# STAR OF THE SOUTH: A HISTORIC 128 CT DIAMOND

By Christopher P. Smith and George Bosshart

The Star of the South is one of the world's most famous diamonds. Discovered in 1853, it became the first Brazilian diamond to receive international acclaim. This article presents the first complete gemological characterization of this historic 128.48 ct diamond. The clarity grade was determined to be $VS_2$ and the color grade, Fancy Light pinkish brown. Overall, the gemological and spectroscopic characteristics of this nominal type IIa diamond—including graining and strain patterns, UV-Vis-NIR and mid- to near-infrared absorption spectra, and Raman photoluminescence—are consistent with those of other natural type IIa diamonds of similar color.

Rarely do gemological laboratories have the opportunity to perform and publish a full analytical study of historic diamonds or colored stones. However, such was the case recently when the Gübelin Gem Lab was given the chance to analyze the Star of the South diamond (figure 1). This remarkable diamond is not only of historical significance, but it is also of known provenance—cut from a piece of rough found in the state of Minas Gerais, Brazil, almost 150 years ago. In addition, the Star of the South has a natural pinkish brown color and is classified as a nominal type IIa diamond (refer to the Spectrometry section). Because of the age and previous descriptions of this diamond, which predate the growth of synthetic diamonds and modern color-enhancement techniques, we are able to guarantee that it was natural and unaltered.

## A BRIEF OVERVIEW OF DIAMOND DEPOSITS IN BRAZIL

The most frequently cited date for the discovery of diamonds in Brazil is 1725 (Legrand, 1980; Lenzen, 1980; Wilson, 1982). Cassedanne (1989) indicated that the first reference to Brazilian diamonds was in 1714, although the source for this information is not provided. However, it is likely that some diamonds were recovered as a byproduct of gold panning activities during the 17th century and even earlier. What is commonly referred to as "The Brazilian Era" in the history of diamonds extended from approximately 1730 to 1870, during which time Brazil was the world's principal source of diamond. This era ended with the discovery of more significant quantities of diamonds in South Africa.

According to Levinson (1998), it has been estimated that prior to the Brazilian finds only about 2,000–5,000 carats of diamonds arrived in Europe annually from the mines of India. In contrast, the Brazilian finds supplied an estimated 25,000 to 100,000 carats of rough diamonds per annum (for some years, such as 1850 and 1851, production reached 300,000 carats). This sudden influx of relatively large quantities of diamonds had a significant effect on the world's diamond market. As Lenzen (1980, p. 55) states, "The importance of the Brazilian discoveries is reflected in the fact that within five years, from 1730 to 1735, the world diamond market exploded. Prices dropped by three-quarters."

Almost all of the diamonds recovered in Brazil to date have been from secondary (alluvial) deposits. The first kimberlite pipe was not even discovered until 1965 (Wilson, 1982). Since then, a large number of kimberlites have been identified, but the vast majority were found to be barren of diamonds. To date, the diamondiferous ones have not been found to contain sufficient concentrations of diamonds to

See end of article for About the Authors and Acknowledgments.

GEMS & GEMOLOGY, Vol. 38, No. 1, pp. 54–64

© 2002 Gemological Institute of America

support commercially viable mining operations. Brazil's alluvial diamond deposits have been classified into three basic types based on where they occur relative to the waterways that are associated with the deposits (Lenzen, 1980; Wilson, 1982): high-level deposits (roughly 1,200–1,500 m above sea level), low- or terrace-level deposits (in the river valleys, above the high-water level), and fluvial or river deposits (in the river sediments).

Brazil's diamond deposits are spread out over an extensive surface area. The Diamantina region alone covers approximately 10,000 km$^2$ (Cassedanne, 1989). Wilson (1982) indicated that diamonds have been discovered in 40 districts in 11 states. He added that the most significant deposits lie in the southwest portion of Minas Gerais, in an area known as the Mining Triangle.

The concentration of diamonds throughout most of these regions is very low. However, there are some exceptions to this general rule. Holes or depressions along some river tributaries occasionally have provided a rich cache of diamonds. Some holes are small and relatively shallow, whereas others have been described as being as large as caves (Lenzen, 1980).

The first large diamond discovered in Brazil, called the Regente de Portugal, reportedly was found along the Abaeté River in Minas Gerais in the mid-18th century (Reis, 1959). It is believed to have been cut into a 215 ct stone, but nothing is known of its subsequent disposition; there is even some question as to whether it ever existed, or was in fact a topaz (Reis, 1959). In 1938, the largest Brazilian diamond ever documented was found. It weighed an impressive 726.6 ct and was named the President Vargas diamond, in honor of Brazil's then president (Balfour, 2000); several stones were cut, the largest of which—originally 48.26 ct (since recut to 44.17 ct)—is known as the Vargas diamond (Krashes, 1984). Certain areas of Minas Gerais have become well known for the number of large diamonds they have yielded. The Coromandel region alone, where the President Vargas was found, produced nine diamonds that weighed more than 200 ct each, as well as another 16 that were more than 100 ct, during the period 1935–1965 (Legrand, 1980). In one five-year period, Coromandel yielded five stones that had an average weight of 320 ct (refer also to Cassedanne, 1989). Cincora, Monte Carmelo, Romaria, Cascalho Rico, Grupiara, Patos, and Estrêla do Sul are other areas that have supplied large diamonds (Wilson, 1982). It was in the area now known as Estrêla do Sul that the Star of the South was found (e.g., Streeter, 1877; Bauer, 1896; Reis, 1959; Balfour, 2000).

*Figure 1. The 128.48 ct Star of the South was originally discovered in Brazil in 1853 and faceted shortly thereafter (in 1856 or 1857). It was the first Brazilian diamond to achieve international acclaim for its size and quality. Photo by Phillipe Hitz.*

For a more thorough discussion of the Brazilian diamond deposits, the authors refer readers to the following reviews: Legrand (1980), Lenzen (1980), Wilson (1982), Cassedanne (1989), and Levinson (1998). Good descriptions and historical aspects of the large diamonds found in Brazil are provided by Reis (1959).

## STAR OF THE SOUTH: KNOWN HISTORY

The Star of the South has earned notoriety for a number of reasons. It was the first Brazilian diamond to become renowned worldwide. In addition, and unlike many historical diamonds, the early history of the Star of the South is well documented. According to Dufrénoy (1856), near the end of July 1853 a slave woman working in alluvial diamond deposits of the Bagagem River in Minas Gerais discovered a diamond that weighed an impressive 52.276 grams or 254 11⁄32 "old" carats (calculated to 261.38 metric carats). The rough measured 42 × 35 × 27mm (Dufrénoy, 1856). As a result of this fortu-

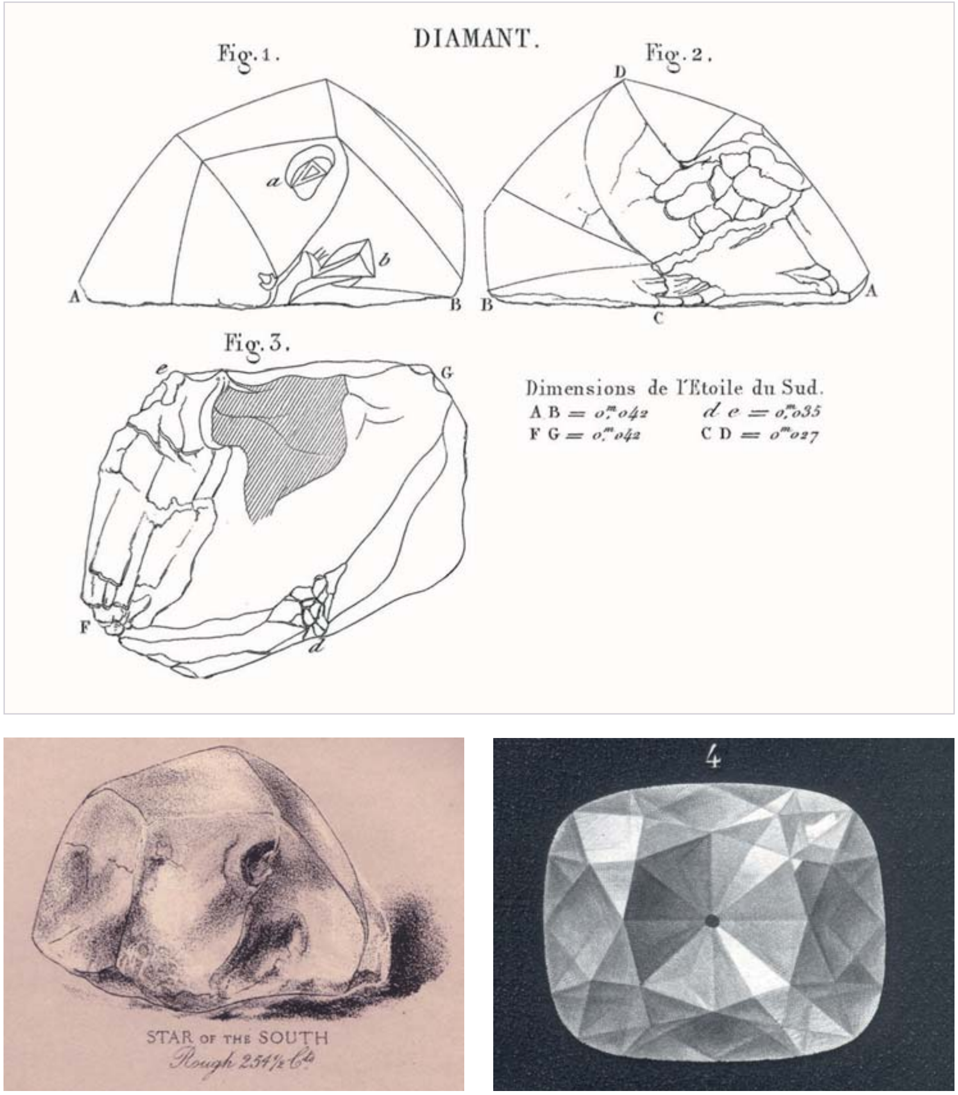



*Figure 2. According to the authors' research, noted French mineralogist A. Dufrénoy provided the only firsthand description of the original crystal from which the Star of the South was cut. (It is unclear if Barbot actually examined the rough.) These three crystal drawings (Figs. 1, 2, and 3—drafted by M. Lemaître, an associate of A. Dufrénoy) represent different views of the crystal, as described in the text. Emanuel (1867) made a more realistic rendering of this crystal seemingly from Dufrénoy's originals. The resulting 128.48 ct cushion-shape faceted stone was illustrated by Simonin (1869).*

itous discovery—and as a reward for turning the stone over to the mine owners—the slave woman was given her freedom and, reportedly, a pension for the remainder of her life (see, e.g., Streeter, 1882). For more than a century, the Star of the South held the distinction as the largest diamond ever found by a woman. In 1967, the Lesotho diamond, weighing an astounding 601.26 ct, was discovered by Ernestine Ramaboa (Balfour, 2000).

Noted French mineralogist A. Dufrénoy, while a professor at the Natural History Museum of Paris, provided a first-hand description of the original crystal from which the Star of the South was fashioned (Dufrénoy, 1856, pp. 93–95). He wrote (as translated by GB; all figure references refer to the three line drawings of the crystal reproduced in figure 2 here):

> One observes on one of the faces of the diamond a rather deep octahedral cavity, situated in *a* (fig. 1, pl. 225); it represents the impression left by a diamond crystal that earlier was implanted on the surface of the Star of the South. The interior of this cavity, examined with a loupe, shows pronounced octahedral striae. One also sees, in *b*, the trace of three other diamonds, which were grouped on the main diamond. The rear face of the Star of the South still bears traces of two diamonds, which have been detached . . . . The kind of base on which one naturally places this diamond, and which we have represented [in] fig. 3, still offers, in *d*, marks of the adherence of several other small diamond crystals. On this side, one notes in *f* a flat part where the cleavage appears. I am very inclined to consider it as a breakage, maybe the point of attachment of this diamond to the matrix; . . . . I have already noted that this beautiful diamond is not symmetrical [refers to figs. 1, 2, and 3]. . . .

Prof. Dufrénoy mistakenly proposed that this diamond grew as part of a larger cluster of diamonds, with this crystal attached to the matrix wall. He suggests that diamonds coated the walls of a geode-like formation, similar to quartz geodes. This explains why he interpreted the cavities and flat area of the crystal as he did. Barbot (1858, pp. 161–162) further described the piece of rough and clarified certain statements made by Dufrénoy:

> . . . the "Étoile du Sud" [Star of the South], was a rhombic dodecahedron, bearing along each of its faces a curved junction [where adjoining faces meet] so that it became a solid of 24 faces. The natural faces were matte and striated. . . . this incomparable diamond exhibited, on one of its faces, a cavity so deep that some have believed it to be due to the implantation of an octahedral crystal of the same nature; we are certain, after further consideration, that this cavity was only an interruption of one of the [crystal] growth layers; the other, shallower cavities were certainly due to the same cause. The flat part that appeared cleaved is probably an accident of nature . . . .
>
> The . . . late Mr. Dufrénoy thought that this diamond had to be part of a group of diamondiferous crystals; in this, he was mistaken: diamonds grow isolated in diverse sections of their matrix, and never agglomerate, or are superimposed, or graft on one another like pyrites and crystals of spar [calcite] and quartz . . . ."

All subsequent mineralogical descriptions and illustrations of this crystal seem to be derived from these two original descriptions and crystal drawings (see, e.g., Kurr, 1859, plate I, figure 5; Emmanuel, 1867; Streeter, 1882; Bauer, 1896; as well as all modern references).

The first owner of the diamond, Casimiro de Tal, sold it shortly after its discovery for a reported £3,000, apparently well below its international market value (Streeter, 1882). In the two years that followed, the diamond remained in its rough state and was again sold, this time for £35,000 (Streeter, 1882). In 1855, the rough diamond was showcased at the Paris Industrial Exhibition (Kurr, 1859). At that time, it was owned by Messrs. Halfen (two brothers who were diamond dealers in Paris) and christened Star of the South (Dufrénoy, 1856). Barbot (1858) stated that the Halfen brothers chose this name. In 1856 or 1857, the diamond was taken to Amsterdam, where it was cut by a Mr. Voorzanger of the firm Coster. We are able to establish this date of cutting because Dufrénoy (1856) reports that the diamond was still in the rough state when he examined it after the 1855 Paris Exhibition, whereas Barbot (1858) indicates that he examined the faceted diamond.

The fashioning of the diamond took three months; the cut stone was illustrated by Simonin (1869; again, see figure 2). Barbot (1858, p. 162) described the cut gem as follows: "Its oval form is rather charming and permits it to refract light well. It is, by the way, a very spread stone, for it is 35 millimeters long by 29 millimeters wide, but only 19 millimeters thick." Various weights and descriptions have been given for the cut stone: Streeter (1882) describes it as an "elegant oval" of 125 "old" carats. In more modern references, some (e.g., Balfour, 2000) describe it as a 129 ct elongated cushion, whereas others (e.g., *Notable Diamonds of the World*, 1990; Liddicoat, 1993) refer to it as a 128.80 ct oval brilliant. Shipley (1935) gives a weight of 128.5 ct. Its color was described in early publications as having a "rather pronounced pink tint" (Barbot, 1858, p. 162) or "decided rose tint" (Streeter, 1882, p. 81), as well as "not perfectly white and pure" (Emanuel, 1867, p. 85). No modern first-hand observations of the faceted diamond's color were found. All contemporary publications seem merely to be repeating these comments.

Subsequently, the small town of Bagagem, near the place where the diamond was discovered in the Bagagem River, was renamed Estrêla do Sul (in Portuguese) in honor of the large gem (see, e.g., Balfour, 2000). According to Simonin (1869), a replica of the faceted diamond along with replicas of several other famous diamonds was put on display during the 1862 London Exhibition and the 1867 Paris World Exhibition. However, most modern references state incorrectly that the actual diamond was put on display (see, e.g., Bruton, 1978; Liddicoat, 1993; Balfour, 2000).

According to Balfour (2000), during the 1860s the Star of the South ranked as the sixth largest faceted diamond in the world. Sometime between 1867 and 1870, Khande Rao, then Gaekwar (official sovereign ruler) of the Indian kingdom of Baroda, purchased the stone for a reported £80,000 (approximately $400,000; Shipley, 1935; Balfour, 2000). Prior and Adamson (2000) incorrectly state that the diamond was acquired in 1865. This was not possible, since the diamond was only offered for sale to the Gaekwar of Baroda after the 1867 exhibition (Streeter, 1882). The diamond remained in the collection of the Gaekwars of Baroda for at least 80 years. In 1934, the grand nephew of Khande Rao, Sayaji Rao III Gaekwar of Baroda, informed Robert M. Shipley (founder of the Gemological Institute of America) that the Star of the South had been set in a necklace along with the English Dresden diamond (figure 3; "Owner of famous jewels. . . ," 1934; Shipley, 1935; Prior and

Figure 3. Khande Rao, Gaekwar of Baroda, had this fabulous necklace created to display both the Star of the South and the 78.5 ct English Dresden below it. The date of this photograph is approximately 1880. Photo courtesy of the British Library, Oriental and India Office.

Adamson, 2000). Also from the Bagagem River, the English Dresden ($119^1/_2$ ct in the rough, cut as a 78.53 ct pear shape; see, e.g., Balfour, 2000) had been found in 1857, not far from the discovery site for the Star of the South.

The English Dresden reportedly was sold by the rulers of Baroda to Cursetjee Fardoonji of Bombay, India in 1934 (Balfour, 2000), and Bruton (1978) reported that the Star of the South also came into the possession of Rustomjee Jamsetjee sometime around 1939. However, this latter claim is not correct. It is now known that the original necklace containing both the Star of the South and the English Dresden was still intact and in the possession of Sita Devi, Maharani of Baroda, as of 1948 (figure 4). The whereabouts of these two diamonds could not be verified after about 1950, and the Star of the South's location for the next 50 years is not clear. In 2001, however, it was purchased through a broker by owners who wish to remain anonymous. In December 2001, the Star of the South was submitted to the Gübelin Gem Lab for a diamond grading report, thus enabling us to assemble the following detailed information.

## ANALYTICAL METHODS

Clarity assessments and the study of internal characteristics such as inclusions and graining were carried out with a binocular microscope and various lighting techniques. We used crossed polarizing filters to observe the internal strain patterns and interference colors. Weight determination was made using a Mettler AE 1000 C electronic scale, calibrat-

Figure 4. In the town of Baroda, India, at the celebration of her husband's birthday in 1948, Sita Devi, Maharani of Baroda, was photographed wearing a slightly modified version of the necklace shown in figure 3, where more diamonds had been added around the bottom portion of the English Dresden. Photo and information by Henri Cartier-Bresson, © Henri Cartier-Bresson/Magnum Photos.

ed to ±0.001 ct. Color observations were made in the neutral viewing environment of a MacBeth Judge II light box. Reaction to long- and short-wave ultraviolet radiation was observed in a darkened room with a dual 365 nm and 254 nm lamp.

We recorded the diamond's ultraviolet-visible-near infrared (UV-Vis-NIR) absorption spectrum at liquid nitrogen temperatures in the region from 200 to 2500 nm using a Perkin Elmer Lambda 19 dual beam spectrometer, equipped with a beam condenser. The spectrum was run at a speed of 1 nm/sec and with a spectral slit width of 0.2 nm.

The near- to mid-infrared spectrum was taken at room temperature in the region 7000–400 $cm^{-1}$, recording 200 scans at the standard 4 $cm^{-1}$ resolution of a Pye-Unicam PU9624 Fourier Transform infrared (FTIR) spectrometer. Both a SpectraTech diffuse reflectance unit and a Specac 5× beam condenser were used.

Raman photoluminescence spectrometry was conducted at liquid nitrogen temperatures with a Renishaw 2000 Raman microspectrometer equipped with a helium/cadmium laser (He/Cd–excitation 324.98 nm) and an argon-ion laser (Ar-ion–excitation 514.5 nm). Five areas were analyzed: two in the center of the table, two on bezel facets on either side of the diamond, and the culet.

## GEMOLOGICAL CHARACTERISTICS

**General Description.** The Star of the South diamond weighs 128.480 ct. Its antique cushion shape has a slightly asymmetric outline. It is faceted in the brilliant-cut style, with eight bezel facets and eight large pavilion mains (again, see figure 1). Its dimensions are: 34.21 × 28.10 × 18.72 mm. The table facet measures 21.10 mm parallel to the length of the stone and 18.80 mm parallel to the width. The octagonal culet facet measures 3.10 and 2.65 mm in the corresponding directions. The total depth percentage is 66.6%. The average percentage for crown height is 15% and for pavilion depth is 52%. The majority of the circumference of the diamond, where the crown meets the pavilion, forms a knife-edge girdle. However, several small girdle facets have been polished, and in some areas a number of extra facets have been placed, primarily around the girdle area.

**Color.** We color graded the Star of the South as Fancy Light pinkish brown. In the face-up position, the color appeared slightly more concentrated at both ends of the diamond, as a result of its shape and cut. Face-down, subtle lamellar bands of a light brown hue could be seen traversing the width of the stone.

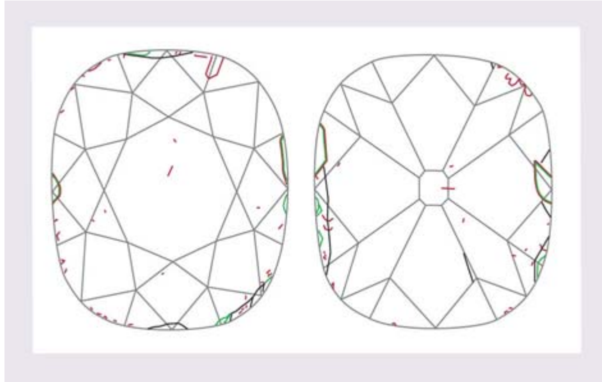


*Figure 5. The Star of the South received a clarity grade of $VS_2$, with inclusions consisting of two indented naturals (one on each side) and a number of shallow chips and small bruises. In addition, a small remnant of a cleavage was present in the table and a pinpoint inclusion can be seen under a bezel facet at one side. Red outside of green = indented naturals, green = naturals, black = extra facets, and red = chips, bruises, cleavage, and pinpoint.*

**Internal Features.** Considering the large size and long history of this diamond, one might expect it to have more inclusions and surface blemishes than it does. The clarity grade of the Star of the South is $VS_2$ (figure 5). The most prominent inclusion features consist of one indented natural on each side of the diamond. The larger of the two indented naturals contained deep triangular depressions, whereas the other displayed a series of parallel striations. Both of these features revealed the orientation of these natural surfaces, along octahedral crystal faces. We also saw several other essentially planar naturals on various areas around the girdle. A pinpoint inclusion in one side of the diamond was visible through either a lower girdle facet or a bezel facet. A small remnant of a cleavage plane was present in the table, as were several small circular feathers in the areas surrounding the naturals. As a result of wear and tear over the years, there were also several, mostly minor, chips around the girdle, as well as numerous other small bruises and tiny feathers on the surface of various other facets. Since the majority of the clarity-affecting inclusions were at or just beneath the surface of the gem, recutting the diamond could improve its clarity to VVS (although the authors strongly recommend against recutting any historic diamond).

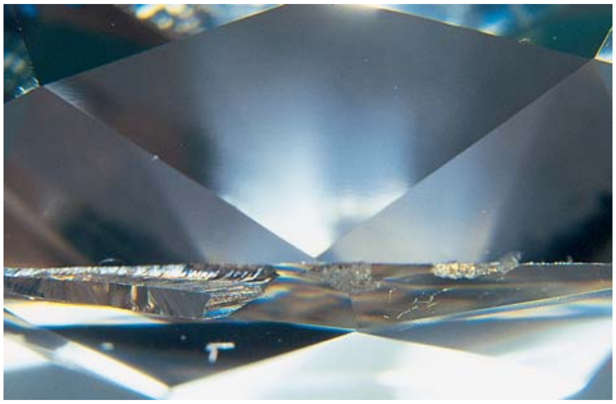


*Figure 6. Whitish graining was evident in certain areas and viewing directions of the Star of the South. This optical effect imparted a sheen-like cast to these areas, as seen here through a bezel facet. Photomicrograph by Christopher P. Smith; magnified 7×.*

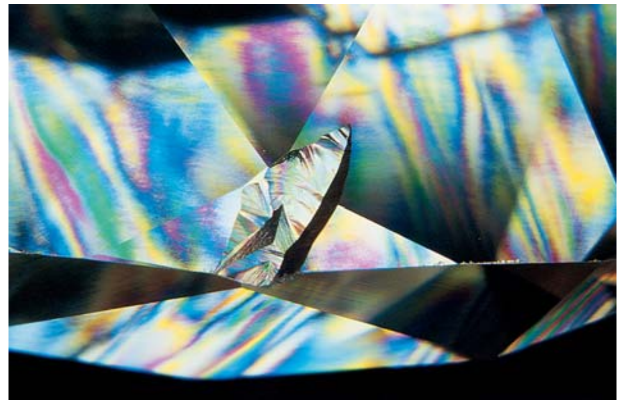


*Figure 7. One distinctive feature of the Star of the South is the prominent irregular strain patterns, which exhibited purple-pink, orange, yellow, green, and blue interference colors. Such strain patterns more typically are associated with type Ia natural-color brown or pink diamonds, although they are encountered in some type IIa diamonds. Also seen here is the larger of two indented naturals. The triangular patterns reveal the octahedral orientation of this remnant of the original crystal surface. Photomicrograph by Christopher P. Smith; magnified 7×.*

**Graining and Strain Patterns.** An optical phenomenon that relates to structural disturbances, described by gemologists as whitish "graining," was visible in specific areas of the gem when viewed at certain angles (figure 6). Internal strain patterns—banded and "tatami," with blue and gray interference colors—also were prominent when the diamond was viewed between crossed polarizing filters. Depending on the crystallographic viewing direction, distinct, irregular or cellular strain patterns with strong interference colors of purple-pink, orange, yellow, green, and blue also were seen (figure 7).

**Fluorescence.** The Star of the South fluoresces a uniformly distributed blue of moderate intensity to long-wave UV radiation (figure 8), and a similar but weaker blue to short-wave UV. No phosphorescence to either long- or short-wave UV was observed.

*Figure 8. A homogeneous blue fluorescence of moderate intensity was emitted by the Star of the South when it was exposed to a long-wave UV lamp. Photo by Franzisca Imfeld and Christopher P. Smith.*

## SPECTROMETRY

**UV-Vis-NIR.** The UV-Vis-NIR absorption spectrum recorded at cryogenic temperature is featureless down to about 600 nm, at which point the absorption starts to increase gradually and becomes steeper until it reaches the fundamental absorption edge at 225 nm in the ultraviolet region (figure 9). Superimposed on this general absorption are five very weak to weak absorption bands in the yellow-green to violet regions: a very weak, broad band centered at approximately 560 nm; a weak, sharp peak at 503.2 nm (H3); a more distinct, sharp peak at 415.2 nm (N3); and two weak, broad bands at 390 and 375 nm. At the foot of the fundamental absorption edge of the diamond, there are two additional small but distinct peaks situated at 236.0 (N9) and 229.5 nm.

**Mid-IR and Near-IR.** The mid-infrared spectrum of the Star of the South diamond reveals the two-phonon and three-phonon absorption bands intrinsic to diamond (2650–1500 and 4000–2650 $cm^{-1}$, respectively; see figure 10). No absorption was apparent in the one-phonon region of the spectrum (1500–1000 $cm^{-1}$). We classified this diamond as a

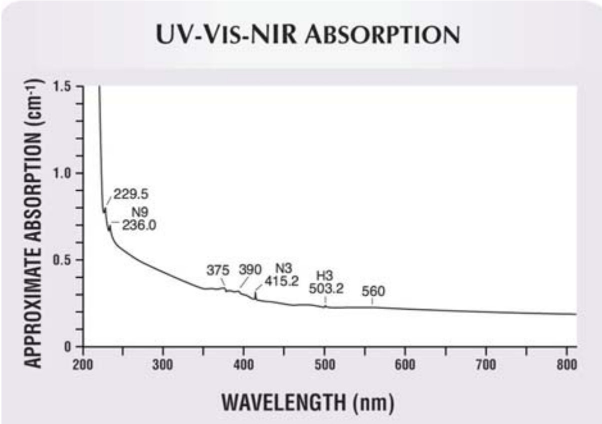
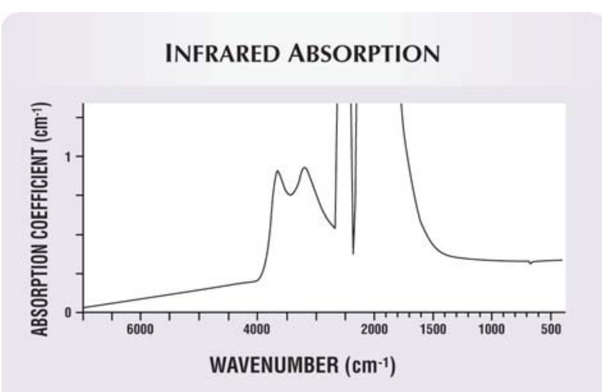



*Figure 9. This representative UV-Vis-NIR absorption spectrum of the Star of the South, recorded at liquid nitrogen temperature and high resolution, displays increasing general absorption starting at approximately 600 nm, which is responsible for the primary brown coloration, as well as a faint broad band at approximately 560 nm, which causes the pinkish color modifier. Other characteristics are peaks at 229.5, 236.0 (N9), and 415.2 (N3) nm, a very weak peak at 503.2 (H3) nm, and weak, broad bands centered at approximately 375 and 390 nm.*

type IIa as a result of the relative absence of IR features in the one-phonon region of the infrared spectrum. However, by expanding the spectrum in this region, a minute, broad absorption band was observed, located at 1174 $cm^{-1}$, which relates to minute traces of nitrogen in the form of B-aggregates. Therefore, we further qualified this diamond as a *nominal* type IIa. No other traces of nitrogen, or of hydrogen or boron, were detected in the infrared region.

*Figure 10. The FTIR absorption spectrum of the Star of the South reveals the two- and three-phonon absorption bands, which are intrinsic to diamond (i.e., at 2650–1500 and 4000–2650 $cm^{-1}$, respectively), but no distinct absorption features related to nitrogen impurities. Hydrogen or boron impurities were not detected either.*




**Raman Photoluminescence.** Overall, the spectra recorded on various facets of the diamond did not reveal significant variations (table 1).

*He/Cd laser (325 nm).* Two dominant photoluminescence systems were apparent (figure 11A): the 415.2 nm (N3), with a series of broad and progressively weaker bands between 420 and 480 nm; and the 503.1 nm (H3), also with a series of broad and progressively weaker bands between 510 and 530 nm. A weak, sharp band located at 437.9 nm was superimposed on a phonon replica of the N3 system. In addition to

**TABLE 1.** Raman photoluminescence of the Star of the South diamond recorded at cryogenic temperatures.[a]

| Band (nm) | Band allocation | Description |
|---|---|---|
| **He/Cd laser, 325 nm excitation** | | |
| 350 | | Faint, broad |
| 380 | | Weak, broad |
| 406.0 | | Faint, sharp |
| 415.2 | N3 | Strong, sharp |
| 437.9 | | Weak, sharp |
| 503.1 | H3 | Moderate, sharp |
| 535.9 | | Weak, sharp |
| 537.4 | | Weak, sharp |
| 574.8 | $(N\text{-}V)^0$ | Faint, sharp |
| 575.8 | | Weak, sharp |
| **Ar-ion laser, 514.5 nm excitation[b]** | | |
| 535.9 | | Moderate-strong, sharp |
| 564.3 | | Faint, sharp |
| 565.8 | | Faint, sharp |
| 566.1 | | Weak, sharp |
| 566.5 | | Weak, sharp |
| 567.5 | | Weak, sharp |
| 569.2 | | Weak, sharp |
| 570.4 | | Faint, sharp |
| 574.8 | $(N\text{-}V)^0$ | Moderate-strong, sharp |
| 575.8 | | Moderate-strong, sharp |
| 600–620 | | Weak, broad |
| 630.5 | | Weak, sharp |
| 637.0 | $(N\text{-}V)^-$ | Moderate-strong, sharp |

[a]*For an explanation of the N3, H3, $(N\text{-}V)^0$, and $(N\text{-}V)^-$ defects, see box A of Smith et al. (2000).*
[b]*Depending on the facet analyzed, the following peak ratios and FWHM (full width at half maximum) values were obtained:*
*575.8/574.8 nm peak ratio = 0.64 to 2.89*
*574.8/637.0 nm peak ratio = 0.92 to 2.88*
*574.8 nm peak FWHM = 0.37 to 0.58 nm*
*575.8 nm peak FWHM = 0.21 to 0.29 nm*
*637.0 nm peak FWHM = 0.47 to 0.56 nm.*

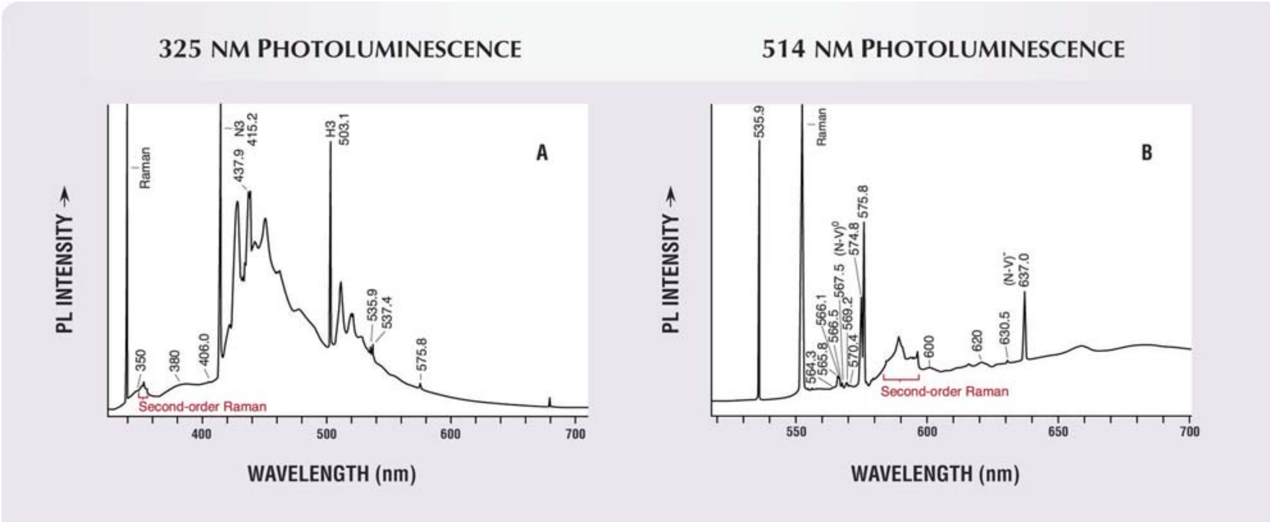



*Figure 11. Raman photoluminescence spectra of the Star of the South were taken at liquid nitrogen temperature for significantly improved sensitivity and spectral resolution. Spectrum A, taken with the helium/cadmium laser (325 nm excitation), shows two dominant photoluminescence systems, resulting from N3 and H3 defects, in addition to several other peaks that were also present. Spectrum B, taken with an argon-ion laser (514 nm excitation), recorded strong PL bands at 535.9, 574.8 (N-V)$^0$, 575.8, and 637.0 (N-V)$^-$ nm. Another series of weak to moderate PL bands were resolved between 564 and 571 nm.*

these, several other more subordinate PL spectral features were present (see figure 11A and table 1).

*Ar-ion laser (514 nm).* With this excitation, several additional PL features above 530 nm were recorded (figure 11B). The 535.9 nm peak and two closely spaced, but unrelated PL bands at 574.8 (N-V)$^0$ and 575.8 nm were the most dominant spectral features present with this laser. The ratio of the 575.8 nm to the 574.8 nm (N-V)$^0$ peaks was variable for the five measurements taken on different facets. The (N-V)$^-$ center at 637.0 nm was present in all the spectra. In all but one of the spectra, the intensity of the (N-V)$^-$ was weaker than the (N-V)$^0$ (also refer to Chalain et al., 2000; Fisher and Spits, 2000; Smith et al., 2000). The full width at half maximum (FWHM) of the (N-V)$^-$, (N-V)$^0$, and 575.8 nm peaks was also variable. Several other weaker PL bands were also recorded (see figure 11B and table 1).

## DISCUSSION

When diamonds were discovered during the 1860s in South Africa, these hugely prolific finds signaled the inevitable end to the Brazilian Era and Brazil's status as the world's primary source of gem-quality diamonds. Although today several countries surpass Brazil in the quantity and value of diamonds mined, Brazil still produces an annual average of approximately 1 million carats, which includes occasional pieces of rough that yield large, high-quality faceted diamonds.

A number of discrepancies were discovered during our search for historical references to the Star of the South diamond, notably the weights indicated for both the rough gem and the faceted stone. The discrepancies in the weight of the original rough are easier to explain, in that it has been reported as either $254\frac{11}{42}$ or just 254 "old" carats, or as 261.24 to 261.88 when converted to metric carats. In part, this is due to differences in "old" carats before this unit of measurement was standardized in 1914 as 0.2 gram (Liddicoat [1993, p. 275] provides a list for local variances for "old" carats from different trading areas.) However, if previous researchers had accessed Dufrénoy (1856, p. 93), they would have seen the accurate weight in grams (52.276), which he calculated to $254\frac{11}{42}$ "old" carats. The conversion to modern metric carats would have been straightforward (261.38 ct). For the faceted gem, Streeter (1882) indicates a weight of 125 "old" carats and Bauer (1896) gives the weight as $125\frac{11}{42}$ "old" carats; however, most modern references indicate 128.80 metric carats (the 128.8[0] ct figure appears to be a calculated weight, as opposed to one that was measured). It is interesting that Shipley (1935) came closest to the actual weight when he stated 128.5 ct. Considering the measurements indicated by Barbot (1858) compared to those taken for this study, as well as the "antique" quality of the polish and the weight indicated by Shipley (1935), there is no evidence to suggest that the diamond has been repolished. The description of the diamond as an oval by some and a cushion shape by others is understand-able, since gemstones with this general shape commonly have an outline that is intermediate between an oval and a cushion.

Other discrepancies were encountered in regard to the name "Star of the South." For both the English and Portuguese derivations, we found more than one diamond with this name (see, e.g,. Reis, 1959; Liddicoat, 1993; Balfour, 2000). In English, the other Star of the South is a 14.37 ct kite shape that was purchased in 1928 by Evalyn Walsh McLean (who at the time also owned the Hope diamond) and sold by her estate to Harry Winston (Krashes, 1984). In Portuguese, a 179.36 ct rough diamond found during 1910 or 1911, also in the Bagagem River, was called Estrêla do Sul or Estrêla do Minas, but nothing is known of its ultimate disposition (Reis, 1959). A 140 ct green piece of rough discovered in Minas Gerais in 1937 was christened "New Star of the South" (Cassedanne, 1989); again, though, nothing is known about the current location of this diamond (Reis, 1959). It is not uncommon to encounter such potentially confusing information when attempting to trace the history of famous gems. However, the provenance of the present diamond as the original "Star of the South" is well established.

Diamonds are classified as type IIa based on the relative absence of nitrogen-related features in the infrared region of the spectrum (1500–1000 $cm^{-1}$) when recorded at room temperature (for a general discussion of diamond type, see, e.g., Fritsch and Scarratt, 1992, pp. 38–39). However, it is not uncommon for such diamonds to reveal minute traces of nitrogen-related (and even hydrogen-related) absorption in the ultraviolet and visible regions when the spectrum is taken at liquid nitrogen temperature with a high-quality UV-Vis-NIR or Raman spectrometer (see, e.g., Fisher and Spits, 2000; Smith et al., 2000). The spectral analyses of the Star of the South identified that it is such a nominal type IIa diamond. It revealed traces of nitrogen-related point defects in very low concentrations when analyzed at cryogenic temperatures with UV-Vis-NIR and Raman. These included very weak to weak absorption bands of H3, N3, and N9 recorded in the UV-visible range, as well as very weak to strong photoluminescence excitation of the $(N\text{-}V)^-$, $(N\text{-}V)^0$ , H3, and N3 systems with a Raman spectrometer. In addition, we recorded several other PL bands that we are unable to assign to specific point defects in diamond.

As a nominal type IIa, most of the properties and characteristics of the Star of the South were consistent with those of other type IIa diamonds of similar color. This includes its large size and the relative lack of inclusions, the banded and tatami strain patterns, and the essentially featureless spectral trace throughout most of the visible and near-infrared region of the spectrum, as well as the gradual absorption leading to the fundamental absorption edge of diamond at 225 nm, and the He/Cd and Ar-ion Raman PL spectral features. One rather less common trait was the strong irregular or cellular strain pattern with distinct purple-pink, orange, yellow, green, and blue interference colors. This type of strain pattern is observed more often in type Ia pink or brown diamonds. However, the authors have noted similar strain on occasion in other brown to colorless type IIa diamonds. Also, the blue UV fluorescence seen in the Star of the South is more intense than the faint to weak blue luminescence evident in some type IIa diamonds (others typically are inert or have a weak yellow—or, rarely, distinct orange—reaction). In addition, the pinkish brown color is not a common hue in the family of brown type IIa diamonds.

The primary brown coloration of the Star of the South is due to the increase in general absorption that begins at about 600 nm and continues into the ultraviolet region of the spectrum, whereas the weak, broad band centered at approximately 560 nm is responsible for the pink modifying color.

Brown type IIa diamonds have received a lot of attention recently because it is now known that the color of such diamonds may be modified using high-pressure/high-temperature annealing (for a review, see Smith et al., 2000). Recording spectral data on diamonds with a known history that confirms the natural, unaltered origin of their color is crucial for building a database of natural-color diamonds against which diamonds of a questionable origin of color can be compared. This helps better establish identification criteria for both natural- and treated-color type IIa diamonds.

## CONCLUDING REMARKS

The 128.48 ct Fancy Light pinkish brown Star of the South now enters an elite circle of historic diamonds for which a full gemological characterization has been published. Other diamonds in this group include the Hope (Crowningshield, 1989), the Dresden Green (Bosshart, 1989; Kane et al., 1990), and the Tavernier (Lu et al., 1998). We identified the earliest references to this 149-year-old diamond in both its rough and cut forms, which clarified several details of its early history, and provided significant new information about its more-recent history. In addition, we were able to characterize this diamond with advanced analytical techniques, such as Raman photoluminescence using He/Cd and Ar-ion lasers, which were not routinely available to those other researchers. The spectral data obtained on this historic diamond will help future researchers better understand the properties of—and establish identification criteria for—natural-color type IIa diamonds.

*ABOUT THE AUTHORS*

*Mr. Smith (cpsggl2@hotmail.com) is managing director, and Mr. Bosshart is chief gemologist, at the Gübelin Gem Lab in Lucerne, Switzerland.*

*Acknowledgments: The authors thank ESG Jewels of Geneva, Switzerland (Emmanuel and Sophie Guillaume), for submitting the Star of the South diamond to the Gübelin Gem Lab, thus providing the opportunity to perform the analysis, and for permission to publish our results. They are also grateful to Rose Tozer of GIA's Richard T. Liddicoat library for her post-deadline efforts to collect additional original references. Thomas Gübelin, president of Gübelin AG, Lucerne, is thanked for his continued financial support. The authors are pleased to be able to make a contribution describing a diamond of historical significance for an issue that is dedicated to a man whose significance to the history and development of gemology is unquestionable.*

## REFERENCES

Balfour I. (2000) *Famous Diamonds*, 4th ed. Christies, Manson & Woods Ltd., England, 320 pp.

Barbot M.C. (1858) *Guide Pratique du Joaillier ou Traité Complet des Pierres Precieuses*. Nouvelle Éd., J. Hetzel et Cie, Paris.

Bauer M. (1896) *Edelsteinkunde*, 1st ed. Chr. Tauchnitz, Leipzig.

Bosshart G. (1989) The Dresden Green. *Journal of Gemmology*, Vol. 21, No. 6, pp. 351–362.

Bruton E. (1978) *Diamonds*, 2nd ed. N.A.G. Press Ltd., London, England.

Cassedanne J.P. (1989) Diamonds in Brazil. *Mineralogical Record*, Vol. 20, pp. 325–336.

Chalain J.-P., Fritsch E., Hänni H.A. (2000) Detection of GE POL diamonds: A second step. *Journal of Gemmology*, Vol. 27, No. 2, pp. 73–78.

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

Dufrénoy A. (1856) *Traité de Minéralogie*, 2nd and 5th Vols., 2nd ed. Victor Dalmont, Paris.

Emanuel H. (1867) *Diamonds and Precious Stones.* John Camden Hotten, London.

Fisher D., Spits R.A. (2000) Spectroscopic evidence of GE POL HPHT-treated natural type IIa diamonds. *Gems & Gemology*, Vol. 36, No. 1, pp. 42–49.

Fritsch E., Scarratt K. (1992) Natural-color nonconductive gray-to-blue diamonds. *Gems & Gemology*, Vol. 28, No, 1, pp. 35–42.

Kane R.E., McClure S.F., Menzhausen J. (1990) The legendary Dresden Green diamond. *Gems & Gemology*, Vol. 26, No. 4, pp. 248–266.

Krashes L. (1984) *Harry Winston: The Ultimate Jeweler.* Harry Winston Inc., New York.

Kurr J.G. (1859) *The Mineral Kingdom.* Edmonston & Douglas, Edinburgh.

Legrand J. (1980) Brazil. In R. Maillard, Ed., *Diamonds—Myth, Magic and Reality*. Smeets Offset, Weert, Netherlands, pp. 172–178.

Lenzen G. (1980) Southern Africa and the birth of a great industry. In R. Maillard, Ed., *Diamonds—Myth, Magic and Reality*, Smeets Offset, Weert, Netherlands, pp. 66–84.

Levinson A.A. (1998) Diamond sources and their discovery. In G. Harlow, Ed., *The Nature of Diamonds*. Cambridge University Press, New York, pp. 75–77.

Liddicoat R.T., Ed. (1993) *The GIA Diamond Dictionary*, 3rd ed. Gemological Institute of America, Santa Monica, CA.

Lu T., Liu Y., Shigley J., Moses T., Reinitz I.M. (1998) Characterization of a notable historic gem diamond showing the alexandrite effect. *Journal of Crystal Growth*, Vol. 193, pp. 577–584.

*Notable Diamonds of the World* (1990) Diamond Promotion Service.

Owner of famous jewels visits America (1934) *Gems & Gemology*, Vol. 1, No. 1, p. 7.

Prior K., Adamson J. (2000) *Bijoux de Maharadjas*, Assouline, Paris, France. [English edition © 2000, *Maharajas' Jewels*, The Vendome Press, New York.]

Reis E. (1959) *Os Grandes Diamantes Brasileiros.* DNPM-DGM, Boletim No. 191, Rio de Janeiro, 65 pp.

Simonin L. (1869) *Les Pierres, Esquisses Minéralogiques.* Librairie de L. Hachette et Cie., Paris, 516 pp.

Shipley R.M. (1935) The Star of the South diamond. *Gems & Gemology*, Vol. 1, No. 8, pp. 220–222.

Smith C.P., Bosshart G., Ponahlo J., Hammer V.M.F., Klapper H., Schmetzer K. (2000) GE POL diamonds: Before and after. *Gems & Gemology*, Vol. 36, No. 3, pp. 192–215.

Streeter E.W. (1877) *Precious Stones and Gems.* Chapman & Hall, Piccadilly, London.

Streeter E.W. (1882) *The Great Diamonds of the World: Their History and Romance*, 1st ed. George Bell & Sons, London.

Wilson A.N. (1982) *Diamonds, from Birth to Eternity.* Gemological Institute of America, Santa Monica, CA, 450 pp.