G&G

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TUCSON 2016

For decades, buyers and sellers from every aspect of the gem and jewelry industry have flocked to the gem fair in Tucson, a town in the heart of Arizona's Sonoran Desert that is rich in cultural and natural heritage. The annual shows are widely considered a forecast for the rest of the year. While the shows of the past few years have reflected a sluggish industry, the atmosphere in 2016 was dramatically different, with an increase in both attendance and business. The 34th AGTA GemFair saw record pre-registration numbers, and more than 300 exhibitors greeted a full house of buyers on the opening day. Gabrièl Mattice of Pala International (Fallbrook, California) said that sales were very strong this year, even on the first day of the show. The energized interaction between exhibitors and buyers was evident throughout the convention center. Though diamond sales have slowed, colored stones have gradually gained momentum among jewelry customers, and designers are responding in kind. Although the overall market share for colored stones is still small compared to the diamond sector, efforts to promote them have had very positive results.

Figure 1. Tucson's GJX show saw considerable traffic this year, including a higher number of American buyers. Photo by Andrew Lucas.

More Serious Buyers. After the surge of foot traffic on the opening day, attendance remained stable at the shows for the rest of the week (figure 1). Vendors saw fewer Chinese buyers than in 2014, though Josh Saltzman of Nomad's Co. (New York) indicated that those who came were serious buyers picking up high-quality goods. Gaurav Shah from Real Gems Inc. (New York) confirmed that his company has seen greater demand for emerald in mainland China since 2007, a market that slowed in 2015. He said that the Chinese are more cautious and specific in their purchases, and he predicted an upswing in Chinese buying activity in the near future. Joseph Nakamura of Shogun Pearl (White Plains, New York) said that 95% of his customers were from the United States, while Gabrièl Mattice also saw many Europeans on the floor, especially French buyers. Many new buyers attended, possibly due to the stabilized prices and heightened interest in colored stones (figure 2). Mr. Shah observed three categories of clients in Tucson: buyers from television and Internet companies, retailers, and designers.

David Bindra of B&B Fine Gems (Los Angeles) noted that the number of transactions relative to the attendance was much higher than in previous years. He felt that this year's AGTA show was much better than the September 2015 Hong Kong Jewellery and Gem Fair, where many sellers felt the slowdown of the mainland Chinese market.

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Figure 2. A customer examines some calibrated emeralds at the Real Gems booth in the AGTA show. Photo by Tao Hsu.

Calibrated Goods. Though high-end colored gems continue to set auction records, the market for these stones remains slow. As a result, the colored stone trade still mainly consists of goods in standard calibrated sizes rather than custom-cut material (figure 3). Many cutting factories are able to provide a greater selection of sizes that fit their clients' requirements. This especially benefits the jewelry manufacturers in China and India, as setting calibrated gems is the bulk of their workload. Thus, mid-priced colored goods were the overall best sellers in Tucson. Nirmal Bardiya of RMC Gems (Bangkok) informed us that calibrated goods of various millimeter sizes are best sellers in the American market, while Arthur Groom Jr. of Eternity Natural Emerald (Ridgewood, New Jersey) noted that Afghan emerald melee is one of his biggest sellers. Guarav Shah reported that the most popular calibrated cuts are oval, emerald, and pear shapes; these goods generally range from \$200–\$2,000 per carat.

Figure 3. Assorted goods in calibrated sizes sold very well at the shows. Photo by Tao Hsu.

Figure 4. Morganite attracted many American buyers this year. Photo by Andrew Lucas.

Classics. No single stone stole the show this year. Some relatively new varieties were available, but their potential is still hard to evaluate. Some people asked about the color-change pink pyrope garnet that has recently been covered by multiple trade magazines, including the Winter 2015 *G&G*. Ms. Mattice said it will take time to educate people about this stone, and it is not easy to predict the market potential. Mr. Bardiya informed us that morganite (figure 4), aquamarine, and blue topaz were popular among RMC's American clients. According to Joseph Nakamura, white pearls still dominate, while other colors come and go with different fashion trends. According to multiple dealers, Paraíba tourmaline is still in high demand (figure 5).

Even so, the "big three" of ruby, sapphire, and emerald still dominate the market and fetch higher prices, which was reflected in this year's shows. Corundum is still the most popular material in the high-end sector. David Bindra and Gabrièl Mattice both said that sapphires sold very well,

Figure 5. According to many exhibitors, Paraíba tourmaline remained one of the shows' best sellers. Photo by Andrew Lucas.

Figure 6. Colored stone jewelry is becoming increasingly popular among consumers, as designers such as Paula Crevoshay use colors in more creative ways. Photo by Tao Hsu.

and Mr. Bindra thinks that blue and green material will be especially strong this year, though yellow sapphires drew more interest than at previous shows. Pink and pastel-colored sapphires also attracted many buyers, perhaps because they evoke rose quartz and serenity blue, Pantone's colors of the year for 2016.

Interest and Demand for Color. As one of the best platforms to trade and promote colored gemstones, the Tucson shows provide buyers with the finest goods sourced from all over the world. Some one-of-a-kind stones debut here, such as the 332.24 ct Imperial topaz carving seen on pp. 88–89. Spectacular stones such as these usually attract immediate attention.

Mr. Bindra tied the increase in sales to a growing awareness of colored stones. Once-daunted consumers are becoming more knowledgeable about different varieties and are better prepared before they purchase. This interest in learning was reflected at the AGTA GemFair seminars, which saw a 30% increase in attendance.

Greater appreciation for colored stones motivates designers and retailers to source more of them (figure 6). Mr. Shah did business with more designers than in previous shows. The authors themselves saw materials in more unique cuts that seemed intended to capture the designers' imagination (figure 7). Mr. Shah said that even though Real Gems is a wholesaler, the company does not have a minimum order requirement for any buyers. This is very helpful for many designers, especially the young ones. This exhibitor feels that it is worthwhile to do business with people who are willing to work with and promote colored stones in their own work.

Summary. Based on their own observations, the authors were not surprised to hear vendors say that this was one of the strongest Tucson shows in recent history. People were encouraged by the renewed momentum of the American market, even though high-end buyers were still cautious. Relatively stable prices also contributed to increased sales, although the price of sapphire, ruby, and emerald remained high. With the positive forecast from Tucson, the trade is expecting a prosperous 2016.

We thank the many exhibitors who provided insight, photos, and materials.

Tao Hsu and Andrew Lucas
GIA, Carlsbad

Afghan emerald, Tajik ruby, and clarity-enhanced tourmaline. Eternity Natural Emerald (Ridgewood, New Jersey) exhibited a number of fascinating stones at the AGTA show. The emerald melee from Afghanistan (figure 8) immediately caught our attention. One of the authors was present in Afghanistan when Eternity's Arthur Groom ex-

Figure 7. Some pieces offered excellent options for designers who wish to create a unique look. Photo by Tao Hsu.

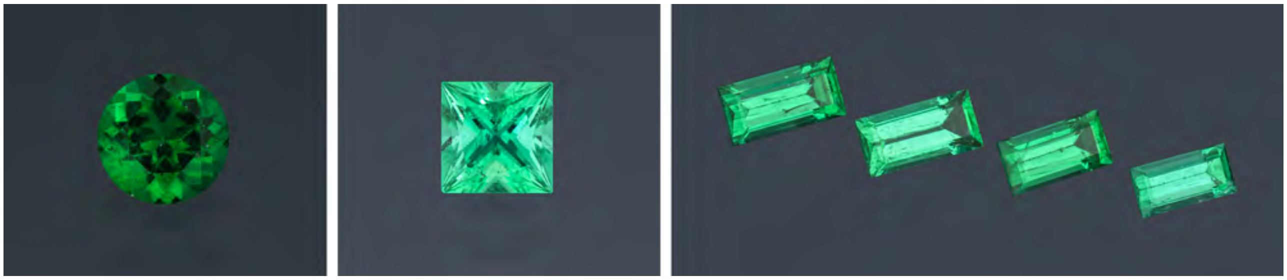


Figure 8. Left: Eternity Natural Emerald offered precision-cut Afghan emeralds, including "star" (left), princess (center), and baguette cuts (right, ranging from 6 × 3 mm to 5 × 2 mm). Photos by Robert Weldon/GIA, courtesy of Eternity Natural Emerald.

amined the original material (called "pencil rough" for its long and thin shape). The color was retained even when cut into small stones.

This rough is typically not treated, but a consistent supply of Afghan emerald is difficult to obtain. Prices are high, and negotiating is complex. Security concerns make it difficult to move rough in the country, and material is often smuggled to Dubai for the international market. To purchase the material, the company makes four to six buying trips a year, with permanent buyers located in Kabul and the Panjshir Valley. Much of the rough consists of the pencil crystals used for cutting precision melee. Once the pencil rough is sawn and preformed, the stones are cut for maximum brightness and the tightest measurement tolerances possible. All melee is cut in Sri Lanka.

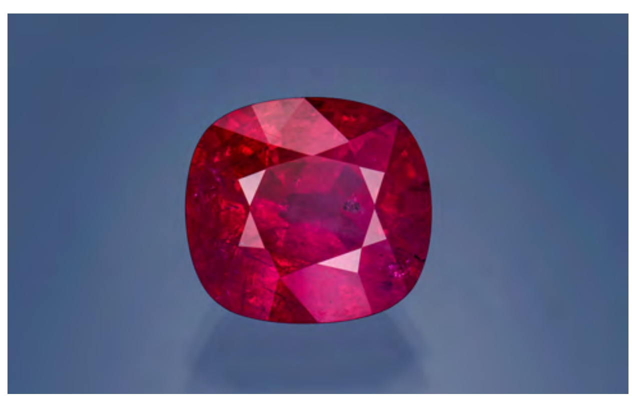
The emeralds were displayed in a variety of cuts and sizes. Most of the production is between 2 and 4 mm; they try to cut the melee within 0.05 mm tolerance. Mr. Groom expects to unveil 10,000–15,000 carats at the 2016 JCK show in Las Vegas. Eternity Emerald is also purchasing rough from Zambia and Brazil to ensure a continuous supply of melee.

We also saw a 12.52 ct cushion-cut emerald (figure 9) that came from a 60 ct Afghan rough. The stone was difficult to cut because the rough was highly fractured and color zoned. Also from the 15,000-carat parcel purchased this year were four stones that did not require enhancement, the largest of which weighed 4.61 ct. Mr. Groom estimated that, given the same size and quality, the value difference between treated and untreated emerald ranges from 20% to 100%.

Also on display was a 17.14 ct ruby that had the intense red color of marble-hosted material and a slightly sleepy transparency. The untreated ruby was cut from a 45.37 ct rough, part of a parcel of more than 1,000 carats, purchased directly from Tajik miners in May 2015. While this rough is available within Tajikistan, Mr. Groom said the material is not easily found on the global market. The asking prices for the rough were high and firm. The parcel was much more difficult to evaluate than ruby from Myanmar or Mozambique, as the rough was highly fractured. This is not uncommon for Tajik ruby, and it makes determining the yield and quality of the finished stones problematic. Due to the fracturing of the rough, heat treatment may not be a viable option for color improvement. The parcel

Figure 9. This 12.52 ct cushion-cut Afghan emerald came from a highly fractured and color-zoned 60 ct rough. Photo by Robert Weldon/GIA; courtesy of Eternity Natural Emerald.

Figure 10. The decision to recut a 21.17 ct ruby into this 17.14 ct gem added substantial value. Photo by Robert Weldon/GIA; courtesy of Eternity Natural Emerald.



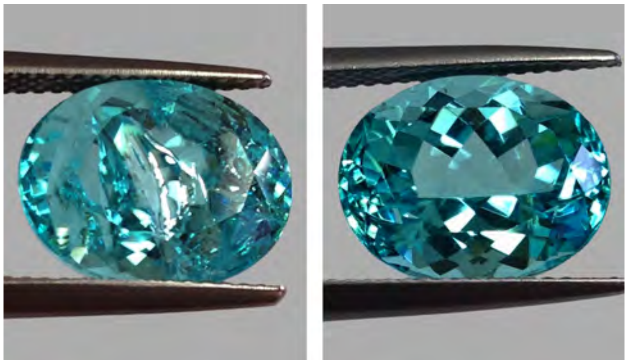


Figure 11. The surface-breaking fissure in this faceted Paraíba tourmaline (left) is less visible after cleaning and filling (right). Photos courtesy of Eternity Natural Emerald.

Figure 12. Prior to treatment, the highly visible fissure detracted from the rubellite's clarity (left). After treatment, the fissures were less visible, and the stone had a more uniform clarity (right). Photos courtesy of Eternity Natural Emerald.

yielded a total of nine faceted stones, none of which were heat treated. The largest, a 21.17 ct stone, was cut from the original 45.37 ct rough. A large black inclusion was still visible after cutting. After being shown to several potential buyers, the ruby was recut to 17.14 ct. The inclusion was less visible in the resulting gem (figure 10), and the color and brightness were also improved. Mr. Groom said recutting increased the ruby's overall value more than 30%.

At the booth, we also saw photos of their clarity-enhanced tourmalines. Clarity Enhancement Laboratories (CEL) performs the filling of the surface-reaching fractures. Mr. Groom pointed out that fracture filling of tourmaline is nothing new. Most of the material he has seen in the market has been filled with oils and resins, often without disclosure, since the trade has not traditionally thought of fracture filling as a way to improve tourmaline's apparent clarity. In August 2015, CEL announced tourmaline clarity enhancement service. The process, which is similar to its ExCel method for filling emerald fractures, is offered in their New York City laboratory for all colors and varieties of finished tourmaline. This treatment is not available for rough material.

Although they will fill any variety and color of tourmaline, CEL has mostly received Paraíba (figure 11), rubellite (figure 12), and bicolor material. Mr. Groom attributes this to the intrinsically higher values for these varieties. These color varieties often have surface-reaching fractures, and the filling process makes the material much more marketable. Since there is a high demand for these types of tourmaline, treated goods are still of value to dealers. Mr. Groom hopes to promote CEL's clarity enhancement method as a positive thing that will be fully disclosed through the value chain.

Tao Hsu and Andrew Lucas

Rare emerald from China and pink sapphire from Sri Lanka. At the AGTA show, David Nassi of 100% Natural Ltd. (New York) showed the authors a 5.06 ct bright yellowish green emerald from China's southwestern Yunnan province. The stone had some eye-visible inclusions, mainly fissures (figure 13). Other than a few tiny chips along the girdle, the cut gave the emerald a very elegant appearance. Mr. Nassi purchased the stone from a reliable Thai gem dealer who bought it from a Pakistani merchant who obtained it along the China-Pakistan border. Since Mr. Nassi is a cutter who deals with many antique jewelry pieces mounted with stones, he usually recuts stones before selling them. He kept this emerald "as is" due to the superb quality and size for this specific source. The stone was certified by the American Gemological Laboratory as without oil treatment, with China as the country of origin.

China's only economically viable emerald deposit is located in Malipo County in Yunnan province. The deposit was first discovered in the early 1990s but has never been

Figure 13. This 5.06 ct emerald from China's Yunnan province is one of the finest from this source. Photo by Robert Weldon/GIA, courtesy of 100% Natural Ltd.

Figure 14. Due to the fissures in Chinese emerald, stones are usually marketed as mineral specimens. This emerald crystal is still in the matrix. Courtesy of Yunnan Emerald Magazine.

extensively prospected or mined. Emerald specimens and crystals are extracted as the byproduct of the tungsten and tin deposit. Geologically, the ore body occurs in a core complex and is related to granitic intrusions in that area. Geochemical studies revealed that the trace element vanadium concentration is about one magnitude higher than that of chromium, indicating that V is the predominant chromophore in Yunnan emerald.

The size and quality of this emerald are rare for Yunnan. Since the stones contain abundant fissures, most of the production is sold as mineral specimens or ornamental pieces (figure 14). A very small percentage can be faceted for jewelry. As the local government pays more attention to this emerald resource, new development and further exploration are expected.

Mr. Nassi also showed us an intensely saturated 24.69 ct Sri Lankan pink sapphire (figure 15), from a necklace he had obtained from another estate jewelry dealer. Although the necklace itself was unattractive, Mr. Nassi immediately saw potential in the sapphire. He estimated the weight of the mounted stone and made an offer to buy the necklace. The stone, which was abraded with multiple scratches, lost two carats in its recutting but showed a dramatic improvement.

Figure 15. This 24.59 ct Sri Lankan pink sapphire was removed from an estate necklace and recut to bring out its full potential. Photo by Robert Weldon/GIA, courtesy of 100% Natural Ltd.

Tao Hsu and Andrew Lucas

Fordite from the Corvette assembly plant. Gemstone cutter and mineral specimen collector Jason Baskin of Jay's Minerals (Flemington, New Jersey) presented some spectacular freeform fordite cabochons, a byproduct of an automobile painting process that is long gone.

Workers once painted automobile bodies on train cars, which are commonly used on large assembly lines. As the paint was sprayed onto the target, the overspray collected on the train cars, and the accumulated layers of excess paint went together with the painted car body to the oven. The factory removed the accumulation periodically to clean the working platform and possibly recycle the paint. Mr. Baskin was informed by his contact in the factory that it takes about 997 layers of paint to build a one-inch-thick fordite slag specimen (figure 16). Since hand spraying has been replaced by powder painting, fordite is no longer produced, and the material on the market is all that exists. Fordite was first collected at Ford Motor Company in Michigan in the 1940s. The material saved from the 1960s and 1970s has the boldest colors, since cars were painted in very bright colors during that period.

Mr. Baskin was introduced to fordite about three years ago by a friend and fellow gem cutter whose uncle worked at the Corvette assembly plant in Bowling Green, Ken-

Figure 16. Three fordite slag specimens alongside a partially open piece that shows paint layers with various colors and thicknesses. Photo courtesy of Jay's Minerals.

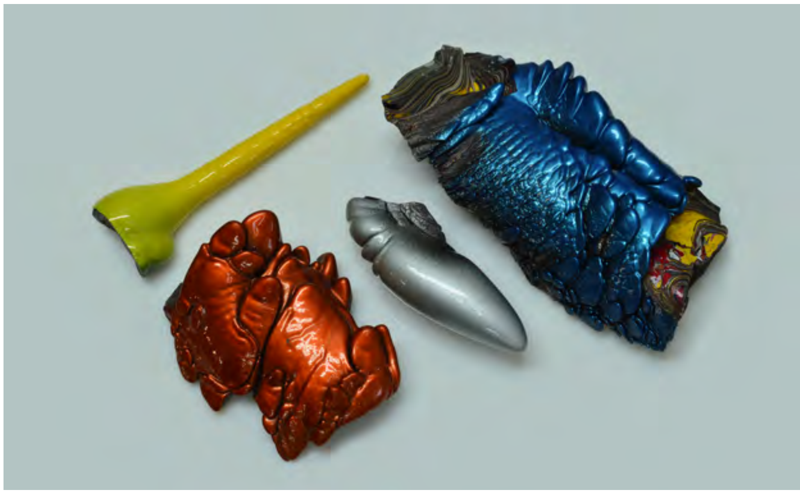


Figure 17. Different patterns may be exposed when the fordite material is cut open. The original profile of the paint slag can be kept as well. Strata and concentric color circles are some of the most spectacular patterns. On the left is a 32.36 ct (52 × 64 mm) specimen; the one on the right is 41.86 ct (28 × 73 mm). Both pieces were polished by Jason Baskin. Photo by Robert Weldon/GIA; courtesy of the Clamshell.

Figure 18. The finished pieces shown here are some of the finest fordites on the market. Photo by Orasa Weldon/GIA; courtesy of Jay's Minerals.

tucky. Mr. Baskin and his friend now own a substantial collection of the material from that location. Mr. Baskin is also pursuing other sources, including Lincoln-Mercury paint from a Canadian plant and Ford paint from Detroit. He is also looking for fordite from Harley-Davidson motorcycles to fulfill the appetite of Harley lovers.

The color layers and patterns of polished fordite are eye-catching, and experienced cutters know how to unveil its most beautiful side (figure 17). Because it is composed of paint, the material is very light. Protection such as a dust mask is necessary during the cutting and polishing processes.

Mr. Baskin noted that jewelry designers and hobbyists purchase most of his fordite, though he also sells the cut material (figure 18) through other gem dealers. Some of the knobs from the heaters and gear shifters in the old Corvettes had a piece of embedded plastic; clients have him cut Corvette fordite to replace that plastic. Pricing ranges from $20 to several hundred dollars apiece. A very rare type of fordite from 1972 with large metal flakes sold for $400 once it was cut into a 40 × 30 mm cabochon.

Tao Hsu and Andrew Lucas

Imperial Flame topaz sculpture. One of the 2016 Tucson show's most noteworthy gems was a 332.24 ct freeform Imperial topaz (figure 19) at the GJX booth of gem cutter Alexander Kreis (Sonja Kreis Unique Jewelry, Niederwörresbach, Germany). Topaz with this red, pink, or orangy yellow color component is rare and highly sought after in the trade. Named the "Imperial Flame" by the Kreis family, the crystal was reportedly recovered from Brazil's Ouro Preto topaz mines two decades ago. Topaz has been known from this area of Minas Gerais since 1768 (P.C. Keller, "The Capão topaz deposit, Ouro Preto, Minas Gerais, Brazil," Spring 1983 *G&G*, pp. 12–20).

Although mining was extensive at Ouro Preto in the mid-1990s (D.A. Sauer et al., "An update on Imperial topaz from the Capão mine, Minas Gerais, Brazil," Winter 1996 *G&G*, pp. 232–241), the Kreis family confirmed that there is currently no large-scale mining. They visited the area after a collector informed them of a 615 ct crystal with exceptional color and clarity (figure 20). According to their contact, the crystal is "old production" mined at least 20 years ago. After analyzing the rough over a period of four months, the family purchased it in December 2015 with

Figure 19. The Imperial Flame, a magnificent natural-color Brazilian topaz, was cut from a 615 ct crystal recovered some 20 years ago. The finished 89.53 × 20.56 × 19.15 mm sculpture weighs 332.24 ct. Photo courtesy of Sonja Kreis Unique Jewelry.

Figure 20. The original 615 ct Imperial topaz crystal from which Alexander Kreis fashioned the 332.24 ct Imperial Flame. Photo courtesy of Sonja Kreis Unique Jewelry.

the objective of cutting the largest, highest-quality Imperial topaz known.

Due to the gem's perfect basal cleavage, cutters must avoid grinding the stone perpendicular to the cleavage plane, while also accounting for inclusions that might cause the stone to break on the wheel. According to Sauer et al. (1996), well-formed, largely inclusion-free crystals typically yield up to 2 ct per gram (5 ct), which is a 40% recovery rate. Cutting the Imperial Flame took approximately eight days, spread over a period of 3–4 weeks, to allow Kreis to make trial carvings with smaller Imperial topaz pieces to test his cutting concepts. The cutting process began with sawing off the included portions and grinding to shape the solid crystal (figure 21), followed by faceting and carving to produce the reflective, grooved surfaces. The fashioning process yielded a spectacular gem measuring 89.53 × 20.56 × 19.15 mm. At 332.24 ct, it had a finished yield of 54%.

Intended as an arresting gem sculpture for a connoisseur or high-end collector, the piece is for sale.

Duncan Pay
GIA, Carlsbad

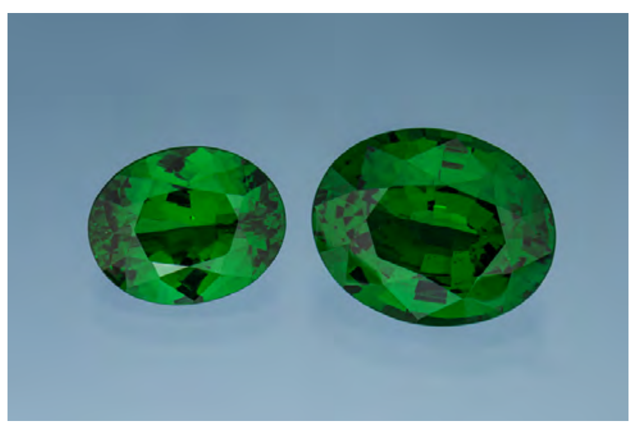
Figure 21. After trimming away included portions of the crystal's base, Alexander Kreis gently removes any surface-reaching inclusions and begins to shape the crystal to his own unique design. Photo courtesy of Sonja Kreis Unique Jewelry.

Update on the Scorpion tsavorite mine. At the AGTA show, Bruce Bridges (Tsavorite USA Inc.) detailed current activity at the Scorpion mine in Kenya and showed some new production (figure 22). The mine lay dormant for more than five years after the 2009 murder of owner Campbell Bridges, who originally discovered tsavorite. While waiting for the courts to hand down verdicts, the Bridges family and their employees were the target of numerous death threats. In January 2015, after four of the eight defendants received sentences of 40 years without parole, the mine reopened with a larger scale of operations than ever before.

Activities expanded for a variety of reasons. As a corporation rather than a small family operation, the Bridges family felt that they were less of a target for criminals. The Bridges also found that the demand for tsavorite rose exponentially during the mine's closure. With a limited supply and greater popularity, the higher selling price has made larger-scale mining more feasible.

There are 80 to 100 workers at the Scorpion mine, three times the number employed when it closed in 2009. The miners work in continuous shifts seven days a week. Mechanization has increased to include more powerful generators and 15-kilowatt fans for ventilation in the tunnels. The tunnel is now below the oxidized zone, requiring a blast approximately every half meter of forward progress.

Figure 22. The new production from the Scorpion mine includes these 6.48 ct and 3.43 ct tsavorites. Photo by Robert Weldon/GIA, courtesy of Tsavorite USA Inc.



The stronger fans allow the ventilation system to remove the smoke and dust in about two hours rather than the full day previously needed. They have also invested heavily in trucks, buildings, jackhammers, drills, and more explosives. Campbell Bridges's original campsite and tree house remain intact.

The main focus of the current operation is the Bonanza tunnel, also called tunnel 4, which was Scorpion's most prolific tunnel in the 1980s. They are also working the adjacent tunnel 2, the largest producer in the 1990s. Tunnel 2 produced five kilograms of facet-grade material over one carat from one pocket during this period. A few kilometers from Scorpion is mine GG2, which typically produces tsavorite with lighter tones. GG2 is an open-cast operation on a hill, with plans to move into a tunnel phase later this year. An untouched surface deposit near tunnels 2 and 4 is also in development for open-cast mining, and the Bridges have high hopes for it, as the ratio of yield to waste is high on new deposits. Other sources include GG3, which is several kilometers away and primarily uses tunnel mining, and Snake Hill, which is one kilometer from Scorpion and has been mined by both open-cast and tunnel methods. Snake Hill is also a tanzanite source. These deposits have been put on hold in favor of tunnels 2 and 4 and GG2, as well as the untouched surface deposit.

There is now greater sophistication and manpower in Tsavorite USA's mining process. The drill team bores large holes in the tunnels and then places the explosives. After the blast, the air is flushed out by the new ventilation system. The removal of waste has been accelerated by the use of a mono winch, which allows up to eight tons of waste to be removed hourly. The waste is hauled to the dump site, where it is separated from the rock face. The mine manager examines the rock face for tsavorite crystals or nodules, also checking for indicators in the reef such as calcite, quartz, and pyrite. Depending on the indications, teams will either continue blasting or extract material with hammer and chisel until the gem body is reached. At that point, miners use sharpened six-inch nails and finally their hands. The gem-bearing specimens are bagged and marked for quality. Once out of the mine, the material is washed and the tsavorite crystals are separated from the host rock. Sieves are used to sort the production by size before it is graded on a sorting table (figure 23). It is then bagged, sealed, and taken to Nairobi by ground or air, depending on its value.

All rough that can be cut to yield a 50-point stone or higher will be cut in-house in Kenya, while the cutting of smaller rough is outsourced. Campbell Bridges learned to cut gemstones in Idar-Oberstein, Germany, and he later trained local Kenyans. One expert cutter on-site is cutting at least 200 stones a month. The Bridges family is proud of their high cutting standards and that they cut most of the high-quality rough in Kenya (figure 24). They also pay a higher export value for finished cut stones than rough, generating more revenue for Kenya. The stones are exported to Tsavorite USA's main sales office in Tucson or to customers worldwide.

Figure 23. Prior to cutting, the Bridges operation sorts the tsavorite rough into categories by size, color, clarity, and shape. Photo courtesy of Tsavorite USA Inc.

Even with the new investment and expenses, current production is only about 10% higher than before the mine was closed. Electromagnetic surveys have shown extensive anomalies that indicate tsavorite enrichment zones. Most experts believe the reserves are very good, and Campbell Bridges himself believed he could follow the lines of the Scorpion mine's saddle reef structure and the nose of the folds for two kilometers while producing tsavorite in pockets. Each tunnel at Scorpion is about 200 meters deep. These reserves must be balanced, however, with the growing cost of delving every meter further into the earth.

Bruce Bridges told us that "demand is through the roof" for tsavorite. With its popularity potentially on the rise, Tsavorite USA will have to outsource rough. Melee demand is at an all-time high, particularly in China and other Asian countries, where it far exceeds the available supply. Mr. Bridges foresees overall growth for tsavorite through

Figure 24. The Bridges intend to keep their tsavorite cutting in Kenya for as long as it is economically viable. Photo courtesy of Tsavorite USA Inc.

television sales, but he wants to keep as much cutting in Kenya as possible. Challenges for the company include possible changes in the political scene, mining regulations, and the threat of crime and violence. Upon returning to Kenya, Mr. Bridges reported to the authors that death threats had started again.

Tao Hsu and Andrew Lucas

Jewelry Television in Tucson. Jay Boyle, senior gemstone buyer at Jewelry Television (Knoxville, Tennessee), spoke with us about the importance of the Tucson shows to JTV as well as the impact of television on the trade at large. We saw him conduct live broadcasts from the gem fair and interview dealers at their booths (figure 25). Mr. Boyle said the key to buying for television is finding beautiful gems at low market prices and being able to tell the story and romance the stone while educating the customer.

He pointed out that finding beautiful stones is easy, but it is considerably more difficult to obtain them at a great value price point that is right for the television network's customers; in fact, there is an art to the process. Major dealers from all over the world come to Tucson and sell all varieties of gemstones, making it advantageous for JTV to attend. These dealers frequently sell stones among themselves at true wholesale prices, so Mr. Boyle has the opportunity to find attractive stones at the right price and value for television (figure 26). In Tucson, buyers can survey everything coming from the sources, including new production, and discover the true market prices, all within one week. He added, "If you have a reputation as a serious, knowledgeable buyer that buys in quantity and has cash to buy, you can find the real market price."

Figure 25. Broadcasting from the gem shows helps Jewelry Television educate viewers about colored gemstones. Photo courtesy of Jewelry Television.

Figure 26. During times when prices are firm, buying decisions and quality control are even more crucial. Jay Boyle and Natalie Tjaden of Jewelry Television keep this in mind as they examine gemstones in a dealer's booth. Photo courtesy of Jewelry Television.

According to Mr. Boyle, the best time to purchase is when the material first hits the market. Another good time to buy is when there is a sudden increase in production. In 2001, JTV bought a large tsavorite lot containing more than 2,200 carats of material ranging from 2 to 10 ct per stone. The color and clarity were fine, and the price was a good value at $350 per carat. They took a small margin and sold the production quickly; 5 to 7 ct gem-quality tsavorites went for $500 per carat. Today, the wholesale prices for the material are many times that price, and longtime customers see the value of purchasing at the right time. Another successful venture began in 2006, when Mr. Boyle started buying "best of show" material of all gem species, at the best price possible. These stones were sold during special broadcasts called "The Vault" (figure 27). The highest price recorded on the show was a $400,000 sapphire. Regular viewers know that at times JTV has sold remaining inventory below cost, and some actually make a business out of reselling this merchandise.

Founded in 1993, Jewelry Television broadcasts 24 hours a day, reaching 84 million homes. Ninety-five percent of the gemstones sell for $10 to $5,000 apiece. Viewers are introduced to gemstones they had never encountered, such as padparadscha sapphire, Paraíba tourmaline, and color-change garnet, while learning about the gem business and how to recognize bargains. Some steady customers tune in for 10 hours a day. When Jewelry Television first started offering loose colored stones, they were thrilled to sell $15,000 in an eight-hour period. Now they sell up to $400,000 of loose colored stones in an hour, and it is common to ship between 18,000 and 25,000 packages in one day. Mr. Boyle feels that JTV is driving business throughout the retail industry by promoting colored stones, as some viewers will learn about a given gemstone and then visit a local jeweler to make a purchase.

Between 30% and 35% of the company's $400–$500 million in annual sales are online at jtv.com, which complements rather than replaces television sales. The website is also used to clear inventory from television at liquidation prices. Due to the extremely high cost of airtime in the U.S., JTV must not only sell the entire inventory, but also sell it in a short time. That means the Internet can be used to move leftover inventory while fresh, faster-moving products are sold on television. The network plans to eventually host web-only streaming video broadcasts.

Interestingly, one of the most successful periods for Jewelry Television was during the global economic crisis. While many industry players had stopped buying by January 2009, Mr. Boyle had learned over the years that dealers sell below cost during a recession. At the 2009 Tucson show, he bought $7 million in gemstones, including $3 million in tanzanite from one dealer alone. Since Mr. Boyle had well-established buying relationships with dealers, they were willing to accept his plan to promote a buying opportunity for TV customers. The promotion of below-market prices created a frenzy of activity for Jewelry Television. While these bargains were more plentiful in 2009, Mr. Boyle said there are still great opportunities below market value every year in Tucson. Although he was buying less than usual this year, JTV still actively sought material throughout the show. Among the stones we saw Mr. Boyle buying were rhodochrosite and Ethiopian opal.

Tao Hsu and Andrew Lucas

Figure 28. The "Rainbow Over Montana" bracelet contains 76.83 carats of Montana sapphire (71.42 carats rough and 5.41 carats faceted). The ring from the same collection contains 11.57 carats of rough and 1.12 carats of faceted Montana sapphires. Photo by Robert Weldon/GIA; courtesy of Paula Crevoshay.

Figure 27. The pendant worn by host Dawn Tesh (left) contains a 102 ct aquamarine that was sold during a 2009 broadcast of "The Vault" on Jewelry Television. Photo courtesy of Jewelry Television.

Paula Crevoshay's American Collection, plus jewelry with nontraditional gemstones. Paula Crevoshay's American Collection, created as a cultural and artistic inheritance for future generations, featured gemstones from the United States. The first pieces we saw were from her "Rainbow Over Montana" collection of rough and faceted Montana sapphires (figure 28). She used the faceted sapphires to show "the story of light" told by the gemstone after the human contribution of cutting, while the crystal slices display the natural hexagonal shape and luster of the flat crystal faces. The blue faceted stones represent the "Big Sky Country" of Montana, and the crystals demonstrate the range of rainbow colors in Montana sapphire.

Figure 29. This 31.34 ct bicolor tourmaline pin, which contains gemstones exclusively from the Stewart Lithia mine in San Diego County, has an emotional connection for the artist. Photo by Robert Weldon/GIA; courtesy of Paula Crevoshay.

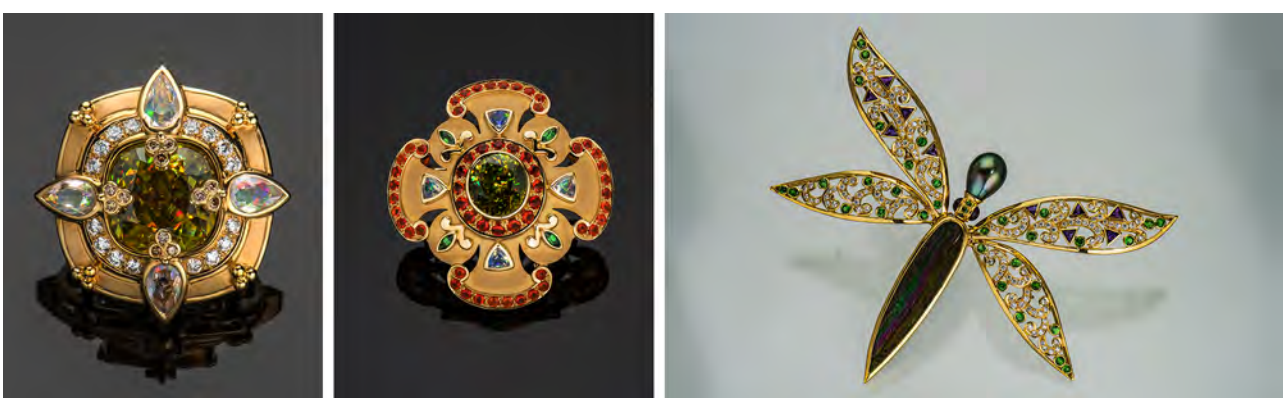
Figure 30. While not as large as some of the other colored stones used by Paula Crevoshay, the intense color and unique cut of the 2.77 ct Oregon sunstone makes this ring one of her favorite pieces. The center stone's color is complemented by 3.24 carats of red spinel. Photo by Robert Weldon/GIA; courtesy of Paula Crevoshay.

The next piece was a pin featuring a 31.34 ct bicolor pink and green tourmaline (figure 29) from the Stewart Lithia mine in San Diego County, California. The stone was purchased back from a customer who had bought it from Paula's late husband, George Edward Crevoshay, who first cut the stone more than 30 years ago. The pink and green tourmaline melee in the piece was also cut by Mr. Crevoshay and came from the Stewart Lithia mine. Besides featuring gemstones from a famous U.S. mine, this piece carries the sentiment of a great love that inspired Paula Crevoshay to move from painting and sculpture into the world of gemstones and creating jewelry.

The third piece (figure 30) was a ring that contained one of the most intense red Oregon sunstones the authors had ever seen. The stone features the trademarked "Medicine Wheel" cut by award-winning lapidary Larry Woods. The ring also contains red spinels and diamonds.

While visiting her booth at the AGTA show, the authors also noticed some nontraditional stones ingeniously incorporated into jewelry. The first two pieces we viewed contained center stones of sphalerite (figure 31, left) and sphene (figure 31, center), both in pendants. For Ms. Crevoshay, creating jewelry is all about working with light. How she selects and combines gems depends on properties such as refractive index, bodycolor, luster, and phenomenal optical effects.

Figure 31. These Paula Crevoshay jewels include gems not typically used in jewelry. Left: The 8.25 sphalerite pendant creates an eye-catching fire, complemented by the play-of-color of the opal and the colorful sparkle of the diamond melee. Center: The green color of the 11.78 ct sphene pendant is accentuated by tsavorite melee, with the orange fire opals offering a striking contrast. Right: This dragonfly pin features a 38.24 ct hematite drusy as the insect's body. The drusy's iridescence and sparkle creates a shimmering effect that is intensified by the orient of the Tahitian cultured pearl used for the head. Photos by Robert Weldon/GIA; courtesy of Paula Crevoshay.



Both sphalerite and sphene are highly dispersive, and the flashes of rainbow color created by the dispersion excite the eye. For the sphalerite piece, she added Mexican opals showing a rainbow of colors, combining a highly dispersive gem with phenomenal accent stones to create a dance of colors across the pendant. The pendant also contains cognac and colorless diamonds to create even more of a symphony of colors. Ms. Crevoshay chose the sphene for its high dispersion and her attraction to the green bodycolor. As with the sphalerite pendant, she added Mexican opals showing a subtle rainbow of phenomenal colors. With both pieces, she combines gemological knowledge with art to create jewelry that paints with the surrounding light.

Another piece that caught our attention was a dragonfly containing rainbow hematite drusy as the insect's body (figure 31, right). With the hematite, Ms. Crevoshay was able to highlight the iridescent colors and sparkle of the drusy. She finds that the rainbow colors of the hematite are not as bold as those caused by dispersion from the sphene and sphalerite but still have a seductive effect.

Public awareness of gemstones such as sphene and sphalerite has been growing thanks to high-end designers such as Paula Crevoshay and through mass marketing of commercial jewelry on television. Ms. Crevoshay told us she often piques customers' interest by informing them about some of these lesser-known gem materials and how light interacts with them. The authors found this to be a fascinating look at how stones that were once a gemological novelty are becoming more widely known.

Tao Hsu and Andrew Lucas

Figure 32. The "Wheel of Light" Numinous pendant contains an 825 ct carved quartz centerpiece. Different rough gems have been placed into a channel drilled into the quartz by the lapidary artist, which was then set in 24K gold. Photo by Robert Weldon/GIA; courtesy of Nature's Geometry.

Wheel of Light's mesmerizing optics. Lapidary artist Brian Cook, of Tucson-based Nature's Geometry, is astonished that the optical designs he has experimented with and refined for more than 25 years have finally come of age. Appreciation for his work culminated with a first-place award in this year's AGTA Spectrum's Fashion Forward category for his "Wheel of Light" Numinous pendant (figure 32), which graces the cover of this issue.

The 825 ct quartz center stone of this piece was carved to resemble a rounded disk with a softly contoured apex, or dome. After drilling the apex, Mr. Cook carefully inserted rough crystals of Paraíba tourmaline, haüyne, ruby, and spessartine garnet. The channel was then filled with jojoba wax and hermetically sealed with a quartz plug. The trapped "inclusions" are visible if the disk is observed from the side. As the disk is turned, with the viewer gazing down the apex, an interesting optical effect is noted: The colors corresponding to the included gem rough are revealed as concentric rings. To the eye, the ringed colors appear as painterly brushstrokes. Mr. Cook explained that the quartz vessel becomes both a frame and a mirror for what the eye sees. "The colors are amplified by the quartz, reflected off its inside surface. The jojoba wax, with a refractive index close to that of quartz, causes the channel to virtually disappear. This is how the luminosity and color of the included crystals is accentuated."

Goldsmith Paula Brent, a longtime collaborator, brings the pieces to completion. The wheels are crafted using 24K gold, which accentuates the strength and purity of the finished object.

Mr. Cook says that the work of Nature's Geometry is futuristic and imaginative, but at the root of it is a mystical, ancient attraction to the mineral world. The company is connecting with innovative young designers and is appreciative that the "millennial" generation is affected by the beauty and power of gems and hungry for a nontraditional approach to jewelry. Mr. Cook has been involved with the exploration for and marketing of copper-bearing tourmaline from Paraíba, Brazil, since 1988, shortly after its discovery. "The rough I saw were often too small for cutting, and the material was always extremely rare. But the color was so vibrant that I kept looking for a way to bring that 'electrifying' color to a greater audience."

With the Wheel of Light numinous pendant, Brian Cook has done just that.

Robert Weldon
GIA, Carlsbad

GILC 2016. The International Colored Gemstone Association (ICA) held its annual Gemstone Industry & Laboratory Conference on February 1 during the Tucson shows. Invited participants included jewelry trade association leaders, laboratory representatives, academic institutions, and ICA members. This year, other industry members were welcomed into the afternoon open discussion session.

Lore Kiefert (Gübelin Gem Lab, Lucerne, Switzerland), presenting on behalf of her colleague **Daniel Nyfeler**, spoke on age determination by radiogenic isotopes. Laser ablation–inductively coupled plasma–mass spectrometry (LA-ICP-MS) has enabled the Gübelin Lab to use radiometric dating to test inclusions at or near the surface of materials such as corundum and emerald, which do not have radioactive atoms. When traditional methods such as observation of inclusions and growth structure and trace element analysis lead to more than one possible country of origin, radiometric dating can furnish the decisive data. U/Pb decay in zircon has been well documented as a means to establish an approximate timeline for known sapphire and emerald populations. The corundum timeline established the oldest population as African, with an age of 450–650 million years (Ma), and the youngest as Colombian, at 10 Ma. Emerald formation ranged from South Africa at 2900 Ma to Colombia at 65–35 Ma. This method is limited when the gemstone presents no analyzable inclusions or has been treated.

James Shigley (GIA, Carlsbad) presented the Institute's latest research findings. GIA's work with color analysis has its foundation in observation and color grading of colored diamonds. Dr. Shigley noted that the visible spectrum is not the only cause of color; in fact, the face-up appearance is influenced by about 15 factors, including the emission spectrum of the light source, the absorption spectrum of the stone, and the color sensitivity of the eye. Since humans are more adept at distinguishing differences than similarities, the use of master stones and bracketing between pairs is well suited for visual grading. GIA uses instrumentation to supplement visual grading in face-down evaluation of round near-colorless D to Z diamonds; however, fancy-color diamonds are graded face up. GIA has been working on analytical tools that can "detect" color in the same way that the human eye processes it.

Bruce Bridges (Tsavorite USA, Inc.) asked whether gems can be reliably traced from the source to the consumer. Today's consumer wants to know where products come from and how their manufacture affects both the environment and workers. Vertically integrated companies can promote traceability and control over ethical sourcing, but the business model cannot be applied to the small-scale operations that characterize most of the industry. Bridges outlined the convoluted path from small-scale or individual miner through a series of brokers to cutting and the "end user" market, where it may go through another series of dealers before reaching a consumer. Most colored stone sources are overwhelmingly alluvial or placer deposits in remote areas, making them difficult to centralize. Traceability is even challenging at the mine, where it is not uncommon for material from a different location to be sold without disclosure. Traceability from cutting centers can improve as host countries introduce limits on rough exports and begin developing cutting facilities, which has happened in parts of Africa, South America, and Asia.

The conference proceeded to an open session for invited participants to discuss topics of concern, including:

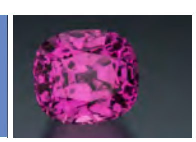
1. The increasing use of color enhancement and "anti-scratch" (silicon carbide) coatings, which are virtually invisible and sometimes too thin to be detected with instruments. With advances in nanotechnology, more research is needed to develop detection strategies.
2. The inconsistent use of descriptive terminology in laboratory reports, a topic carried over from the 2015 conference. The laboratories maintained that they were responding to the demands of the trade. One participant pointed out that the terms "pigeon's blood" and "royal blue" had no meaning in Chinese culture until about ten years ago. Since then, they have become "deeply implanted," and a seemingly irreversible demand has been created for the level of distinction that these terms confer.
3. Unethical or fraudulent use of lab reports. An example cited is the treatment of a gemstone after it had received a "clean" report. Another is the manufacture of both treated and synthetic diamonds to match an existing natural diamond report. GILC participants stressed the importance of checking reports against stones through every phase of the grading process.
4. The use of "undetermined" on a lab report in regard to treatment or synthetic origin. Some participants voiced concerns that such determinations are beyond the technologies of labs, or that the word "undetermined" left untreated natural diamonds vulnerable to being matched with treated or synthetic stones.

At the conclusion of the conference, it was announced that AGTA had revised its code of ethics and principles of fair business practice. ICA is proposing to adopt AGTA's code of ethics, due diligence protocol, and source disclosure language as a basis for its own code.

Donna Beaton
GIA, New York

For More on Tucson 2016

Tucson 2016: Take a virtual tour of the gem fair with our in depth reports on colored stone trends, unique designs, and industry forecasts.



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REGULAR FEATURES

COLORED STONES AND ORGANIC MATERIALS

Blue sapphires from a new deposit near Andranondambo, Madagascar. In January 2016, author VP was informed by Nirina Rakotosaona (Societe Miniere du Cap, Madagascar) and Jack Mampihao of a sapphire rush in the south of the island near Andranondambo. The blue sapphires (figure 33) are reportedly from a primary deposit and similar to those produced near Andranondambo, the region that put Madagascar on the map as a world-class sapphire source two decades ago (D. Schwarz et al., "Sapphires from the Andranondambo region, Madagascar," Summer 1996 *G&G*, pp. 80–99). Details emerged as miners returned from the rush in February. According to these firsthand accounts, the new mines are located near Vohitany, north of Tiramena (figure 34). They are only accessible by foot, and it takes about a day of walking from Tiramena to reach the area.

The author's contacts in Madagascar did not consider it safe to travel to that area, which is known to be a haven for bandits, called *malaches* or *dahalo*. In early February, the author learned from Karim Guerchouche (Premacut, Bangkok) that a 1 kg parcel of the new material had arrived in Thailand. The owner, Isaac Stern, wanted to perform some heat treatment experiments with Premacut. This offered us a chance to conduct a preliminary study of the material before visiting and collecting samples at the site.

Most of Mr. Stern's parcel consisted of rough weighing between 1 and 4 ct. The largest stone was an etched crystal weighing nearly 15 ct (again, see figure 33). The parcel was composed of attractive, well-formed crystals still associated with kaolin. Out of more than 300 stones studied, only one showed some indication of weathering. This suggests that the material is from a primary deposit. The stones were euhedral transparent crystals with strong blue color zoning. Overall, the material was very similar to the specimens the author collected in Andranondambo and Tiramena during visits in 2005, 2008, and 2010.

Sixty-three stones from the original parcel (mainly clean and milky specimens) were selected for a heat treatment experiment. Fifteen other stones, most of which hosted inclusions, were studied at GIA's Bangkok lab (figure 35). The study confirmed their similarity to GIA reference samples from Andranondambo; details will be published in a *News from Research* entry on the GIA website.

The new stones showed a medium to high iron content (between 300 and 1100 ppma), consistent with the classic Andranondambo material. Strong blue color zoning and an abundance of negative crystals dominated the inclusion

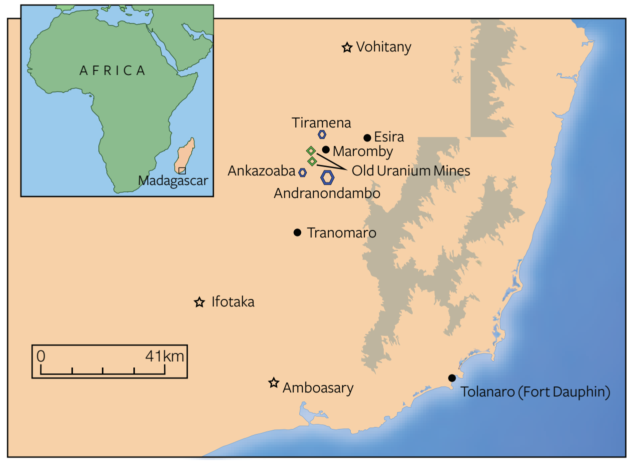
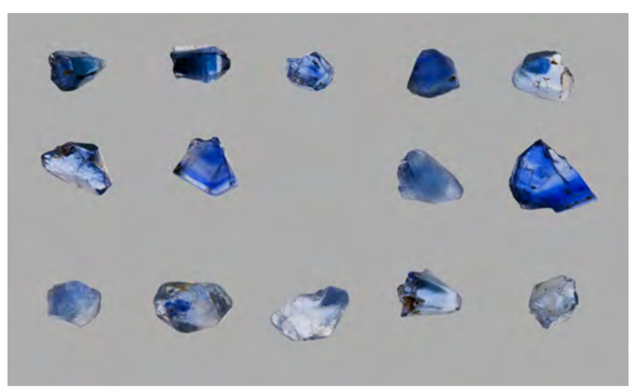


Figure 34. According to miners, the new deposit is located near Vohitany, north of Tiramena. This remote area is only accessible by foot.

Figure 33. These three rough unheated sapphire crystals, weighing (from left) 9.98, 14.56 and 7.7 ct, are reportedly from Madagascar's newest rush area. Beside them are heat-treated faceted sapphires believed to be from the old deposits around Andranondambo. The pear-shaped faceted stone weighs about 4.17 ct. Photo by Vincent Pardieu/GIA.

Figure 35. A detailed view of the 15 unheated samples selected for a preliminary study. The stones were placed on a light box and are seen here using bright diffused light. Under such conditions, the strong color zoning is obvious. Photo by Sasithorn Engniwat/GIA.



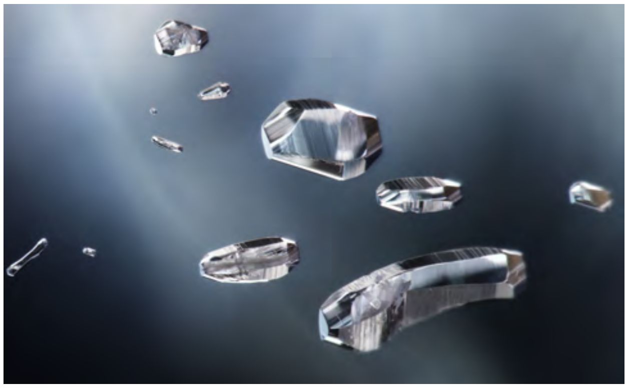


Figure 36. A blue sapphire from Madagascar's newest deposit hosts this group of negative crystals. Some crystals host white hairlike diaspore needles, identified using Raman spectroscopy. Photo by Victoria Raynaud/GIA; field of view 1.2 mm.

scene (figure 36). Many stones contained bands of minute particles, thin needles, and growth tubes. Calcite mineral inclusions were common; we also identified mica and apatite crystals.

The heat treatment experiment was successful. The light-colored, slightly milky material turned into fine transparent, deep blue stones after heat treatment under reducing conditions for seven hours at approximately 1600°C. Most of the included stones broke during the experiment, probably due to the presence of negative crystals.

This exciting discovery suggests that the Andranondambo sapphire deposit is much larger than originally expected. The main challenges are the security issues and the nature of the deposit itself, as the rocks hosting the sapphires are very difficult to work.

Vincent Pardieu, Supharart Sangsawong,
Wim Vertriest, Stanislas Detroyat,
Victoria Raynaud, and Sasithorn Engniwat
GIA, Bangkok

Red cordierite from Madagascar. At the Mineral Expo show in Paris in early December 2015, we procured a large piece of dark red cobbed rough presented as cordierite. This would be the first documented occurrence of red cordierite. The slightly fractured 3 cm rough offered a magnificent deep red color when examined using transmitted light from a Maglite illuminator. The identity of the rough as cordierite was confirmed using Fourier-transform Raman (FTR) spectrometry. The spectrum obtained showed excellent agreement with a reference spectrum for cordierite from Madagascar in the RRUFF database (http://rruff.info).

Author TP confirmed that the piece we examined was from the Iakora district, Fianarantsoa province, in southeast Madagascar. Cordierite has long been known in this general area (A. Lacroix, *Minéralogie de Madagascar*, A. Challamel, Paris, 1922). There is no mechanized mining. According to a miner's sketch obtained locally by one of the authors, red cordierite occurs in a "vein" (probably a layer) associated with orange and blue cordierite, parallel to other layers containing kornerupine or blue spinel. The cordierite vein is about 1.50 m thick and wide and is apparently contained in a kornerupine layer. Cordierite is usually found in a metamorphic environment, but the layered appearance, with each band containing specific minerals in thicknesses of about 1 m, is reminiscent of metasomatic deposits. The association of cordierite with kornerupine and spinel is already known; blue gem-quality cordierite is found in such a metasomatic reaction zone in Kenya (C. Simonet, pers. comm., 2015).

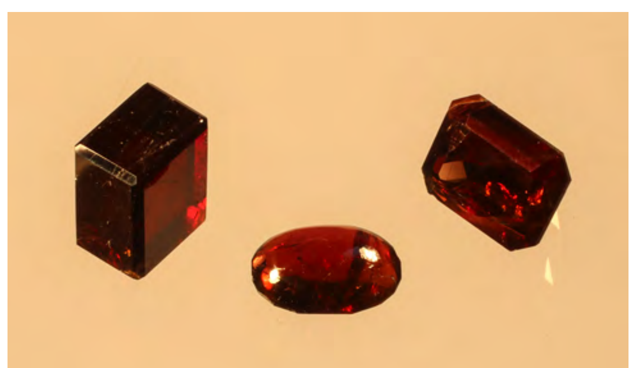
To determine the material's gemological properties, three stones were fashioned by Jacques Le Quéré (Auray, France): a 2.69 ct modified rectangle; a 1.28 ct flat cabochon, cut to obtain a lighter color; and a 4.17 ct parallelepiped, faceted based on the optical directions to best show its trichroism (figure 37). The RIs, measured with a Rayner LED sodium-equivalent lamp, ranged from 1.527 to 1.541 (n_x = 1.528–1.530, n_y = 1.532–1.533, and n_z = 1.538–1.540). Interestingly, this crystal presented a biaxial positive character, whereas gem cordierite is typically biaxial negative.

The trichroism was very strong, as expected with cordierite. With a standard dichroscope, the colors ranged from deep red to orange to grayish brown with a hint of blue or purple (figure 38), this last color becoming black at a thickness of about 1 cm (figure 39). Hydrostatic SG measured 2.548–2.554. These properties are consistent with cordierite, though SG was at the lower end of the range.

As the rough was sawed, we noticed that the vivid red transparent color of the thick crystal turned to orange with reduced thickness. This is the definition of dichromatism, also known in gemology as the Usambara effect, a variation of hue that is affected by the optical path length.

The UV-visible absorption spectrum was measured on

Figure 37. These three gems, weighing (from left) 4.17, 1.28, and 1.28 ct, were fashioned from the same piece of cordierite rough; red is a new color for this gem. The specimen originated from a recently explored deposit in southeast Madagascar. Photo by Benjamin Rondeau.



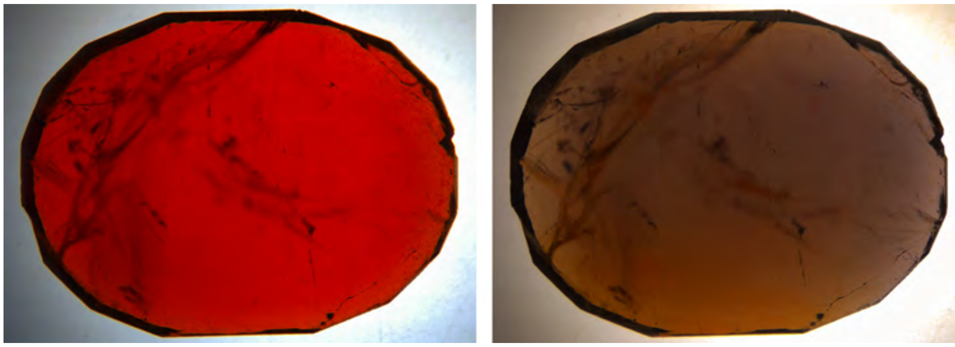


Figure 38. Pleochroism of the oval cabochon observed in polarized light in the two orthogonal directions. On this thinner sample (about 3 mm thick), the desaturated grayish brown color with a hint of blue or purple is best observed. The stone measures 9.85 × 6.75 mm. Photos by Emmanuel Fritsch.

a Unicam UV4. When the material was a few millimeters to a centimeter thick, in the direction where red is observed there is an extremely strong absorption in the violet and blue areas; this band leads to the red color. The absorption decreases abruptly from about 550 to 685 nm, with only a weak broad band from about 710 to 800 nm. This leaves a steep transmission window in the red, which is consistent with the color observed. The shape of the absorption and a rapid decrease in the orange-yellow also explains the Usambara effect. Through a few millimeters, the perceived color is orange; through a centimeter or more, it is deep red.

Emmanuel Fritsch
Benjamin Rondeau, University of Nantes, France
Thierry Peclet, Manakara, Madagascar
Patrick Lefebvre, Aix en Provence, France
Yves Lulzac, Nantes, France

Ruby and sapphire from Muling, China. Only a few Chinese sources produce gem-quality corundum, such as Changle, in Shandong province, but sapphires from that location are not considered top quality in the trade because of their dark hues. An emerging deposit in Muling, in northeast Heilongjiang province (figure 40), produces gem-quality corundum comparable to some world-renowned sources. The main deposits are seated in mountain valleys about 70 km from the town center. Corundum was known in Muling as early as 1985; after preliminary exploration, further activity virtually stopped because of technical and logistical limitations. As a result, production has been very limited, and very little information was published about rubies and sapphires from Muling until 1995 (J.X. Sun, "Basalt related to ruby and sapphire in eastern Heilongjiang and reconstruction of paleovolcanic mechanism," *Acta Petrologica et Mineralogica*, Vol. 14, No. 2, 1995, pp. 126–132).

According to Aijun Yi, director of mineral resource administration in Muling, the region has produced large amounts of gem-quality eluvial materials since 1994, including corundum, brownish red zircon, garnet, and spinel (T. Chen et al., "Brownish red zircon from Muling, China," Spring 2011 *G&G*, pp. 36–41). As colored stones became more popular in the Chinese gem markets, interest in ruby and sapphire from Muling grew accordingly.

We acquired a parcel of rubies and sapphires from local miners. The stones ranged from 0.8 to 15.2 ct (figure 41). Most exhibited well-formed tabular hexagonal crystals, though some broken sapphires had a tumbled appearance. The sapphires were pink, yellow, violetish blue, greenish blue, light blue, and deep blue; there were also near-colorless specimens. Most of the rubies and pink sapphires had a purplish component. Samples other than the deep blue material showed high transparency. Rubies and pink sapphires exhibited medium red fluorescence under long-wave (356 nm) UV light and a weak reaction under short-wave (245 nm) UV. Other varieties of sapphire had no reaction under long- or short-wave UV.

Figure 39. Trichroism of the 9.45 × 6.95 × 5.28 mm cordierite parallelepiped observed in polarized light in the three orthogonal directions to represent the three "extreme" colors of the material's pleochroism: deep red, black (both seen with a thickness of 9.45 mm), and orange (seen with a thickness of 6.95 mm). Photos by Emmanuel Fritsch.

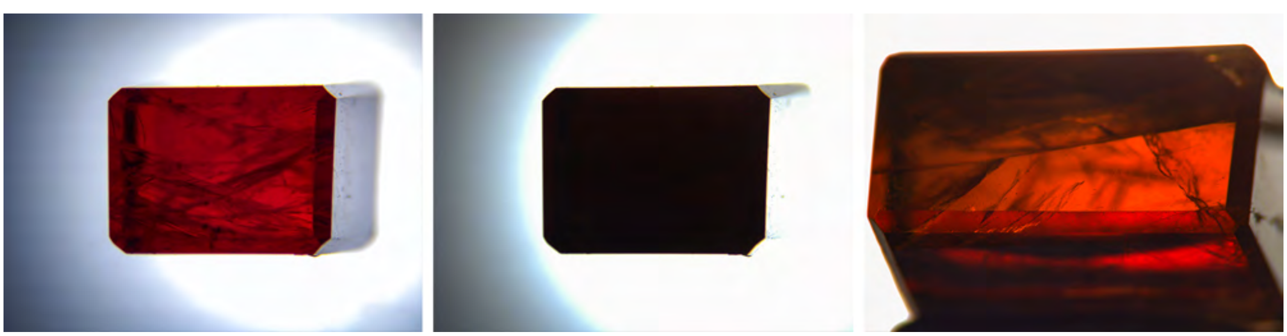


Figure 40. Muling, the site of an emerging corundum deposit, is located in northeastern China.

The samples generally showed abraded features and unhealed fissures, but some were predominantly clean under the loupe and large enough to be faceted. Fourteen stones were fabricated as parallel polished windows for microscopic examination. Several interesting internal features were visible under the microscope. The inclusions, which mainly appeared as rounded single crystals or multiphase syngenetic clusters, were in micron sizes (50–200 μm) and were identified by Raman as feldspar and sillimanite. The

Figure 41. Ruby and sapphire rough from Muling exhibited well-formed tabular hexagonal crystal forms; some sapphires showed a tumbled appearance in broken pieces. Photo by Yimiao Liu.

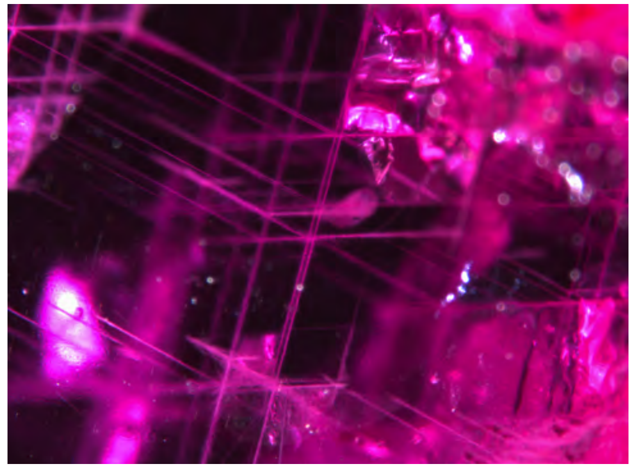


Figure 42. A detailed structure of whitish needles forming a three-dimensional skeleton network in a ruby sample. Photo by Yimiao Liu.

latter mineral only occurred as component mineral crystals in a multiphase inclusion. Most rubies hosted whitish needles forming three-dimensional skeleton networks that might be the result of diaspore exsolution (figure 42). Further microscopic observations under polarized light showed characteristic lamellar twining structures in every sample.

Trace element analysis by LA-ICP-MS showed a Cr content of 173–636 ppma in the pink-red series, accompanied by a significant level of Fe (1650–2510 ppma) and a noticeable level of Ti (36–70 ppma) to add a blue component through Fe-Ti intervalence charge transfer. This explained why Muling rubies and pink sapphires always had a purplish hue. Mg content was about 46–79 ppma, while Ga (13–17 ppma) fell into the expected range for natural corundum.

Yellow sapphires showed the highest Fe content (4480–4800 ppma); this contributed to their saturated yellow coloration. Iron content was much lower in blue sapphires, along with an appreciable amount of titanium (80–500 ppma) as a blue chromophore. Based on color distribution and transparency, blue sapphires could be grouped as either light blue or deep blue. Most of the light blue sapphires had very high transparency and even color distribution, while deep blue sapphires were less transparent, with hexagonal dark blue color zoning. Among all blue samples, Mg content ranged from 10 to 80 ppma and did not show clear correlation to color, while Ga content (10 to 100 ppma) was noticeably higher than in rubies and pink sapphires.

At Muling, most rubies and sapphires are found by casual surface digging. Gem-quality corundum usually occurs in eluvial deposits derived from weathered Cenozoic alkali basalts. Unlike other igneous-related deposits known for dark blue sapphires and very limited red material, such as Australia's Anakie and New England fields (T. Coldham, "Sapphires from Australia," Fall 1985 *G&G*, pp. 130–146) and Shandong, China (C. Simonet. et al., "A classification of gem corundum deposits aimed towards gem exploration," *Ore Geology Reviews*, Vol. 34, 2008, pp. 127–133), in Muling ruby production was larger than that of sapphire; over 60% of pink sapphires and rubies were high-quality materials.

In some ways, some Muling rubies have competitive advantages over Mozambique specimens. Their high color saturations and particular internal features (whitish needles forming three-dimensional skeleton networks) resembled those of rubies from Mozambique and might cause confusion in gem markets. On the other hand, blue sapphires from Muling have a pure blue color with no gray component. The variety of colors and the amount of fancy sapphires found in Muling are quite different from sapphires from other classic igneous deposits (see again Simonet et al., 2008).

At present, the precise location of the Muling gem deposit source rocks has not been confirmed. According to previous geological studies, the area is localized in the northern terminal of the branch of the Tanlu fault (Z. L. Qiu et al., "Trace element and hafnium isotopes of Cenozoic basalt-related zircon megacrysts at Muling, Heilongjiang Province, northeast China," *Acta Petrologica Sinica,* Vol. 23, No. 2, 2007, pp. 481–492). The lava in this region can be divided into six volcanic eruption cycles; Muling has experienced three such cycles (Sun et al., 2005).

Based on mining and geological information and our analysis of Muling rubies and sapphires, we inferred that this material might have originated as xenocrysts from an earlier volcanic eruption and undergone subsequent high-pressure geological processes. These are likely non-classic alkali basalt deposits. Large corundum deposits exist from eastern China to Primorye in far eastern Russia (I. Graham et al., "Advances in our understanding of the gem corundum deposits of the West Pacific continental margins intraplate basaltic fields," *Ore Geology Reviews*, Vol. 34, pp. 200–215), but exact locations have not been confirmed.

Although Muling's corundum deposit have yet to be mined commercially, the existing production has drawn the attention of Chinese gemologists and gem dealers. The production may rival that from other high-quality deposits, and this source holds great promise for the future.

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"Star of David" spinel twin crystal with multiphase inclusions from Mogok. In December 2015, author VP obtained from the Mogok gem market a remarkable spinel crystal with a fascinating Star of David (figure 43). This unusual pattern was formed by two triangles on opposing sides of a central 12-sided polygon. Furthermore, the specimen hosted some conspicuous crystals that resembled fluid inclusions, which are rare in spinel. The stone was reportedly mined in the early 2000s near Pein Pyit, a village in eastern Mogok that is famous for such twinned spinel crystals (T. Themelis, *Gems & Mines of Mogok*, published by the author, Bangkok, 2008). Hundreds were found in the Mogok market between 2002 and 2004, but most were tiny or broken (V. Pardieu, "Hunting for 'Jedi' spinels in Mogok," Spring 2014 *G&G*, pp. 46–57). The newly acquired crystal was added to the GIA reference collection. With a chemical formula of $MgAl_2O_4$, spinel belongs to the cubic crystal system. It is often found as octahedrons (with *o* faces), but sometimes dodecahedron *d* faces are visible. This specimen presents a fascinating case of twinning parallel to the octahedral plane O (111), commonly called "spinel-law" twinning. The general crystal outline is a 12-sided polygon instead of the expected hexagon. If a spinel crystal shows only *o* faces, a crystal flattened along the (111) plane will appear as a hexagon. But a spinel with both *o* and *d* faces that is flattened along the (111) octahedral plane will show 12 sides, as in this specimen.

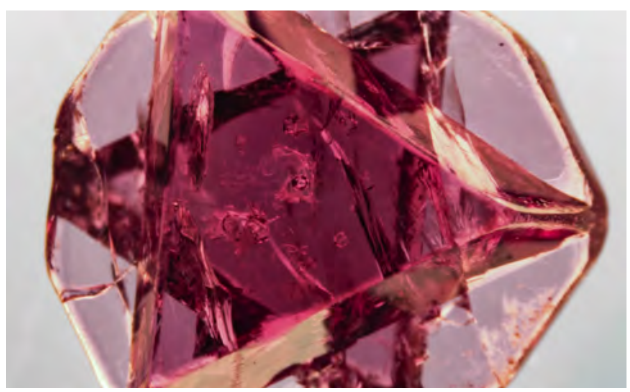
The crystal hosted several fractures as well as interesting fluid and crystal inclusions. Fractures are very common in such thin crystals, causing them to break easily. This specimen broke during the cleaning process (figure 44), and extra care should be taken while handling such crystals.

One inclusion was a flat, opaque, and foliated black crystal (possibly graphite) that we could not identify with Raman spectroscopy. There were also carbonate inclusions (identified as calcite and dolomite using Raman spectroscopy). The most fascinating features were the multiphase inclusions; at least eight were located in the center of the specimen (figure 45). They were composed of a negative crystal filled with colorless liquid, hosting a flattened or spherical bubble, filled with a liquid and a gas. This was unlike the features in spinel from Man Sin, where negative crystals are filled with an orange liquid rich in sulfur (again, see Pardieu, 2014).

We assumed that the gas inclusions were mainly CO_2, as some of the small bubbles disappeared while the stone was under the microscope and gently heated by the well light. This could not be confirmed by Raman analysis; the CO_2 concentration in the solution may have been too low.

FTIR spectroscopy confirmed the presence of carbonates and oil in some fractures. This might be explained by the

Figure 43. This 12-sided crystal recently obtained in Mogok is a rare spinel macle, hosting fascinating multiphase (liquid + gas) inclusions. The stone is reportedly from the eastern part of the Mogok Valley. Photo by Victoria Raynaud/GIA; field of view 5.7 mm.



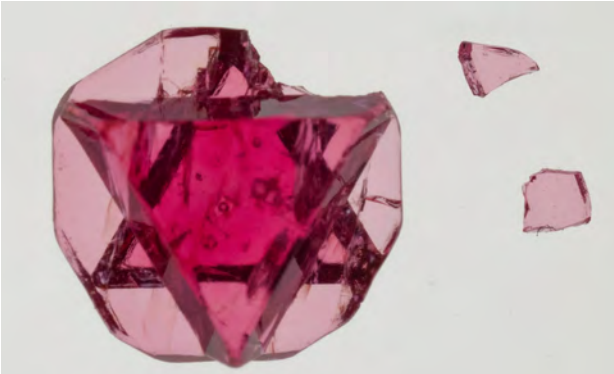


Figure 44. The Star of David spinel hosts some interesting multiphase inclusions. Such fractured, thin crystals are very brittle; this one was damaged during the cleaning process. Photo by Sasithorn Engniwat/GIA.

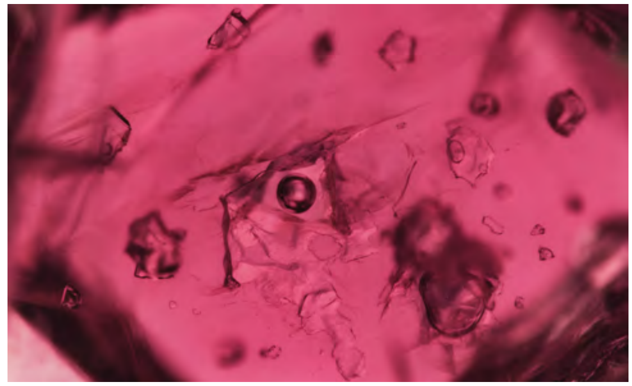


Figure 45. About five multiphase inclusions associated with colorless carbonate crystal are seen in the spinel's center, shown using diffused brightfield illumination. Photo by Victoria Raynaud/GIA; field of view 2.40 mm.

common practice (in Mogok) of keeping crystals in oil before selling them. We also studied the sample using photoluminescence and UV-Vis spectroscopy. The Cr^{3+} band in the PL spectra was approximately 0.89 nm wide. In the UV-Vis spectra, there was a clear absorption in the green around 537 nm. These features confirmed the absence of treatment (S. Saeseaw et al., "Distinguishing heated from unheated spinel," *GIA News from Research*, 2009, www.gia.edu/ongoing-research/distinguishing-heated-unheated-spinel).

The sample was analyzed using LA-ICP-MS. Three spots were studied and compared to GIA reference data obtained on other red spinels from different origins. The main trace elements observed were V, Cr, and Zn. Other elements (Li, Be, Ti, Mn, Fe, Co, Ni, and Ga) were also detected in lower but still significant concentrations. Based on GIA's reference data for origin determination, we would have identified these as Burmese, with other localities (Tanzania, Vietnam, or Tajikistan) excluded due to the elevated Zn and Ni content.

Star of David spinels are rare crystals that fascinate many gemologists and collectors. Studying these macles promotes our understanding of them and will contribute to origin determination for red spinel.

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SYNTHETICS AND SIMULANTS

Large colorless HPHT synthetic gem diamonds from China. High-pressure, high-temperature (HPHT) technology for gem diamond synthesis has made rapid progress in the last few years. It is now being used to produce many melee-size diamonds around 2–3 mm in diameter and large colorless single crystals, all with significantly improved quality and growth rate. One Russian company is reportedly growing multiple large, gem-quality colorless diamond crystals in a single run (U.F.S. D'Haenens-Johansson et al., "Large colorless HPHT-grown synthetic gem diamonds from New Diamond Technology," Fall 2015 *G&G*, pp. 260–279). Here we report on large diamond crystals manufactured using a similar technology by Jinan Zhongwu New Materials Co. Ltd in Shandong, China.

We visited the Chinese factory in early March 2016 and obtained 50 crystals (figure 46). The crystals were examined using the instrumentation and techniques applied to all diamonds submitted to GIA for grading; all exhibited the typical characteristics of HPHT growth and were identified as synthetic. These were basically colorless, with only a few metallic inclusions observed. These crystals showed typical cuboctahedral morphology, with well-developed {100}, {110}, and {111} growth sectors and a weakly developed {113} sector. The crystals we obtained ranged from about 0.5 to 1.2 ct each. Absorption spectra in the infrared region showed they were type IIa diamond, but trace absorption from boron was detected (2800 cm^{-1}). Detailed gemological and spectro-

Figure 46. A factory in Shandong, China, is producing a large number of colorless HPHT synthetic diamonds for the jewelry industry. These crystals have typical cuboctahedral morphology and weigh up to 3.5 ct. Photo by Jian Xin (Jae) Liao.

scopic analyses are ongoing and will be reported separately. According to the manufacturer, large quantities of gem-quality colorless and blue diamonds are produced in this factory, in sizes up to 3.5 ct each. While the total production volume remains unclear, it is undoubtedly significant, and capacity is likely to expand in the near future. This strongly suggests that even more large HPHT synthetic diamonds will be introduced into the jewelry industry.

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TREATMENTS

Polymer-treated hessonite. Early in 2016, gem merchant Abdul Hafiz (Jaipur, India) showed this contributor a parcel of orangy brown rough hessonite he had purchased, said to be "glass-filled" hessonite. Upon initial observation, the specimens appeared to be treated, as individual crystals were stuck together (figure 47). This is commonly seen in glass-filled corundum rough; however, the typical glassy surface was absent. Rather, the surface appeared greasy, as if it was heavily oiled. Since the crystals were stuck together, it was obvious that some more stable form of treatment has been performed. Further testing was conducted to identify the treatment.

Under 10× magnification, the joints and cavities showed a concentration of a foreign substance that was readily indented with a metal pin, ruling out the presence of glass. Because of the unpolished surface, we could not see the filler, but the stone was transparent enough for infrared spectroscopy. The spectra showed strong features at approximately 3060, 3032, 2923, and 2871 cm^{-1}; these peaks are associated with polymer. Other absorption features were consistent with grossular garnet, specifically hessonite and tsavorite, according to the laboratory's database.

Figure 47. These three rough hessonite samples (17.92 grams total) are joined by a polymer, which is also found in surface cavities and joints. The treatment is evident from the rough's "oily" look. Also note the visibility of fractures in the 5.31 ct (left) and 5.35 ct (right) cut samples. Photo by Gagan Choudhary.

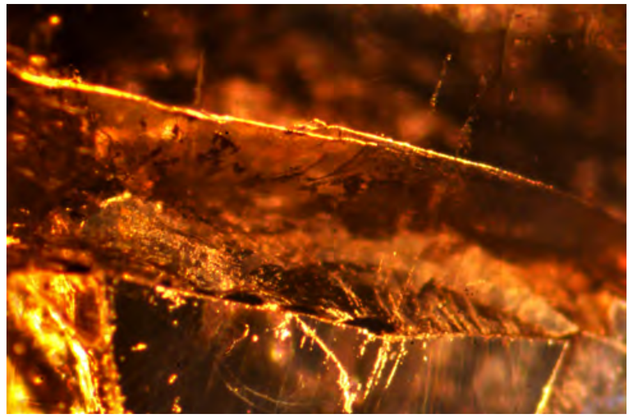

Figure 48. Fractures of the cut samples display thick and cloudy patches, suggesting uneven filling. Photomicrograph by Gagan Choudhary; image width 6.35 mm.

To check for a polymer filler and record gemological properties, two specimens were faceted, weighing 5.35 and 5.31 ct, respectively (again, see figure 47). Both specimens gave an RI of 1.745 and a hydrostatic SG of 3.60, within the range for hessonite (M. O'Donoghue, *Gems: Their Sources, Descriptions and Identification*, 6th ed. Butterworth-Heinemann, London, 2006). Both displayed a strong roiled or "heat wave" effect and numerous transparent rounded to elongated colorless crystals, features consistent with hessonite. The stones had obvious fractures visible to the unaided eye. When magnified, these fractures displayed thick and cloudy patches (figure 48), suggesting that a foreign substance was used to create an uneven filling. None of the iridescence or color flashes typically associated with a filled fracture were visible. Both faceted stones also displayed characteristic polymer-related peaks in IR spectroscopy.

This was our first encounter with a polymer-treated hessonite. Because the fractures were eye-visible, it is unclear how much value the treatment adds to these low-grade stones. According to Mr. Hafiz, the treatment is performed to stabilize the rough for cutting and polishing; otherwise the highly fractured material crumbles while processing. He added that hundreds of kilograms of such rough (reportedly African) have been sent to China for treatment.

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ERRATUM

In the Winter 2015 GNI entry on grandidierite from Madagascar (pp. 449–450), the color of the sample was incorrectly presented in figure 4. Please go to www.gia.edu/gems-gemology/winter-2015-gemnews-grandidierite-madagascar to see its actual color.