journal of Gemmology*, Vol. 37, No. 3, 2020, pp. 262–280), this is the first time we have identified two kinds of copper-bearing inclusions in agate from Yanyuan.

Su Xu and Dapeng Chen
National Gold-Silver Gem & Jewelry Quality Supervision & Inspection Center, Sichuan

Unusual repair of a natural emerald. A 5.24 ct bluish green emerald (figure 61) was presented to the State Gemmological Centre of Ukraine for identification and determination of the presence of treatment. The client reported that this stone was mined in Colombia. The stone exhibited a refractive index of 1.566–1.571, birefringence of 0.005, hydrostatic specific gravity of 2.67, moderate pleochroism with bluish green to green colors, and a very weak pink fluorescence to long-wave and short-wave UV. Qualitative analysis using EDXRF spectroscopy showed major amounts of vanadium, chromium, and iron and minor amounts of gallium.

Magnification with a gemological microscope revealed an abundance of fluid growth tubes, as well as two-phase and three-phase inclusions. Thick masses of gray matter were revealed inside the cracks of the emerald. Infrared spectroscopy (FTIR) was subsequently performed to ana-

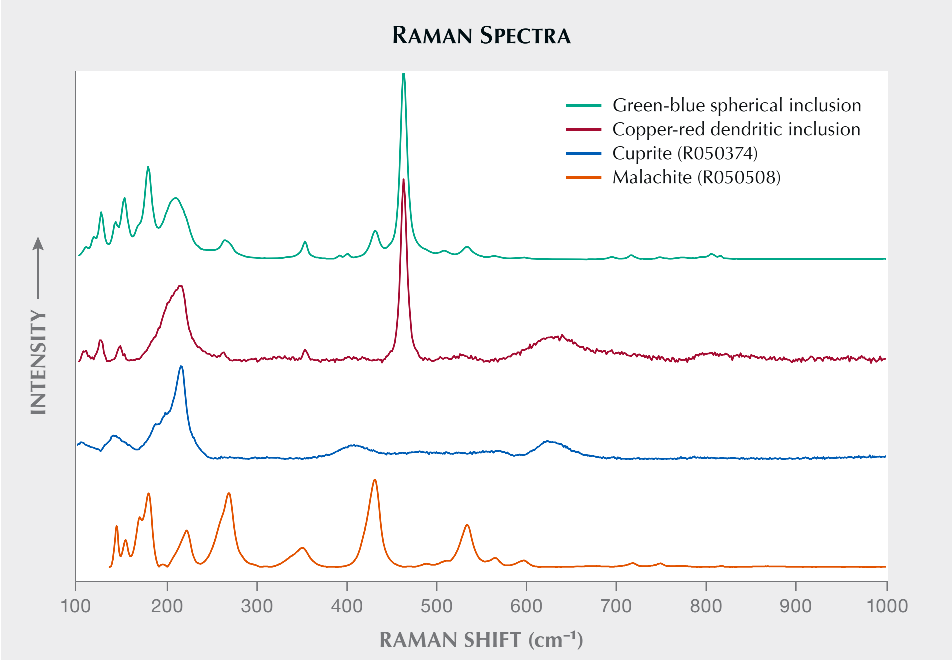


Figure 60. Comparison between the Raman spectra obtained for the two kinds of inclusions found in the agate and reference spectra for cuprite and malachite from the RRUFF database. Spectra are offset for clarity.

lyze this gray substance. Epoxy resin peaks at 3060, 3035, 3000, 2964, 2932, and 2871 cm^{-1} confirmed an epoxy resin treatment (M.L. Johnson et al., "On the identification of various emerald filling substances," Summer 1999 *G&G*, pp. 82–107).

DiamondView imaging clearly revealed the epoxy resin filler within the fissures as a series of blue lines extending over the entire surface against the emerald's red-fluorescing bodycolor (apparently due to the presence of the Cr^{3+} impurity). Additionally, careful examination from all sides of the stone revealed a patch in one of the corners. This patch was covered with rounded pits and glowed strong blue in the DiamondView (figure 62). In daylight, there was a clear, even border between the patch and the emerald (figure 63). EDXRF analysis showed additional admixtures of potas-

Figure 61. Examination of this 5.24 ct clarity-enhanced emerald revealed unusual repair work. Photo by Iurii Gaievskyi.

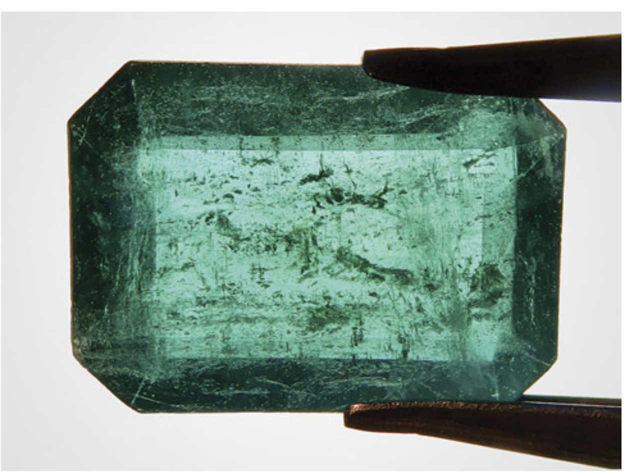
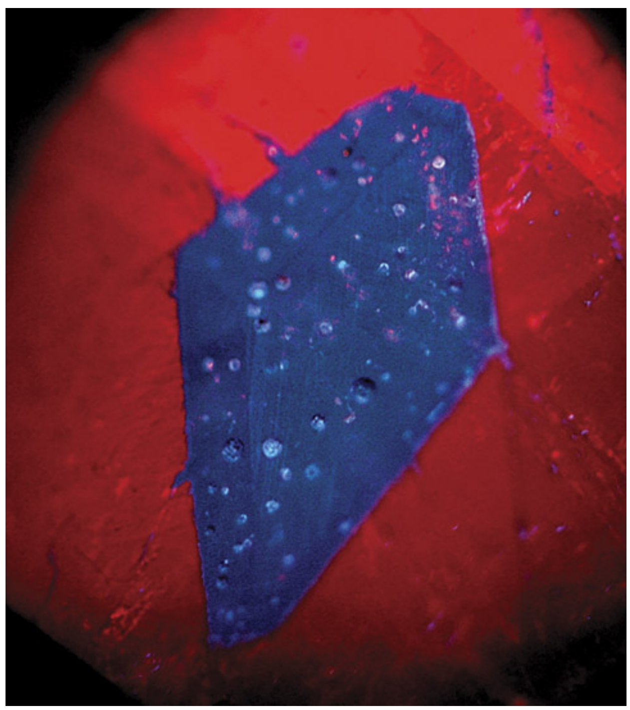


Figure 62. DiamondView imaging of a patch applied to a corner of the emerald. Image by Iurii Gaievskyi.



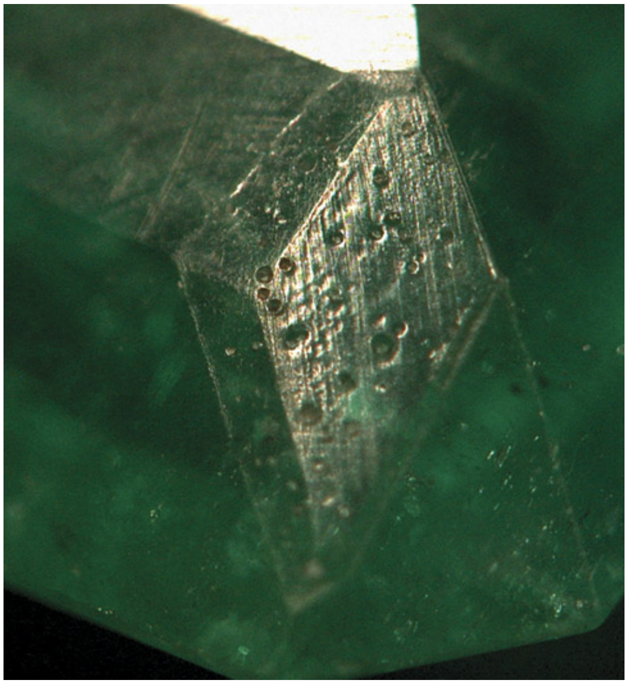


Figure 63. The clear, even border between the patch and the emerald, shown in daylight. Photomicrograph by Iurii Gaievskyi; field of view 4.0 mm.

sium and calcium on the side of the patch. All of these properties suggest that glass was the raw material for this patch, which was presumably used to conceal a damaged part of the cut emerald. This kind of repair is extremely unusual for cut stones.

Iurii Gaievskyi (gaevsky@hotmail.com)
State Gemmological Centre of Ukraine, Kyiv

Inclusions and spectroscopic features of yellowish green enstatite. Gem-quality enstatite is the magnesium end member of the enstatite-ferrosilite series in the clinopyroxene subgroup of the pyroxene group. While the most common color is brown, it can also be colorless, green, or gray. Myanmar, Tanzania, and Sri Lanka are the main sources of gem-quality stones currently in the market. Enstatite can yield clean faceted gems but can also display four-, six-, or eight-rayed asterism.

Enstatites have been documented many times from various sources. Six-rayed star brown enstatite was reported from India (W. Eppler, "Star-diopside and star-enstatite," *Journal of Gemmology*, Vol. 10, No. 6, 1967, pp. 185–188). Sri Lankan samples were reported in U. Henn and H. Bank, "Sternbronzit aus Sri Lanka," *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 40, No. 2–3, pp. 145–148. Star enstatite from Madagascar was described in T. Cathelineau, "Six-rayed star enstatite from Madagascar," *Journal of Gemmology*, Vol. 36, No. 8, 2019, pp. 688–690. Four-rayed star brown enstatites from Sri Lanka were documented in E.J. Gübelin and J.I. Koivula, *Photoatlas of Inclusions in Gemstones, Volume 3*, Opinio Publishers, Basel, Switzerland, 2008. Faceted brown enstatite was reported in Koivula et al., "Gemmological investigation of a large faceted East African enstatite," *Journal of Gemmology*, Vol. 21, No. 2, 1988, pp. 92–94. Yellowish green enstatites from Africa were discussed in K. Schmetzer and H. Krupp, "Enstatite from Mairimba Hill, Kenya," *Journal of Gemmology*, Vol. 18, No. 2, 1982, pp. 118–120, as well as in B.M. Laurs et al., "Yellowish green enstatite (and star enstatite) from Tanzania," *Journal of Gemmology*, Vol. 36, No. 8, 2019, pp. 691–693. Norwegian stones were documented in F. Schmitz et al., "Polymer-filled star enstatite from Norway," *Journal of Gemmology*, Vol. 35, No. 2, 2016, pp. 98–101.

Recently, GIT Gem Testing Laboratory (GIT-GTL) received six bright yellowish green enstatite samples weighing 0.65 to 2.78 ct (figure 64) that were reported by author SD to be from Africa. The stones appeared fairly similar to the previously documented four-rayed star yellowish green

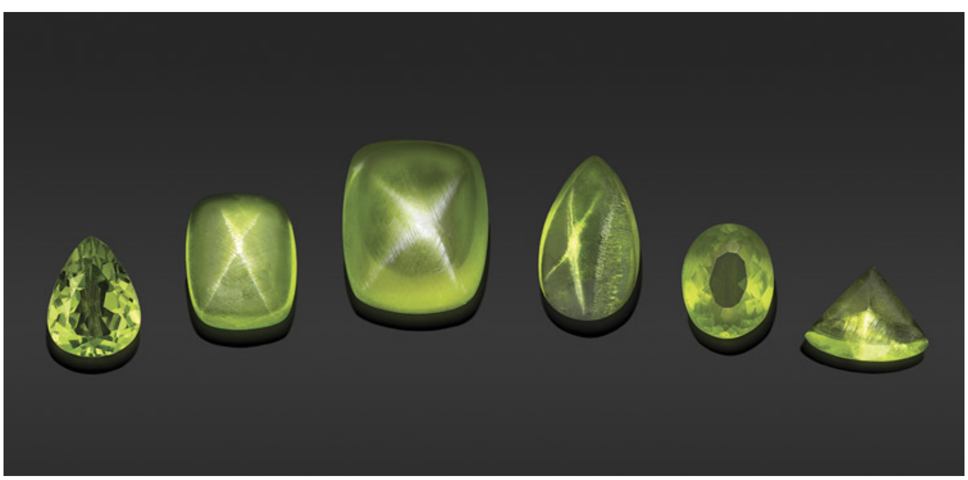


Figure 64. Two faceted and four cabochon bright yellowish green enstatites. Left to right: a 1.02 ct pear (sample no. e102), 1.32 ct cushion (e132), 2.78 ct cushion (e278), 1.44 ct pear (e144), 0.65 ct oval (e065), and 0.67 ct modified triangle (e067). Photo by C. Kamemakanon; courtesy of American-Thai Trading.

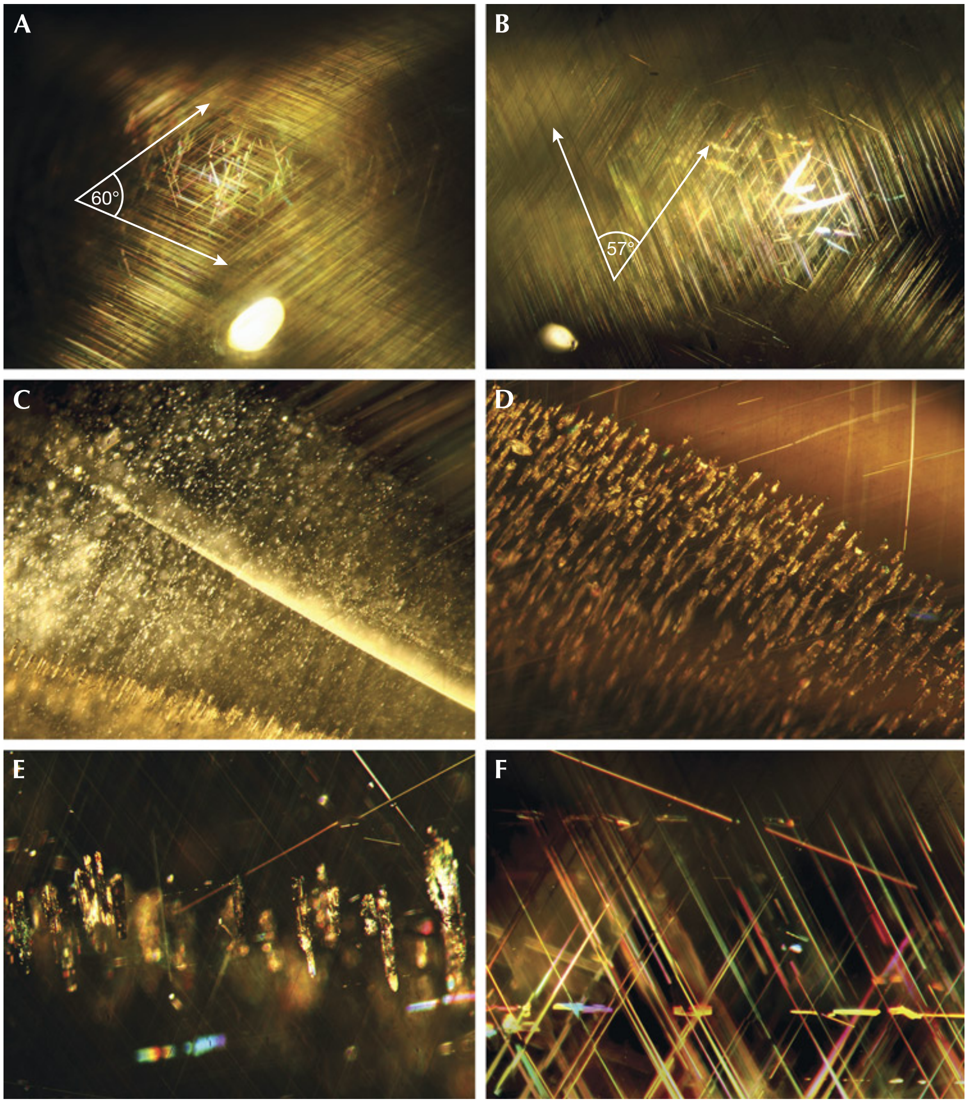


Figure 65. A and B: Using oblique fiber-optic lighting, the four-rayed star enstatite cabochons reveal two sets of densely and regularly oriented fine needle-like inclusions intersecting at approximately 57° to 60°. C–E: The pear cabochon shows patches of densely oriented minute white particles (C), a plane of oriented tubes partially filled with small brownish white to colorless magnesite crystals (D), and oriented tubes filled with magnesite (E). F: Rectangular platelets and needle inclusions with bright interference colors in the modified triangle. Photomicrographs by S. Promwongnan; fields of view 3.6 mm (A–D) and 1.5 mm (E–F).

enstatite from Tanzania documented by Laurs et al. (2019). In that article, needle-like inclusions were found to be the cause of the four-rayed asterism, but their mineralogical identity was not reported.

Of the six stones examined in this study, four were cabochons displaying a four-rayed star effect while two were faceted (figure 64). The five stones with at least one polished flat surface gave refractive indices of α = 1.655–1.660, β = 1.661–1.665, and γ = 1.668–1.669, with a birefringence of 0.009–0.014, and are therefore biaxial positive. The spot RI reading of one cabochon without a flat surface was ~1.66. The hydrostatic specific gravity of all samples was 3.22–3.25. All these values fall well within the range of enstatite. The stones appeared weak orange under the Chelsea color filter and showed moderate yellow and yellowish green pleochroism. All were inert to both long-wave and short-wave UV.

The main diagnostic internal features were the two sets of dense and regularly oriented needle-like inclusions (figure 65, A and B). The two sets measured on the same plane at the top of three cabochons (e278, e132, and e144) were found to intersect at an approximate angle of 57° to 60°, producing the four-rayed star effect seen on the cabochon surface (figure 64). While the two faceted stones also contained fine needle-like inclusions, they were not cut to display a star.

Close examination also uncovered two sets of needles that did not produce asterism. In addition, patches of densely oriented minute white particles (figure 65C) and a plane of oriented short tubes (figure 65, D and E) were found in one stone (e144). These tubes were partially filled with tiny brownish white to colorless crystals identified by Raman spectroscopy as magnesite (figure 66). The presence of epigenetic magnesite ($MgCO_3$) could have resulted from alteration of the host enstatite. The other feature consisted of sparse rectangular platelet inclusions occurring in various directions within the dense mesh of needle inclusions (e067, figure 65F).

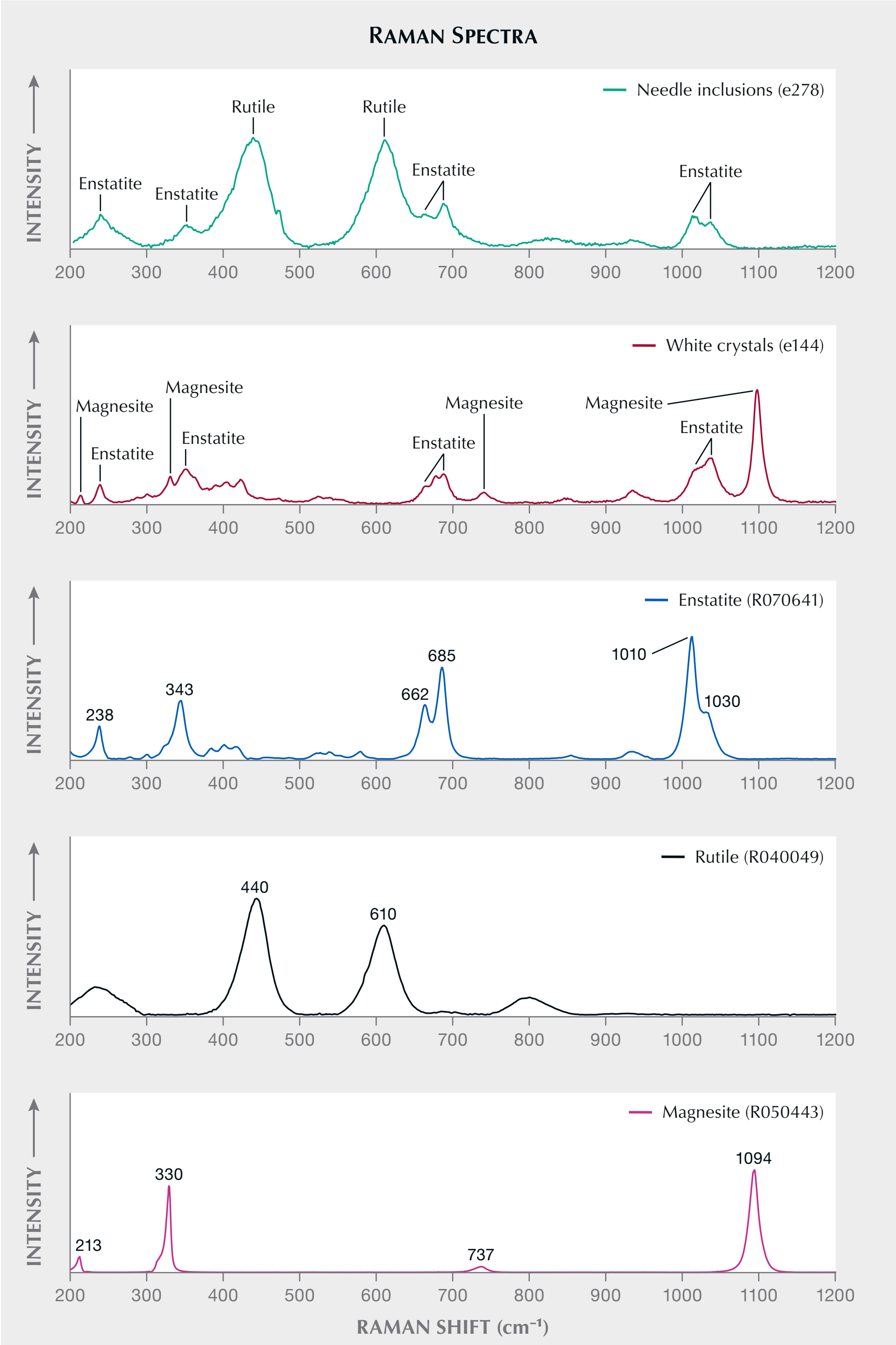


Figure 66. Raman spectra of the exposed fine needle inclusions plus host mineral (green line) show the superimposed peaks of rutile and enstatite that match with the RRUFF reference spectra (black and blue lines, respectively). Similarly, the spectra of exposed white to colorless crystals in short tubes plus host mineral (red line) display peaks of magnesite and enstatite that match with the RRUFF reference spectra (pink and blue lines, respectively).

The Raman spectra of all host mineral samples, recorded using 532 nm laser excitation, similarly showed dominant peaks that matched the enstatite reference spectrum from the RRUFF database (not shown here). Moreover, the Raman spectrum of the exposed fine needle inclusions plus host mineral in one sample (e078) gave the superimposed peaks of rutile (440 and 610 cm^{-1}) and enstatite (238, 343, 662, 685, 1010, and 1030 cm^{-1}), consistent with the RRUFF reference spectra in figure 66. Similarly, the Raman spectrum of exposed white to colorless crystals in short tubes plus the host in a sample (e144) showed overlapping peaks of magnesite (213, 330, 737, and 1094 cm^{-1}) and enstatite, also consistent with the RRUFF reference spectra. The identity of the rectangular platelet inclusions, however, could not be resolved due to their sparsity and their depth below the surface.

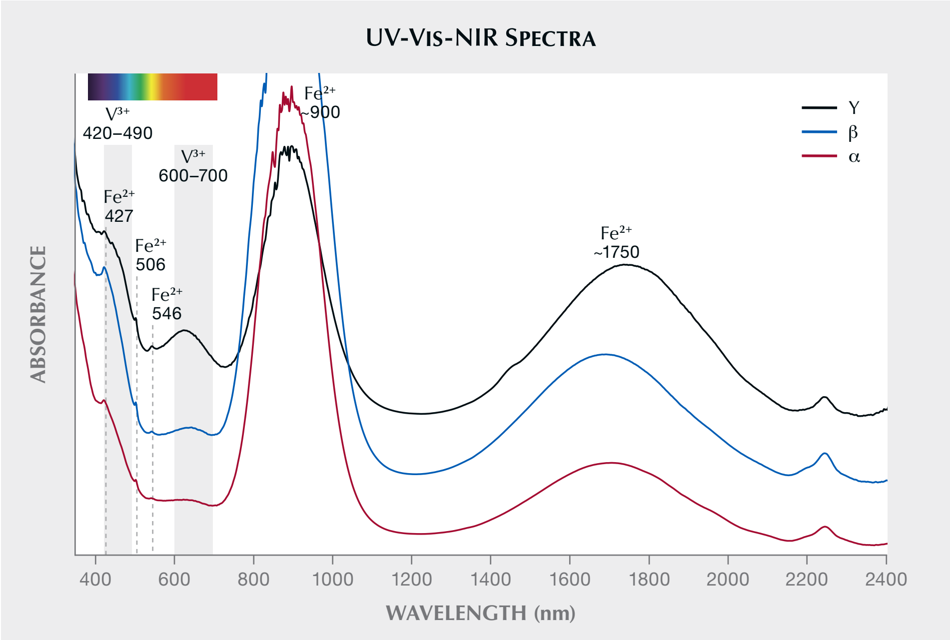


Figure 67. Polarized UV-Vis-NIR absorption spectra of an enstatite (e132) showing a dominant Fe^{2+}-related broad band around 900 nm and additional Fe^{2+}-related absorptions at 1750 nm in addition to a continuous rise from ~700 nm toward the UV with smaller absorptions at 427, 506, and 546 nm. The iron absorptions are superimposed by two broad bands around 420–490 nm and 600–700 nm due to the presence of V^{3+} plus trace Cr^{3+} in the stone lattice (see table 1). Spectra are offset for clarity.

Polarized ultraviolet/visible/near-infrared (UV-Vis-NIR) spectra of a sample (e132) showed features dominated by broad absorption bands of Fe^{2+} in the NIR region centered at ~900 and ~1750 nm (figure 67). The spectra rise continuously from ~700 nm toward the UV with small Fe^{2+} peaks at 427, 506, and 546 nm in the visible range (Cathelineau,

TABLE 1. Chemical contents of the six enstatite samples measured by EDXRF in this study and those of previously reported yellowish green enstatites from Africa.

Sample no./locality	Element oxides (wt.%)									
	MgO	Al_2O_3	SiO_2	CaO	TiO_2	V_2O_5	Cr_2O_3	MnO	Fe_2O_3	ZnO
e278	31.53	7.65	58.92	0.08	0.07	0.07	0.02	0.32	1.28	0.05
e065	31.10	7.34	58.05	0.14	0.13	0.13	0.04	0.55	2.41	0.11
e067	31.16	7.14	58.24	0.12	0.13	0.15	0.06	0.59	2.30	0.10
e102	31.05	6.29	59.19	0.14	0.11	0.11	0.04	0.70	2.24	0.13
e132	30.88	7.34	58.19	0.12	0.14	0.13	0.03	0.56	2.50	0.12
e144	26.49	8.09	59.15	0.21	0.23	0.22	0.07	1.04	4.26	0.24
Kenya (Schmetzer and Krupp, 1982)[a]	38.27	3.60	55.57	n.a.[c]	n.a.	n.a.	0.22	n.a.	1.62	n.a.
Tanzania (Laurs et al., 2019)[b]	n.r.[d]	n.r.	n.r.	n.r.	0.12	0.14	0.01	0.52	2.00	n.r.

[a]*Electron microprobe*
[b]*EDXRF*
[c]*n.a. = not analyzed*
[d]*n.r. = not reported*
Detection limits: ~0.01 wt.% for all elements.

TABLE 2. Comparison of the localities and physical properties of gem enstatites from this study and those reported previously.

Locality	Color	Asterism	Inclusion features	Properties	Color-causing ions	References
Tanzania (probable locality)	Yellowish green	4 rays	Rutile needles, 57°–60°	RI α = 1.655–1.660 β = 1.661–1.665 γ = 1.668–1.669 SG = 3.22–3.25	Fe^{2+}, V^{3+}, Cr^{3+}	**This study**
Tanzania	Yellowish green	4 rays	Needles	RI = 1.660–1.669 SG = 3.25	V^{3+}	**Laurs et al. (2019)**
Kenya	Yellowish green	None (faceted)	—	RI=1.652–1.662 SG = 3.23	Fe^{2+}, Cr^{3+}	Schmetzer and Krupp (1982)
Tanzania	Brown	None (faceted)	Parallel needles	α = 1.662 β = 1.667 γ = 1.673 SG = 3.33–3.41	—	Koivula et al. (1988)
Sri Lanka	Brown	6 rays	Hollow channels, 57° and 61°	—	—	Henn and Bank (1991)
Sri Lanka	Brown	4 rays	Rutile or sillimanite	—	—	Gübelin and Koivula (2008)
India	Brown	6 rays	Possible rutile needles, 57° and 64°	—	—	Eppler (1967)
Norway	Brown	4 rays	Ilmenite, 64°	RI n_α = 1.685 n_β = 1.693 n_γ = 1.697 SG = 3.35	Fe^{2+}	Schmitz et al. (2016)
Madagascar	Brown	6 rays	Needles, 57° and 62°	—	Fe^{2+}	Cathelineau (2019)

2019). In addition, these iron absorption features were superimposed by absorption bands around 420–490 nm and 600–700 nm due to the presence of V^{3+} with trace Cr^{3+} (see table 1). These two bands cause the absorption of the violet-blue and orange-red ends of the visible spectrum. Such overlapping absorption features allow the transmission window in the green to the yellow region, giving rise to the bright yellowish green color (Laurs et al., 2019). The origin of the absorption band at ~2220 nm, however, could not be resolved.

Semi-quantitative EDXRF chemical analyses revealed enriched contents of silicon (58.1–59.2 wt.% SiO_2), magnesium (26.5–31.5 wt.% MgO), and aluminum (6.3–8.1 wt.% Al_2O_3), with trace amounts of iron, calcium, titanium, vanadium, chromium, manganese, and zinc (table 1). Furthermore, the end-member compositions were calculated and appeared close to the enstatite end members (92.0–96.2% enstatite, 3.5–7.5% ferrosilite, and 0.3–0.5% wollastonite) of the enstatite-ferrosilite series.

In summary, the attractive bright yellowish green colors of these enstatites are caused by the combination of significant iron and vanadium with a trace of chromium substituting magnesium in the crystal lattice. The four-rayed asterism phenomenon is caused by light reflection

Figure 68. The 271.76 ct topaz was very light blue and transparent under daylight (A). Directing the flashlight as reflected light on the dome caused an eight-rayed star effect. Because of the wide light zone, the ray extending along the stone was blurred when the light was directed at the dome (B) and became more defined as the stone was moved (C and D). Photos by Le Ngoc Nang.

from two sets of very dense fine rutile needle inclusions intersecting one another at approximately 57° to 60°. The similarity of these stones and those reported by Laurs et al. (2019) (tables 1 and 2) leads us to conclude these stones could also be from Tanzania.

Supparat Promwongnan, Visut Pisutha-Arnond, Wilawan Atichat, Thanong Leelawathanasuk, and Cheewaporn Suphanan
Gem and Jewelry Institute of Thailand (GIT), Bangkok

Scott Davies
American-Thai Trading, Bangkok

Star topaz from Vietnam. In addition to ruby, sapphire, spinel, tourmaline, garnet, and aquamarine, Vietnam is a source of topaz, discovered in many mining areas of several northern and Central Highlands provinces. These crystals are mainly colorless or very light to light blue. In 2020, we purchased a star topaz, reported to be from Lam Dong, Vietnam (figure 68). It was cut and sold by a gem setter in Ho Chi Minh City.

This transparent oval cabochon weighed 271.76 ct and measured 43.98 × 32.16 mm and 19.12 mm tall. Observed with the unaided eye under a spotlight, it had a visible eight-rayed star effect. Testing at Liu Gemological Research and Application Center revealed the following standard gemological properties: refractive index—1.620–1.627 (measured on the flat polished bottom); hydrostatic specific gravity—3.56; biaxial optic figure under the polariscope; inert to long- and short-wave UV radiation; very weak pleochroism (colorless to light blue); and two-phase inclusions and needle-like inclusions. These characteristics confirmed a natural topaz.

We directed a flashlight as reflected light on the top of the stone, keeping the background dark to accentuate the phenomenon. An eight-rayed asterism appeared, caused by a strong band of light that extended along the length of the stone. This band of light formed the two main arms of the star. Six sharper arms extended from the main band. These six arms were formed by three bands—one perpendicular to the main light band and the other two inclined to it. Depending on the stone's orientation, the arms of the inclined light bands were split into two parts or crossed the intersection of the main light band and the light band perpendicular to it. Each pair of inclined arms formed an angle of ~98° (i.e., the single light band was inclined at ~49° to the main light band). The length and width of the rays changed when we directed the light at different angles (figure 68). See video of this effect at www.gia.edu/gems-gemology/spring-2022-gemnews-star-topaz-from-Vietnam.

Under the microscope, we recorded white needle-like inclusions but could not identify them. They were oriented in four directions, and this was responsible for the eight-rayed star effect. These inclusions did not form long nee-

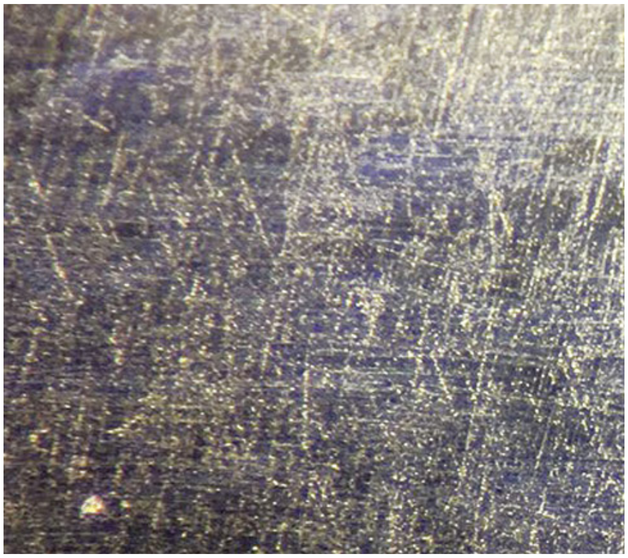
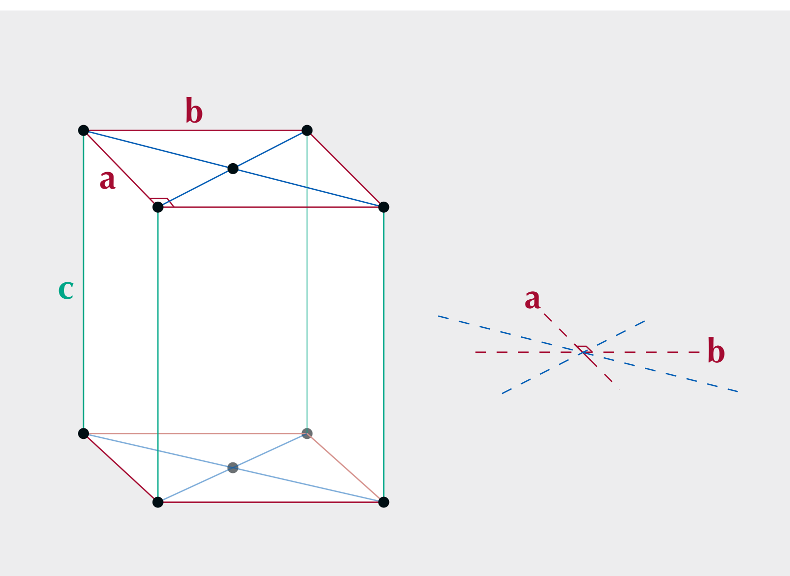


Figure 69. Needle-like inclusions arranged in four directions, viewed here from the top of the stone, created the asterism effect in the Vietnam topaz. Photomicrograph by Le Ngoc Nang.

dles but slightly elongated dashes that were unevenly distributed in the stone (figure 69). This uneven distribution of inclusions explains why some rays became blurred or vanished while others were continuous and sharp.

Topaz has been documented to have chatoyancy, four-rayed asterism (Spring 2007 GNI, p. 73; Summer 2008 GNI, pp. 182–183), and six-rayed asterism (M. Steinbach, *Asterism—Gems with a Star*, MPS Publishing and Media, Idar-Oberstein, Germany, 2016). However, there have been no reports of topaz with eight-rayed asterism. The orthorhombic system has four Bravais lattices: primitive, base-centered, body-centered, and face-centered. When the topaz crystal has a base-centered lattice, the needle-like inclusion will align to four directions on the (001) plane: two perpendicular directions of *a* and *b*, and two diagonal directions intersected at the center of the top and bottom faces of the lattice. These directions are perpendicular to the c-axis (figure 70). When the light reflects off these inclusions, an eight-rayed asterism will appear. A typical example of an orthorhombic mineral with an eight-rayed asterism was bronzite, introduced by Steinbach (2016). Nevertheless, this eight-rayed star topaz was a rare and intriguing case.

Figure 70. Bravais lattice with base-centered orthorhombic system (left). On the (001) plane, the needle-like inclusions aligned in four directions to form an eight-rayed asterism (right).



Le Ngoc Nang
Liu Gemological Research and Application Center and University of Science, Vietnam National University
Ho Chi Minh City

Pham Minh Tien
Liu Gemological Research and Application Center
Ho Chi Minh City

DIAMONDS

The discovery of davemaoite, the $CaSiO_3$ perovskite, in a diamond from Earth's lower mantle. Common silicate minerals such as olivine and garnet convert to other phases when brought to great depths in the planet, where they are subjected to extreme pressures. It has long been thought that two of the most common phases at depth in Earth have the perovskite structure. They have long been known from experimental studies in which they have been called magnesium silicate perovskite ($MgSiO_3$) and calcium silicate perovskite ($CaSiO_3$). Only recently has the magnesium silicate perovskite been found in nature, in a meteorite, where it was characterized and named bridgmanite (O. Tschauner et al., "Discovery of bridgmanite, the most abundant mineral in Earth, in a shocked meteorite," *Science*, Vol. 346, 2014, pp. 1100–1102). More recently, the calcium silicate perovskite has been found in a diamond and sufficiently characterized to be given a mineral species name (O. Tschauner et al., "Discovery of davemaoite, $CaSiO_3$-perovskite, as a mineral from the lower mantle," *Science*, Vol. 374, 2021, pp. 891–894).

Diamonds are one of the few minerals that bring us samples of the minerals found in the deep earth. Diamonds serve as chemically inert and nearly volume-conserving hosts for these minerals, thereby allowing them to retain

Figure 71. A typical coated diamond from Orapa. This is not the stone studied, but rather one from the same batch and locality with approximately the same color and size. Photo by George Rossman.

Figure 72. The polished slab of the diamond containing davemaoite showing the round spots where the grains were excavated for LA-ICP-MS analysis. Photo by Aaron Celestian.

their composition and in some cases even their original structure. The examination of the inclusions in an 81 mg (~0.405 ct) octahedral diamond from Orapa, Botswana, has resulted in the discovery of the high-pressure form of $CaSiO_3$ in the perovskite structure occurring as a natural mineral in the diamond (figure 71). This phase has been approved by the International Mineralogical Association with the name davemaoite, named in honor of Dave (Ho-kwang) Mao, for his contributions to understanding the deep-mantle geophysics and petrology of our planet.

Experimental studies in the laboratory have indicated that $CaSiO_3$ assumes the perovskite structure at depths between 420 and ~2700 km. This phase, first synthesized in 1975 (L. Liu and T. Ringwood, "Synthesis of a perovskite-type polymorph of $CaSiO_3$," *Earth and Planetary Science Letters*, Vol. 28, 1975, pp. 209–211), is only thermodynamically stable at pressures greater than 200,000 atmospheres (20 GPa). Furthermore, the rate of back-conversion to low-pressure polymorphs is rapid if the pressure is lowered. Consequently, the natural mineral is unlikely to survive transport from the deep earth to the surface.

Davemaoite was first identified and characterized within a diamond studied at the Advanced Photon Source at Argonne National Laboratory in Illinois, where an X-ray beam was focused to a 0.5 × 0.5 μm spot. Calcium-rich inclusions in the diamond were first located. Two inclusions, 4 × 6 μm and 4 × 16 μm in size, were examined with X-ray diffraction. They both produced a perovskite pattern. Their identity was further confirmed by infrared spectroscopy. Theoretically, a cubic perovskite has no Raman pattern, and none was obtained from these inclusions. The inclusions were next excavated from the surrounding diamond and analyzed with laser ablation–inductively coupled plasma–mass spectrometry (LA-ICP-MS) (figure 72). Their composition corresponded to the calcium silicate perovskite.

Davemaoite is significant in Earth's deep mantle because it acts as a host to many elements that are incompatible with upper-mantle minerals, fulfilling a role that garnet plays in the upper mantle. Davemaoite may be the most geochemically important phase in the lower mantle because it will act as a repository in which the radioactive, heat-generating elements thorium and uranium become concentrated. Calculations suggested that davemaoite was entrapped in the host diamond at pressures of at least 290,000 atmospheres and temperatures of at least 1400 K. These diamonds from Orapa are also noteworthy because in addition to davemaoite, a high-pressure form of ice was found as a solid inclusion within them where the diamond's internal pressure was great enough to maintain the ice in the solid form, allowing it to be characterized as the new mineral species ice-VII (O. Tschauner et al., "Ice-VII inclusions in diamonds: Evidence for aqueous fluid in Earth's deep mantle," *Science*, Vol. 359, 2018, No. 6380, pp. 1136–1139).

George R. Rossman
Division of Geological and Planetary Sciences
California Institute of Technology

Oliver Tschauner
Department of Geoscience
University of Nevada, Las Vegas

Natural near-colorless type IIb diamond. While colorless to near-colorless HPHT laboratory-grown diamonds usually contain detectable boron impurities (classified as type IIb; see S. Eaton-Magaña et al., "Observations on HPHT-grown synthetic diamonds: A review," Fall 2017 *G&G*, pp. 262–284), it is uncommon to encounter a boron-bearing diamond of natural origin due to its rarity (0.02% of natural gem diamonds; E.M. Smith et al., "Blue boron-bearing diamonds from Earth's lower mantle," *Nature*, Vol. 560, No. 7716, 2018, pp. 84–87). The boron concentrations in natural diamonds are generally low (typically <1 ppm), but boron is such an efficient coloring agent that it imparts a blue color to most type IIb diamonds. However, exceptions still exist. For example, when boron absorption is accompanied by absorptions from plastic deformation, the combined effects may give rise to other colors (e.g., yellowish green; Spring 2012 Lab Notes, pp. 47–48; see also Summer 2009 Lab Notes, p. 136). Occasionally, some type IIb diamonds are near-colorless because their boron concentrations are too low to cause a blue color (e.g., E. Fritsch and K. Scarratt, "Natural-color nonconductive gray-to-blue diamonds," Spring 1992 *G&G*, pp. 35–42), but they are far from common. Therefore, any near-colorless type IIb diamond submitted to a gem laboratory should be given particular attention to determine its possible lab-grown origin.

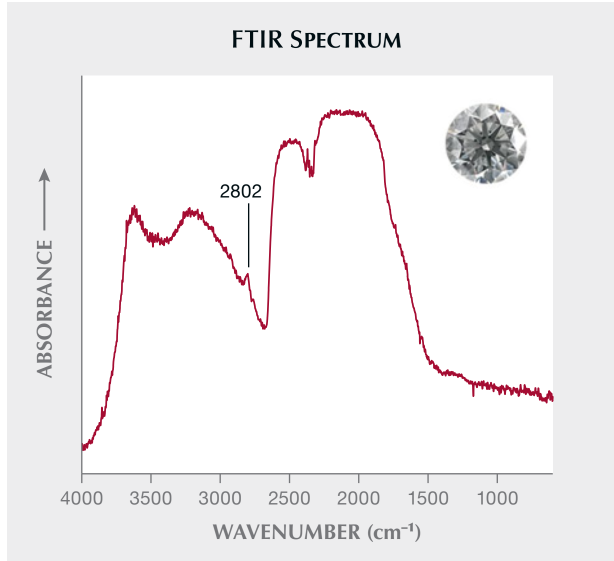


Figure 73. FTIR spectrum of the sample showing a band (2802 cm^{-1}) characteristic of type IIb diamond.

Recently, we had the opportunity to examine such an example. This 0.24 ct round brilliant cut had an I color grade due to its grayish component, usually seen in natural type IIb diamond. Fourier-transform infrared (FTIR) absorption spectroscopy detected a weak band at 2802 cm^{-1} (figure 73), characteristic of uncompensated boron, and identified the sample as type IIb. The diamond was inert to both long- and short-wave ultraviolet radiation. When observed with the DiamondView, it exhibited blue fluorescence and moderate blue-green phosphorescence (figure 74). The dislocation net-

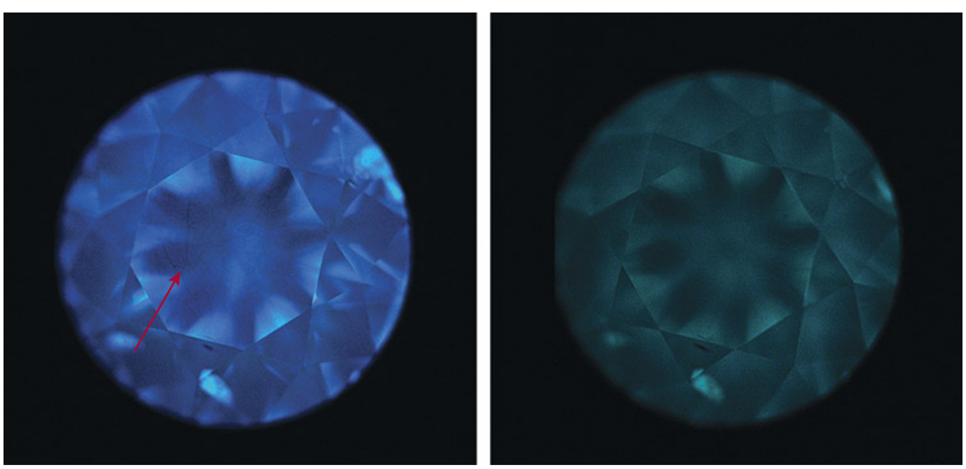


Figure 74. DiamondView imaging of the 0.24 ct diamond revealed blue fluorescence (left) and moderate blue-green phosphorescence (right). Subtle dislocation networks on the table (red arrow) that resulted from plastic deformation, typically observed in type IIa and IIb diamond, are consistent with a sublithospheric origin. Images by Wenqing Huang.

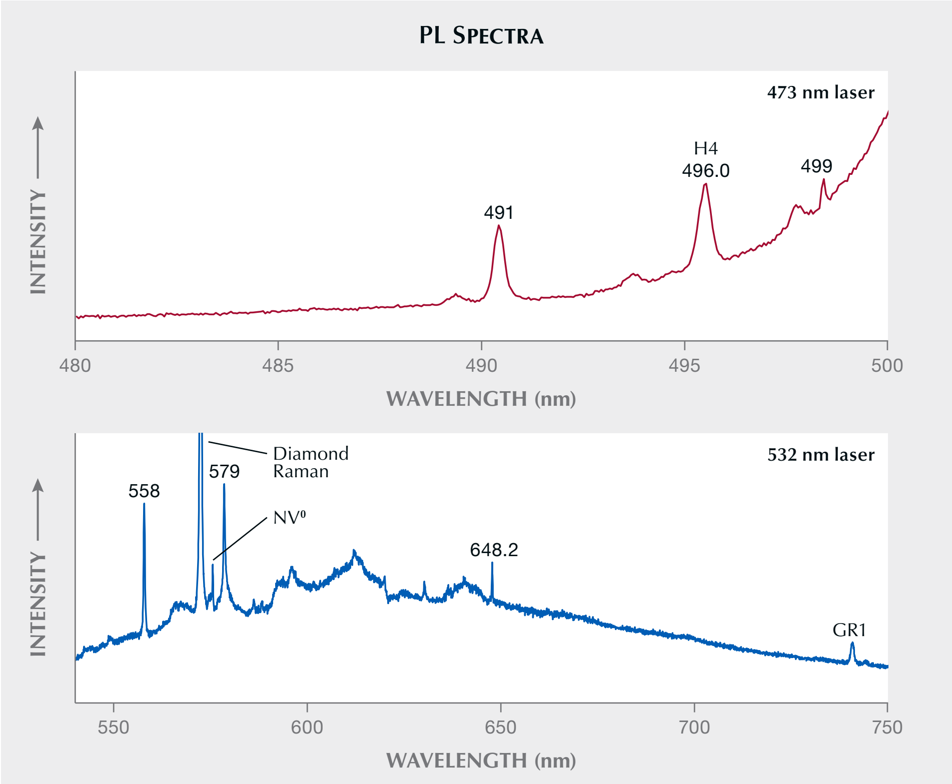


Figure 75. Photoluminescence spectra from the type IIb diamond under 473 nm and 532 nm laser excitations. Nitrogen-related defects such as H4 (top) and NV^0 (bottom) were observed, along with GR1 (bottom).

works observed on the table (figure 74, left), typically seen in some natural type IIa and IIb diamonds but not previously described for lab-grown diamonds, suggest a natural origin. Further evidence of natural origin came from photoluminescence (PL) spectroscopy and inclusion analysis.

Multiple laser excitations (473, 532, and 633 nm) were used to characterize its photoluminescence features at liquid nitrogen temperatures. The PL spectrum measured with a 473 nm excitation revealed the presence of nitrogen-related defect H4 (496.0 nm) (figure 75, top). PL spectroscopy using a 532 nm laser (figure 75, bottom) revealed the occurrence of GR1, NV^0, and a sharp peak at 648.2 nm that is probably related to interstitial boron, all of which have been documented previously in type IIb diamonds (S. Eaton-Magaña et al., "Natural-color blue, gray, and violet diamonds: Allure of the deep," Summer 2018 *G&G*, pp. 112–131). Nickel defect-related peaks (883/884 nm), a common feature in HPHT laboratory-grown diamonds of various colors, were not detected with any of these excitations.

Magnification indicated several solid inclusions (figure 76), mostly in the crown, that resulted in its SI_1 clarity grade. The inclusion scenes were consistent with those described in natural type IIb blue diamonds (Smith et al., 2018). Namely, they tended to show a tiny satellite-like appearance composed of the main inclusion and accompanying decompression cracks. Raman spectra using a 532 nm laser revealed that two of these inclusions were coesite (figure 77). This feature confirmed the diamond's natural origin. Coesite is a relatively common inclusion in lithospheric diamonds that formed at depths of ~150–200

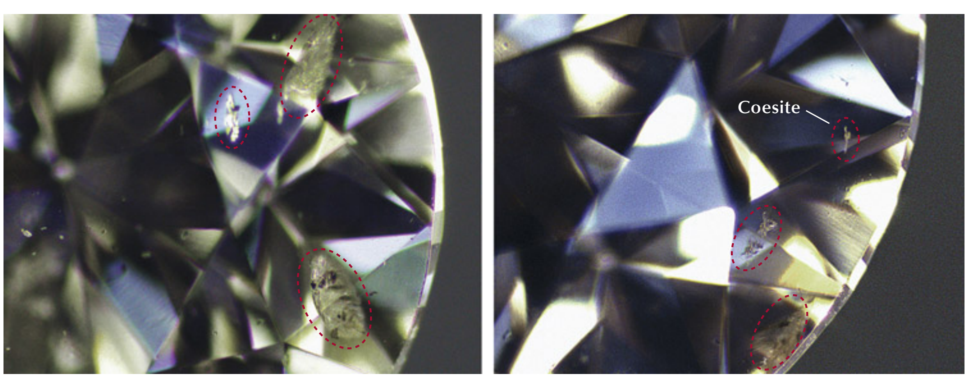


Figure 76. Inclusions (outlined in red circles) observed in the type IIb diamond tended to show a satellite-like appearance. Fields of view are 2.5 mm (left) and 2 mm (right), respectively. Photomicrographs by Wenqing Huang.

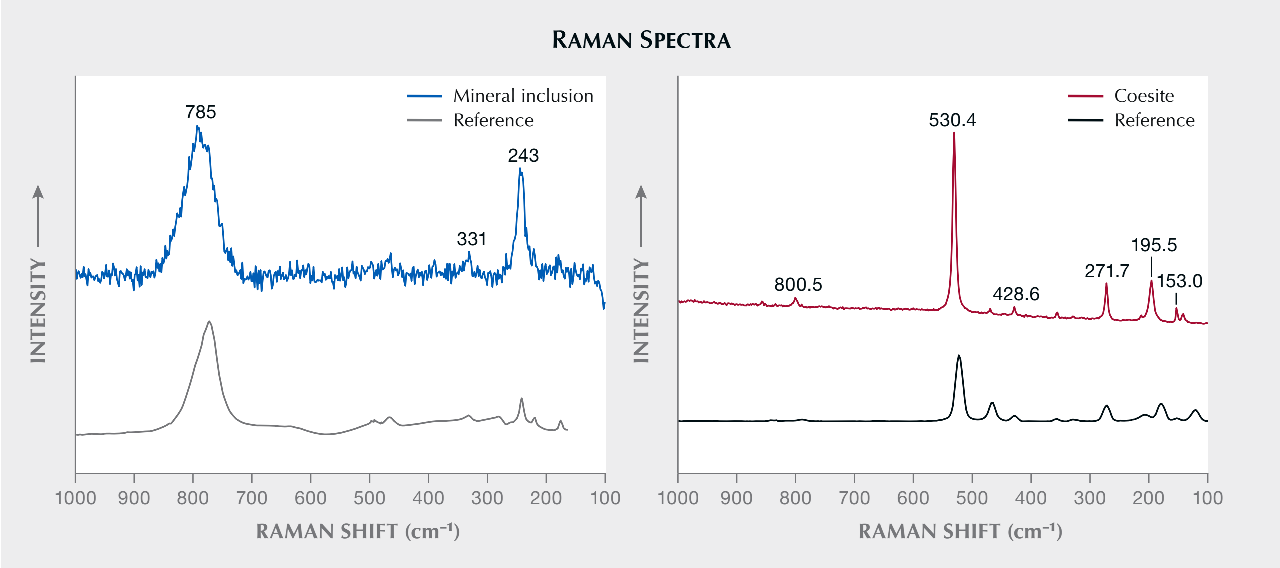


Figure 77. Raman spectra of mineral inclusions in the type IIb diamond. Left: Baseline-corrected Raman spectra of a mineral inclusion (blue line) match the $CaTiO_3$ perovskite reference spectrum (light gray line) from Nestola et al. (2018). The included mineral could be perovskite or $CaSiO_3$ perovskite, since their Raman spectra are almost indistinguishable. Right: Baseline-uncorrected Raman spectrum of a coesite inclusion inverted from the presumed stishovite, showing main bands at approximately 530, 272, and 195 cm^{-1}. Reference spectrum is from RRUFF-X050094.

km. However, recent studies show that type IIb diamonds have a sublithospheric origin and are formed in the upper part of the lower mantle (Smith et al., 2018). For type IIb diamond formed at such depths, the coesite inclusion has not been considered to be in its original pristine form, but rather the back-transformation product from stishovite. Another inclusion showed bands matching roughly with perovskite ($CaTiO_3$) (figure 77), but its precise mineralogy was difficult to determine. This is because the Raman spectra of perovskite and $CaSiO_3$ perovskite, both of which have been described in sublithospheric diamonds, are very similar (F. Nestola et al., "$CaSiO_3$ perovskite in diamond indicates the recycling of oceanic crust into the lower mantle," *Nature*, Vol. 555, No. 7695, 2018, pp. 237–241). No matter what exact mineral this inclusion corresponds to, its occurrence implies a sublithospheric origin for the host diamond. Other mineral inclusions could not be identified, probably because of their depth within the diamond.

Due to the scarcity of natural type IIb diamonds, any near-colorless diamond that contains boron detectable by FTIR spectroscopy should be given close attention to determine its origin. The near-colorless type IIb diamond examined here, though rarely encountered, was identified as natural on the basis of its gemological and spectroscopic characteristics.

Ting Shui
China Geological Survey, Nanjing

Wenqing Huang
National Center of Inspection and Testing on Quality of Gold and Silver Products
Nanjing Institute of Product Quality Inspection

SYNTHETICS AND SIMULANTS

Barite-calcite composite as imitation "Wulanhua" turquoise from Hubei Province, China. "Wulanhua" turquoise is well known in the Taiwan and mainland China market. It has also been called "Ulan flower" turquoise in previous publications (L. Liu et al., "Unique raindrop pattern of turquoise from Hubei, China," Fall

Figure 78. The bracelet submitted as "Wulanhua" turquoise. Photo by Shu-Hong Lin.

2020 *G&G*, pp. 380–400). The term "Wulanhua" is a Chinese transliteration that means black orchid, and it usually refers to turquoise of medium dark to very dark blue color with a black spiderweb pattern found in Hubei Province.

A bracelet recently submitted to Taiwan Union Lab of Gem Research (TULAB) as Wulanhua turquoise (figure 78) contained dark blue opaque beads with a black spiderweb pattern on the surface. The spot refractive index of these beads was about 1.62–1.63, close to that of turquoise. EDXRF analysis determined that the composition of the beads was inconsistent with that of turquoise ($CuAl_6(PO_4)_4(OH)_8{\cdot}4H_2O$). Instead, it was composed mainly of barium (Ba) and calcium (Ca).

To further identify the composition, Raman spectra (785 nm laser) were analyzed and compared with those from the RRUFF database. The beads displayed mixed spectra of barite, calcite, and other unknown materials. With the consent of the client, a bead was cut into two halves and polished for more testing. One half was immersed in 95% ethanol for 72 hours to extract the dark blue dye (figure 79). After the ethanol volatilized, the blue precipitate was analyzed with Raman spectroscopy and the spectrum was compared with that of the bead and the spectra from the RRUFF database. Raman analysis and the extraction experiment revealed that this material was composed of barite and calcite with an unidentified blue dye (figure 80). Microscopic observation of the cross section suggested that the beads were made of irregularly shaped barite and barite with minor calcite particles with an unknown black filling as a bonding material (figure 81).

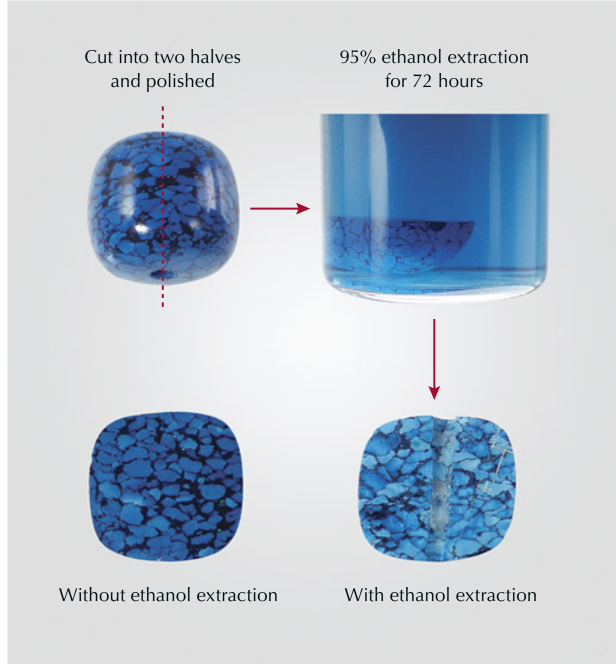


Figure 79. A bead from the bracelet was cut into two halves. One half was immersed in 95% ethanol for 72 hours, clearly extracting the blue dye. Photos by Yu-Ho Li.

The beads could be defined as a composite material made of barite ($BaSO_4$), calcite ($CaCO_3$), and blue dye.

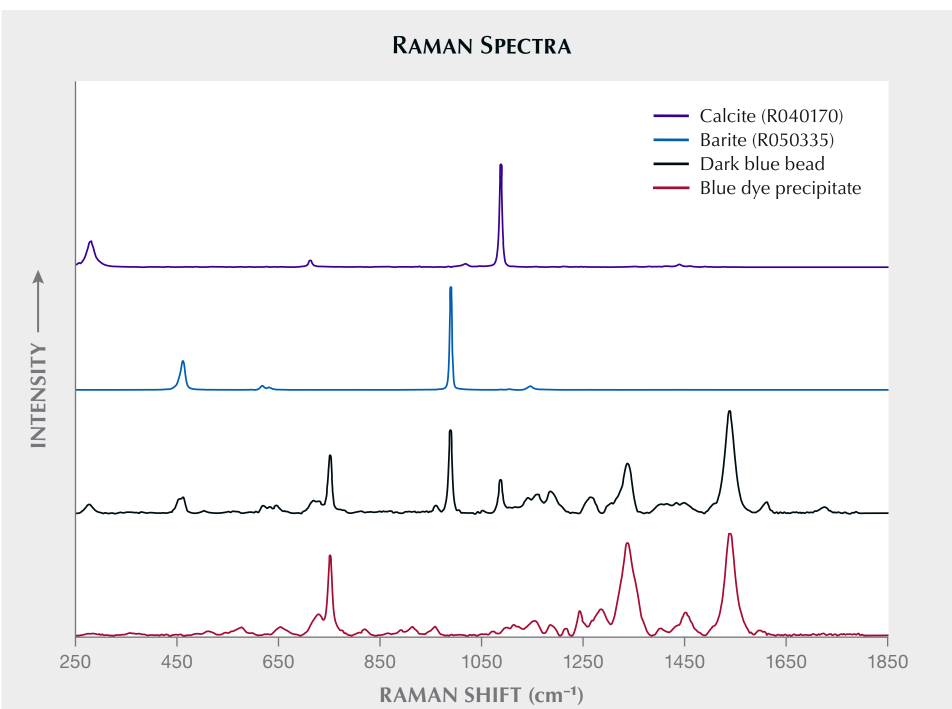


Figure 80. Raman spectra comparisons between the bead, the blue dye precipitate, and those of barite and calcite from the RRUFF database suggest that the bead consisted of barite, calcite, and blue dye. The stacked spectra are baseline-corrected and normalized.

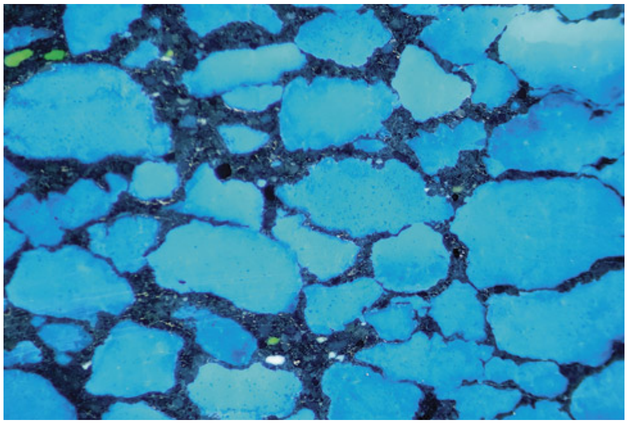


Figure 81. The cross section of one bead showed irregularly shaped barite and barite with minor calcite particles, along with a black filling that could be some unknown bonding material. Photomicrograph by Shu-Hong Lin; field of view 8.56 mm.

While visual observation and refractive index might not be enough to distinguish these beads from true Wulanhua turquoise, Raman spectroscopy and EDXRF analysis were able to reveal their true identity.

Shu-Hong Lin
Institute of Earth Sciences, National Taiwan Ocean University
Taiwan Union Lab of Gem Research, Taipei
Yu-Ho Li
Institute of Earth Sciences, National Taiwan Ocean University
Huei-Fen Chen
Institute of Earth Sciences, National Taiwan Ocean University
Center of Excellence for Oceans, National Taiwan Ocean University, Keelung

TREATMENTS

Amber filled with epoxy resin. Amber prayer beads are very popular in the Gulf countries. Due to this high demand, the Dubai Central Laboratory receives many of them for identification. Recently we noticed that a majority of the amber rosary samples received for identification contain an epoxy resin filling. These fillings are seen in cavities of different sizes but sometimes show up in tiny veins.

The fillings are not always easy to detect without magnification because of the nearly identical luster of both amber and epoxy, but sometimes they are obvious, as shown in figure 82. Occasionally gas bubbles can be observed in epoxy fillings by microscope. Fillings may show a mixed reaction under both long-wave and short-wave UV radiation, and the fluorescence is more intense in long-wave UV. Filled beads can be inert under UV or show weak to strong white or blue fluorescence (figure 83).

Figure 82. Epoxy resin is easily detected in the amber of this rosary. Photo by Nazar Ahmed Ambalathveettil.

To identify the fillings, we observed the rosary under the microscope, marked the suspected areas or spots, and analyzed them by Raman spectroscopy to confirm the presence of fillings. The spectra were compared with those of amber and epoxy reported previously in *G&G* (figure 84;

Figure 83. When exposed to long-wave UV radiation, the epoxy resin displayed weak to moderate white fluorescence. Photo by Nazar Ahmed Ambalathveettil.

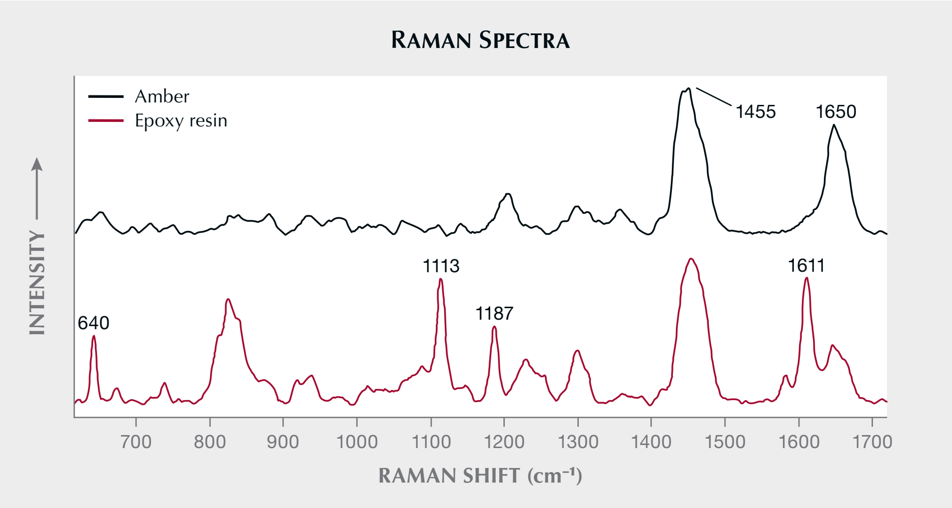


Figure 84. The Raman spectra of the bead and the cavity filling shown here matched with spectra previously reported in G&G *for amber and epoxy resin.*

see Fall 2013 GNI, pp. 181; Summer 2021 GNI, pp. 179–180). Nowadays, having an amber rosary tested by a gemstone laboratory before buying can avoid a costly mistake.

Nazar Ahmed Ambalathveettil (nanezar@dm.gov.ae), Nahla Yaqub Al Muhari, and Sameera Mohammed Ali
Gemstone Unit, Dubai Central Laboratory

Characteristics of amber with irradiation treatment. The organic gem amber is particularly popular in China, Europe, the Middle East, and South Asia. With strong demand for rarer colors, some enterprises use electron accelerator–charged particles or ^{60}Co gamma-ray radiation to irradiate amber and enhance its color from light yellow to orange-yellow and orange-red.

As early as 2012, foreign suppliers tried to introduce irradiation-treated amber into the Chinese market. Due to the booming demand for natural golden and beeswax amber in the Chinese market, amber manufacturers had little interest in the irradiated products. After the market cooled in late 2015, irradiated amber emerged as a new variety (figure 85). Some irradiated amber (containing microstructure defects in the original material before treatment) was accompanied by dendritic inclusions with

Figure 85. A: Rough amber material after irradiation treatment. B: Irradiated amber products with dendritic inclusions. C: Irradiated amber pendants without root-like inclusions and irradiated amber with a red-white alternating pattern (far right). D: The current irradiated amber products have much more natural color. Photos by Yamei Wang.

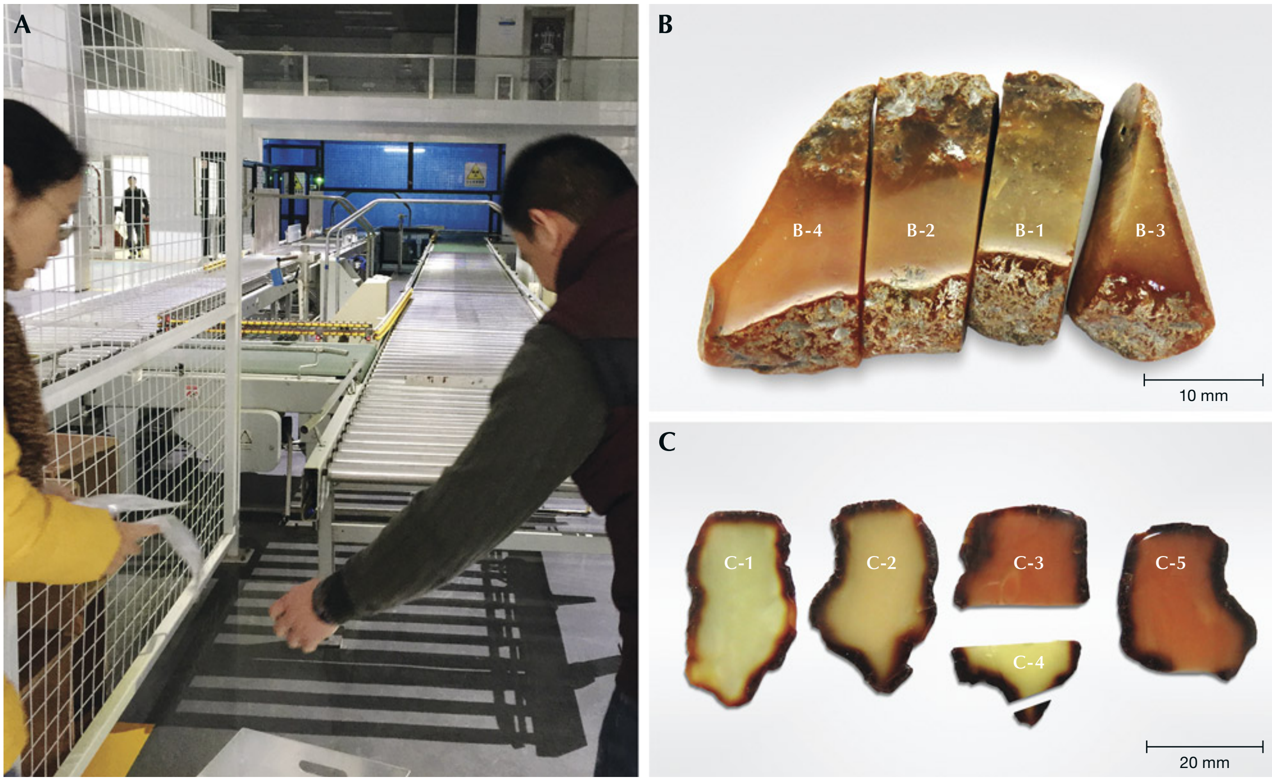


Figure 86. A: The irradiation treatment of amber via an IBA Rhodotron TT200 accelerator. B: The color improvement of sample 1 at different irradiation doses: before irradiation (B-1) and after irradiation doses of 10 kGy (B-2), 150 kGy (B-3), and 200 kGy (B-4). C: Color enhancement and annealing of sample 2 with different irradiation doses: before irradiation (C-1) and after irradiation doses of 10 kGy (C-2), 170 kGy (C-3), and 200 kGy (C-5). C-4 shows discoloration after heat treatment (10 minutes, 100°C) after cutting. Photos by Yamei Wang.

color enhancement or change (figure 85B). The amber materials used for irradiation treatment were selected from Baltic amber. After irradiation, the red color was usually internally uniform when the weathered skin was polished. Due to differences in original bodycolor and flow pattern, the irradiated amber with the superimposed red color can be red, orange-red, orange-yellow, or yellow-brown, or have a red-white alternating pattern (figure 85C, far right). Early irradiated amber from the end of 2015 was easy to identify due to the presence of dendritic inclusions. Recently, the generation of dendritic inclusions has been suppressed and the quality of the samples has improved (figure 85C). The dendritic inclusions are basically inhibited, and the irradiated amber will not produce them as long as there are no cracks or defects on the surface that can be broken down by the irradiation source. Moreover, the enhanced color via irradiation treatment is much more natural (figure 85D).

The authors selected 13 Baltic rough amber samples for irradiation treatment via an IBA Rhodotron TT200 electron accelerator to investigate the effects of different irradiation doses on the color enhancement of amber (figure 86A), considering that the utilization of high-energy gamma-ray could change its color into red, possibly accompanied by the introduction of dendritic inclusions.

Since the irradiated amber on the market consists of Baltic amber, 12 of the 13 sample groups were Baltic amber (including transparent, translucent, and opaque yellow polished double-sided wafers and round beads), and one group was Burmese amber. The irradiation dose ranged from 10 to 200 kGy (1 kGy = 1000 J/kg), accumulated multiple times, and the samples began to display a red color at 150 kGy. When the irradiation dose reached 200 kGy, the samples turned obvious red, and the irradiation effect showed most clearly. The color changes of representative samples (1 and 2) under different radiation doses were selected; only sample 1 with surface cracks produced dendritic inclusions. When the irradiation dose exceeded 200 kGy, the samples turned varying degrees of red (figure 86B); sample 2 most clearly showed the effect (figure 86C).

The dendritic inclusions are triggered by microstructure defects (physically weak points) and extend like microfractures (figure 87). The roots usually start from the micro defects of amber and form a structural deterioration zone with microcracks. Under the high-energy electron beam,

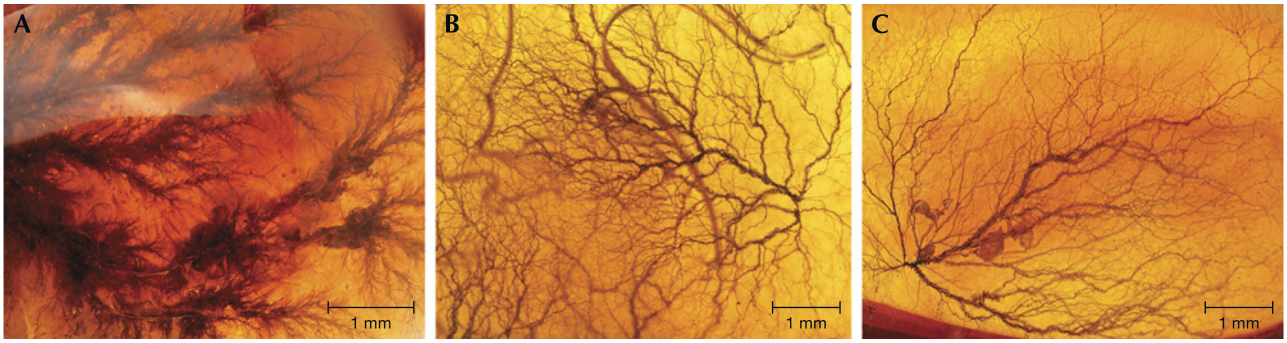
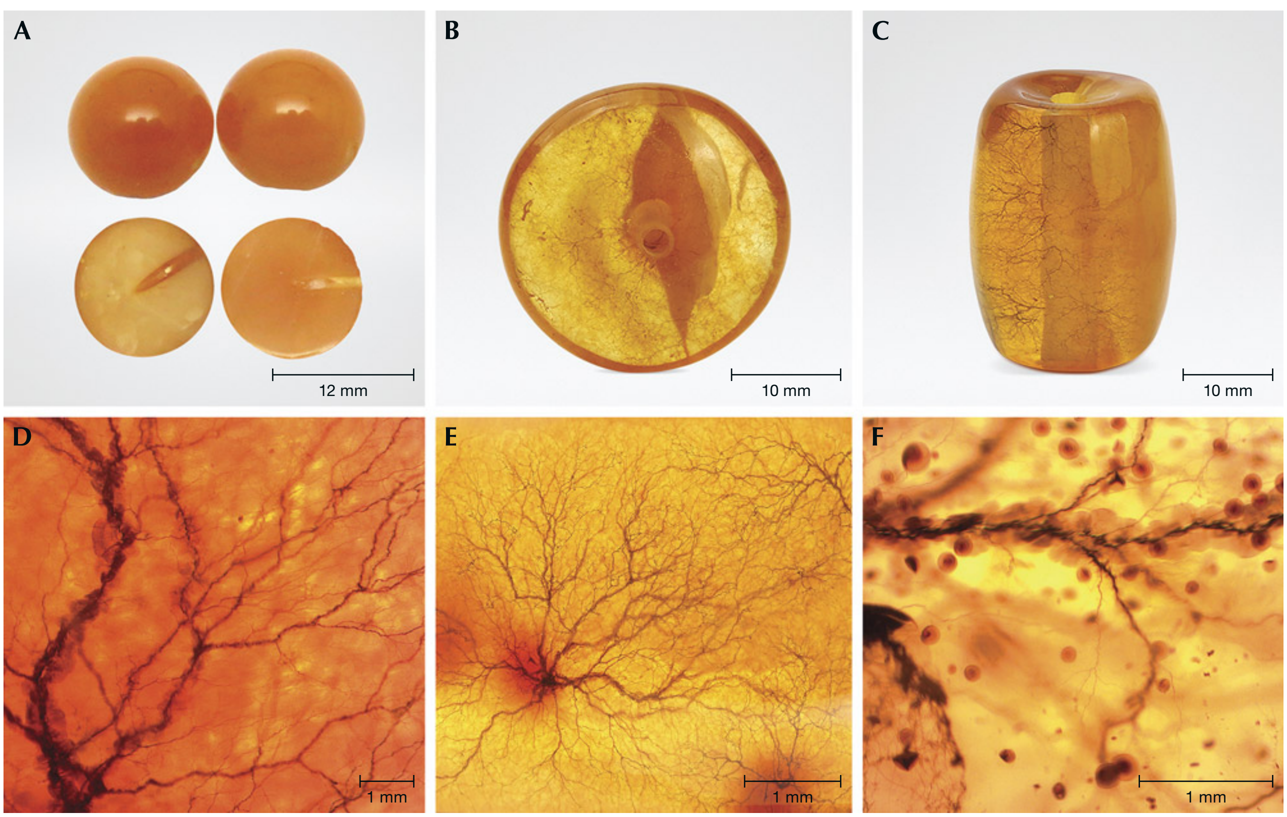


Figure 87. Various appearances of the dendritic inclusions. Photomicrographs by Yamei Wang.

the microcracks in the degradation zone expand rapidly and connect to form a submicroscopic "tree." The continuous development of the submicroscopic tree forms the root-like whisker region with a macro fractal structure. The growth of dendrites can be regarded as a random growth process of fractal clusters composed of discontinuous microcracks.

If the irradiated amber undergoes heat treatment at 100ºC for 10 minutes in an oven, its original color will be restored (figure 88A and figure 85, C-4); the treated color can also fade and return to its original yellow after heating in a pressure furnace. But once the dendritic inclusion is formed, it is irreversible (figure 88B). After about a year in a natural environment, the induced color from irradiation will automatically fade (figure 88C). Along with a significant reduction in brightness, the color will no longer be uniform (figure 88D) and color spots will appear (figure

Figure 88. Discoloration of irradiated amber. A: Two irradiated round beads cut into halves (top). Bottom left: the half bead heated in an oven at 90°C for 10 minutes fades to yellow; on the bottom right, the internal color is uniform after irradiation. B: Heating the bead in the pressure furnace restores the original color but does not heal the root pattern. C: The irradiated color gradually fades after natural storage for 12 months. D: The color of irradiated amber becomes uneven after natural fading. E: Red spots appear at weak points of the dendrites. F: Red dots remain at the site of irradiation. Photos by Yamei Wang.



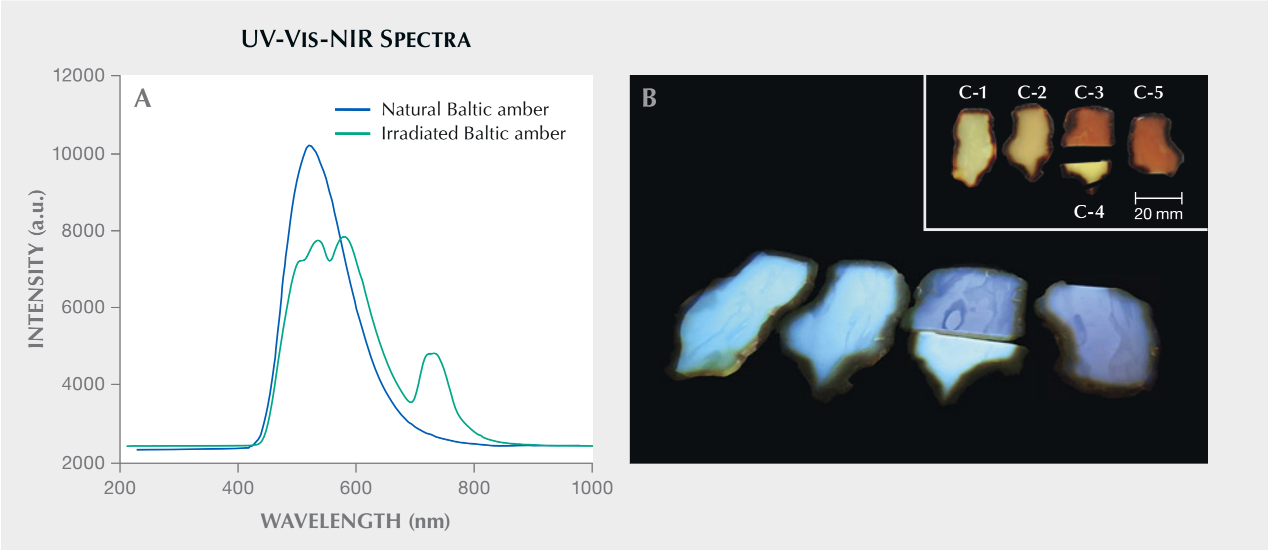


Figure 89. A: The UV-Vis-NIR spectra of natural and irradiated Baltic amber. B: The fluorescence characteristics of irradiated amber under a 365 nm UV lamp. Sample C-2 with a small irradiation dose of 10 kGy; sample C-4 shows discoloration after heat treatment at 100°C for 10 minutes. Photo by Yamei Wang.

88E). Even the original irradiation points are clearly displayed as color spots after fading (figure 88F), indicating that the irradiated color is not stable.

Some irradiated ambers with bright color and high transparency that lack the dendritic inclusions can be distinguished using a conventional 365 nm ultraviolet lamp, but the treatment of lighter-colored amber is not as easy to distinguish. The non-irradiated natural Baltic amber showed a strong absorption peak at 521 nm. The irradiated Baltic amber (orange-red) showed three characteristic peaks at 535, 578, and 728 nm (figure 89A). Dendritic inclusions are common in the earlier versions of irradiated amber. In addition, as the irradiation dose increases, the fluorescence intensity of the amber weakens. Under the 365 nm UV lamp, irradiated amber (samples C-3 and C-5 with irradiation doses higher than 150 kGy) has weaker fluorescence intensity than natural amber. Furthermore, the weaker florescence is superimposed on the darker bodycolor of orange-red (C-3, C-5). The fluorescence of amber with heat treatment (C-4) is the same as that of unirradiated natural sample (C-1).

Yan Li, Yamei Wang, and Quanli Chen
Gemological Institute, China University of Geosciences
Wuhan

ANNOUNCEMENTS

18th Annual Sinkankas Symposium. The 2022 Sinkankas Symposium, an annual event featuring presentations by specialists in gem-related disciplines, will follow a virtual format once again this year with pre-recorded sessions available on-demand. Sponsored by the Gemological Society of San Diego, the Geo-Literary Society, and GIA, the symposium will include 10 pre-recorded 30-minute presentations available to view from April 25 through June 6, highlighting alexandrite and other color-change gemstones (figure 90).

Speakers will include Evan Caplan, William Larson, Cigdem Lüle, Sally Eaton-Magaña, Niveet Nagpal, Nathan Renfro, Stuart Robertson, Aaron Palke, George Rossman, Wim Vertriest, and Robert Weldon. The presentations will cover a variety of topics regarding alexandrite and other color-change gemstones, from characteristics and sources to market trends and photography.

Registration closes June 1. The registration cost of $25 includes a PDF of the symposium volume, available June 23. Visit https://sinkankassymposium.net for more details.

Figure 90. A 32.35 mm alexandrite twinned crystal and a 2.61 ct faceted alexandrite, both from Russia, shown in daylight (left) and incandescent light (right). Photos by Robert Weldon; courtesy of William Larson.