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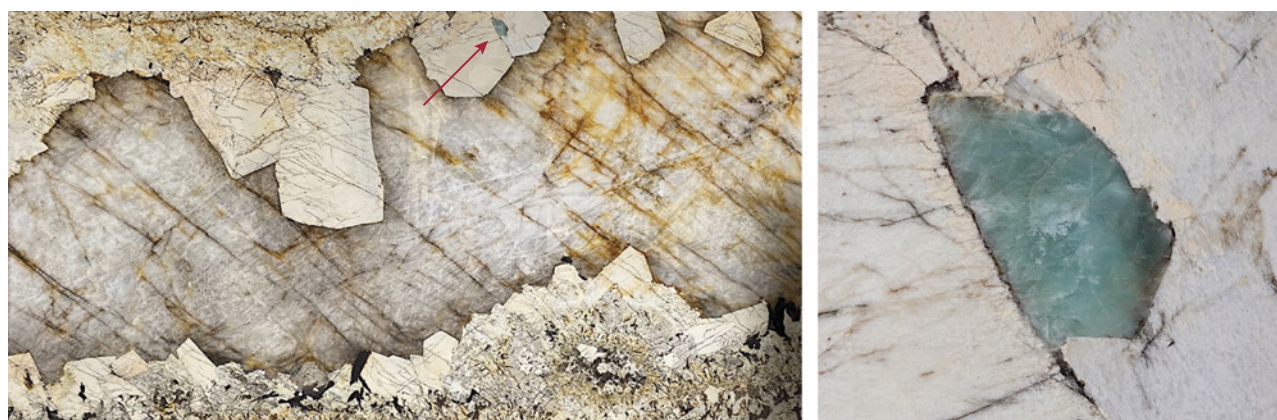


Figure 1. Left: The polished pegmatite plate measures 3.28 m × 1.80 m × 2.5 cm and originates from the Governador Valadares area, Minas Gerais, Brazil. At the top of the plate, an unidentified bluish green translucent mineral is present (indicated by the arrow). Right: An enlargement of the 7.1 × 2.9 cm bluish green mineral, which formed in a vacuole between two crystals of perthitic microcline. Photo by Pierre Barbey.

COLORLED STONES AND ORGANIC MATERIALS

Determination of aquamarine in a Brazilian pegmatite plate.

A remarkable Brazilian pegmatite plate hangs on the ground-floor wall of the Centre for Petrographic and Geochemical Research (CRPG) in Vandœuvre, France. This rock, called “Patagonia granite” by the trade in reference to the granitic mountain peaks in southern Argentina, came from the Galiléia region, near Governador Valadares,

in the state of Minas Gerais, Brazil. Famous for its gem-bearing pegmatites, the region, located north of Rio de Janeiro, is marked by the presence of granitoids belonging to the Neoproterozoic Galiléia magmatic suite formed by tonalites, granodiorites, granites, and pegmatites. Dating of these rocks by the uranium-lead method on zircon has given ages between 594 and 570 million years, characteristic of the Brasiliano or Pan-African orogeny.

The polished pegmatite plate, measuring 3.28 m × 1.80 m × 2.5 cm, exhibits three distinct mineral assemblages from the border to the core (figure 1, left): (1) the edges composed of quartz, feldspar, and large brownish laths of mica (black in the photo) ending at the top with a close association of wedge-shaped quartz and potassium-feldspar (graphic texture); (2) large and zoned euhedral perthitic microcline feldspar crystals hosting disseminated centimetric schorlite and an unidentified 7.1 × 2.9 cm bluish green translucent mineral (figure 1, right); and (3) the whole core filled by translucent and healed grayish quartz.

Editors' note: Interested contributors should send information and illustrations to gandgeditorial@gia.edu.

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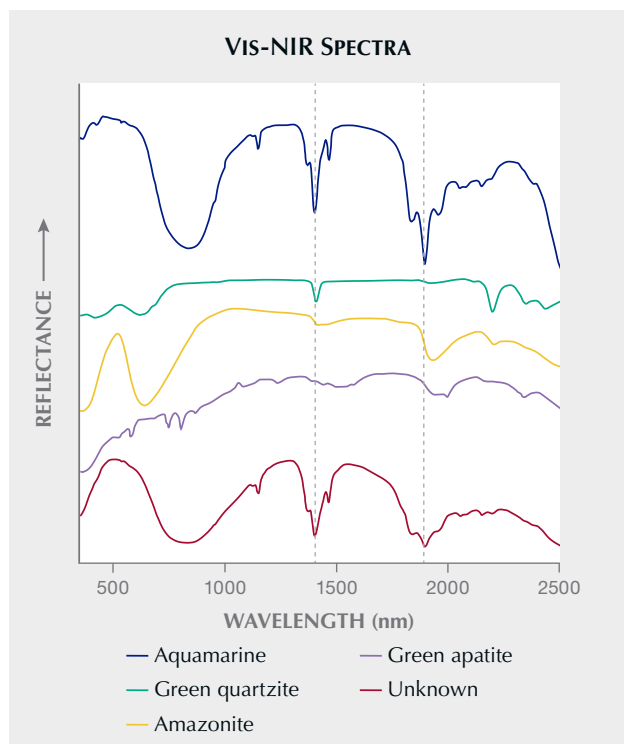


Figure 2. Comparison of Vis-NIR reflectance spectra for four samples from the CRPG standards database to the spectrum of the unknown mineral, matching the aquamarine reference. Thus, the unknown mineral belongs to the beryl family. Spectra are offset vertically for clarity.

The unidentified bluish green mineral was analyzed using visible/near-infrared (Vis-NIR) reflectance spectroscopy with an analytical point-spectrometer. The technique allows for the acquisition of a reflectance spectrum of a 1 cm diameter surface area. Spectra collected in the 500–2500 nm range are sometimes used to analyze the mineralogical composition of rocks based on the position and shape of the absorption band.

The spectrum of the bluish green mineral was compared with that obtained from sample standards in the CRPG database (amazonite, green apatite, aquamarine, and green quartzite; figure 2). The positions of the two absorption bands at 1400 nm and 1900 nm are linked to the vibration of water molecules in the structure, while the wide absorption band centered at 800 nm is due to an electronic transition of iron. Therefore, the unknown mineral was positively identified as a member of the beryl family.

Chemical analysis on the bluish green beryl by a handheld X-ray fluorescence (XRF) spectrometer showed the following analytical ranges for trace elements, in ppmw: iron = 3000 (± 100), titanium = 447–474 (± 27), zinc = 305–350 (± 13), and cesium = 157–180 (± 6). Chromium and vanadium were not detected, ruling out emerald and identifying the mineral as aquamarine, with its color attributed to the combination of iron and titanium. The presence of cesium confirmed the magmatic source of the aquamarine.

The determination of aquamarine on the large plate of Brazilian pegmatite combining handheld Vis-NIR reflectance and XRF spectrometers underscores the importance of the use of nondestructive methods on polished petrological sections in galleries of mineralogical museums. These qualitative point chemical analyses offer insight into the knowledge of mineral associations across diverse geological environments and enhance understanding of the genesis of gems.

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Rare colors of Chinese freshwater cultured pearls. The Gem-mological Institute at the China University of Geosciences recently received 53 freshwater cultured pearls displaying rare colors (figure 3): 21 purple, 7 green, 7 blue, and 18 orange pearls with rich hues. While white, orange, pink, and purple freshwater cultured pearls are common in the market, green, blue, and yellow colors are scarce. These pearls were nearly round, ranging from 7 to 14 mm in diameter, with most exhibiting good luster and smooth surfaces. The pearls were sourced from Menghao Jewelry, a supplier working directly with local pearl farmers in Zhejiang Province. With the increasing advancement of nucleated freshwater pearl cultivation technology in China, dozens of farms are capable of producing such rare-colored pearls, which typically range from 4 to 15 mm in diameter and require one to two years

Figure 3. These 10 representative pearls from the 53 studied, selected for Raman analysis, range in color from deep purple to orange-red. Photos by Chuting Zhang.



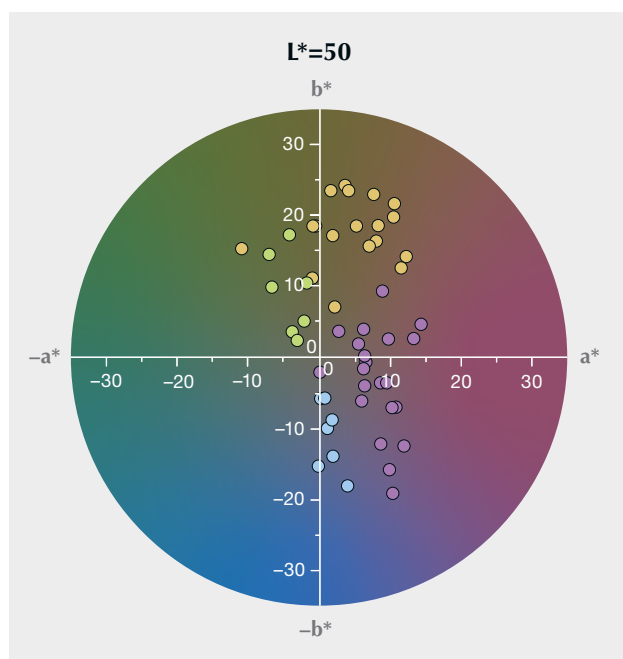


Figure 4. The color parameters of all samples are presented as point plots on the two-dimensional cross section at $L^* = 50$. The colorimetric data are defined in the CIE $L^*a^*b^*$ color space as follows: L^* (lightness) represents the brightness of color, ranging from 0 (absolute black) to 100 (absolute white); a^* represents the position on the red-green axis (positive values indicate red tones, while negative values indicate green tones); and b^* represents the position on the yellow-blue axis (positive values indicate yellow tones, while negative values indicate blue tones).

to grow. The main mollusk species used for their cultivation are *Hyriopsis cumingii* and *Hyriopsis schlegelii*.

Microscopic observation of the studied pearls revealed clear surface contour textures with no artificial staining. The ultraviolet/visible spectroscopy analysis exhibited a stable characteristic absorption peak at 280 nm, typical of natural pearls, with no abnormal absorption signals, thus confirming the natural coloration of the samples. $L^*a^*b^*$ color parameters were collected for all samples, captured under a standard D65 light source and measured from the edges of pearl images. The $L^*a^*b^*$ parameters were widely distributed in CIE $L^*a^*b^*$ color space. The L^* values of the purple-hued pearls were relatively lower than those of the orange-yellow-hued pearls. To provide an intuitive understanding of the color distribution, the data points were projected onto a two-dimensional cross section at $L^* = 50$ (figure 4). The a^* values of the 53 studied pearls ranged from a more greenish hue ($a^* = -11$) to a more reddish hue ($a^* = 15$). The b^* values ranged from -20 to 25 , covering both yellow and blue tones.

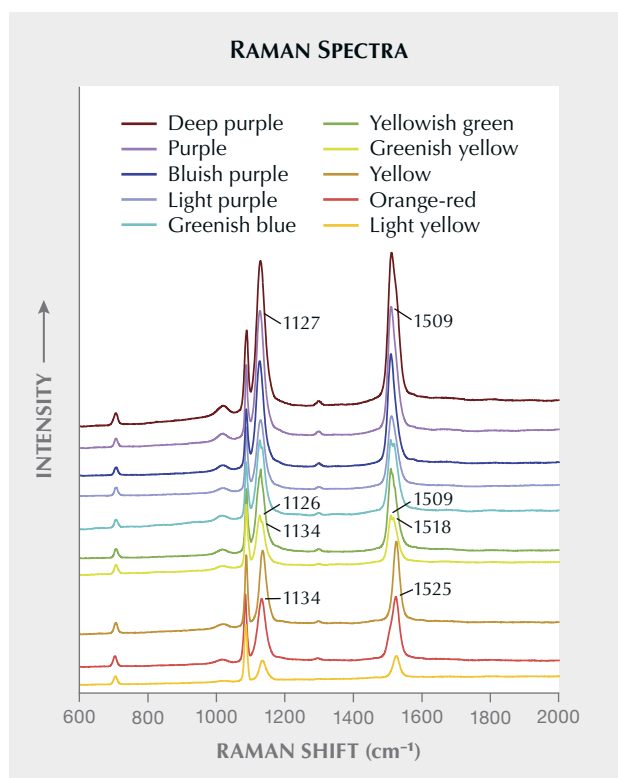


Figure 5. Raman spectra of the 10 representative pearls studied. Spectra are offset vertically for clarity.

Of the 53 pearls, 10 representative samples were selected for Raman analysis (again, see figure 3). Two sets of Raman peaks related to natural polyenic pigments were detected in the pearls, including $1127/1509 \text{ cm}^{-1}$ and $1134/1525 \text{ cm}^{-1}$ (figure 5). The former is associated with purple pigment, while the latter is linked to orange pigment. Interestingly, the pearls with 1509 cm^{-1} Raman peaks not only exhibited the common hue of purple, but also rare hues of green and blue. The pearls with 1525 cm^{-1} Raman peaks were not limited to the yellow color, but presented a gradient series ranging from light yellow to orange-red. Additionally, two unusual Raman peaks were detected. The greenish yellow and greenish blue pearls exhibited double peaks at 1509 and 1518 cm^{-1} , indicating the presence of mixed pigments within the pearls (S. Karampelas et al., "Role of polyenes in the coloration of cultured freshwater pearls," *European Journal of Mineralogy*, Vol. 21, No. 1, 2009, pp. 85–97).

According to scientific studies, the rare colors of these types of pearls are primarily determined by the donor oyster's nacre color (S. Karampelas and A. Lombard, "Gemological characteristics of saltwater cultured pearls produced after xenotransplantation," Spring 2013 *G&G*, pp. 36–41; Z. Wang et al., "How cultured pearls acquire their colour," *Aquaculture Research*, Vol. 51, No. 10,

2020, pp. 3925–3934). For example, *Hyriopsis cumingii* “Shenzi No. 1,” cultivated in China, can grow purple pearls, while another golden strain of *Hyriopsis cumingii* can grow yellow pearls.

However, some artificial treatments, such as dyeing, irradiation, bleaching, or coating, may be used to change the natural color to rare yellow, green, or blue colors, thus misleading less experienced buyers. Therefore, careful analysis is required to accurately distinguish between natural and artificial colors.

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Six-rayed star quartz containing exsolved rutile needles.

Asterism, the optical phenomenon producing a star-like pattern on the surface of a cabochon, arises from the reflection and scattering of light due to the presence of oriented groups of parallel needle-like inclusions. In quartz, two distinct forms of asterism have been reported: the star effect in rose quartz, typically caused by multiple sets of oriented fibrous inclusions (K. Schmetzer and M. Krzemnicki, “The orientation and symmetry of light spots and asterism in rose quartz spheres from Madagascar,” *Journal of Gemmology*, Vol. 30, No. 4, 2006, pp. 183–191), and three-rayed asterism induced by intersecting rutile needles (Summer 2022 GNI, pp. 249–252).

Recently, author JL acquired two quartz specimens from the Donghai Crystal Market in Jiangsu Province, China, each displaying a well-defined six-rayed star under



Figure 6. Six-rayed star quartz specimens: 5.77 ct, 13 × 9.5 × 6.5 mm (left) and 13.23 ct, 15.5 × 13 × 9 mm (right). Photo by Haoran Zhu.

point-source illumination (figure 6). Standard gemological analysis yielded a refractive index of 1.54 and a specific gravity of 2.68, with Raman spectroscopy confirming the specimens as quartz. Microscopic observation revealed reflective layers composed of three mutually interlaced sets of parallel acicular inclusions oriented at approximately 120° to one another (figure 7). These inclusions caused the observed asterism and consisted of two morphologically distinct types: fine silvery white needles and thicker yellowish brown needles.

Both the silvery white and yellowish brown needles exhibited Raman peaks at 142, 238, 446, and 614 cm⁻¹,

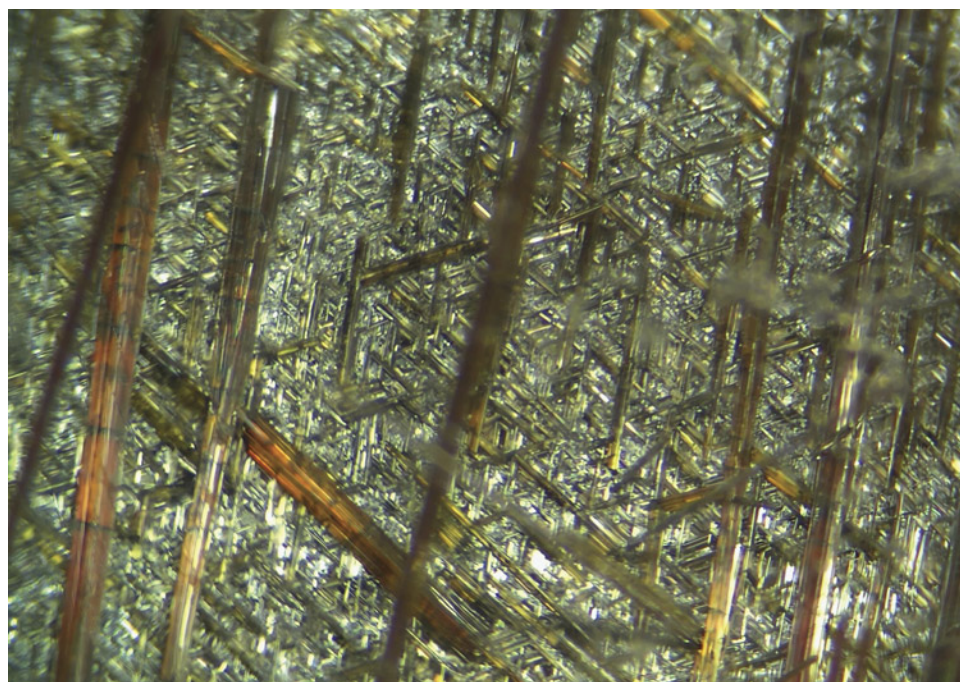


Figure 7. Three sets of interwoven needle-like hematite and rutile inclusions within a six-rayed star quartz. Photomicrograph by Haoran Zhu; field of view 5.00 mm.

characteristic of rutile, whereas certain inclusions displayed additional peaks at 225, 244, 290, 410, 493, 614, and 663 cm^{-1} , consistent with hematite. These findings suggested that some rutile needles contained hematite precipitates. This coexistence likely originated from titanium- and iron-rich hydrothermal fluids; under highly oxidizing conditions, titanium crystallized preferentially as rutile, followed by iron oxidation and subsequent hematite precipitation, resulting in a tightly intergrown microstructure responsible for the distinct six-rayed star effect.

Although rutile-induced asterism is common in quartz and the three-rayed star effect associated with asteriated rutile networks has been previously reported, the phenomenon observed in this specimen—arising from the synergistic presence of hematite and rutile needles—is both attractive and unique. To the best of the authors' knowledge, it has not been documented previously.

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An unusual yellow raindrop turquoise. Recently, author YYL encountered a unique specimen of turquoise characterized by yellow raindrop-like patterns in the Zhushan County turquoise market in Hubei Province, China. The sample exhibited a blue-green substrate, with bright yellow spots distributed individually and in clusters across its surface. Both the substrate and the spots were opaque, with the individual spots nearly round and measuring between 2 mm and 1 cm in size (figure 8).

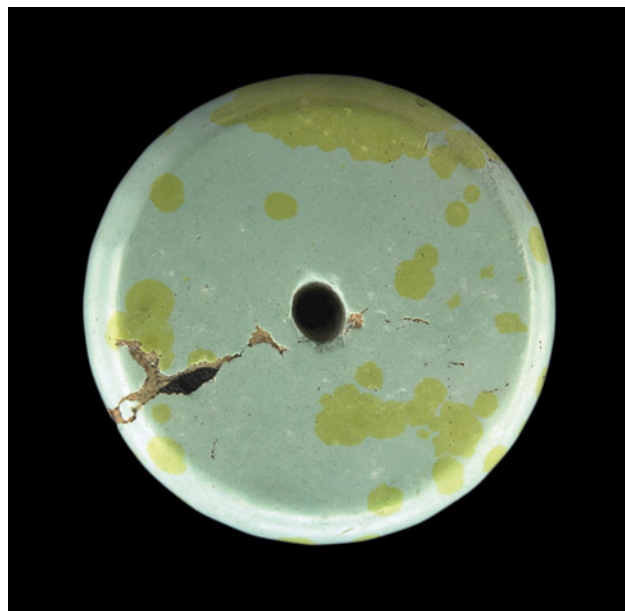


TABLE 1. XRF analysis (in wt.%) of the sample substrate and spot regions. Average values are shown in parentheses.

Oxide	Substrate	Raindrops	Ideal turquoise	Detection limit (wt. %)
Al_2O_3	35.21–35.82 (35.62)	35.32–35.91 (35.57)	45.70	0.2
SiO_2	1.85–2.11 (1.99)	1.08–1.65 (1.37)	—	0.3
P_2O_5	44.11–44.56 (44.30)	43.99–44.49 (44.28)	42.41	0.1
FeO_T	5.75–6.14 (5.85)	5.98–6.65 (6.44)	—	0.004
CuO	10.46–10.70 (10.60)	10.66–10.87 (10.78)	11.89	0.004
ZnO	0.09–0.10 (0.10)	0.08–0.10 (0.09)	—	0.01
K_2O	0.30–0.41 (0.36)	0.28–0.41 (0.34)	—	0.006
CaO	0.05–0.06 (0.05)	0.05–0.06 (0.05)	—	0.005
Total	—	—	100	—

Fourier-transform infrared (FTIR) analysis of both the substrate and the raindrop-like spots revealed turquoise vibrational peaks. Two absorption peaks attributed to a stretching vibration were noted at 2858 and 2979 cm^{-1} , indicative of wax (Fall 2015 GNI, pp. 343–345). The stronger absorptions for these two features in the substrate suggested a higher wax content, likely from residual wax after polishing due to the sample's lower hardness.

To determine the compositions of the substrate and the spots, four points in each of these regions were tested with X-ray fluorescence (XRF) spectroscopy using a quantitative method developed by the School of Jewellery laboratory, China University of Geosciences, Wuhan, with the total content of major oxides ranging from 98 to 100 wt.%. The results indicated that the primary chemical compositions of the yellow spots and the substrate were largely consistent (table 1). Specifically, the average Al_2O_3 content was 35.57 wt.% for the yellow spots and 35.62 wt.% for the substrate. Similarly for the yellow spots and substrate, the CuO content was 10.78 wt.% and 10.60 wt.%, respectively, while the total iron oxide (FeO_T) content was 6.44 wt.% and 5.85 wt.%, respectively.

Trace element analysis was performed using laser ablation–inductively coupled plasma–mass spectrometry on three spots each in the substrate and raindrop areas across both sides of the sample, with the results demonstrating broadly consistent element enrichment patterns between the substrate and raindrops. No significant con-

Figure 8. An unusual raindrop turquoise measuring 23 × 23 × 5 mm. Photo by Yunyu Liu.

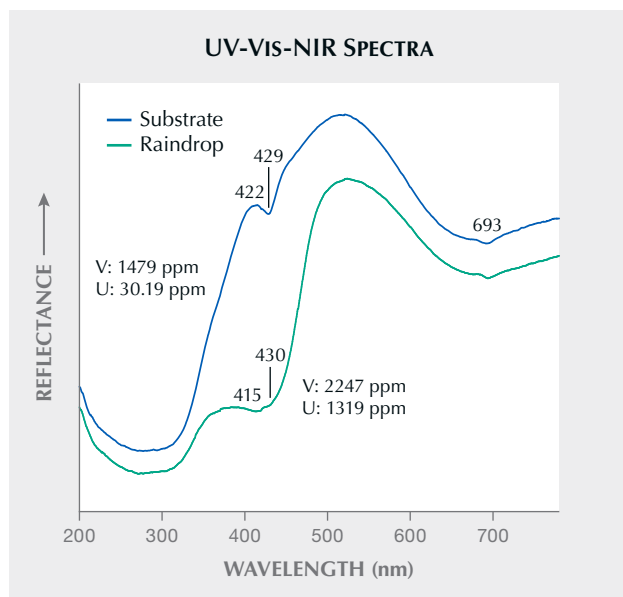


Figure 9. In the UV-Vis-NIR spectrum, both the substrate and the spots exhibit absorption in the blue-violet and red regions, with stronger absorption observed in the spots.

centration differences between the yellow raindrop regions and the blue-green substrate were observed for the trace elements analyzed, with the exception of vanadium and uranium, which were both significantly higher in concentration in the yellow regions.

The ultraviolet/visible/near-infrared (UV-Vis-NIR) reflectance spectra of the substrate exhibited characteristics typical of turquoise (figure 9). In contrast, the yellow spots displayed a strong absorption band at 415 nm, accompanied by a shoulder band at 430 nm. The violet-blue region showed significant absorption, while the red region exhibited a broader absorption band, albeit with lower intensity compared to the blue-violet region. From a compositional perspective, the primary distinction between the substrate and the yellow spots lies in their uranium and vanadium contents. Uranium exhibits a strong absorption band at 415 nm in the violet region, forming a broad absorption feature. The low-energy end of this absorption extends to approximately 460 nm, which is attributed to the magnetic dipole transition of the uranyl ion (A.N. Platonov and C. Jin, "Color of uranyl-containing minerals," *World Nuclear Geoscience Journal*, Vol. 1, 1975, pp. 38–42). An increase in vanadium content causes the absorption related to iron ions (Fe^{3+}) at 422 nm to shift toward the red region, resulting in an absorption feature at 430 nm (X. Wang and Y. Guo, "The impact of trace metal cations and absorbed water on colour transition of turquoise," *Royal Society Open Science*, Vol. 8, No. 2, 2021, article no. 201110). In summary, absorption in the violet region is primarily caused by uranium, vanadium, and iron, while copper contributes to absorption in the red region. These elemental contributions collectively account for the intense yellow coloration observed in the spots.

Although this raindrop turquoise exhibits distinct color variations, there were no significant differences observed in the FTIR spectral characteristics or bulk chemical composition between the substrate and the yellow spots. However, when looking at trace element chemistry, significantly higher levels of vanadium and uranium were identified in the spots compared to the substrate. A slightly higher concentration of iron was also observed in the yellow spots.

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IN MEMORIAM

Harold Van Pelt, 1925–2026. Pioneer of gem photography Harold Van Pelt—"Van" to his friends and colleagues—passed away at the age of 100 (figure 10). Over three decades, he and his wife, Erica, contributed hundreds of photographs—including 93 covers—to *Gems & Gemology*.

Born in Paola, Kansas, Van graduated from the Brooks Institute of Photography in Santa Barbara, California, in 1953. After he and Erica married in the early 1960s, they made a good living photographing commercial furniture. Since this work was seasonal, they used their downtime to visit Europe, Africa, and Asia. Shooting thousands of photographs in museums during their travels, they became attracted to minerals and ultimately gems. By the late 1960s and early '70s, they began attending the Tucson gem and mineral shows, soon photographing major gem crystals and, inevitably, fashioned gems.

In 1981, when *G&G* transitioned to a larger, full-color format with an expanded editorial review board, the Van Pelts played a pivotal role in the journal's growing accept-

Figure 10. Harold Van Pelt with his wife, Erica, in his studio. Photo by Harold & Erica Van Pelt.



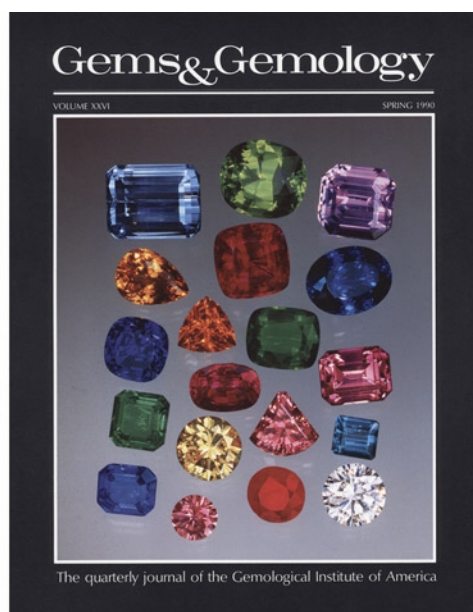
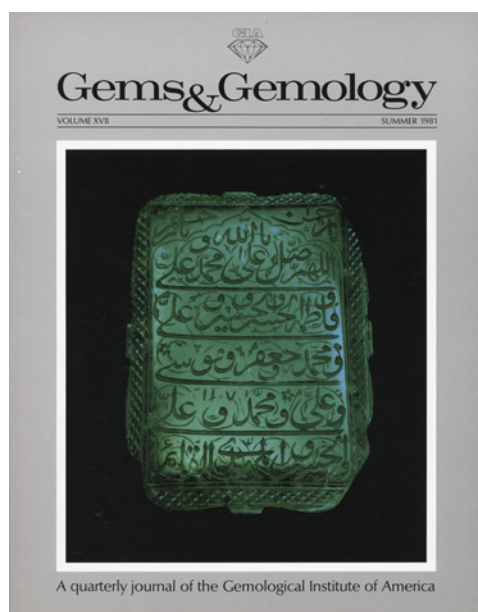


Figure 11. Left: The Van Pelt's first G&G cover (Summer 1981) featuring the 217.8 ct engraved Mogul emerald. Right: Taken in a single shot, these gemstones demonstrate the Van Pelt's ability to accurately capture color (Spring 1990). Photos by Harold & Erica Van Pelt.

ance by both the gem industry and the scientific community. Their first cover, the 217.8 ct Mogul emerald featured on the Summer 1981 issue (figure 11, left), and the many superb images they provided for Peter Keller's landmark article on Colombian emeralds in that issue, demonstrated that a scientific article could be beautiful and substantive at the same time.

While the Van Pelt's published gem and mineral photos in numerous books and magazines during their career, their collaboration with G&G is one of their longest and, perhaps, most demanding professional relationships. Unlike images produced today, where gems are photographed individually and then composited into a single picture, they photographed multiple gems in a single shot. Their attention to lighting and color typically required many hours of setup for a single 8 × 10 transparency. Readers often commented that the accuracy of their color was unmatched in the field (figure 11, right).

More than a gifted photographer, Van was also an accomplished gem carver. Inspired by the museum collections seen during their world travels, he fashioned large pieces of rock crystal, agate, and other gem materials into exquisite objects that have been displayed at museums in the United States and Germany (figure 12). Using machinery he made or modified, he carved hundreds of items over 60-plus years.

We share our heartfelt condolences with Erica and Van's extended family, friends, and colleagues. May Van's legacy live on in the many extraordinary photos he and Erica produced—and in the beautiful objects he created—with skill, patience, and the eye of a true artist.

Alice Keller

Editor-in-Chief Emerita, Gems & Gemology

Dona Dirlam

GIA Librarian Emerita

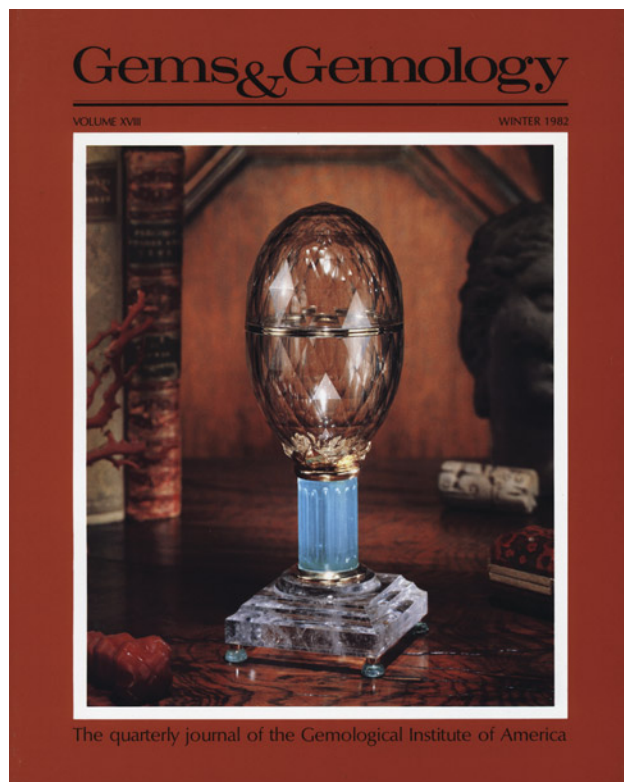


Figure 12. The Winter 1982 cover depicts a quartz egg with an aquamarine and quartz base carved by Harold Van Pelt. The issue also includes an article detailing the techniques and equipment Van used to fashion the egg. Photo by Harold & Erica Van Pelt.