The Wittelsbach-Graff and Hope Diamonds: Not Cut from the Same Rough

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Two historic blue diamonds, the Hope and the Wittelsbach-Graff, appeared together for the first time at the Smithsonian Institution in 2010. Both diamonds were apparently purchased in India in the 17th century and later belonged to European royalty. In addition to the parallels in their histories, their comparable color and bright, long-lasting orange-red phosphorescence have led to speculation that these two diamonds might have come from the same piece of rough. Although the diamonds are similar spectroscopically, their dislocation patterns observed with the DiamondView differ in scale and texture, and they do not show the same internal strain features. The results indicate that the two diamonds did not originate from the same crystal, though they likely experienced similar geologic histories.

The earliest records of the famous Hope and Wittelsbach-Graff diamonds (figure 1) show them in the possession of prominent European royal families in the mid-17th century. They were undoubtedly mined in India, the world's only commercial source of diamonds at that time.

The original ancestor of the Hope diamond was an approximately 115 ct stone (the Tavernier Blue) that Jean-Baptiste Tavernier sold to Louis XIV of France in 1668. Tavernier purchased the diamond in India, possibly at the Kollur mine, but its exact source is not known. Louis XIV had Tavernier's stone recut into the ~69 ct diamond called the *Diamant Bleu de la Couronne* (Blue Diamond of the Crown), later known as the French Blue. The diamond was set into the Golden Fleece of the Colored Adornment (*Toison d'Or de la Parure de Couleur*) in 1749, but was stolen in 1792 during the French Revolution. Twenty years later, a 45.52 ct blue diamond appeared for sale in London and eventually became part of the collection of Henry Philip Hope. Recent computer modeling studies have established that the Hope diamond was cut from the French Blue, presumably to disguise its identity after the theft (Attaway, 2005; Farges et al., 2009; Sucher et al., 2010). For a thorough look at the history of the Hope diamond, see Patch (1976), Morel (1988), and Kurin (2006), along with the references cited above.

The first reliable record of the Wittelsbach Blue diamond dates to 1673 in Vienna, when it was listed as part of the estate of Empress Margarita Teresa of Austria. As with the Hope diamond, its exact source in India is unknown, though the Kollur mine has been mentioned (e.g., Balfour, 2009). The stone passed from the Hapsburg court to the Bavarian Wittelsbach family in 1722 as part of a dowry, and it remained in the Bavarian crown jewels until the

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Figure 1. In late January 2010, the 31.06 ct Wittelsbach-Graff diamond (left) joined the 45.52 ct Hope diamond (right) for a seven-month display at the Smithsonian Institution's National Museum of Natural History. Photo by Chip Clark.

creation of the German republic after World War I. To support the former Bavarian royal family, the Wittelsbach diamond was put up for auction in 1931 with other royal jewels. When the bidding was too low, it went back to a government safe for the next 20 years until it was secretly sold. It briefly reappeared, anonymously, during the 1958 World Exhibition in Brussels.

In 1962, the Wittelsbach Blue was recognized by a Belgian diamond dealer who had been asked to recut it; he refused and bought the stone instead. The gem was then sold to a private owner and remained out of the public eye until a Christie's auction on December 10, 2008. London jeweler Laurence Graff purchased the 35.56 ct stone for just over $24.3 million. Graff decided to have the diamond recut to remove numerous chips around the girdle, enhance its color grade (from Fancy Deep grayish blue to Fancy Deep blue), and reduce the size of its large culet, while attempting to preserve the original shape. The renamed Wittelsbach-Graff diamond now weighs 31.06 ct. The reader is referred to Dröschel et al. (2008) for a comprehensive review of the Wittelsbach's history.

The Wittelsbach-Graff diamond was placed on public display near the Hope diamond at the Smithsonian Institution's National Museum of Natural History from January 28 to September 1, 2010. This marked the first time the two great blue diamonds were brought together. Because of the rarity of large blue diamonds and the historical parallels between the Hope and the Wittelsbach Blue, there has been considerable speculation over the years as to whether they might have been cut from the same piece of rough or from stones that were once part of the same parent crystal (e.g., Balfour, 2009). This speculation is supported by the fact that the Wittelsbach-Graff, like the Hope, exhibits a rare long-lasting orange-red phosphorescence. The exhibition of the two diamonds at the Smithsonian Institution provided an unprecedented opportunity to conduct a side-by-side study. In addition to addressing the question of a common pedigree, this was a rare occasion to gain additional insight into natural blue diamonds by studying two of the largest and finest examples known. All the experiments were conducted during a single night, just before the Wittelsbach-Graff was mounted into its bracket to go on exhibition and while the Hope was unmounted from its necklace.

MATERIALS AND METHODS

Both diamonds were graded by GIA prior to this study. The 31.06 ct Wittelsbach-Graff is a Fancy Deep blue, internally flawless, cushion modified brilliant cut. The 45.52 ct Hope is a Fancy Deep grayish blue, very slightly included (VS_1), antique cushion cut (Crowningshield, 1989). Both stones have relatively large culets (though the Wittelsbach-Graff's culet is significantly larger; again, see figure 1), which enabled us to perform spectroscopy through the parallel table and culet facets.

As our testing had to be conducted in a vault at the National Museum of Natural History for security reasons, portable equipment was necessary. Infrared (IR) spectra were acquired using a Thermo iS10 Fourier-transform infrared (FTIR) spectrometer (2 cm^{-1} resolution). Mirrors were used as beam condensers (figure 2), enabling us to focus the beam through the table and culet of each stone. No purge

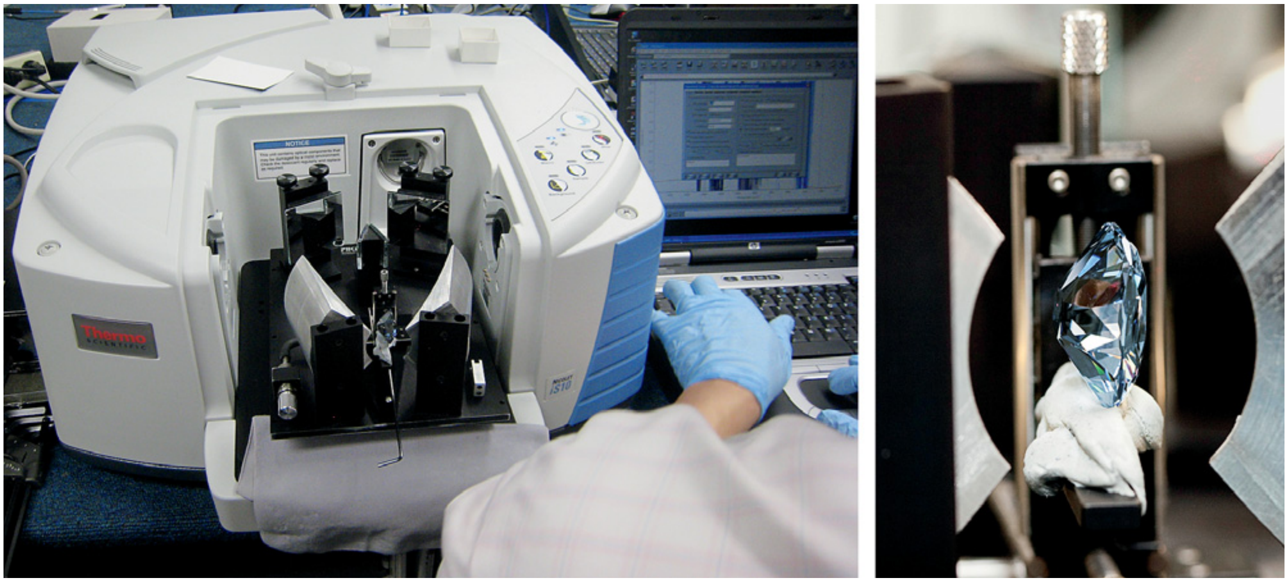

Figure 2. The portable FTIR equipment was mounted with a mirror beam condenser. The photo on the left shows the general apparatus, in which the Hope diamond is set. On the right, the mirrors focus the beam through the table and culet of the Wittelsbach-Graff. Photos by J. Post (left) and Chip Clark (right).

system was used during data collection.

UV fluorescence was tested with a Super Bright long- and short-wave UV lamp (365 and 254 nm, respectively).

Phosphorescence spectra were collected using the portable spectrometer described previously by Eaton-Magaña et al. (2008). The stones were excited with an Ocean Optics DH-2000 deuterium UV lamp (which emits in the 215–400 nm range), and the signal was acquired with an Ocean Optics charge-coupled device (CCD) spectrometer (USB 2000) through a fiber-optic bundle. In this bundle, the UV radiation was transferred through six optical fibers (600 μm diameter each); a seventh fiber in the core of the bundle collected the emitted light from the diamond and delivered it to the entrance aperture of the CCD spectrometer. The tip of the fiber-optic bundle was placed in contact with the diamond's surface, which made it possible to illuminate and measure approximately equivalent volumes for each sample. The phosphorescence spectra were collected after 20 seconds of UV exposure. During decay, the spectra were integrated and recorded at intervals of 0.5, 1, and 2 seconds.

NEED TO KNOW

- The Wittelsbach-Graff and the Hope, two of the world's most famous blue diamonds, share similarities in history, color, and phosphorescence.
- Slight differences in phosphorescence and distinct differences in luminescence emission and internal strain patterns demonstrate that the diamonds did not originate from the same crystal.
- The two diamonds' overall resemblance and common origin (India) suggest that they formed in similar geologic settings.

Luminescence imaging under ultra-short-wave UV radiation (~225 nm) was performed with a Diamond Trading Company DiamondView instrument (Welbourn et al., 1996). High-intensity short-wave UV close to the diamond absorption edge was used to excite the fluorescence and phosphorescence so that only the outermost layer of the diamond was excited, yielding sharp and clear fluorescence images. Birefringence resulting from internal strain was examined in transmitted light between crossed polarizers through a Nikon SMZ1500 microscope.

Attempts were made to acquire UV-visible spectra with a portable spectrometer, but the equipment was not configured for such large stones, so the measurements are not reported here.

RESULTS AND DISCUSSION

Results for both diamonds are summarized in table 1. Based on previous color grading of the two diamonds, we expected their appearances to be quite similar when observed side by side. Diamonds graded by GIA as Fancy Deep are medium to dark in

TABLE 1. Summary of the main characteristics of the Hope and Wittelsbach-Graff diamonds.

Characteristic	Hope	Wittelsbach-Graff
GIA color grade	Fancy Deep grayish blue	Fancy Deep blue
Weight	45.52 ct	31.06 ct
Dimensions	25.60 × 21.78 × 12.00 mm	23.23 × 19.65 × 8.17 mm
FTIR spectroscopy		
Diamond type	IIb	IIb
Boron (uncompensated)	0.36 ± 0.06 ppm	0.19 ± 0.03 ppm
UV fluorescence	None	None
Phosphorescence		
Observed (from short-wave UV)	Intense orange-red, ~1 minute	Intense orange-red, ~1 minute
I_0 500 nm / I_0 660 nm[a] (avg.)	~0.104	~0.093
$\tau_{660\ nm}$[a] (avg.)	~9 seconds	~14 seconds
DiamondView imaging	Moderate-to-strong blue luminescence, mosaic patterns <100 μm	Moderate-to-strong blue luminescence, mosaic patterns >200 μm
Internal strain patterns	Coarse banded internal strain pattern, predominantly in a single direction, with blue, orange, and red interference colors.	"Tatami" pattern visible in all directions, with gray and blue interference colors.

[a] *Abbreviations: I_0 = initial intensity, τ = half-life.*

tone (the lightness to darkness of the color) and moderate to strong in saturation (the strength or purity of the color; King et al., 1998). The Hope's grayish blue color, compared to the blue of the Wittelsbach-Graff, led us to expect a very slightly less saturated and more "steely" appearance, which we did observe. Many factors influence a diamond's color appearance, including size, shape, and proportions. Even with the similar bodycolor, the different proportions and cutting styles of these two stones would lead us to expect different face-up color appearances. The difference was subtle under standard color grading conditions, but more pronounced in less-controlled lighting and viewing environments.

FTIR spectroscopy confirmed that both diamonds were type IIb (figure 3); that is, their substitutional

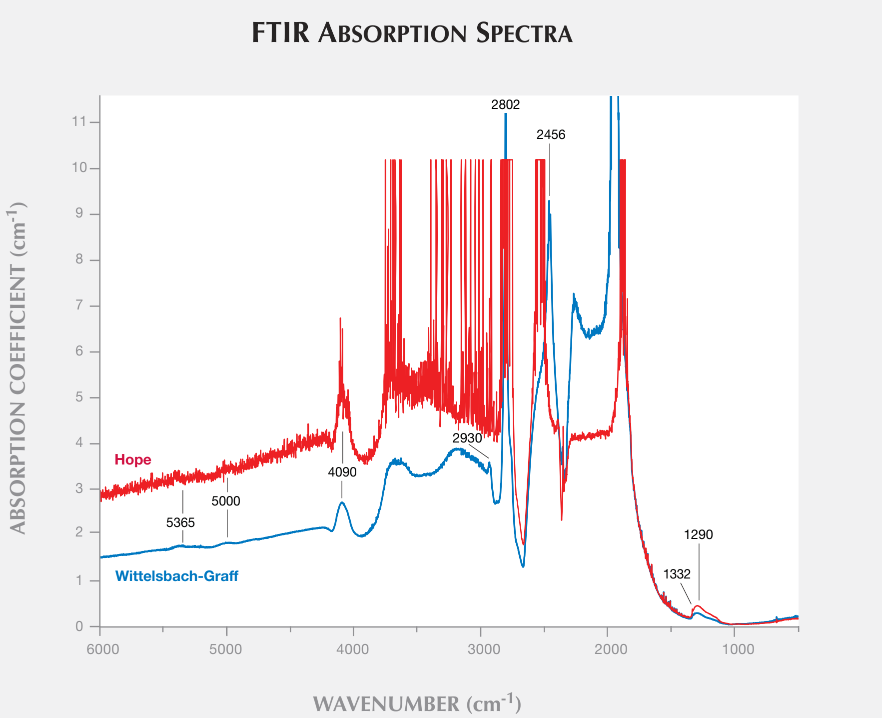

Figure 3. The FTIR spectra of the Hope and Wittelsbach-Graff diamonds confirmed that they were type IIb. Because the stones are thick (12.00 and 8.17 mm, respectively), they fully absorb in the two- and three-phonon regions (especially the Hope diamond, from 3700 to 1800 cm^{-1}). All but one of the labeled peaks correspond to boron; the 1332 cm^{-1} feature is the Raman line (activated by the boron impurities).

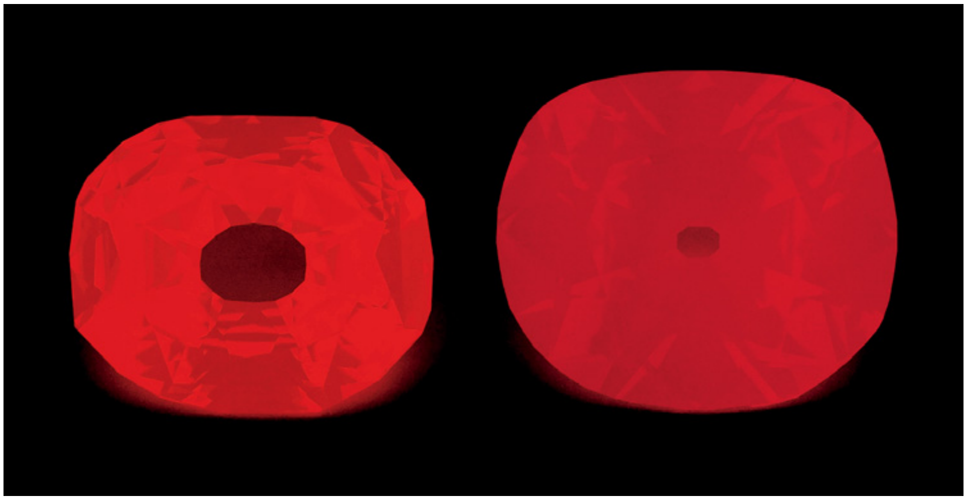

Figure 4. Both the Wittelsbach-Graff (left) and Hope (right) display bright, long-lasting, orange-red phosphorescence after exposure to short-wave UV radiation. Note, however, that the Wittelsbach-Graff is slightly brighter and more orange. This phosphorescence is actually better captured with the camera than with the unaided eye, and agrees with the spectra shown in figure 5. Photo by Chip Clark.

boron concentration exceeds the substitutional nitrogen concentration, if any (Breeding and Shigley, 2009). Due to the long path of the IR beam from the culet facet through the table (12.00 mm for the Hope and 8.17 mm for the Wittelsbach-Graff), both spectra showed complete absorption in the main boron region, which was more pronounced in the thicker Hope. The boron peaks were positioned at 5365, 5000, 4090, 2930, 2802, 2456, and 1290 cm^{-1}. The area of the peak at 2802 cm^{-1} is typically used to calculate the concentration of noncompensated boron (Collins and Williams, 1971; Fisher et al., 2009), but this peak was saturated for both diamonds. However, it was recently shown that it is also possible to estimate the uncompensated boron concentration from the absorption coefficient of the one-phonon peak at 1290 cm^{-1} (Collins, 2010). Using the procedure and the calibration given by Collins (2010) yielded boron concentrations of 0.36 ± 0.06 ppm (atomic) for the Hope and 0.19 ± 0.03 ppm for the Wittelsbach-Graff. For comparison, the uncompensated boron concentrations in natural blue diamonds studied by Collins and Williams (1971) ranged from 0.19 to 0.44 ppm. Thus, the boron concentrations in the Hope and Wittelsbach-Graff are characteristic of other natural type IIb diamonds, and most likely their intense blue color results primarily from their large size rather than an abnormally high boron concentration.

Both diamonds were inert to long- and short-wave UV radiation. As indicated above, after exposure to short-wave UV both diamonds exhibited intense orange-red phosphorescence, which was visible to the unaided eye in a dark room for approximately one minute (figure 4). The Wittelsbach-Graff's phosphorescence was a bit more intense, lasted slightly longer, and was perhaps more orange. To better quantify these observations, phosphorescence spectra were acquired from several areas of the diamonds. Both diamonds showed the two bands previously observed by Eaton-Magaña et al. (2008) in natural type IIb blue diamonds (figure 5), centered at 500 nm (blue) and 660 nm (orange-red).

The study by Eaton-Magaña et al. (2008) of more than 70 natural blue diamonds revealed that their phosphorescence spectra typically display a relatively strong blue emission with a relatively weak red emission (figure 6). The Wittelsbach-Graff and the Hope, however, are among the minority of blue diamonds that have intense 660 nm and weak 500 nm emissions. In these stones, the 500 nm band decays in the first few seconds after UV excitation is stopped, whereas the red luminescence persists for a minute or more. Eaton-Magaña et al. (2008) showed that when the half-life of the 660 nm band is plotted against the ratio of the initial intensities of the 500 and 660 nm bands, each natural blue diamond has a specific combination of these parameters, which might be helpful in their identification. The Wittelsbach-Graff and Hope diamonds plot in the bottom to bottom-right portion of this graph (again, see figure 6) and have the longest-lasting red emissions of any natural blue diamonds measured to date.

At first glance, the phosphorescence spectra from the Hope and Wittelsbach-Graff diamonds (again, see figure 5) looked strikingly similar. The initial relative intensities of the 500 and 660 bands were nearly identical, and the relative decay times corresponded closely. In fact, no other blue diamond from the Eaton-Magaña et al. (2008) study exhibited phosphorescence behavior as similar to the Hope's

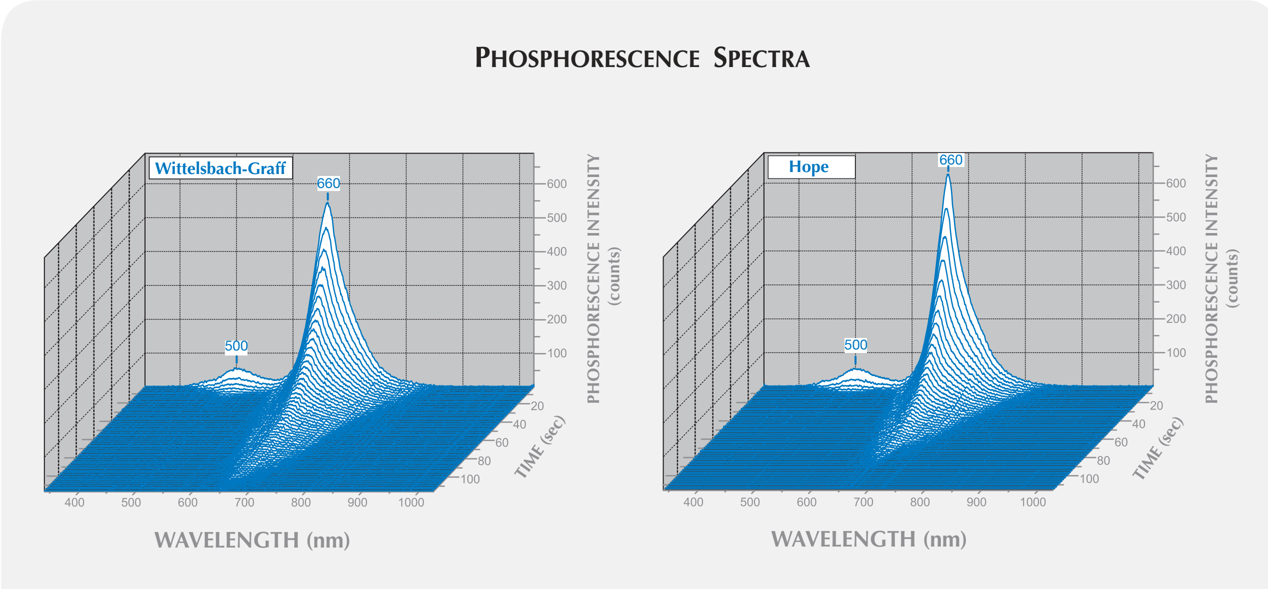

Figure 5. Some differences were seen in the phosphorescence spectra of the Wittelsbach-Graff and Hope diamonds. The Hope shows a greater initial intensity, at about 625 counts compared to 545, but its red (and even blue) phosphorescence fades sooner (85 seconds compared to 110). The abscissa spans just over the range of visible light. Each spectrum was acquired at two-second intervals, until the phosphorescence completely faded away.

as that of the Wittelsbach-Graff. On closer examination, however, the decay time of the Wittelsbach-Graff's 660 nm band was slightly but reproducibly longer than that of the Hope (again, see figure 5).

Both diamonds had a heterogeneous phosphorescence distribution, with initial intensity and half-life variations depending on the probed areas (table 2). This heterogeneity was not mentioned by Eaton-

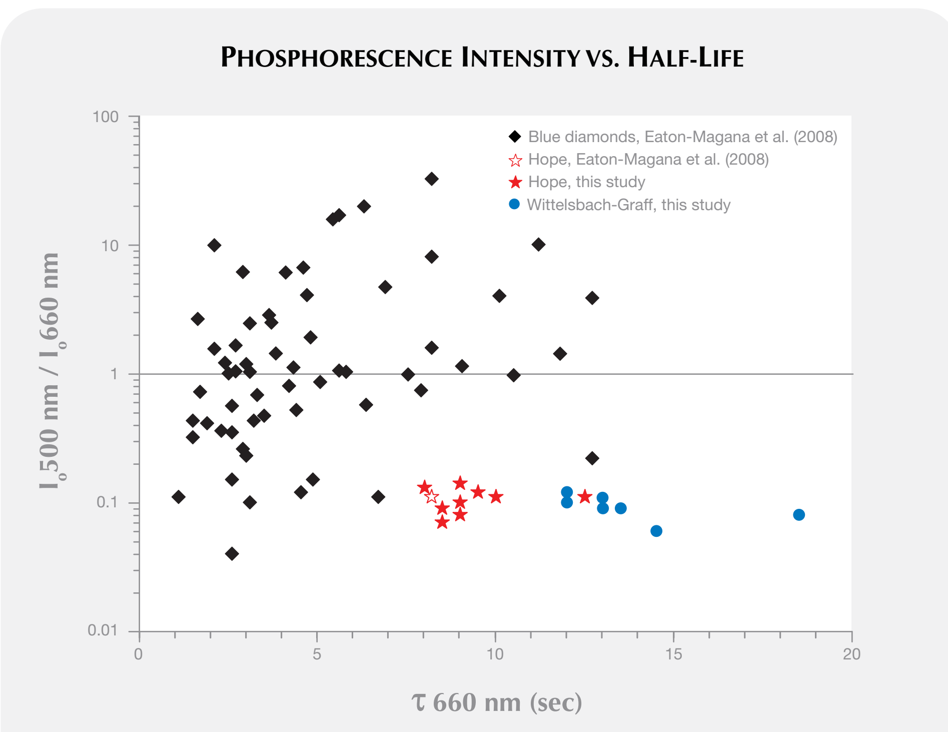

Figure 6. This graph of the phosphorescence data plots the ratios of initial intensities of the 500 and 660 nm bands against measured half-lives of the 660 nm emission for the Wittelsbach-Graff and Hope, compared to some natural type IIb diamonds (from Eaton-Magaña et al., 2008). For y-axis values greater than 1, the blue band dominates, whereas the red band dominates for values less than 1. The Hope and the Wittelsbach-Graff diamonds have extremely long-lasting red phosphorescence. "I_0" represents initial intensity, and "τ" the half-life.

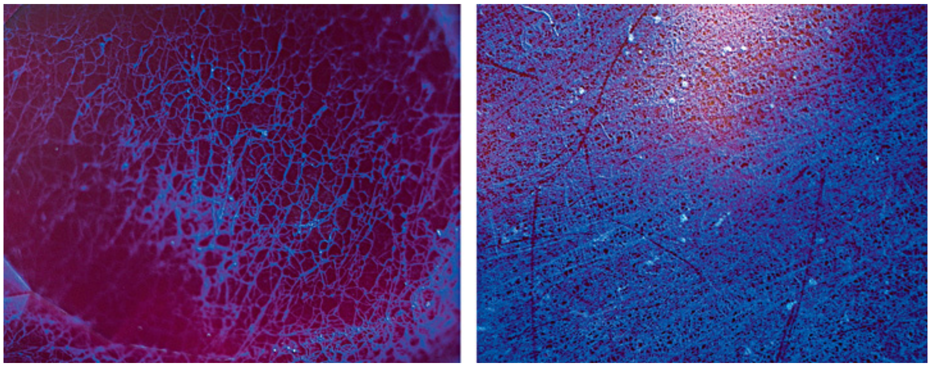

Figure 7. In these DiamondView images from the culet of the Wittelsbach-Graff (left) and table of the Hope (right), the texture of the mosaic patterns is much finer for the Hope (<100 µm vs. >200 µm). Fields of view 6.1mm (left), 6.4 mm (right); exposure time 2.8 seconds.

Magaña et al. (2008), who also examined the Hope diamond, possibly because the present study probed more areas on the diamonds.

In addition to the table and culet facets, spectra were collected from some of the crown facets, which produced the more extreme values. Curiously, phosphorescence intensity was stronger in the crown facets than in the culet and table for both diamonds, suggesting that the angle of illumination in large stones might affect their phosphorescence spectra. The average decay half-life of the 660 nm band for the Wittelsbach-Graff was ~14 seconds, compared to ~9 seconds for the Hope. (The 500 nm band decayed too quickly for a half-life measurement to be meaningful.) The cause of the 500 and 660 nm emissions is not fully understood, but it is generally agreed that the phosphorescence is due to donor-acceptor pair recombination, and that the acceptor is boron. The fact that there are two emission bands with peaks at different energies suggests that two donor centers are involved, neither of which has been positively identified, although nitrogen may play a role (Watanabe et al., 1997; Eaton-Magaña et al., 2008).

In the ultra-short-wave UV excitation of the DiamondView, both diamonds exhibited a moderate-to-strong blue emission throughout the entire stone. The blue emission was not homogeneous, but formed a mosaic pattern (figure 7). This pattern has been observed previously in type II diamonds, and studies suggest that the cell walls of the mosaic network consist of dislocations (e.g., Hanley et al., 1977; Kanda et al., 2005). It is also known that the polygonization of these dislocations occurs during plastic deformation at high pressure and high temperature in the earth's lower crust/upper mantle (Kanda et al., 2005). Note that the scale and texture of the mosaic pattern was coarser in the Wittelsbach-Graff (mainly features >200 µm) than in the Hope (<100 µm). Doubling the imaging exposure time from 2.8 to 5.6 seconds revealed superimposed red phosphorescence for both diamonds, consistent with the phosphorescence results described above.

Last, when examined between crossed polarizers, the two diamonds exhibited dramatically different internal strain patterns (figure 8). The Wittelsbach-Graff displayed a typical "tatami" pattern (two directions of strain lamination), with gray and blue interference colors (figures 8A–8C) visible in all directions through the diamond. The Hope, on the other hand, showed a distinctly coarser banded internal strain pattern, predominantly in a single direction, with blue, orange, and red interference colors (figures 8D–8F). The components of the tatami patterns, oriented in the {111} planes, are due to strain caused by plastic deformation with little or

TABLE 2. Phosphorescence data acquired for the Hope and Wittelsbach-Graff diamonds.[a]

Spectral interval (seconds)	Area probed	I_0 500 nm (arbitrary units)	I_0 660 nm (arbitrary units)	I_0 500 nm/ I_0 660 nm	τ 660 nm (seconds)
Hope					
0.5	Table-3	20.14	168.14	0.120	9.5
1	Table-1	18.71	277.86	0.067	8.5
1	Table-2	23.71	310.14	0.076	9
1	Table-5	28.71	295.57	0.097	9
1	Culet-1	38.43	283.86	0.135	9
1	Culet-2	29.71	234.71	0.127	8
1	Crown-1	43.14	375.29	0.115	10
1	Crown-2	30.29	268.43	0.113	12.5
2	Table-4	53.86	628.71	0.086	8.5
Wittelsbach-Graff					
0.5	Table-3	16.29	138.00	0.118	12
1	Table-1	25.57	245.57	0.104	12
1	Culet-1	8.29	145.14	0.057	14.5
1	Culet-2	15.86	169.14	0.094	13.5
1	Crown-1	30.71	328.57	0.093	13
1	Crown-2	21.43	253.86	0.084	18.5
2	Table-2	54.43	545.57	0.100	13

[a] *Abbreviations: I_0 = initial intensity, τ = half-life.*

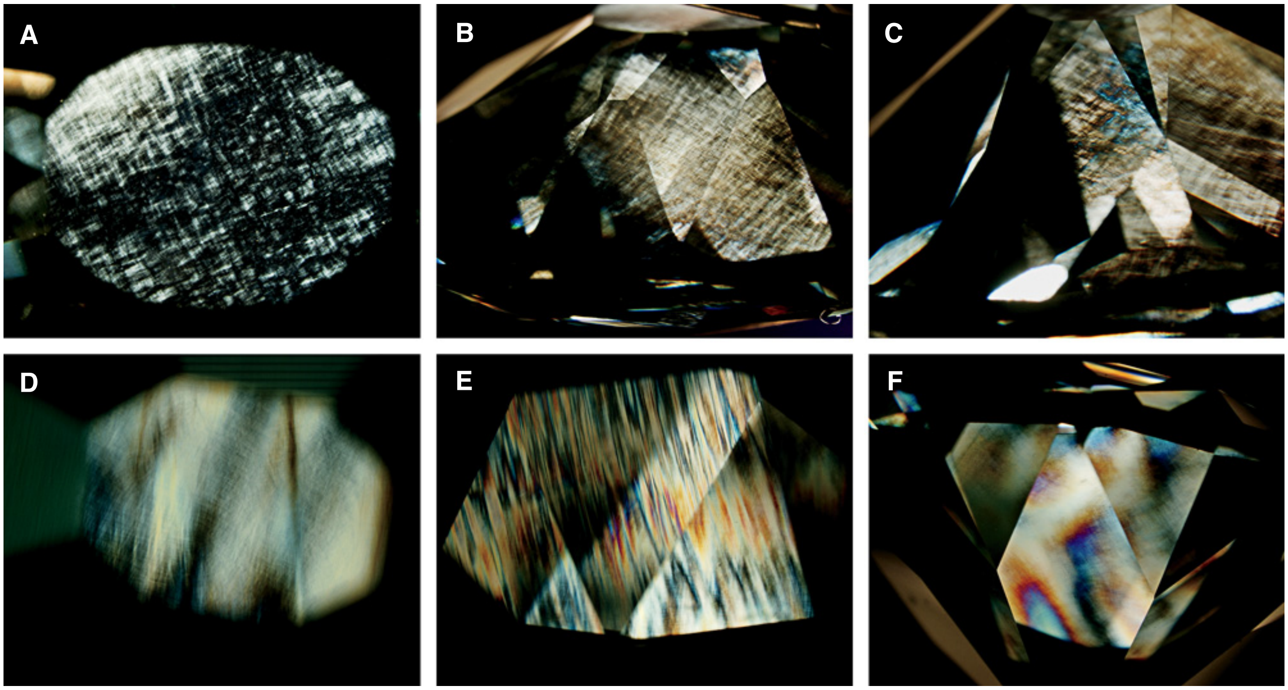

Figure 8. These images of the Wittelsbach-Graff (top row) and the Hope (bottom row) were taken in transmitted light with crossed polarizers. Both diamonds show internal strain, but with different patterns. The Wittelsbach-Graff displays the typical tatami pattern when viewed in all three directions: (A) through the culet, (B) through the longest side, and (C) through the shortest side. The Hope has strongly banded strain, shown here: (D) through the culet, (E) through the longest side, and (F) through the shortest side (which is perpendicular to the bands, so no strong direction of strain can be observed). A subtle tatami pattern can also be seen in the Hope. Fields of view: (A) 7.9 mm, (B) 11.8 mm, (C) 9.9 mm, (d) 3.8 mm, (E) 9.9 mm, (F) 14.8 mm. Photomicrographs by W. Wang.

no subsequent annealing (e.g., Hanley et al., 1977; Collins et al., 2000; Kanda et al., 2005).

CONCLUSION

Despite their uncanny similarities in history, color, and phosphorescence, our study clearly shows that the Wittelsbach-Graff and Hope diamonds did not originate from the same crystal. Small but significant differences were observed in their red phosphorescence, as the Wittelsbach-Graff's is slightly longer and more intense. Major differences were noticed during the examination with crossed polarizers and in the luminescence patterns observed with the DiamondView. Nevertheless, their overall resemblance and common origin (India) suggest that both diamonds formed under similar geologic conditions.

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REFERENCES

Attaway N. (2005) The French connection. *Lapidary Journal*, Vol. 59, No. 3, pp. 24–28.

Balfour I. (2009) *Famous Diamonds*. Antique Collectors' Club, Woodbridge, Suffolk, UK, 335 pp.

Collins A.T. (2010) Determination of the boron concentration in diamond using optical spectroscopy. Diamond Conference, University of Warwick, July 13–16 (unpublished abstract).

Collins A.T., Williams A.W.S. (1971) The nature of the acceptor centre in semiconducting diamond. *Journal of Physics C: Solid State Physics*, Vol. 4, pp. 1789–1799.

Collins A.T., Kanda H., Kitawaki H. (2000) Colour changes produced in natural brown diamonds by high-pressure, high-temperature treatment. *Diamond and Related Materials*, Vol. 9, pp. 113–122.

Crowningshield R. (1989) Grading the Hope diamond. *G&G*, Vol. 25, No 2, pp. 91–94.

Dröschel R., Evers J., Ottomeyer H. (2008) The Wittelsbach Blue. *G&G*, Vol. 44, No. 4, pp. 348–363.

Eaton-Magaña S., Post J.E., Heaney P.J., Freitas J., Klein P., Walters P., Butler J.E. (2008) Using phosphorescence as a fingerprint for the Hope and other blue diamonds. *Geology*, Vol. 36, pp. 83–86.

Farges F., Sucher S., Horovitz H., Fourcault J.-M. (2009) The French Blue and the Hope: New data from the discovery of a historical lead cast. *G&G*, Vol. 45, No. 1, pp. 4–19.

Fisher D., Sibley S.J., Kelly C.J. (2009) Brown colour in natural diamond and interaction between the brown related and other colour-inducing defects. *Journal of Physics: Condensed Matter*, Vol. 21, article no. 364213 [10 pp.].

Hanley P.L., Kiflawi I., Lang A.R. (1977) On topographically identifiable sources of cathodoluminescence in natural diamonds. *Philosophical Transactions of the Royal Society of London A*, Vol. 284, No. 1324, pp. 329–368.

Kanda H., Abduriyim A., Kitawaki H. (2005) Change in cathodoluminescence spectra and images of type II high-pressure synthetic diamond produced with high pressure and temperature treatment. *Diamond and Related Materials*, Vol. 14, pp. 1928–1931.

King J.M., Moses T.M., Shigley J.E., Welbourn C.M., Lawson S.C., Cooper M. (1998) Characterizing natural-color type IIb blue diamonds. *G&G*, Vol. 3, No. 4, pp. 246–268.

Kurin R. (2006) *Hope Diamond: The Legendary History of a Cursed Gem*. Harper Collins, New York, 400 pp.

Morel B. (1988) *The French Crown Jewels*. Fonds Mercator, Antwerp, 417 pp.

Patch S.S. (1976) *Blue Mystery: The Story of the Hope Diamond*. Smithsonian Institution Press, Washington, DC.

Sucher S.D., Attaway S.W., Attaway N.L., Post J.E. (2010) Possible "sister" stones of the Hope diamond. *G&G*, Vol. 46, No. 1, pp. 28–35.

Watanabe K., Lawson S.C., Isoya J., Kanda H., Sato Y. (1997) Phosphorescence in high-pressure synthetic diamond. *Diamond and Related Materials*, Vol. 6, pp. 99–106.

Welbourn C.M., Cooper M., Spear P.M. (1996) De Beers natural versus synthetic diamond verification instruments. *G&G*, Vol. 32, No. 3, pp. 156–169.

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