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CONVERGE 2025

Converge took place at the Omni La Costa Resort in Carlsbad, California, on September 7–10, 2025. This new event united GIA's gemological research and industry-leading education with the American Gem Society's (AGS) professional development and networking opportunities.

GIA's research sessions featured 24 speaker presentations (see pp. 416–435 of this issue) and more than 30 posters (see pp. 438–444 of this issue), covering broad topics, including colored stones and pearls, diamond identification, diamond and mineral geology, diamond cut, gem characterization, gemology and jewelry, and new technologies and techniques. GIA also offered a number of hands-on sessions including differentiating between natural and laboratory-grown diamonds, an introduction to jewelry forensics, and the photomicrography of gems (see pp. 444–447 of this issue).

SPEAKER PRESENTATIONS

This section provides summaries of the 24 speaker presentations offered at Converge. All entries written by GIA staff.

COLORED STONES AND PEARLS

Colored Stone Treatments in the Twenty-First Century: A Review and Current State of Research

Dr. Aaron Palke (GIA, Carlsbad) observed that a major focus of gemological research is always to improve a laboratory's ability to detect gems accurately and efficiently that are artificially treated to enhance their appearance. As our knowledge grows, laboratories focus on treatments that are increasingly difficult to detect, such as low-temperature heat treatment, chromophore diffusion, and artificial irradiation. Dr. Palke's talk provided a review of the innovative research on colored stone treatment identification in the twenty-first century. He noted that treatments are not inherently bad, but rather are crucial for miners and the industry because most gems need treatment to be marketable. Similarly, treatments do not decrease value because gemstones that require enhancement typically have little worth otherwise. He quipped, "Big, clean, untreated gems make you rich…treated gems pay the bills!"

Dr. Palke noted that gem enhancement is not new; ancient treatments included dyeing and quench crackling, foil backs, boiling amber in oil, and low-temperature heat treatment of sapphire. By the twentieth century, treaters employed sophisticated furnaces with precise temperature and atmosphere control, radiation, and advanced clarity enhancements such as resins and epoxies for emerald and flux and glass fillings for ruby. Gem treatment in the twenty-first century centered on modifications to established treatments, "new recipes," and extending existing enhancements to different types of gems, including lattice diffusion, low-temperature heat treatment, irradiation of pink sapphire, and clarity enhancement for non-emerald gemstones. Although lattice diffusion is not a new treatment—titanium-diffused sapphire appeared in the 1970s to '80s—treaters experimented with introducing other chromophores into gems at high temperatures. Gemological laboratories saw an unusual influx of padparadscha-colored sapphires in the early 2000s and quickly determined their

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Figure 1. Gem laboratories saw an unusual influx of padparadscha-colored sapphires in the early 2000s and quickly attributed their color to beryllium diffusion. This group of pink and orangy pink treated sapphires ranges from 0.51 to 0.84 ct. Photo by Kevin Schumacher.

color was due to beryllium diffusion (figure 1). Gem labs also encountered lattice-diffused spinel (first treated with cobalt then nickel) and copper-diffused feldspar. Early production beryllium-diffused sapphire and ruby usually had a thin diffusion rim as beryllium did not diffuse too far into the stone, but treaters soon found the right techniques to diffuse beryllium all the way through. Beryllium treatment usually adds orange, but can also take away blue color. Inclusions in treated stones are often heavily altered, but in general, this is associated with high-temperature heated sapphires.

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Field Gemology: A Foundation to Better Understand Gemstones

Wim Vertriest (GIA, Bangkok) presented the exciting topic of field gemology. For more than 15 years, GIA has visited mining locales around the globe to collect gems for scientific research (figure 2). Collecting samples with a high reliability of stated provenance and treatments is critical for any research institution, since the quality of scientific data is directly related to the quality of the samples. Vertriest quoted famed naturalist Sir David Attenborough to illustrate that the research library associated with collections is almost of greater importance than the objects themselves. Important information also comes from the circumstances of documentation that should accompany every scientifically collected specimen. GIA's colored stone

Figure 2. Besides gemological and geologic aspects, the practice of field gemology allows gemologists to understand the culture, political dynamics, and trade complexities related to gemstones. Here field gemologists Wim Vertriest (seated center) and Aaron Palke (seated right) examine rough material from Wa Khan Sho, near Mogok, which produces ruby, sapphire, and spinel. Photo by Robert Weldon.

reference collection is well-documented in terms of origin (provenance) and treatment status. It presently contains 30,165 samples—primarily ruby, sapphire, emerald, and spinel, but also other gems including opal and garnet.

Vertriest posed the question of why jewelers, cutters, hobbyists, clients, wholesalers, and retailers should care that GIA invests in field gemology. To answer this question, he introduced the "four pillars" of field gemology, starting with the first: understanding the gems. This means characterizing the gems in terms of their identification, inclusions, chemistry, extent or absence of treatment, and often their geographic origin, if possible. As an aside, Vertriest noted that there are no bad treatments, only bad disclosure. The second pillar is understanding the earth. This means assimilating the environmental and health impacts of mining gems and the working conditions of the miners, as well as deciphering the geological processes at work and why gems are found where they are.

The third pillar is understanding how people trade gems. Who works with the stones, how do they move through the supply chain, where is the value added, and which skills add to those values? Vertriest cited Mozambique's Winza ruby deposit as an example. Connoisseurs regard its top-quality rubies as the world's finest, but apart from this tiny percentage, the rest are unusable without treatment. That Mozambique rubies react so well to treatment is one of the key reasons for the success of this material: "B-grade" goods can be made attractive and sellable. If there is no market for low-grade gems, mining will stop and the highest value material will not be found. In other words, treatment is one way to "upgrade" lower-quality material; it allows us to get more value out of the full mine run by producing a range of gems at different price points, which keeps the gem supply chain alive. The fourth pillar is understanding the source. This refers to the context of where the gemstones come from and the people who work with them, along with the meaning these specific gems hold for those who handle and make their livelihoods from them. Vertriest noted that the trade places a lot of value on the origin of certain gemstones without knowing what that means. If you try to understand the source, what makes a certain place so special in terms of its people, culture, and politics becomes clear, because these factors often dictate supply to the trade.

Field gemology allows gemologists to understand the intricacies, dynamics, and complexities that are related to gemstones. Forming a holistic view of a gem and what it represents is critical for any modern gemologist wanting to address the gem industry's current challenges.

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The Value of Pearl Impact

Pierre Fallourd (Onegemme, Perth, Western Australia) addressed the origin and societal and environmental impact of cultured pearls, rather than the physical attributes, that contribute to their perceived worth. The presentation focused on the mission to measure, manage, and share the value of pearls' social and environmental impact. Fallourd noted that origin and impact are emerging as equally important factors throughout the jewelry value chain; pearl is the one gem that exemplifies the need for humans and nature to coexist in harmony.

Traditionally, pearls are valued based on their appearance using GIA's 7 Pearl Value Factors: size, shape, color, luster, surface, nacre, and matching. Fallourd posed the concept of pearl as the first "nature positive" gem, adding that the pearl farming-to-retail supply chain has the potential to make a positive impact on climate change, water quality, biodiversity, habitat, and society. Fallourd identified how a well-run, ecologically conscious cultured pearl farm might offset climate change and improve water quality and marine habitat. Both pearls and oyster shells capture carbon and produce mother-of-pearl, which is a widely used, long-lasting decorative product. Oysters extract nutrients, in the form of nitrogen and phosphorus, and heavy metals to improve water quality. One metric ton of farmed oysters can remove 10 kg of nitrogen, 0.5 kg of phosphorus, and 0.7 kg of heavy metals. A farm of 40,000 oysters turns over >2,000,000 liters (nearly one Olympic-sized swimming pool) every hour. Pearl oysters house diverse and abundant epifauna that adds to the ecosystem; a 1-hectare farm might produce more than one extra metric ton of catchable fish by providing additional spawning habitats.

Pearling and pearl farming are labor-intensive and create direct skilled employment often in remote locations. Communities also benefit through fair trade, creation of wealth, and transfer of knowledge. However, there are risks to be mitigated; badly run farms can produce excess sewage, increase sediment, and encourage overfishing, invasive species, and disease, while emissions reduction and use of renewable energy might be costly. The social and environmental benefits of marine pearl farming vary according to species, processes, and location. Every opportunity comes with an attached risk that should be monitored and moderated. The benefits can exceed the cost to the communities and ecosystems for each hectare farmed. Their value can be measured and managed, and pearl farming can deliver value throughout the entire pearl supply chain, leading to a virtuous cycle. If provenance and best practices can be demonstrated, retailers have additional storytelling resources to engage and enthuse consumers.

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Pearl Testing and Research at GIA: A Brief History and Recent Updates

In this presentation, **Dr. Chunhui Zhou** (GIA, New York) provided a brief history of GIA's advances in pearl testing technology and research, which have helped GIA solve various identification challenges for this unique and timeless biogenic gem. Dr. Zhou traced GIA's pearl testing legacy back to the 1930s, when Japanese akoya cultured pearls were first successfully commercialized, and the ability to separate natural pearls from their cultured counterparts presented gemological laboratories with a major identification challenge. In the 1930s, GIA used the endoscope, an optical device that revealed the presence of a bead nucleus under the nacre of a cultured pearl. In the 1940s, GIA elaborated this device into the Pearloscope, which also detected the shell-banding structure in the beads. By the 1950s, X-ray equipment was obligatory for pearl identification, and pearl testing amounted to more than 90% of the GIA Gem Testing Laboratory's business. Dr. Zhou emphasized that the importance of pearls to the industry has continued to drive four primary areas of pearl-related research at GIA: a pearl's natural or cultured nature (figure 3), whether it was produced in a saltwater or freshwater environment, the type of mollusk that produced it, and whether the mollusk produces nacreous, porcelaneous, or non-nacreous pearls. A fifth consideration, if present, is the degree and type of treatment. Dr. Zhou highlighted the various research publications GIA scientists have contributed over the years, many of which are listed below.

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Figure 3. Modern gemological laboratories use real-time X-ray imaging systems to assess the transparency of gem materials, which is especially important for distinguishing natural from cultured pearls. Photo by Nuttapol Kitdee.

An Overview of the Natural Gulf Pearl Trade

Abeer Al-Alawi (GIA, Mumbai) provided an overview of the natural pearl trade in the Persian (Arabian) Gulf. Historically, this area—particularly Bahrain, Qatar, Kuwait, and the United Arab Emirates (UAE)—was considered the center of the natural pearl trade. Pearl diving was an essential livelihood of many communities in the Gulf, which were renowned for producing some of the world's finest natural pearls, known among Indian traders as "Basra pearls," a term that remains in use to this day. Traders transported Persian Gulf pearls from the port town of Basra in southern Iraq by sea on *dhows* and other vessels to India, where they were processed, sorted, drilled, and strung before being sold in Europe and other markets worldwide.

The period between 1850 and 1930 marked the peak of natural pearl fishing in the Persian Gulf, when the area supplied perhaps 70–80% of the world's natural pearls. During this time, Bahrain was the epicenter of the natural pearl trade. Al-Alawi noted that Bahrain had the richest pearling beds followed by Kuwait and Qatar. Two important sites are considered the "home of pearling" in the UAE: Dubai and Abu Dhabi. Julfar, now known as Ras Al Khaimah in the UAE, was one of the most important pearling centers and was recognized for producing the best quality pearls due to its location between the main pearl banks and Hormuz. The pearling beds were typically at depths between 6 and 20 meters, with deeper areas reaching up to 30 meters. Traditionally, the diving season was from April to September. Divers remained under water for 60 to 90 seconds using a nose clip. Larger pearling ships required a crew of 60 to 80, including a captain, captain's assistant and crew head, singer (one of the most important roles), diver, trainee, puller, and cook. At the end of the season, shares would be distributed by function; the diver would take two shares and the puller only one, while the singer would take two shares for his distinguished role on board.

In the nineteenth and early twentieth centuries, most Gulf pearls were shipped to and processed in Bombay (now Mumbai), India, which has been a significant pearl manufacturing, processing, and trading hub for centuries. To showcase the high-quality Basra pearls, Bombay traders would sort the pearls, string them with silk threads, and tie them together at both ends using decorative metallic cords of various colors. These bunches were in great demand in Europe's pearl markets and were sold as "Bombay bunches." By the mid-1930s, three factors caused natural pearl revenues to plunge more than 70%: the economic impact of the Great Depression, the discovery of oil in the Persian Gulf, and the advent of commercial quantities of Japanese akoya cultured pearls. However, Al-Alawi highlighted the present-day resurgence of interest in natural pearls driven by a growing appreciation for their rarity and unique history (figure 4).

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Figure 4. The majority of these loose natural pearls are from the Pinctada radiata *mollusk. They were recently collected off the coast of Kuwait in the Persian (Arabian) Gulf. Photo by Robert Weldon.*

An Overview and Update on the GIA 7 Pearl Value Factors Classification System

Cheryl (Ying Wai) Au (GIA, Hong Kong) opened by posing the question of how we should describe the beauty or the quality of pearls in language that everyone can understand. Similar to the Four *C*s for diamonds, GIA developed the GIA 7 Pearl Value Factors. This system offers consistency and provides customers with the knowledge needed to make an informed purchase. We can apply it to all nacreous pearls, including the four major cultured pearl types in the market: akoya, South Sea, Tahitian, and freshwater (figure 5). Au summarized GIA's long history with pearls. The Institute began offering pearl identification services in 1949, a few years before the introduction of diamond grading. *Gems & Gemology* published the first paper discussing pearl value factors and classification in 1942, though it focused on natural pearls. In 1967, the GIA 7 Pearl Value Factors were first identified and described by Richard T. Liddicoat Jr. with an emphasis on cultured pearls. Today, a GIA Pearl Identification Report provides extensive information including pearl quantity, weight, size, shape, color, overtone, natural or cultured identity, mollusk type, saltwater or freshwater environment, and any detectable treatments.

In 2021, GIA launched a Cultured Pearl Classification Report that clearly states the 7 Pearl Value Factors of the submitted pearl items. Au covered recent updates to some terms adopted by GIA including the recently expanded nacre quality scale, and defined each value factor:

1. Size is determined by weighing and measuring the pearl. Pearl size is expressed in millimeters and pearl weight in carats (typically), both to two decimal places. Different pearl types have different size ranges. For example, akoya pearls are generally smaller with a typical size range of 6–9 mm, and South Sea pearls might range from 13–20 mm.
2. GIA classifies pearls into seven main shapes: round, near-round, drop, oval, button, semi-baroque, and baroque.
3. Pearl colors have three different components: bodycolor, overtone, and orient. Bodycolor combines hue, tone, and saturation. GIA uses 19 hue names for pearls. Tone is the relative lightness or darkness of a color, ranging from white, through various shades of gray, to black. Saturation is the relative weakness or strength of color, first neutral, then from very light to strong. Overtone is a single translucent color overlying a pearl's bodycolor, while orient is any combination of multiple overtone colors or iridescence overlying a pearl's color.
4. Luster describes the intensity and sharpness of reflections seen on a pearl's surface. After comparison with specific pearl luster masters, GIA classifies a pearl's luster grade as Excellent, Very Good, Good, Fair, or Poor. Different pearl types have varying inherent luster ranges, so an Excellent luster for one type might only be Very Good for another.
5. Surface classification describes the degree of spotting on a pearl's surface, and also considers the number,

Figure 5. The GIA 7 Pearl Value Factors classification system is applicable across the whole pearl supply chain, from buyers checking the quality of pearls at an auction to consumers shopping for pearls at the retail level. Photo by Wim Vertriest.

severity, and positioning of visible blemishes. After comparing to pearl surface masters and judging the surface condition, a pearl's surface is classified into one of four categories: clean, lightly spotted, moderately spotted, and heavily spotted.

6. Nacre grades are based on three elements: thickness, continuity, and condition. GIA's nacre grade reflects the condition of a pearl's nacre, which affects luster, surface, and sometimes durability. The pearl's nacre layer should meet required minimum thickness standards for each pearl type: for akoya this is at least 0.15 mm, for Tahitian at least 0.80 mm, and for South Sea at least 1.50 mm. Pearls with thin nacre show a chalky appearance and the beads are readily visible under strong lighting. Nacre continuity is the lack of disruptions or "movement" in nacre layering, or in other words, the smoothness and "cleanliness" of the pearl. Nacre condition includes any post-harvest considerations, such as processing, polishing, and working, as well as wear and damage.
7. Matching is defined as the uniformity of appearance in strands and multiple pearl groups or items. Well-matched, high-quality pearl sets show uniformity of color and shape, while lower-quality sets display greater variation in shape and color.

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DIAMOND IDENTIFICATION

Distinguishing Diamonds: Understanding the Differences Between Natural and Laboratory-Grown Diamond Formation and Their Unique Stories

Dr. Ulrika D'Haenens-Johansson (GIA, New York) outlined the momentous transformation in the diamond industry over the past 20 years due to the advent of commercial laboratory-grown diamonds (LGDs), discussing the differences in natural and LGD formation and highlighting the resulting clues that they provide, which allow conclusive separation (figure 6). Production of LGDs has surged significantly with pronounced improvements in their size and quality; forecasted 2025 production is approximately 30 million carats of LGD gem rough. Despite sharing key crystal properties with natural diamonds, LGDs have fundamentally distinct formation mechanisms and stories from diamonds that formed millions to billions of years ago deep within the earth.

Dr. D'Haenens-Johansson noted that LGDs are widely available and have garnered a lot of press coverage, resulting in a mixture of both highly informed and misinformed clients and retailers, which creates considerable confusion and mistrust. "Bad actors" can intentionally mix LGDs with natural diamonds, or it might happen inadvertently. Dr. D'Haenens-Johansson stressed that clear differentiation of both products is key.

Natural diamonds are old, having formed 90 million to 3.5 billion years ago. For comparison, the extinction of dinosaurs happened 65 million years ago, and the age of Earth is 4.56 billion years. Natural diamonds form within the earth from carbon-containing fluids and rocks at greater depths than any other gemstone. Most derive from rocks 150–200 km below the earth's surface, but some originate deeper: 700 km. They are brought up to the surface by ancient volcanic eruptions in kimberlite pipes. Natural diamonds are rare; it takes roughly 100,000 metric tons of ore to find a single one-carat D-color flawless diamond (a grade of >0.01 carat/metric ton).

LGDs are mass-produced in factories. Their composition and crystal structure are the same as natural diamond, with essentially the same physical, chemical, and optical properties. They can be differentiated because they have a fundamentally different origin from natural diamonds. LGDs are produced by two main methods: high-pressure, high-temperature (HPHT), accounting for 20% of production, and chemical vapor deposition (CVD) representing 80%. HPHT synthesis uses a press that mimics the conditions of natural diamond growth, but not the chemistry.

Figure 6. The different growth conditions of natural and laboratory-grown diamonds provide distinctive clues that allow gemologists to conclusively separate them. Here laboratory-grown CVD (left) and HPHT (middle) rough diamonds are pictured next to a natural rough diamond (right). Photos by Robert and Orasa Weldon; courtesy of the GIA Sir Ernest Oppenheimer Student collection (left).

LGD growth occurs at pressures of 5–6 GPa and temperatures of 1300–1600ºC over durations of days to months. CVD synthesis uses a gaseous carbon source with hydrogen, diamond seed plates, microwaves to activate plasma and low pressures (one twentieth to one quarter atmospheres) and temperatures of 700–1200ºC to build up LGDs layer-by-layer over a period of days to months.

GIA has been researching synthetic diamonds since their inception. Robert Crowningshield was the first gemologist to inspect General Electric's gem-quality specimens in the 1970s. GIA continues to analyze LGDs from the trade and also conduct in-house synthesis of CVD LGDs. GIA has developed a fundamental understanding of the material and its evolution over time and can recognize the difference between natural diamonds and LGDs. Humans cannot reproduce natural diamond formation and residence conditions, so natural diamonds and LGDs are not identical. They each contain clues of their origin that allow us to clearly separate them using laboratory services and screening equipment.

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Screening and Detection of Synthetic Diamonds

Dr. David Fisher (De Beers, Maidenhead, United Kingdom) acknowledged that laboratory-grown diamonds (LGDs) are now an established part of the jewelry trade and gave a brief history of diamond synthesis from the 1950s, citing the many advances in quality and size that have made LGDs a commercial commodity in today's markets. The talk outlined the approaches taken to date to address the challenge along with the developments that have allowed the application of screening technology to the wide range of sizes affected by LGD production. Dr. Fisher emphasized the need to extend screening capability beyond the laboratory and into retail, where the ability to clearly demonstrate a diamond's natural origin could assist retailers in the promotion of natural diamonds.

The presentation outlined the many options for diamond verification instruments (DVIs) available to the trade. Some of the screening methods these devices use include absorption, fluorescence, or phosphorescence, often relying on the N3 defect (a vacancy surrounded by three nitrogen atoms, which appears in the vast majority of natural diamonds, but is absent in LGDs and diamond simulants). Dr. Fisher also described the pressures the trade exerts on manufacturers of DVIs, including cost, compact size, accuracy of screening, and volume, especially where melee-size diamonds are concerned. The Natural Diamond Council's (NDC) Assure Program verifies the performance of commercially available DVIs used to separate natural diamonds and LGDs. All instruments are rigorously tested by an independent third-party laboratory using a standard methodology and various sample sizes of natural diamonds, LGDs, and diamond simulants. Key metrics include false-positive rate (wrongly identifying a synthetic diamond as natural) and the referral rate (correctly identifying a stone that needs further testing). NDC publishes results online, which are available to anyone in the diamond trade. Dr. Fisher noted that the optimal false-positive rate is 0%; it is "really bad" if any LGDs are passed as natural. Of the 32 DVIs tested in the first iteration of the Assure Program (2019), only 14 (32%) gave a 0% false-positive rate. By Assure 2.0 (2025), the false-positive rate was much better: 15 out of 18 (83%) returned a zero false-positive rate.

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DIAMOND AND MINERAL GEOLOGY

Determining a Diamond's Country of Origin: Dream or Reality?

Dr. Michael Jollands (GIA, New York) questioned whether gemological laboratories might develop methods to determine a diamond's country of origin just as many have for colored gems such as sapphire, ruby, and emerald, which are generally submitted without any documentation. In this talk, Dr. Jollands discussed the challenges of determining a diamond's country of origin, the pitfalls of some proposed methods, and future opportunities for tracing a diamond's mine-to-market path. Most colored stones form up to a few tens of kilometers below the earth's surface, where there can be major geologic differences from place to place. In contrast, diamonds form much deeper in the lower lithosphere or mantle, hundreds of kilometers below the surface. Here, there are only minor differences between different parts of the earth.

For colored gems, laboratories use several methods for determining origin: inclusions or visual observations, trace element chemistry (energy-dispersive X-ray fluorescence or laser ablation–inductively coupled plasma–mass spectrometry), and spectroscopy. Trace elements exist in gems in very small amounts at the parts-per-billion (ppb) or parts-per-million (ppm) level and are not normally part of the crystal. Some well-known trace elements in diamond are nitrogen, hydrogen, boron, silicon, oxygen, and nickel. Many other elements can exist in fluid inclusions inside diamonds. These inclusions may be visible or invisible, and unevenly distributed, and the elements they contain are generally present at the parts-per-million to parts-per-trillion levels. Analysis is extremely challenging and destructive, even with new, highly sensitive equipment.

Published work and GIA's own testing show complete overlap between the trace element chemistry of diamonds from different locations. Some differences do exist, but these are associated with different diamond-forming fluids, which are not geographically specific. In contrast, colored stones often show very clear separation between samples from different geographic origins. For example, copper-bearing tourmaline from different locales can be separated using gallium, lead, copper, strontium, and zinc levels. To the best of current knowledge within GIA and the academic community, no similar separation exists for diamonds. Gemologists routinely use three kinds of spectroscopy: infrared (IR), ultraviolet/visible/near-infrared (UV-Vis-NIR), and photoluminescence (PL). Only IR spectroscopy shows promise. One set of defects associated with nitrogen and hydrogen may be useful because their spectra can be used to determine how long the diamond sat in the earth at a given temperature. Diamonds from different locations have different time and temperature histories. Although a current global dataset of around one million stones shows some correlation, samples from the same location can fall across the whole plot, with overlap between diamond ages from different locations.

Dr. Jollands concluded that many diamonds lack visible inclusions, trace elements are very challenging to measure, and characteristics completely overlap between sources. Spectroscopy offers no geographical separation, and tracing stones from source to consumer appears to be the only viable method for tracking diamond origin today (figure 7). This brings many challenges, including tagging stones at every step and stopping inadvertent or deliberate swapping of stones, but these can be overcome, whereas geologic limitations cannot.

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Figure 7. Once rough diamonds such as these from Angola enter the supply chain and are mixed with diamonds from other mines, determining their geographic origin is currently impossible. Photo by Robert Weldon; courtesy of Diamond Trading Antwerpen.

Lithospheric Diamonds and Their Mineral Inclusions: A Glimpse into the Ancient Earth's Mantle

Dr. Mei Yan Lai (GIA, Carlsbad) began by explaining how kimberlite and lamproite eruptions sample Earth's mantle to bring diamonds to the surface. The extreme hardness and chemical inertness of diamond enable it to serve as a probe into the composition of Earth's mantle and as a recorder of geotectonic history spanning millions to billions of years. Approximately 99% of recovered diamonds form in the subcratonic lithospheric mantle at depths of 140–200 km. While these depths cannot be directly sampled by any physical method, mantle rocks and occasionally diamond have erupted to the surface by deep-seated kimberlite volcanism.

The two mantle rocks for lithospheric diamond formation are peridotite (primarily made of olivine, enstatite, and chrome diopside, along with accessory minerals such as spinel, garnet, and sulfides) and eclogite (mostly garnet and omphacite with accessory minerals such as kyanite, coesite, rutile, corundum, and sulfides). Diamonds can be monocrystalline, fibrous, or polycrystalline. Monocrystalline diamonds typically display octahedral shapes, but can be cubic, twinned (e.g., macles), or irregular in shape. Diamond crystals can also undergo dissolution, transitioning from octahedral to dodecahedral forms, depending on the extent of resorption. Surface features including trigons or tetragons, hillocks, deformation lines, or hexagons are signs of dissolution and may be preserved on the girdles of polished diamonds. Mineral inclusions in diamond are signatures of the mantle rocks they grew in and can be identified by Raman spectroscopy. Characteristic inclusions of peridotitic diamonds are purple garnet, bright green chrome diopside, colorless enstatite, olivine, and dark red chromite. Eclogitic diamonds might contain orange garnets (figure 8), grayish green omphacites, colorless coesite, brownish orange rutile, or blue kyanite.

Dr. Lai explained the circumstances under which scientists employ a technique called chemical geothermobarometry to estimate the pressure and temperature conditions of the mantle. They analyze the chemical composition of pairs of coexisting mineral inclusions such as garnet and olivine in peridotitic diamonds or garnet and omphacite in eclogitic ones. Iron and magnesium partition themselves between these minerals in a way that is highly dependent on temperature. After measuring each mineral's iron-magnesium ratio, scientists use experimentally derived equations to calculate the formation temperature.

The eruption ages of diamond-bearing kimberlites and lamproites range from around 20 million to 1 billion years. Scientists use radioactive decay systems to infer diamond age. Unfortunately, the half-life of carbon-14 is too short and cannot be used for objects older than 57,000 years. Radioactive decay systems with longer half-lives are used instead (41 billion years for rhenium-osmium in sulfide minerals and 106 billion years for samarium-neodymium in garnets and clinopyroxene). Dr. Lai concluded by placing natural diamonds in context with Earth's 4.56-billion-year timeline. Peridotitic diamonds from Canada's Ekati mine (3.5 billion years old) and eclogitic ones from Botswana's Jwaneng mine (2.9 billion years old) bracket the onset of plate tectonics (about 3 billion years ago). Dr. Lai noted that natural diamonds are among the oldest and most remarkable objects to wear and long predate the extinction of the dinosaurs (65 million years ago) and the advent of our own species, *Homo sapiens*, a mere 300,000 years ago.

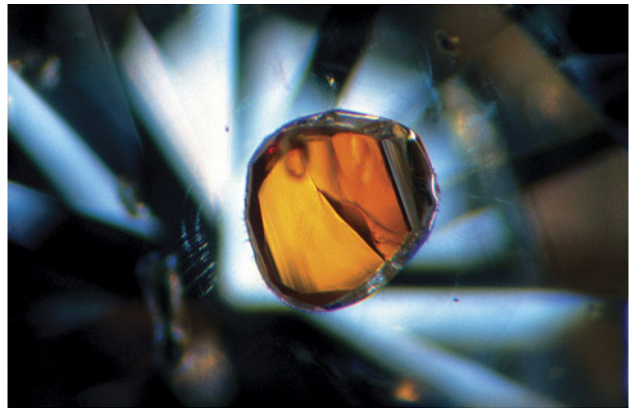

Figure 8. This transparent orange almandine pyrope garnet typifies an eclogitic origin for its host diamond. Photomicrograph by John I. Koivula; field of view 3.6 mm.

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Superdeep Diamonds: Exceptional Gems with an Incredible Backstory

Dr. Evan Smith (GIA, New York) described research led by GIA in the past decade revealing that many high-quality type II gem diamonds, known for their purity, come from unusually extreme depths inside the earth. Known as superdeep diamonds, this rare geological category of diamond originates from depths of 300–800 km. All gem diamonds form much deeper in the earth (around 140 to 200 km) than colored gems (only up to a few tens of kilometers), but only some are superdeep. These represent 1–2% of mined diamonds and ascend in low-density rocks to depths of about 200 km, where they might be brought to the surface in kimberlites. The depths these diamonds originated from are determined by their mineral inclusions that represent the pressure and temperature conditions of their formation. Scientists recognized ferropericlase and majoritic garnet in the 1980s and used high-pressure experiments as a basis for comparison to confirm their deep origin in the mantle. These discoveries provide a bigger picture of diamonds; lithospheric diamonds crystallize from carbon-containing fluids at depths of 150 to 200 km, whereas superdeep or sublithospheric diamonds form at depths of 300 to 800 km and subduction of oceanic lithosphere is a key ingredient in their formation. Ringwoodite, a high-pressure version of olivine, is stable at depths of 520 to 660 km in Earth's mantle, so the discovery of a hydrous ringwoodite inclusion in a superdeep diamond is evidence of subducted water. Unlike most lithospheric diamonds, which contain nitrogen and are therefore type I, superdeep diamonds are type IIa—containing essentially no nitrogen with levels of <5 parts per million (ppm)—or IIb, which contain traces of boron. Type I lithospheric diamonds represent 98% of all gem diamonds, whereas type IIa (1–2%) and IIb (<0.02%) are incredibly rare. Some of the world's most valuable gems are type IIa superdeep diamonds, including the 530.2 ct Cullinan I diamond set in the Sovereign's Scepter with Cross, part of the British Crown Jewels.

Scientists use the acronym CLIPPIR to describe these big gems: Cullinan-like, Large, Inclusion-Poor, Pure, Irregular, and Resorbed. The inclusions in CLIPPIR diamonds are associated with deeply subducted oceanic plates. Some of these inclusions are metallic (a mix of iron, nickel, carbon, and sulfur), and molten during diamond growth, representing the diamond-forming medium. Superdeep diamond genesis results from the warming and deformation of altered oceanic lithosphere at depth. Three fluid-generating mechanisms are important to diamond formation: the melting of carbonates, the release of water, and the evolution of a metallic melt. The ideas associated with natural diamond are some of the most unique in all geosciences: they form as a result of large-scale movements of plate tectonics; they are ancient (up to 3.5 billion years old); they are the deepest-derived objects you can touch; and they reach the earth's surface in strange volcanoes. Diamonds are a window into the hidden processes of the planet's interior, giving them both a tremendous scientific value and a fascinating natural history.

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Gem Mineral Evolution: Gemology in the Context of Deep Time

Dr. Robert M. Hazen (Carnegie Institution Earth and Planets Laboratory, Washington, DC, and George Mason University, Fairfax, Virginia) placed gem minerals in the context of mineral evolution. The range and diversity of Earth's minerals are a consequence of more than 4.5 billion years of new physical, chemical, and ultimately biological processes. The concept of mineral evolution represents a new framing of mineralogy for education and public engagement. It explains the change over time of the diversity of mineral species, their relative abundance, and compositional ranges, along with their grain sizes and shapes. It also explains why smaller bodies in our solar system, such as Mars and our own moon, have less diverse assemblies of minerals. Dr. Hazen noted that mineral evolution focuses exclusively on near-surface mineral phases (<3 km in depth), as these are accessible on Earth and most likely to be observed on other planets and moons.

Ten mineral evolution stages were identified over a period of 4.5 billion years, starting with just 25 mineral species and 16 chemical elements, and leading to >6,000 minerals and 72 essential elements today. Dr. Hazen related each stage to major events in Earth's history, including the heat and impact of planetary accretion, the transition from a "dry" to a "wet" planet through volcanism and outgassing of water and other volatiles, and the formation of granite and the onset of plate tectonics to oxygenation and the rise of life. At each stage, the range of possible minerals increases, including gems. Peridot appears around 4.55–4.35 billion years ago, as the young planet's internal heat drove volcanism and outgassing of water. Pegmatite gems such as beryl, spodumene, and tourmaline (figure 9) occur as granite forms through crustal remelting and differentiation around the 3.5-billion-year mark. With the onset of plate tectonics around 3 billion years ago, conditions became suitable for the formation of gem corundum, garnet, and jadeite. With the dawn of life, the rise of photosynthesis, and the production of an oxygen-rich atmosphere between 2.5 and 1.85 billion years ago, gem minerals such as azurite, malachite, and turquoise became possible. At each stage of mineral evolution, the range, diversity, and number of minerals increased. Dr. Hazen explained that each mineral or gem specimen is a treasure trove of information, revealing rich detail about formation processes and times.

Dr. Hazen introduced applications of powerful analytical and visualization methods to the characterization of mineral origins and the prediction of new mineral deposits, noting that we have entered a new age of mineral informatics where multidimensional analysis and visualization of mineral systems are leading to insights into the co-evolution of Earth and life. The talk concluded with a proposal that the diversity and distribution of minerals on Earth is a planetary-scale biosignature.

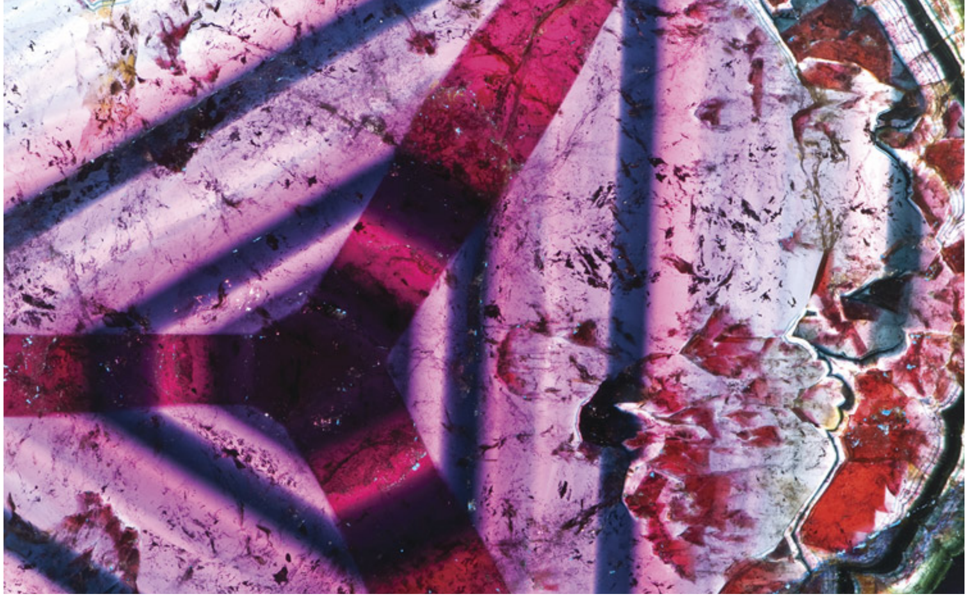

Figure 9. In a microcosm of mineral evolution, the color zoning in this liddicoatite tourmaline slice from Madagascar reflects changes in chemistry during growth. Photo by Robert Weldon.

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DIAMOND CUT

Modern Diamond Design

Dr. Jim Conant (GIA, Las Vegas) explored how new computational tools help navigate the vast design space of possible facet arrangements for polished diamonds, enabling both novel cuts and optimization of traditional cuts for light performance. Dr. Conant explained the basics of diamond optical performance and the work behind the creation of some new diamond cuts. The foundation of all diamond cut analysis is the concept of "virtual facet pattern." This helps interpret and model the various optical phenomena that contribute to or detract from the beauty of a cut diamond. It accounts for attributes such as brightness, light leakage, "crushed ice," "dark zone" patterns, fire, and scintillation, as well as enabling the creation of new diamond cuts, faceting arrangements, and cut geometries.

Virtual facets are the complex shifting patterns of little polygons that the observer sees, similar to a hall of mirrors, as a moving diamond's facet geometry reflects light back to the eye. Taking a single virtual facet near the edge of the table of an ideal cut round brilliant as an example, Dr. Conant explained that light striking the inside surface of a diamond at all but the steepest angles reflects off the internal surface like a mirror. As the remaining light enters the gem, it refracts as it passes through the crown, reflects twice off the pavilion, and finally travels out of the stone from the crown back to the observer's eye. Because this light meets several different facets along the way, it fragments into several columns. From the observer's perspective, each virtual facet collects light from a different region in the environment.

Dr. Conant explained that a diamond's appearance is quite sensitive to slight differences in pavilion angle; at 41.4 degrees, the beam path no longer exits the crown but reflects back down to the pavilion where it collects light from underneath the diamond, leading to "partial leakage." Showing the example of a poorly cut pear-shaped diamond cut to match the shape of the rough and maximize weight, Dr. Conant noted that sometimes leakage is even more obvious when the beam immediately exits through the pavilion without any reflections. The stone's poor appearance results from a too shallow pavilion, allowing light to leak out the bottom and create a "dark zone." Leakage detracts from a diamond's appearance, especially when it creates a big and blocky pattern. This is an example of a virtual facet drawing light from a dark place in the environment.

Next, Dr. Conant touched upon "crushed ice," the part of some diamond fancy shapes composed of thousands of tiny virtual facets. These tiny virtual facets draw light from a randomized subset of the environment and correspond to differing focal lengths. Rather than distinct, geometric facets with crisp edges and high contrast between light and dark areas, crushed ice features many small, irregular facets that blend light in a shimmering way, like shattered glass. Diamonds with little variation in brightness can appear less appealing than those with some contrasting dark regions. However, some dark features are universally disliked. Classic "bow tie" patterns can be appealing when less severe and more transient. The more persistent a dark zone is across different tilts, viewing distances, and lighting environments, the more likely it is to be perceived as negative.

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Toward a Fancy Cut Grade

For **Jason Quick** (GIA, Las Vegas), diamond cut is more than symmetry and light; it shapes style, taste, and personality. How can GIA help define and teach the design factor? Fancy cuts offer seemingly limitless design possibilities that defy exhaustive exploration (figure 10). However, exploring this vast array of potential fancy-cut designs enables rather than constrains innovation. Quick reflected that both AGS and GIA have a long history of diamond-cut research leading to today's Project Everest. This collaboration started with high-level meetings in 2020, led to the integration of both research teams in 2022, and to AGS Labs formally becoming GIA's Diamond Cut R&D Lab in 2023.

GIA's upcoming fancy cut grading system will use ray tracing on 3D wireframe models to assess light performance and will prioritize diamond beauty over fixed proportion ranges. This system must solve challenges for retailers, and by necessity, be packaged with education that makes the system intuitive to use and explain to consumers. He noted that diamond cut planning involves three stages: (1) mapping of rough, (2) planning, and (3) polishing. Mapping involves 3D plotting of inclusions (size, type, and location) along with color estimation. Planning produces permutations of size and cutting style to maximize yield and quality in terms of the Four *C*s. This provides an estimate of potential gem value and marketability (liquidity). Polishing transforms the diamond through sawing, bruting (shaping), blocking, and final polishing into a finished gem.

Recent advances in GIA cut research encompass cut space (mathematical models of all possible faceting arrangements), optics (simulations of light moving through faceted diamonds), and metric development (modeling and quantifying optical phenomena, such as "crushed ice" and "bow ties"). The objective of the system is to produce fancy-cut designs that deliver high performance across the most commonly encountered lighting environments and that maintain superior performance face-up, when tilted, and from various viewing distances. To support manufacturers, GIA is developing Facetware "software as a service" (SaaS), enabling the submission of 3D models for preliminary cut grade assessments to assist diamond designers and manufacturers. This system will provide cut analysis (a provisional cut grade, including symmetry evaluation), plans to support decisions before polishing, and scans to support quality control metrics after polishing.

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GIA "Excellent" Fancy Recutting Solutions

Janak Mistry (Lexus, Surat, India) looked forward to the introduction of GIA's fancy cut grading system, noting that the industry must prepare to manufacture fancy cut diamonds to "nicer makes" that receive better grades from the new GIA system and appeal to well-educated buyers. Leading laboratories have certified 8–10 million fancy-shaped diamonds over the last two decades. The majority were polished to retain mass rather than to optimize beauty and will likely require recutting to match clients' expectations. A similar challenge arose in 2005–2006 when AGS and GIA introduced cut grading for round brilliants, prompting some manufacturers to recut inventory.

Figure 10. Fancy-shaped diamonds such as these offer a multiplicity of design possibilities for consumers to explore. Photos by Robert Weldon.

Mistry's talk explored the implications of fancy cut grading through case studies on light performance and potential recut strategies. To demonstrate this process, Mistry selected a number of diamonds that performed poorly in the proposed new GIA system (beta version) and recut them to a GIA Excellent cut grade. The first example was a 0.51 ct oval with a very strong dark "bow tie" pattern. The best recutting plan option in the new system reduced the weight by 0.04 ct but removed the bow tie and improved the cut and symmetry grades to Excellent, resulting in a value addition of 22% and a far more marketable gem. The second example was a 0.96 ct emerald cut with Very Good cut, Fair symmetry, and Good polish. Its clarity was only I_1 due to a deep cavity on the gem's table. Recutting to the best solution reduced weight by almost 0.14 ct, but resulted in the removal of the cavity, which improved clarity from I_1 to SI_2, produced Excellent grades for cut, symmetry, and polish, and made the gem much brighter and pleasingly symmetrical. Mistry noted that the combination of these improvements was a value addition of 73%.

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GEM CHARACTERIZATION

Rare and Radiant: The Science and Beauty of Fancy-Color Diamonds

Dr. Sally Eaton-Magaña (GIA, Carlsbad) explored the rainbow of natural diamonds and their varied causes of color, highlighting some of the most rare and magnificent diamonds that GIA has evaluated. Every natural diamond has a unique story of its creation written into its atomic-scale defects and inclusions (figure 11). Most receive the ingredients for color within the earth as they form. Impurities of nitrogen, boron, nickel, and hydrogen produce yellow, yellowish green, violet, and blue colors, while abundant tiny inclusions create black or white colors. Once they reach the earth's surface, diamonds can be exposed to radioactive minerals that might color them green or blue. By contrast, the majority of natural pink diamonds colored by the 550 nm absorption band derive their color from the geologic forces of mountain-building events deep within the earth.

Natural yellow diamonds are the most common fancy colors, while pure orange diamonds are among the rarest. Both are colored by atomic-level structural defects associated with nitrogen impurities. Four groups of defects cause color in nearly all yellow and orange diamonds: cape defects (N3 and associated absorptions), isolated nitrogen defects, the 480 nm visible absorption band, and H3 defects. Some of the spectacular yellow to orange diamonds seen at GIA include the 30.54 ct Arctic Sun, the 128.54 ct Tiffany Yellow, and the 5.54 ct Fancy Vivid orange Pumpkin.

Natural blue diamonds are among the rarest and most valuable gems, and many come from very specific mines: South Africa's Cullinan and Australia's Argyle. While boron impurities are often associated with blue color, some blue and gray to violet colors also originate from simple structural defects produced by radiation exposure or from more complex defects involving hydrogen. Examples of remarkable blue diamonds include the 45.52 ct Hope, the 31.06 ct Wittelsbach-Graff, the 15.10 ct De Beers Blue, and the 20.46 ct Okavango Blue.

Dr. Eaton-Magaña then discussed the four major causes of color for green diamonds. Radiation exposure is the most common and can create vivid pure green colors. Some yellow-green diamonds owe their bodycolor to the combination of the H3 defect and green fluorescence, or to hydrogen- or nickel-related defects. Among the most famous green diamonds are the 41 ct Dresden Green, the 5.51 ct Ocean Dream, and the 5.03 ct Fancy Vivid green Aurora Green.

There are two primary causes of color for pink to red diamonds. The so-called "Golconda" pinks get their color from nitrogen vacancy centers, while the overwhelming majority of natural pink diamonds (about 99.5%) get theirs from an absorption band centered on 550 nm. This absorption band is created when the diamond experiences stresses at high pressure and temperature and plastically deforms,

Figure 11. Fancy-color diamonds, such as these examples from the Aurora Butterfly of Peace, owe their spectacular hues to many causes, including tiny amounts of impurities, atomic-level structural defects, or plastic deformation deep in the earth. Photos by Robert and Orasa Weldon.

typically due to mountain-building events. The 34.65 ct Fancy Intense pink Princie, the 11.15 ct Fancy Vivid pink Williamson Pink Star, the 5.11 ct Moussaieff Red, and the 2.33 ct Winston Red are examples of famous pink to red natural diamonds GIA has examined over recent years.

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The Impact of Fluorescence on the Appearance of Gemstones

Dr. Christopher M. Breeding (GIA, Carlsbad) explained that fluorescence in minerals has long been a subject of intrigue and fascination. For gemstones, it is sometimes considered a benefit and other times a flaw. Fluorescence can affect the appearance of some gemstones, and thus their values, even in normal lighting conditions. Dr. Breeding defined fluorescence as the emission of electromagnetic radiation from a substance stimulated by the absorption of incident electromagnetic radiation. The emission persists only as long as the stimulating radiation is continued. Phosphorescence is any emission that continues after the stimulating radiation is stopped. In gemology and mineralogy, fluorescence is commonly associated with excitation by an ultraviolet (UV) light source. Gemologists use a number of specific wavelengths of UV light, including long-wave at 365 nm, short-wave at 254 nm, and deep-UV (<230 nm, as used by the DiamondView device). Any wavelength of light, including visible light, can induce fluorescence.

Dr. Breeding noted that connoisseurs consider rubies from Myanmar's (formerly Burma's) Mogok region among the finest available. They owe their vibrant red hues to a combination of absorption and fluorescence, both caused by chromium atoms in their structure (figure 12). The trade values strongly fluorescent "Pigeon's Blood" Burmese rubies, and the most exceptional stones have sold for more than US$1 million per carat. Rubies with high iron levels have weak fluorescence, and the trade tends to value them less highly. Research at GIA using filters that only allow

Figure 12. The larger of these two rubies from Namya, Myanmar, weighing 7.5 ct (left) and 4.5 ct (right), is pictured under long-wave fluorescent light. These high-quality gems from Kachin State are often mistaken for Mogok rubies due to their similar quality. Photo by Wim Vertriest.

chromium fluorescence to pass through shows that the impact of fluorescence on ruby's red color may be overstated.

Conversely, the trade applies discounts of 10 to 30% to colorless or near-colorless diamonds with strong or very strong fluorescence. Dr. Breeding noted a common trade perception that D–G color diamonds with strong fluorescence sometimes exhibit a noticeable luminescence, which can give a diamond a "hazy" appearance. As a result, many near-colorless diamonds sell at a discount simply because they have strong blue fluorescence. Observations at GIA among high clarity, D–G color, highly fluorescent diamonds demonstrate that facet junctions remain clear and crisp under UV lighting. On the other hand, the hazy or cloudy appearance in fluorescent diamonds intensifies under UV. Strong blue fluorescence does not cause a diamond to appear hazy on its own, but it may increase the haziness of a stone with light scattering structural defects or inclusions. Experiments using a technique called modulation transfer function (MTF), which measures an optical system's ability to transfer contrast from an object to an image, allow us to evaluate and quantify haziness in diamond. GIA will add comments to grading reports for many fluorescent diamonds beginning in late 2025.

To conclude, Dr. Breeding explained that pearls can be treated with blue-fluorescing optical brighteners to enhance their appearance, and that perceptions about gemstone fluorescence and appearance, even deeply rooted ideas, are not always reality.

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Phenomenal Gemstones: A Brief Overview of the Nanostructures Behind the Optical Spectacles

Dr. Shiyun Jin (GIA, Carlsbad) focused on gem materials that display special optical phenomena including asterism, chatoyancy, aventurescence, iridescence, and color change. Gems with these distinctive properties have attracted the attention of gem lovers and scientists for centuries. Yet scientists have only characterized most of the nanostructures underlying these optical effects in the last few decades, thanks to the development of electron microscopy. Dr. Jin referred to the Summer 2025 *Gems & Gemology* paper, a comprehensive 60-page article documenting more than two dozen types of phenomenal gems with nearly 300 references for those seeking to know more. Dr. Jin noted that the paper provides necessary clarifications because many terms used in the trade to describe phenomenal gems are often poorly defined and subjective. However, the roots of this confusion are understandable: a gemstone might display multiple phenomena; gemologists often use many terms to describe the same phenomena; the same phenomenon might also look dissimilar in different stones; and different phenomena, with disparate underlying causes, may appear similar.

Dr. Jin briefly touched on well-understood phenomena including opalescence (the milky or hazy appearance due to diffuse scattering of light by nanoparticles), asterism and chatoyancy (the star and cat's-eye effects caused by oriented light-scattering needles), and aventurescence (the specular reflections from isolated, typically flat or "platy" inclusions within a transparent gem). A longer segment of the talk covered phenomena due to thin-film interference of reflected light from repeated arrays of transparent thin platy minerals, where the color depends on the thickness of the layers. This includes the blue flashes of labradorescence, the rainbow of orient or overtone shown by nacreous pearls, the iridescence of shell, and play-of-color in opals (figure 13). Iridescence is not exclusive to gems; the flashing colors seen in a pigeon's feathers, a butterfly's wing, or on the surface of a soap bubble are due to the same cause.

Next, Dr. Jin focused on inconsistencies in terms mineralogists, gemologists, and the gem trade use to describe feldspars with iridescence. Mineralogists generally separate iridescent feldspars into three categories based on their bulk chemical composition: labradorite, peristerite, and moonstone. Moonstone, for example, is named after its white or silver iridescent glow that resembles moonlight. Unfortunately, the trade applies the term *moonstone* haphazardly to any light-colored feldspar, such as transparent labradorite displaying a desaturated multicolor iridescence, which is often sold as "rainbow moonstone." This adds confusion to an already complicated subject. Dr. Jin encouraged the use of more general terms such as *iridescence* and *play-of-color* over specific terms such as *labradorescence*. He stressed that phenomena should be defined based on the underlying texture and physics processes instead of vague descriptions of appearance.

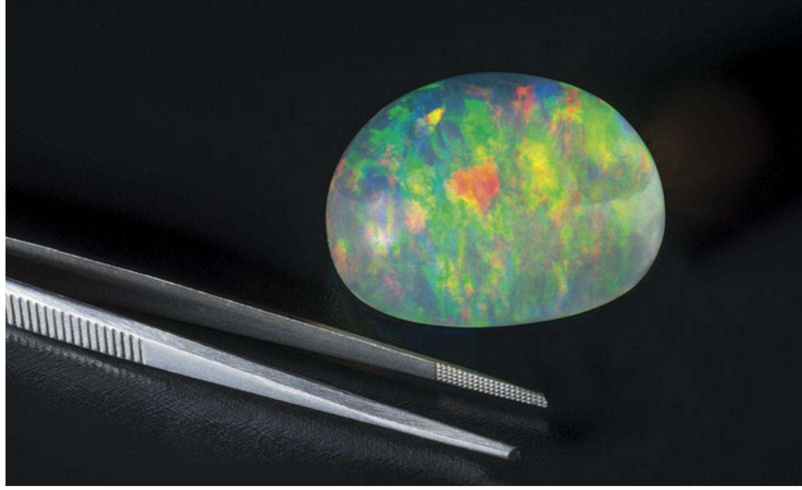

Figure 13. This 264.44 ct Ethiopian opal displays a spectacular play-of-color phenomenon. Photo by Robert Weldon; courtesy of Tewodros Sintayehu, Orbit Gems, and Bill Marcue, DW Enterprises.

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GENERAL GEMOLOGY

The Science That Makes Gems Shine: Understanding Metrology at GIA

Dr. Yun Luo (GIA, Carlsbad) began by differentiating *metrology*, the science of measurement and its application, from *meteorology*, the study of the weather, and explaining its relevance to GIA. Dr. Luo explored how metrology underpins GIA's research and laboratory services through rigorous validation, verification, and intra- and inter-laboratory testing of various measurement instruments. Precision and accuracy are at the heart of every gemstone measurement and evaluation GIA undertakes. Metrology ensures consistency and reliability across GIA's global laboratories. Dr. Luo explained how the three pillars of traceability (every result must link back to a recognized reference), reference standards (the agreed reference everyone measures against), and accuracy (how close a measurement is to the true value) ensure that the measurements of a diamond taken at one GIA laboratory match those of the same diamond if submitted to another GIA location. Dr. Luo defined accuracy as the closeness to a desired target value and precision as the consistency and repeatability of the results achieved. Both are essential for reliable measurements. Uncertainty is the level of confidence we have in the result, and calibration is the process of correcting systematic error. Together, precision, uncertainty, and calibration transform a number on a screen into a scientifically sound and meaningful measurement. Dr. Luo reminded the audience that measurement without an estimate of uncertainty is meaningless.

Every instrument has a range of reproducibility or tolerance. Reproducibility measurements allow metrologists to track the performance of each device and assess whether any of them need extra attention. Testing a gemstone at GIA includes measurement of carat weight, dimensions, color, clarity, fluorescence, spectrometry, imaging, and chemical analysis. These measurements have to be accurate, precise, and consistent across all of GIA's labs. What makes GIA stand out is that metrologists verify instruments daily before evaluating client stones, regularly submit unannounced blind control stones to check accuracy, have well-defined standards and inter-lab tests for global consistency, and capture hourly data during business hours at all GIA laboratories to ensure quality.

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The Vault and Beyond: The Exciting Lives of Museum Specimens

Dr. Rachelle Turnier (GIA, Carlsbad) offered a behind-the-scenes look at the GIA Museum to highlight the essential roles its exhibits and specimens play in GIA's mission. When Robert M. Shipley founded GIA in 1931, he needed specimens for teaching. In those early days, there was no distinct "museum," but rather simply an "education collection." Over the years, the collection grew as diamonds and gemstones were loaned or purchased. Eventually some of the loans became gifts. In 1976, Dr. Vincent Manson, GIA's "director of dreams," had a vision for separate museum and education collections. A former curator at New York's American Museum of Natural History, he recognized the value of GIA's pieces and their many potential uses and separated them into two collections.

However, it was not until 2000 that GIA created a formal museum department. The catalyst was undoubtedly the 1997 opening of the Carlsbad campus. GIA is a living museum, with more than 100 exhibits spread throughout the Carlsbad campus to serve the students, public, and employees. Of the 50,000 specimens in the collection, 75% are donations from alumni, industry leaders, and retiring enthusiasts who donate their treasures knowing they will be used and appreciated (figure 14). The Sir Ernest Oppenheimer Student collection is perhaps the most foundational donation. Loaned in 1933, then later donated in 1955, it consists of more than 1,500 carats of diamonds, worth $20,000 at the time. Its spectacular diamond crystals, both loose and in matrix, would be valued at several million dollars if donated today. Through donations and purchases, GIA acquired additional important collections including the Dr. Kurt Nassau Synthetic collection, the Dr. Frederick H. Pough Synthetic collection, a collection of Pierre Touraine's Southwest-inspired jewelry, and in 2005, the Dr. Edward J. Gübelin collection. Recent donations include pre-Columbian jewelry, a collection of 850 polished gem and mineral eggs, the models and findings of

Figure 14. This past GIA Museum birthstone exhibit at the San Diego International Airport represents one way GIA promotes its mission to engage, inspire, and educate the public about gemology. Photo by Kevin Schumacher.

Peter Lindeman, who worked for important jewelry brands including Tiffany & Co., and a significant donation of high-end jewelry ranging from an Egyptian necklace fabricated around 1500 BCE to Victorian high-end jewelry from brands such as Cartier, Tiffany & Co., and Fabergé.

While GIA's Museum collection serves to educate students and inspire visitors on public tours, it is also a crucial resource for GIA's scientists. GIA researchers draw on the collection for experiments and research purposes, including using gemstones of known localities to develop new geographic origin services, studying gems for causes of color, and even for developing laboratory standards.

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Exploring the Behind-the-Scenes of the Smithsonian National Gem Collection

Dr. Gabriela Farfan (Smithsonian National Museum of Natural History, Washington, DC) shared how research, "behind-the-scenes" teams, and iconic exhibits work together to spark curiosity about the natural world, highlighting the new Winston Fancy Color Diamond collection—including the 2.33 ct Winston Red—which was unveiled in 2025. The Smithsonian National Museum of Natural History is part of the U.S. national collection of museums, has no admission charge, and sees more than 6 million visitors per year. Its gems and minerals are a gateway to science for many visitors. In Dr. Farfan's reckoning, a gem is a mineral that has been transformed by an artist, and the Institution's many such gem icons include the 45.52 ct Hope diamond, the 48.68 ct "Whitney Flame" topaz, the 10,363 ct Dom Pedro aquamarine, the 75.47 ct Hooker emerald, and the Marie Antoinette diamond earrings. Dr. Farfan noted that the National Gem and Mineral Collection contains approximately 385,000 specimens, of which more than 10,000 are gemstones. The Institution's role is to preserve mineral and gem specimens for generations to come.

Although all the Smithsonian's specimens come via donations, other museums may request loans for exhibits, and scientists can request samples for study. Recent acquisitions include the 55.08 ct Kimberley diamond (2019); the 116.76 ct "Lion of Merelani" tsavorite garnet (2023); a 30.50 ct spessartine garnet, a 12.85 ct bicolor zoisite, a spectacular morganite carving of cockatoos (2024); and a 13.34 ct Paraíba tourmaline and a 73.55 ct lavender spinel (2025). Dr. Farfan explained how the collection is expanded by filling its "holes." This includes adding new mineral species, covering representation of specific localities, responding to popular research topics, including unique gemstones, and making significant "upgrades" for exhibitions. The Winston Fancy Color Diamond collection donated in 2025 is one such example. It encompasses 118 diamonds in all colors of the rainbow. Forty of these diamonds, ranging from 0.4 to 9.5 ct, are now on exhibit. Of these, the Winston Red, a 2.33 ct old mine brilliant cut diamond with an unmodified Fancy Red hue, is the most well-known.

A group of researchers from the Smithsonian, GIA, and the École des Mines de Paris (Paris School of Mines) undertook a 2025 study of the Winston Red to answer specifics about the gem, namely the cause of its unique pure red hue, and its history, geographic origin, and rarity. Dr. Farfan outlined the results of the team's research. Analyses confirmed the presence of plastic deformation bands, and dislocation network patterns classified the Winston Red as a type IaAB (A) Group 1 "pink" diamond. To achieve its red color and dense dislocation networks, the Winston Red diamond likely experienced immense strain in Earth's mantle. Although the team traced the Winston Red back to 1938, its old mine brilliant cut suggests a richer story. Based on its mineralogical characteristics and history, Dr. Farfan concluded that the likely geographic origin of the stone is Venezuela or Brazil and called out the recent Spring 2025 *Gems & Gemology* article on the gem.

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NEW TECHNOLOGIES AND TECHNIQUES

Revealing the Hidden World of Diamond in 3D

Dr. Daniel Jones (GIA, New Jersey) explained that all diamonds possess an interior "hidden world" that reveals their growth history, information about their chemical composition, and evidence of post-growth events. In this talk, Dr. Jones explored the unseen world of diamond, showing the structures of growth using photoluminescence with a newly developed GIA 3D imaging system. This system allows for high-resolution 3D mapping of the internal structure of diamonds using defect photoluminescence and high-powered lasers. It also identifies defects using spectroscopy.

Natural diamonds grow deep in the earth over a period of millions to billions of years and are subject to changing environments, which cause subtle, sometimes imperceptible changes to their atomic structure. Dr. Jones asked the audience to liken diamond growth to tree rings, showing layers radiating outward with the oldest part in the center. A diamond's growth history can be viewed using complex imaging techniques. Dr. Jones remarked how visual observations can be useful in analyzing diamond, and that spectroscopy, a method for determining the existence of atomic-scale color centers, can be applied across the bulk or at specific points of a diamond. Some of these color centers create visible color through absorption, and others emit light through fluorescence when excited via a laser light source. Using a combination of visual observation, spectroscopy, and 3D scanning, gemologists can visualize the structures of natural diamonds in their full crystallographic majesty.

Unlike a human eye or a conventional camera, which "sees" only three broad bands of light (red, green, and blue), hyperspectral data as captured by an imaging spectrometer contains hundreds of narrow, continuous spectral bands across a wide part of the electromagnetic spectrum beyond the visible range into the infrared and ultraviolet. This creates a hyperspectral "data cube" where two dimensions are spatial (X + Y), and the third (Z) is spectral, which allows for characterization of the diamond based on its unique "spectral fingerprint." Critically, this process is nondestructive, making analysis much more viable. Dr. Jones explained that the downside is the amount of data generated and the processing power required to render it into a three-dimensional model. Dr. Jones showed several examples of the technique including video renderings revealing defects and structure in both rough and faceted natural diamonds, allowing the rotation of the image around its axes to show three-dimensional structure. This allows the observer unprecedented resolution and access to the gems' internal growth patterns. Dr. Jones demonstrated the technique with examples of high-pressure, high-temperature (HPHT) and chemical vapor deposition (CVD) laboratory-grown diamonds, which also revealed their distinctive structures and defect patterns.

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Figure 15. AI tools that can generate photorealistic images from text prompts are becoming more widely used to rapidly iterate jewelry designs. While designers can benefit from these tools' capabilities, they must be aware of their flaws. This image output includes irregularly shaped gems and "floating" bezels.

Art and Algorithm: Advances in Generative AI and Jewelry Design

Michael Magee (GIA, Carlsbad) explored recent advances in both generative artificial intelligence (AI) technology and regulations, demonstrating how jewelry designers and retailers can leverage these powerful tools responsibly for innovation. While initially controversial, many ethical and regulatory challenges surrounding AI tools have begun to find resolution. Magee explained how generative AI learns patterns from large datasets, identifies underlying structures and elements, and generates something new and unique based on this input (figure 15). The talk covered general models such as ChatGPT (Open AI), Gemini (Google), and Copilot (Microsoft); image generators including Midjourney, Leonardo, and Firefly (Adobe); and provided examples with jewelry-specific applications such as Dzine, Bez, GemArt AI, and Blng.

Magee discussed a recent U.S. Copyright Office report that identified key copyrightability issues related to AI-generated outputs. The existing legal framework governing copyright protection in the U.S. requires human authorship, as established by the Copyright Clause in the Constitution. No court has recognized copyright for works created solely by non-humans. In fact, the U.S. District Court ruled that while human contributions must be assessed on a case-by-case basis to determine authorship, works generated without human involvement do not meet the authorship requirement. The report emphasizes that prompts alone do not provide sufficient control for copyright eligibility. Human authors are entitled to copyright for their contributions, including selection, coordination, and arrangement of AI-generated material. Magee explained that the distinction lies in whether AI is used to enhance human expression or if it makes expressive choices independently, and that there is a divergence of opinion on the extent of human contribution required for copyright protection.

Next, Magee illustrated some of the current capabilities of AI applications, showing a range of designs along with the written and visual prompts—including the speaker's own hand-drawn sketches—that produced them. The products included photorealistic images and a near-cinematic 5-second video that could be used in a luxury jewelry commercial. Current challenges in using generative AI for jewelry design include creating desirable and original designs, understanding manufacturability to create usable 3D models, and energy consumption. Per a recent *MIT Technology Review* article, the electricity needed to generate 15 chat questions, render an image using 10 attempts, or produce three 5-second videos amounts to approximately 2.9 kWh, equivalent to the electricity necessary to power an e-bike for 100 miles, run a microwave for 3.5 hours, or drive a small electric car for 12 miles.

Magee emphasized that designers must work harder to create desirable and original designs rather than simply using prompts together with data "scraped" from other images and sources, and went on to suggest creating custom training for an AI application using up to 20 images with a consistent style, photos, or better yet, the designer's original digital renderings. He explained that using the designer's own hand or digital sketching is best because this incorporates human creativity and expression into designs. To make designs manufacturable, Magee suggested vetting the AI renderings for both outlandish and subtle errors. To ensure good quality control, the AI must be trained with accurate 3D models in order to calculate dimensions or estimate material weights accurately. Currently, AI-generated 3D models show poor surface quality, uneven dimensions, and improper segregation of parts.

Magee concluded by observing that good design still relies on knowledgeable individuals to catch both wildly impossible and subtly wrong AI-rendered images, provide CAD models or other manufacturing data for 3D, create accurate weight and cost estimates, and decide which tools are right for the job and the designer's brand. Future directions will include better 3D model generation, plugins for Rhino and other jewelry-specific CAD programs, cost estimates, bill-of-materials (BOM) lists from images, and further integration into the customer experience.

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Innovative Spectroscopic Instrumentation for Gemstone Screening and Identification

Dr. Tsung-Han Tsai (GIA, New Jersey) described how GIA is developing new gem testing instrumentation. The talk focused on fluorescence spectroscopy for diamond screening, pearl testing, and colored stone identification, as well as image-assisted Raman and photoluminescence equipment for diamond jewelry identification and multi-excitation photoluminescence spectroscopy for gemstone analysis. Conventional luminescence observation uses filtered long-wave (365 nm) and short-wave (254 nm) ultraviolet light. The mercury lamps used have limitations: Their emission spectra typically include a mixture of all mercury lines, which can interfere with luminescence observations, and the filters they use degrade over time. Nonetheless, they provide powerful UV excitation (~200 μW) at an affordable cost. Making luminescence measurements with spectroscopy leads to more objective conclusions than visual observations and allows for automation and more rapid screening. Gemstone screening maintains transparency in the gem market by helping prevent undisclosed mixing of laboratory-grown and treated color diamonds and simulants, which would threaten the price of natural gems, undermine consumer confidence, and cause legal and regulatory issues. Any screening technology must meet certain identification challenges, manage high volumes of gems, be compact enough to be practical, and be cost-effective.

Approximately 97% of natural diamonds show blue fluorescence caused by the N3 color center (a crystallographic defect in diamond consisting of a vacancy surrounded by three nitrogen atoms). Other less common fluorescence colors include yellow, green, white, orange, and red. While the N3 defect appears in the vast majority of natural diamonds, its absence in laboratory-grown diamonds (LGDs) and diamond simulants allows a 100% referral rate of these materials with fluorescence screening. Similarly, most natural-color pink diamonds only show the N3 defect, while the NV^0 center (a defect consisting of a nitrogen atom that has replaced a carbon atom and an adjacent missing carbon atom) is characteristic of multi-treated and laboratory-grown diamonds but rare in untreated pink ones (about 0.6% of rare, so-called "Golconda" diamonds). This allows fluorescence screening a positive identification rate of 99.8% for natural-color pink diamonds and a 100% referral rate for pink LGD and multi-treated pink diamonds. GIA's iD100 is an example of a newer compact fluorescence screening device. It offers automatic diamond identification for colorless to near-colorless, blue to green, brown, and pink to red diamonds, displays results in approximately 2 seconds, and is suitable for loose and mounted samples (>0.9 mm) in any cut. Fluorescence screening also shows some promise for mineral identification and detection of color treatments in pearls.

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POSTER PRESENTATIONS

More than 30 posters covering broad topics related to the industry were presented at Converge 2025. Presenters were on hand to interact with Converge attendees to share their gemological knowledge (figure 1). In the poster presentations outlined below, only the principal, or first-listed author, appears. All entries were written by GIA staff. To view photos of the posters, visit https://www.gia.edu/gems-gemology/winter-2025-gemnews-converge-posters

COLORED STONES AND PEARLS

Gemological Characterization of Emeralds from North Carolina, USA

Nicole Ahline | GIA, Carlsbad

North Carolina's emerald deposits are among the few recognized in North America, best known because they are historically significant and gemologically distinct due to their chemistry and color zoning. This poster provides the context of the geological environment the emeralds formed in, an overview of their standard gemological properties, inclusion photomicrographs, and chemistry.

Emerald Report Features at GIA Laboratories

Alex Goodsuhm | GIA, Carlsbad

Since December 2024, GIA has offered optional filler identification on its emerald origin reports. This poster details the new service, which is available in addition to the standard report information and includes identification of the stone and the degree of filler. Currently offered at no cost, the service provides the filler information in the following format: Type A (oils and other naturally occurring materials such as Canada balsam, cedarwood oil, and paraffin) and Type B (artificial resins such as Opticon, Permasafe, and Araldite).

Explorations in Brazil: GIA's 102nd Field Expedition

Dr. Aaron Palke | GIA, Carlsbad

This poster focuses on a recent GIA field gemology expedition to Brazil, which remains a colored stone mining powerhouse. The objective was to bolster GIA's colored stone reference collection with representative samples of white opal from Piauí State and emerald from Campos Verdes, Goiás State, and to revisit the legendary copper-bearing tourmaline deposits in Paraíba. The opal samples, which resemble Australian opal, will help support an upcoming new GIA opal report, and the emerald samples are of interest because their chemistry and inclusion suites can resemble gems from other locations including Pakistan, Afghanistan, and Colombia.

Field Gemology and GIA's Colored Stone Reference Collection

Wim Vertriest | GIA, Bangkok

This poster summarizes GIA's field gemology expeditions and the nature of the Institute's colored stone reference collection. A map shows the locations of mining areas visited to date and the types of gem materials collected. Short summaries provide the reference collection's focus along with an explanation of the six sample categories (A–F), based on proximity to the mine when collected by the field gemologist.

Figure 1. On hand to interact with Converge poster session attendees, GIA's Nathan Renfro, Nicole Ahline, John Koivula, and librarian emerita, Dona Dirlam represent a wealth of gemological and geo-literary experience. Photo by Emily Lane.

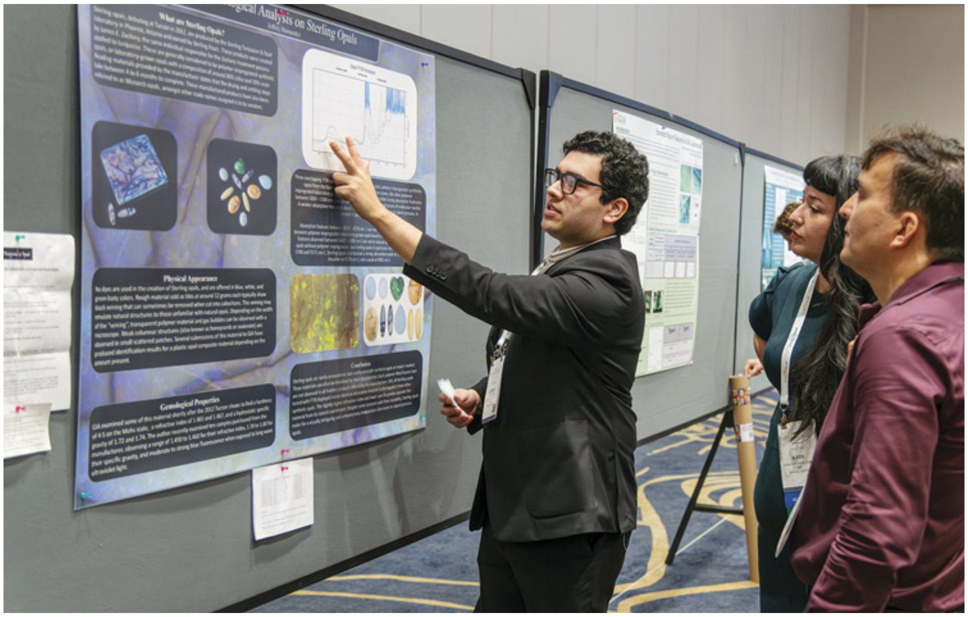


Figure 2. Jeffrey Hernandez interprets the distinctive absorption peaks of Sterling synthetic opal to show how these features allow gemologists to identify this material. Photo by Emily Lane.

Glass Ceramics as Imitation Gems

Dr. Wasura Soonthorntantikul | GIA, Bangkok

Glass ceramics are materials consisting of crystalline phases dispersed in an amorphous glass matrix, which combine properties of glass and ceramics. While mainly produced for industrial purposes, these materials are very suitable for use as imitation gems. They are tougher and more wear-resistant than regular glass and are inexpensive to produce in any color or transparency. This poster outlines how glass ceramics are made, their gemological properties, and possible identification challenges.

Advances in Jadeite Origin Determination at GIA

Alex Goodsuhm | GIA, Carlsbad

Due to the increase in supply of high-quality Guatemalan jadeite/omphacite jade (known as *fei cui* in the trade) reaching gem markets, GIA recently conducted a study of untreated Guatemalan and Burmese (Myanmar) material. Trace element chemistry analysis using laser ablation–inductively coupled plasma–mass spectrometry followed by application of machine learning revealed differences that, when coupled with observations, allow separation and permit origin determination of both sources.

Gemological Analysis on Sterling Opals

Jeffrey Hernandez | GIA, Carlsbad

The author presented a gemological characterization of Sterling synthetic opals along with context about their origin, physical appearance, production process, and place in the market (figure 2). This distinctive material, essentially polymer-impregnated laboratory-grown opal, is readily identified by characteristic black polymer-filled fissures and its distinctive Fourier-transform infrared absorption peaks.

Gemological Characteristics of Natural Pearls from Windowpane Oysters (Placunidae Family) from Indonesia

Karan Rajguru | GIA, Mumbai

This poster provides an overview of the gemological characteristics of natural pearls from windowpane oysters, which are widely distributed along the coasts of India, Indonesia, the Philippines, and China. Observations include surface structures and real-time X-ray microradiography and X-ray computed microtomography of the pearls' interiors. Spectroscopic and trace element analyses are also presented, confirming these pearls are composed of calcite rather than aragonite.

Organic-Rich Cores in South Sea Non-Bead Cultured ("Keshi") Pearls

Nishka Vaz | GIA, Mumbai

The authors present a study of 43 South Sea "keshi" non-bead cultured (NBC) pearls from the *Pinctada maxima* mollusk using real-time X-ray microradiography, X-ray computed microtomography, and Raman spectroscopy. Examination revealed a variety of internal structures including cores with light gray nuclei, seedlike features, off-round nuclei, and multiple cores and nuclei, which are key indicators of NBC pearls from this mollusk. Raman spectroscopy confirmed that the cores primarily combine conchiolin and aragonite nacre.

Hydrogen-Related Peaks in the Infrared Spectra of Corundum: What Are They, and What Can They Tell Us?

Dr. Michael Jollands | GIA, New York

In corundum, most infrared absorption bands relate to hydrogen in defects associated with a small number of other trace elements: beryllium, magnesium, nickel, iron, cobalt, titanium, tin, vanadium, and silicon. The exact positions of these bands correlate to the atomic structures of these defects. The author outlines how specific bands can correspond to different localities, heat treatment conditions, or laboratory-grown material. The nature of these bands can be determined by combining atomic modeling with analysis of trace element concentrations.

Nanoparticles in Natural Beryllium-Bearing Sapphires

Dr. Shiyun Jin | GIA, Carlsbad

Trace element analysis of gem corundum is important because it helps us understand which chromophores color them and often informs country of origin determination. Although beryllium is most often associated with diffusion treatment, it does occur naturally in corundum, where it is always associated with heavy high field strength elements (HHFSEs) such as niobium, tantalum, and tungsten. These elements are found in primary nano-inclusions that precipitate out of the corundum as irregular-shaped clouds or milky bands as it cools. This poster presents an analysis of the distribution and nature of these particles.

Diversity in Kashmir Sapphires

Sudarat Saeseaw | GIA, Bangkok

Kashmir's blue sapphire mines owe their legendary status to a relatively short window of production in the 1880s and 1890s. What little production has emerged since then has been of much lower quality than that of this early period. The trade identifies old production as "Classic" and more recent material as "New Kashmir." GIA recently had the opportunity to study a suite of 400 sapphires sourced from old collections and more recent finds near the mines. As both types contain very similar inclusion patterns, they are likely from the same deposit. This poster presents a representative set of photomicrographs from this research.

Chromophore Simulation of Copper-Bearing Tourmaline

Dr. Yusuke Katsurada | GIA, Tokyo

Paraíba tourmaline owes its blue to green color to the presence of trace amounts of copper and manganese. Although the influence of copper, which creates an absorption between 600 and 1000 nm, is relatively well understood,

Figure 3. Dona Dirlam's poster presentation on the wealth of gem and ornamental materials associated with the Taj Mahal. Photo by Emily Lane.

the role of manganese has not yet been studied in detail. Following experimental analysis of the other chromophores that contribute to color in elbaite tourmaline, the authors propose a model to predict their influence in addition to copper. The addition of iron creates a darker blue, manganese (Mn^{3+}) a violet to purple, and manganese plus titanium (Mn-Ti) a greenish blue to green color.

The Evolution of Persian Turquoise Classification from Past to Present

Dr. Niloofar Mousaviapak | Claude Bernard University, Lyon, France

This poster examines the evolution of Iranian turquoise classification. Originally, naming and valuation were linked to the name of the mine producing the turquoise, but during the Qajar Period (1794–1925), factors such as the texture, presence of matrix, and depth of color were introduced, making the description of quality and appearance more consistent. This poster is centered on a chart that shows how ancient, Qajar, and modern terminology correlate.

DIAMONDS

Correlations Between Spectroscopic Characteristics and Growth Parameters of Nitrogen-Doped CVD Diamond

Dr. Matthew Dale | De Beers, Maidenhead, United Kingdom

This poster summarizes a photoluminescence (PL) spectroscopy and luminescence imaging study of specially grown chemical vapor deposition (CVD) diamonds, exploring correlations between the intensities of different PL features and the nitrogen concentrations and growth rates of the samples.

The Current Gemological Landscape of Laboratory-Grown Diamonds

Dr. Sally Eaton-Magaña | GIA, Carlsbad

This work surveys the current production of laboratory-grown diamonds (LGDs), showing how color, clarity, cut grades, and color distribution have changed over time (2015–2025) using both high-pressure, high-temperature (HPHT) and chemical vapor deposition (CVD) methods. The poster outlines the advanced testing methods used by GIA to conclusively identify LGDs, the services provided by the GIA laboratory, and the growth of CVD diamonds at GIA.

Fluorescence Lifetime Analysis and Mapping of a Hydrogen-Rich Diamond

Dr. Paul Johnson | GIA, New York

This poster presents details of a custom-built instrument designed to measure the lifetime of diamond color centers over picosecond to millisecond timescales, along with analysis of a hydrogen-rich, type Ia diamond sample specially prepared for this study. The sample, a natural diamond crystal from Zimbabwe fashioned into a 0.92 ct cube and subsequently heated and irradiated, contains a stellate-shaped cloud inclusion.

Reflecting on Fancy-Cut Diamond Patterning

Dr. James Conant | GIA, Las Vegas

The author provides a visual guide to various aspects of fancy-cut diamond patterns, beginning with generating symmetrical diamond designs and determining the degree of symmetry to create a three-dimensional model. This allows for the modeling of light and demonstrates the visual appearance of virtual facets and the evaluation of any patterning, such as "bow ties" or "crushed ice," that a particular design might display.

Spatial Distribution of Defects in Natural C-Center–Bearing Diamonds

Taryn Linzmeyer | GIA, Carlsbad

A C-center is a crystallographic defect in which a single isolated nitrogen atom substitutes for a carbon atom within a diamond's crystal structure. Diamonds with this defect are called type Ib and are rare in nature because residence in Earth's mantle tends to cause the defects to aggregate into pairs (A-centers) or clusters of four nitrogen atoms surrounding a vacancy (B-centers). C-centers might cause vibrant yellow to orange colors, making these diamonds valuable to the gem trade. In this study, the authors use photoluminescence and Fourier-transform infrared spectroscopy to characterize these rare natural diamonds.

GENERAL GEMOLOGY

10,000 Years of Collecting Malachite

Dona Dirlam | Geo-Literary Society, Redwood Falls, Minnesota

This poster features a list of important malachite deposits by country and a timeline of malachite references in historic literature flanking an image of the GIA Museum's specimen "Atlantis," a stunning 70 × 20 cm array of green malachite spires coated with blue chrysocolla from the Star of the Congo mine in Lubumbashie, Haute-Katanga, Democratic Republic of the Congo.

The Elephants Are Winning

Charles Carmona | Guild Laboratories, Los Angeles

Although the global elephant population has started to rebound following historic lows between 1990 and 2010, they are still threatened by the illegal ivory trade and human-elephant conflict, including encroachment of livestock into elephant habitats and habitat fragmentation driven by human population growth. This poster contrasts the modest rebound in elephant numbers with the serious decline in the global coral population driven by overharvesting and climate change, and creates awareness of other endangered species.

Gem Mineral Localities at the Time of the Taj Mahal

Dona Dirlam | Geo-Literary Society, Redwood Falls, Minnesota

Long-established maritime and land trade routes, including the Silk Road, enabled Shah Jahan and other Mughal rulers to amass mineral and gem resources, resulting in remarkable jewelry pieces and spectacular monuments such as the Taj Mahal in the 1600s and 1700s. Centered on a map illustrating historic gem sources and the routes that connected the gem trade to the Mughal markets, this poster features examples of emerald, diamond, and spinel jewelry pieces produced during this opulent period (figure 3).

For more information, see Dirlam D.M., Rogers C.L., Weldon R. (2019) Gemstones in the era of the Taj Mahal and the mughals. *G&G*, Vol. 55, No. 3, pp. 294–319, http://dx.doi.org/10.5741/GEMS.55.3.294

The Global Trade Routes and Localities of Gemstones According to 17th–18th Century Armenian Sources

Dr. Sona Tajiryan | Los Angeles

This poster illuminates the early modern (1500s–1800s) gem trade by way of previously unpublished archival sources. It documents the practices of Armenian merchants

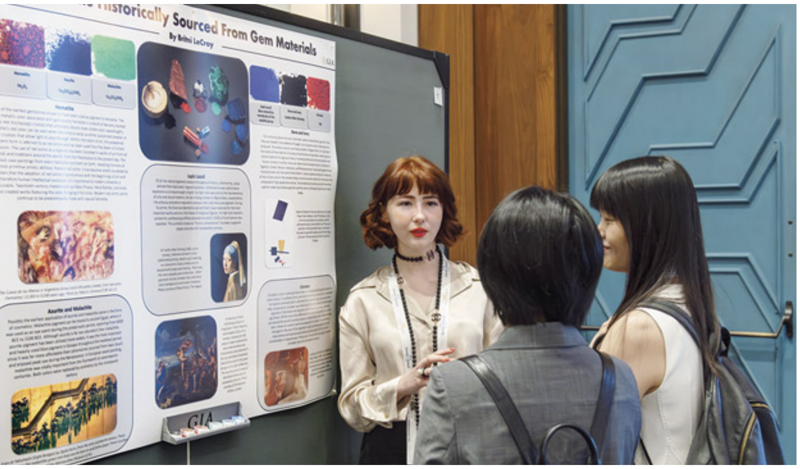


Figure 4. Britni LeCroy links gem-derived pigments to pivotal works of art in human history. Photo by Emily Lane.

who were central to the transcontinental movement of gems at the time. A map shows the major trade routes of the most sought-after gems—ruby, pearl, sapphire, turquoise, lapis lazuli, amber, and coral—from mines or manufacturing centers and onward to hubs of consumption, illustrating the sophistication of these early modern trading networks.

Inclusion Chronicles: A Pursuit of Photomicrography

Randall Lightfoot | Mayflower Estate Buying & Consulting, Towson, Maryland

This poster is a reminder of the wonders within gems as revealed by the practice of photomicrography. The author, winner of Gem-A's 2023 Photographer of the Year Award, presents a set of gemstone inclusion photomicrographs as an inspiration to others to explore and record the interior of gems.

The Literature of Gem-Bearing Granitic Pegmatites

Dona Dirlam | Geo-Literary Society, Redwood Falls, Minnesota

Pegmatites have fascinated scientists since the dawn of mineralogy. This poster explores the term's origin in early literature, beginning with its coining by French mineralogist René Just Haüy. The authors provide pointers to more modern references, plus a list of the world's major gem pegmatite districts along with specific examples of important pegmatites from the literature—Brazil's Pederneira pegmatite and the Emmons pegmatite from the U.S. state of Maine. Also included is a QR code linking to a unique pegmatite bibliography provided by GIA's Dr. James Shigley.

For more information, see Palke A.C., Shigley J.E. (2025) Colored Stones Unearthed: Gem granitic pegmatites. *G&G*, Vol. 61, No. 2, pp. 192–204.

Mineral-Driven Technology and Aesthetics: Material Basis and Cultural Expression of Chinese and Western Colored Glaze Crafts

Dr. Shangjia Wen | Gemmological Institute, China University of Geosciences, Wuhan

Minerals have often served as vehicles for human technological innovation and cultural expression. This poster explores the use of the copper mineral malachite, source of the copper pigment used to color ancient Egypt's turquoise blue Faience (circa 3000 BCE) as well as the vibrant green glazed ceramics produced by the Changsha Kiln during the Tang Dynasty (eighth to ninth century).

Pigments Historically Sourced from Gem Materials

Britni LeCroy | GIA, Carlsbad

This presenter examines the pivotal role of six gem and mineral materials—hematite, azurite, malachite, lapis lazuli, bone and ivory, and cinnabar—as the sources for pigments throughout human history (figure 4). The poster cites examples using these pigments, from red ochre–outlined handprints in ancient caves to master works by Vermeer, Titian, Malevich, and Degas, showing how gem materials and human ingenuity infuse art through the ages.

For more information, see LeCroy B. (2022) Gems on canvas: Pigments historically sourced from gem materials. *G&G*, Vol. 58, No. 3, pp. 318–337, http://dx.doi.org/10.5741/GEMS.58.3.318

Revision of the GIA Pearls Course

Dr. Tao Hsu | GIA, Carlsbad

This poster outlines the updated GIA Pearls eLearning course and Pearl Lab Class, showing a list of each assignment's contents. The updated course includes the addition of two new assignments covering natural nacreous pearls and natural non-nacreous pearls, respectively, addressing a gap in the curriculum.

An Update on the GIA Library's Rare Book Digitization Project

Dianna Parsons | GIA, Carlsbad

With more than 50,000 books and 1,000 magazine and journal titles on topics related to gemstones and jewelry, GIA's Richard T. Liddicoat Gemological Library and Information Center is the largest, most complete library of its kind. This poster spotlights the library's work digitizing rare books, outlining the digitization system used and citing examples of works publicly available through this initiative. Works cited and accessible by QR codes include Clinton's *The Story of a Pearl Oyster* (1914), Schmidt's *Diamond Gold and Silver Invoice* (1702), John Brogden's

Jewellery, Original Watercolor Drawings for Decorative Jewellery (1885), and Nawab Ahsanullah's *Dacca Collection* (circa 1900).

Young's Durability Scale

Kennon Young | Vermont Gemological Laboratory, Burlington

The author proposes a rating system for the durability of gemstones, which considers three properties: Mohs hardness (35%), fracture toughness (45%), and inclusions (20%). This produces a practical scale of 1 through 10 with opal, fluorite, and pearl at one end (1–2) and chrysoberyl, jadeite, corundum, and nephrite at the other (9–10).

NEW TECHNOLOGIES AND TECHNIQUES

Advanced Data Analysis and Machine Learning: Applications in Gem Identification

Dr. Matthew Hardman | GIA, Carlsbad

Natural and laboratory-grown diamonds (LGDs) can be indistinguishable to the unaided eye, and practical considerations dictate that they must be separated by nondestructive analytical techniques. The author demonstrates how a combination of photoluminescence spectroscopy and machine learning can allow evaluation and simplification of this spectral data by presenting a study of 1,121 natural diamonds and 1,178 chemical vapor deposition LGDs.

Polish to Rough Matching: Delivering Objective Assurance

Mayank Jain | DiaDNA AI Labs, Surat, India

The author presents a potential solution for rough-to-polished diamond traceability from mine to market. With many touchpoints in diamond manufacturing and multiple changes of hand thereafter, tracking a diamond from rough to a finished gem in jewelry is one of the industry's greatest challenges. The author proposes a solution involving high-resolution scanning followed by automated matching using artificial intelligence.

An Extended Application of Quantitative Description Methods for Color Cause of Chrysoberyl

Xinxin Gao | University of Chinese Academy of Sciences, Beijing

Guided by recent research into the chromophores of corundum, the authors present a parallel study of iron- and chromium-bearing chrysoberyl, driven by the similarities in the two minerals' chemistry, structure, and ultraviolet/visible/near-infrared (UV-Vis-NIR) spectral features. Results are presented as calculated color circles and UV-Vis-NIR absorption cross sections for both chromophores in chrysoberyl.

Figure 5. Artitaya Homkrajae explains how machine learning combined with trace element chemistry can enhance the pearl identification process. Photo by Emily Lane.

Identification of Known *Pinctada maxima* Pearls Using Trace Element Analysis and Machine Learning

Artitaya Homkrajae | GIA, Carlsbad

Although most pearl identification still relies on X-ray techniques, a combination of trace element chemistry and machine learning can provide a useful adjunct with a greater degree of confidence. This poster presents a study on known natural and cultured *Pinctada maxima* pearls employing laser ablation–inductively coupled plasma–mass spectroscopy paired with analysis using machine learning methods (figure 5).

Jewelry Verification Service

Najmeh Anjomani | GIA, Carlsbad

This poster provides an overview of GIA's Jewelry Verification Service and describes aspects of the service with examples. The service verifies the condition, measurements, metal type, and metal purity of a jewelry piece, along with the identity of any stones including the presence of treatments, and authenticates the brand, if applicable. Verification employs energy-dispersive X-ray fluorescence for the metals and Fourier-transform infrared and Raman spectroscopy for the stones. This service checks the description provided by the seller and offers surety for the buyer, benefiting everyone in the supply chain.

Metal Analysis for GIA Jewelry Services

Carlos Bautista | GIA, Carlsbad

This poster explains the use of X-ray fluorescence (XRF) testing to analyze and identify metals in jewelry pieces for GIA's laboratory services. It outlines the process, use of standards, testing procedures for jewelry items, and capabilities of the XRF devices used. Also described are some of the testing considerations involving multitone jewelry items, use of solder and repairs, and the presence of plating, all of which must be taken into account by the technician.

GIA HANDS-ON SESSIONS

Hands-on sessions afforded Converge attendees the opportunity to learn from GIA experts and work with samples from the Institute's extensive reference collection. All entries were written by GIA staff.

The Natural Diamond Story: Natural and Laboratory-Grown Diamond Differentiation

Dr. James Shigley (GIA, Carlsbad) presented a session focused on the incredible geologic story of natural diamond, reminding participants what a remarkable mineral diamond is (figure 1). He explained that the gem's origins provide jewelry professionals with memorable and relatable information they can use to educate consumers on the value of mined diamonds, to differentiate natural from laboratory-grown, and to address common misconceptions about abundance, mining practices, corruption, and human rights abuses. In this practical session, Dr. Shigley covered key aspects of natural diamonds' value and rarity, including their incredible geologic age and remarkable formation process, along with how and when they arrived at the surface through kimberlite eruptions. He explained how geologists search for viable diamond deposits and mining companies recover these diamonds, also providing an outline of the world's significant mines and their projected remaining production years. Also covered were the many positive micro and macro social benefits to communities involved in diamond mining, as well as environmental impact and sustainability. Dr. Shigley explained what is currently scientifically possible in terms of determining the geographic origin of a natural mined diamond—also covered by GIA's Dr. Michael Jollands in a speaker presentation—and outlined GIA origin services. Participants were able to handle natural and lab-grown rough and faceted gems and use their microscopes to examine interesting natural inclusions.

Beauty in Unexpected Places: The New Frontiers of Ruby and Sapphire

In this hands-on seminar, **Dr. Aaron Palke** (GIA, Carlsbad) and **Wim Vertriest** (GIA, Bangkok) provided an in-depth report on rubies and sapphires from lesser-known deposits including the United States (Montana), Tanzania, Kenya, Afghanistan, Sri Lanka, and Greenland (figure 2). They demonstrated practical tips for identifying corundum from these alternative deposits and gave context for understanding the place of these gems in the complex global colored stone trade. Participants were able to examine ruby and

Figure 1. Left: James Shigley presents on the unique story of natural diamond. Right: A kimberlite eruption plucked this 52.45 ct diamond octahedron from deep below the earth's surface, where it might have rested for billions of years. Photos by Emily Lane (left) and Robert Weldon; courtesy of the GIA Sir Ernest Oppenheimer Student collection (right).

Figure 2. Top: Wim Vertriest outlines key characteristics of gem corundum from less familiar localities in a session held during Converge 2025. Bottom: Attendees use their cell phones to capture images of intriguing inclusions. Photos by Emily Lane.

sapphire samples from the GIA colored stone reference collection representative of these newer localities and hear directly from the field gemologists who visited the areas and collected the gems.

(Un)Natural Beauty: Treatments in Ruby and Sapphire and Their Identification

It is increasingly rare to come across ruby and sapphire with beauty and appeal entirely due to natural processes. The majority of stones on the market have been treated to enhance their appearance. In this hands-on seminar, GIA's **Dr. Aaron Palke** and **Wim Vertriest** provided an in-depth orientation into the various artificial treatments for ruby and sapphire (figure 3). Using samples from GIA's colored stone reference collection, participants learned practical tips for identifying these treatments and gained an understanding of their value.

Figure 3. Aaron Palke helps orient a treated gemstone under the microscope for seminar attendees to view its diagnostic inclusions. Photo by Emily Lane.

Figure 4. Left: Nathan Renfro delivers practical hints and tips to seminar participants. Right: Attendees viewed inclusion scenes like these golden yellow rutile needles in rock crystal quartz. Photos by Emily Lane (left) and Nathan Renfro; field of view 7.61 mm (right).

Photomicrography of Gems

Inclusions in gemstones often captivate gemologists with their natural beauty. In this session, **Nathan Renfro** (GIA, Carlsbad) demonstrated that inclusions can also provide valuable information about gems, including what they are and whether they are treated, natural, or synthetic (figure 4). Renfro presented various lighting control techniques used to significantly enhance photomicrographs. He focused on a variety of interesting gemstone inclusions, encouraging participants to use their cell phones to practice some of the lighting techniques covered. Renfro explained that documenting observations with a photograph is a useful method of recording inclusions that is easily shared with others. Photomicrographs appeal to a broad audience, from those who are interested in the hidden beauty of the natural world to an appraiser who uses inclusions as a "fingerprint" to document the identity of a unique stone.

For more information, see Renfro N. (2015) Digital photomicrography for gemologists. *G&G*, Vol. 51, No. 2, pp. 144–159, http://dx.doi.org/10.5741/GEMS.51.2.144

Figure 5. Left: Al Gilbertson provides an introduction to jewelry forensics. Right: Attendees inferred manufacturing processes and likely provenances for jewelry pieces like this platinum and gold Edwardian brooch. Photos by Mimi Travis (left) and Robert Weldon; courtesy of Brian Davenport (right).

Introduction to Jewelry Forensics

While jewelry appraisers, those who take in jewelry for repair, and buyers of used jewelry go through a process to identify, analyze, and assess the quality and nature of a jewelry item, it is often not as comprehensive and systematic as they might wish. Many know only certain aspects of manufacturing and are only able to recognize a narrow range of specific characteristics. In this lecture and hands-on seminar, GIA Carlsbad's **David Etheridge** and **Al Gilbertson** guided participants through a systematic GIA framework to help them recognize and identify basic characteristics of key manufacturing processes (figure 5). They demonstrated the fundamentals of jewelry forensics, including identifying hand-fabricated, cast, and CAD/CAM-manufactured components, as well as cast-in-place gemstones.

Advanced Gemological Testing Workshops at GIA

Three sessions of an advanced gemological testing workshop were offered during the GIA Open House on September 7 as part of Converge 2025. Developed and led by **Dr. Tao Hsu** (GIA, Carlsbad), the two-hour workshop provided an overview of and hands-on experience with the six core advanced testing techniques commonly used in gemological laboratories: ultraviolet/visible/near-infrared, Fourier-transform infrared, Raman, and photoluminescence spectroscopy along with an X-ray fluorescence analyzer and a DiamondView. Together these techniques aid in the accurate identification of diamonds, colored stones, and pearls. The reliability and accessibility of these instruments make them viable tools for students. Some of these instruments are portable and could potentially be used in small businesses.

Each session opened with a lecture on the basic principles and major applications of the six techniques. Then students participated in hands-on activities in pairs. At each activity station, an instructor guided students through the testing process before they conducted their own analyses using select samples showing the main applications, strengths, and limitations of each instrument.

Many participants were GIA Graduate Gemologists with extensive trade experience (figure 6). The workshop helped refresh their knowledge and enhance their understanding of advanced gemological testing. Some participants noted that the workshop clarified questions about the advantages and limitations of these techniques.

Following the success of the workshop, GIA Education continues to develop this program to meet the demand for more in-depth gemology education.

Figure 6. Attendees of the first session of GIA's advanced gemological testing workshop held during Converge 2025, along with workshop developer Tao Hsu and six instructors from the Carlsbad education team. Photo by Russel Samson.

Figure 1. Faceted garnets (1.81–16.00 ct) along with rough fragments (largest piece is 12 g) from a new deposit in the Lao Cai province of northern Vietnam. Photo by Nuttapol Kitdee; courtesy of Precious Le Gems.

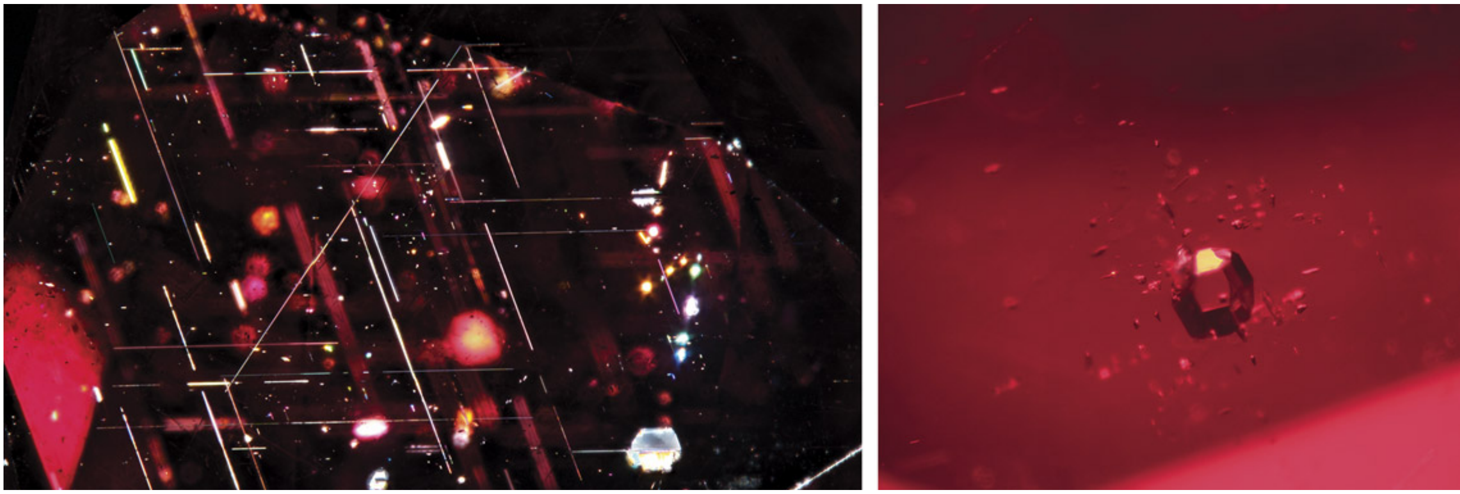
REGULAR FEATURES

COLORED STONES AND ORGANIC MATERIALS

New red garnet production from northern Vietnam. Since mid-2024, a newly discovered deposit in northern Vietnam has produced some fine red garnet. These stones are found in the rural Bao Yen district of the Lao Cai province, roughly 50 km northwest of the ruby-spinel mining district of Luc Yen. Artisanal miners dig for the garnet in river sediments and colluvial material at the base of hilly flanks. The rough stones are typically recovered as broken elongated fragments. Rough fragments can get very large, with pieces over 10 g routinely found. Euhedral garnet crystals have not been reported.

GIA recently studied a selection of rough and cut garnet from the new source (figure 1), loaned by Precious Le Gems. The color of the stones is typically a pure red, with a medium to dark tone. In rare cases, a slight purple tint can be observed. The stones were isotropic with a refractive index (RI) between 1.753 and 1.758. The specific gravity measured between 3.80 and 3.85, correlating

Figure 2. Left: Rutile needles and platelets are commonly observed in red garnet from northern Vietnam. Right: A well-formed, opaque metal sulfide crystal stands out due to its metallic luster. Photomicrographs by Suwasan Wongchacree; fields of view 4.80 mm (left) and 1.80 mm (right).



with the higher RI. A handheld spectroscope showed three strong bands in the green to yellow region of the spectrum around 505, 530, and 575 nm, with the 505 nm band being strongest and sharpest, and two more subtle lines in the blue region around 460–470 nm. These properties are typical for pyrope-almandine garnet. Chemical analysis revealed 50.0–52.7% pyrope and 34.1–37.5% almandine in the garnets, with a smaller component of grossular (11.0–12.5%) and spessartine (1.4–2.7%).

Most stones appeared eye-clean. When observed under high magnification, some stones showed an inclusion scene typical of red garnet (figure 2). The inclusions consisted of reflective needles and platelets. Crystal inclusions were limited to opaque sulfides and small translucent primary rutile, which were identified by Raman spectroscopy.

While northern Vietnam has only been explored for a few decades and has traditionally focused on spinel and corundum, this new discovery shows that there is a large potential for other gems as well.

Narint Jaisanit and Wim Vertriest
GIA, Bangkok

SYNTHETICS AND SIMULANTS

Fuchsite-bearing dolomite aggregate as a new jadeite imitation. Recently, a carved green snuff bottle was submitted as jadeite jade for identification at the Taiwan Union Lab of Gem Research (TULAB) (figure 3). The surface of the bottle displayed a white matrix with dense mottled green areas. A spot refractive index was approximately 1.68–1.69, which was noticeably higher than the typical range of values for jadeite jade. However, such results may occur if jadeite contains kosmochlor.

Under microscopic observation, the surface of the carving revealed a white matrix with green patches (figure 4).

Figure 3. A green snuff bottle (64.7 × 51.3 × 25.9 mm) submitted for identification as jadeite jade. Photo by Shu-Hong Lin.

Interestingly, these green patches appeared red when viewed through a Chelsea filter. To further identify the material, Raman spectroscopy (785 nm laser) was performed and

Figure 4. The surface of the snuff bottle shows a white matrix with green patches and black metallic minerals, most likely chromite. Photomicrograph by Kai-Yun Huang; field of view 2.75 mm.

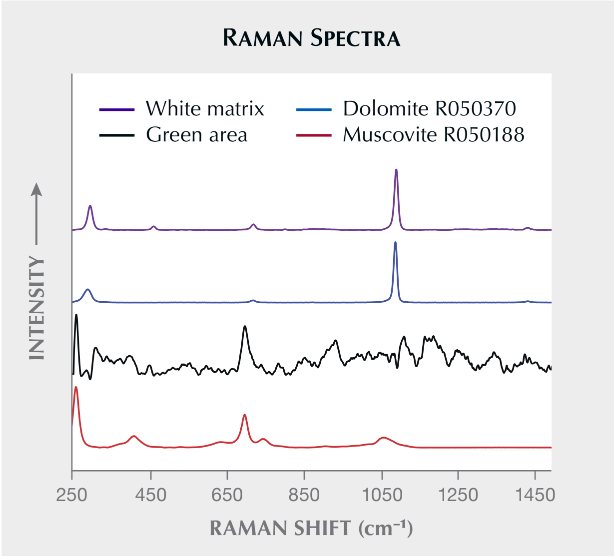


Figure 5. Comparisons of the Raman spectra from the green areas and white matrix of the tested object with spectra for dolomite and muscovite from the RRUFF database. Spectra are baseline corrected and normalized for comparison and offset vertically for clarity.

compared with the RRUFF database (B. Lafuente et al., 2015, https://rruff.info/about/downloads/HMC1-30.pdf). The results indicated that the white matrix was dolomite, while the dark green patches were muscovite (figure 5). With the assistance of energy-dispersive X-ray fluorescence (EDXRF) analysis, the green portions were confirmed to be fuchsite (chromium muscovite).

All testing indicated that the snuff bottle was composed of a dolomite aggregate with fuchsite. Although its appearance resembled jadeite jade, the bottle's refractive index and Chelsea filter reaction clearly distinguished it from jadeite jade. Raman spectroscopy and EDXRF were used as more precise methods to confirm the material, which appears to be a new jadeite simulant that has recently appeared on the market.

Tsung-Ying Yang, Kai-Yun Huang, Yu-Shan Chou, and Shu-Hong Lin
Taiwan Union Lab of Gem Research, Taipei

Reconstructed specimens and the rise of deceptive practices in Pakistan. Recent field observations in Pakistan have revealed that specimens circulating in local gem markets and near mine sites have increasingly been artificially assembled or altered. Local dealers and prospectors from the Hunza and Gilgit mining areas offered "Frankenstein" specimens, pieces assembled by gluing together fragments of crystals and host rock (figure 6). While adhesives can sometimes be seen under magnification, many joints are subtle enough to mislead buyers or tourists. Crystals such as aquamarine are often skillfully mounted onto matrices to imitate natural specimens, with some pieces further polished, dyed, or even oiled to enhance their appearance (figure 7). In certain cases, resins mixed with crushed marble or host rock are applied, making detection even more difficult. For example, in Peshawar's Namak Mandi gem market, a ruby reportedly from Jegdalek was identified as a synthetic crystal mounted on natural host rock. In addition to this deceptive practice of adhering specimens to host rock, broken specimens are also repaired with adhesives, often without disclosure. With time, the quality of assembly is improving, making detection more challenging.

The close proximity of these reconstructed specimens to the mines is a reminder that "from the mine" does not automatically guarantee authenticity. Collectors and gemologists should be aware that stones described as directly sourced may have undergone significant human intervention. Similar practices are common in neighboring regions, including Afghanistan.

Figure 6. Left: Marble-hosted ruby specimens (ruby crystals ranging from 0.6 to 1.0 cm in height) reportedly mined from Hunza and acquired from the nearby local market. The natural specimen components have been artificially assembled with a resin-like adhesive. Right: In some specimens, the adhesive is well camouflaged and difficult to detect (indicated by arrow), especially if oiled. Photos by Talha H. Bakht.

Figure 7. Left: A beryl specimen dyed with pigment clearly visible to the unaided eye. Right: The aquamarine are attached with glue to appear as a natural occurrence within this host rock. Photos by Talha H. Bakht.

Economic pressures play a major role in these trends. With average salaries in Pakistan ranging from 20,000 to 60,000 PKR per month (approximately US$70 to $212), many dealers and retailers offer inexpensive alternatives to natural gemstones. As a result, the domestic trade is dominated by simulants, imitations, and heavily treated stones. Dyed stones including lapis lazuli, nephrite jade, and emerald are widespread, as well as glass-filled sapphires, composite stones, and resin-treated turquoise. Irradiation is another common practice, particularly for beryl, tourmaline, and topaz. Large gemstone trading centers in Lahore, Karachi, Islamabad, and Peshawar (Namak Mandi) are particularly affected, making vigilance essential for anyone in the trade as these treatments are often undisclosed and may be unstable.

In another deceitful practice, problematic gemstones are often mixed into lots of natural stones. One 77 ct parcel of melee-sized red stones labeled as natural Jegdalek ruby, for instance, actually contained a mixture of natural unheated, heated, glass-filled, and synthetic ruby. Some dealers have even dotted natural jasper with blue dye to imitate the popular granite-like stone with distinctive blue spots found near K2 Mountain in Pakistan.

A general lack of understanding of gemstones in Pakistan, coupled with minimal regulation and a challenging economy, allows deceptive dealers to take advantage of unaware buyers, often presenting laboratory reports with misleading words such as "natural dyed emerald" or "natural glass-filled blue sapphire" or failing to disclose treatments. The word *natural* has been used incorrectly for such stones, which is a problem for local gem testing laboratories, although efforts are being made to revise the terminology applied to these types of materials. Similarly, terms such as "Shajri natural turquoise" have been applied to resin-composite mixtures intended to imitate the natural weblike structure of turquoise. Treatments are often left undisclosed, including the dyeing of natural opal and the oiling of natural emerald rough to hide fractures. Additionally, authentic reports have been reprinted and fraudulently attached to multiple stones in various markets such as Lahore.

Historically, Pakistani jewelers supplied royalty, from Nawabs to Maharajas, but many traditional techniques are fading in favor of faster, cheaper production. Many craftsmen are making jewelry with thinner or plated metal and/or including synthetic or imitation stones (figure 8), or closing their businesses, as the domestic trade cannot support the higher costs of gold and precious stones. For collectors, gemologists, and buyers, these trends underscore the importance of scrutiny, education, and caution when navigating Pakistan's complex gemstone market. Once a deal is done, it is very difficult to recover funds.

The increasing presence of glued reconstructed specimens near Pakistan's mining areas and all the above-stated practices underscore the need for vigilance in the field. Transparency in trade practices is essential for maintaining trust in the region's gem market. Unfortunately, many sellers fail to disclose such treatments, making it essential for buyers to exercise caution. Regardless of where the specimen is acquired and the price being asked, one should

Figure 8. Nearly all of the stones in these rings offered in markets throughout Pakistan are synthetics or simulants or have been enhanced. Photo by Talha H. Bakht.

suspect alterations unless proven otherwise. If the gemstone market in Pakistan is to gain worldwide recognition, more awareness and stricter regulations must be implemented. At the same time, many genuine and honest people remain in Pakistan's gem industry, and the actions of a few should not ruin the reputation for all.

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ANNOUNCEMENTS

2026 Sinkankas Symposium: Gems and Minerals of Burma (Myanmar). The Twentieth Sinkankas Symposium will be held at GIA headquarters in Carlsbad on Saturday, April 25, 2026. This all-day educational event will feature presentations related to the science, history, and beauty of Burmese gems and minerals (figure 9). The symposium brings together 10 notable speakers: Tao Hsu, Richard Hughes, Bill Larson, Aaron Palke, Nathan Renfro, Stuart Robertson, Roland Schluessel, Laichen Sun, Rachelle Turnier, and Wim Vertriest. The lectures will be followed by a reception for attendees where they can tour the GIA Museum's exhibit, Temples & Treasures of Southern Asia. To register, go to www.sinkankassymposium.net.

Al Gilbertson receives Robert M. Shipley Award. Al Gilbertson is the 2025 recipient of the American Gem Society's (AGS) prestigious Robert M. Shipley Award, honoring his lifelong commitment to the trade and his contributions to understanding the influence of cut on the appearance of finished gemstones. Named for the founder of both GIA and AGS, the award was presented to Gilbertson (figure 10) on September 9 at Converge, an event combining GIA's gemological research and education with AGS's professional development and networking opportunities.

Figure 10. Al Gilbertson accepts the Robert M. Shipley Award at Converge in Carlsbad, California. Photo by Russel Samson.

Driven from an early age by a fascination with gems and minerals, Gilbertson was shaping cabochons at his parents' lapidary shop in the 1960s. When a short stint in the U.S. Air Force as a Russian linguist was interrupted by the untimely death of his father in 1974, he returned to the family business. Thus began a storied career in the jewelry trade as a colored stone cutter, appraiser, custom jewelry specialist, and period jewelry restorer. Gilbertson's inquiring mind and wide experience with gemstone cutting made him an invaluable research contributor on the appearance of gems and diamonds. After working on the team that established cut grade standards for AGS Laboratories, GIA recruited him as a researcher in 2000, where he helped invent the Institute's cut grading system for round brilliant diamonds. Today, Gilbertson is an integral part of the GIA team developing a cut grading system for fancy-shaped diamonds. He is the seventh GIA recipient to win the Shipley award.

Figure 9. The 2026 Sinkankas Symposium will explore the world of Burmese gems, including peridot (left) and ruby (right). Photos by Robert Weldon; courtesy of the Larson family.

Susan Jacques receives Richard T. Liddicoat Award for Distinguished Achievement. At a staff reception following the November board of governors meeting, GIA honored retiring president and CEO Susan Jacques with the Institute's highest honor—the Richard T. Liddicoat Award for Distinguished Achievement (figure 11). Current board chair Lisa Locklear and incoming GIA president and CEO Pritesh Patel presented the award to Jacques, praising her vision, integrity, compassion, and the lasting impact of her leadership on GIA.

Born in Zimbabwe to an Australian mother and a British father, Jacques' entrée into the industry came with a job as junior typist for the country's largest jewelry company. Noticing her boss taking GIA correspondence courses, she persuaded her parents to enroll her in GIA's in-residence graduate gemologist (GG) program at the Santa Monica, California, campus in 1980. For Jacques, gaining her GG had life-changing results, leading to a job at Borsheims in Omaha, Nebraska—one of the largest U.S. independent jewelers. Investor and philanthropist Warren Buffett's purchase of Borsheims in 1989 elevated the business and provided an opportunity for Jacques, culminating with Buffett offering her the position of CEO, which she held for 20 years. Jacques joined GIA's board in 1996 and became board chair in 2008 before her appointment as GIA's president in 2014. In addition to her GG diploma from GIA, she is a fellow of the Gemmological Association of Great Britain (Gem-A).

Figure 11. Susan Jacques accepts the Richard T. Liddicoat Award for Distinguished Achievement while incoming GIA president and CEO Pritesh Patel looks on. Photo by Russel Samson.

Established in 1994, there have only been 14 recipients of the Richard T. Liddicoat Award for Distinguished Achievement, including Tom Moses, executive vice president and chief laboratory and research officer; Alice Keller, editor-in-chief emerita of *Gems & Gemology*; Dona Mary Dirlam, librarian emerita; Kathryn Kimmel, GIA's first chief marketing officer (retired); John Koivula, analytical microscopist; and Dr. James Shigley, GIA's distinguished research fellow.

New edition of Tillander's *Diamond Cuts in Historic Jewellery 1381–1910.* First published in 1995, Herbert Tillander's classic work on the history of diamond cutting styles from the medieval period to the early twentieth century has been edited and updated by his daughter, jewelry scholar Ulla Tillander-Godenhielm (figure 12). This new edition includes additional scholarship and new photographs of Renaissance jewelry and famous diamonds. Herbert Tillander (1909–2006) was a legend in the Finnish jewelry industry, especially in the nomenclature and practice of diamond grading. Grandson of a jeweler to the Russian Imperial Court, Tillander devoted much of his life to the study of diamond cuts in historic jewelry collections.

Figure 12. A new edition of Herbert Tillander's book, updated by his daughter, Ulla Tillander-Godenhielm.