The 812-Carat Pure Type IaB Constellation Diamond from Karowe – Part of an Even Larger Rough?

Ulrika F.S. D'Haenens-Johansson, Evan M. Smith, Karen V. Smit, Wuyi Wang, Thomas M. Moses

Gemological Institute of America, New York City, NY, USA,
ujohansson@gia.edu, evan.smith@gia.edu, ksmit@gia.edu, wwang@gia.edu, tmoses@gia.edu

Introduction

Lucara Diamond extracted an 812-carat colorless diamond from the AK6 pipe at Karowe mine (Botswana) in November 2015. Named "The Constellation," it is recognized as the sixth-largest gem-quality rough diamond ever discovered. The Constellation attained the highest price for a rough diamond to date, selling in May 2016 to Dubai-based Nemesis International DMCC for $63.1 million ($77,649 per carat) (Graff 2016). Interestingly, several very large diamonds were recovered at Karowe within the same week. This group includes the second-largest gem-quality rough diamond ever found, the 1,109-carat colorless Lesedi La Rona, as well as other colorless diamonds weighing 374, 296, and 183 carats (Lucara Diamond 2016; Graff 2016; Shor 2016). The Constellation and the 296-carat and 183-carat diamonds were investigated at GIA using a combination of gemological and spectroscopic techniques to analyze the diamonds' point defect content. Evidence will be presented demonstrating that these diamonds are not unrelated, but stem from a single rough diamond that was shattered into multiple pieces.

Sample and Experimental Details

The Constellation and the 296-carat and 183-carat rough diamonds were separately submitted to our laboratory for scientific examination in 2016, prior to any cutting or polishing (see Figure 1). Their external morphologies and internal features were studied under magnification using Gem Instruments and Nikon SMZ1500 binocular microscopes using dark field and fiber optic illumination.

The diamonds' fluorescence behavior to ultraviolet (UV) illumination was tested using a combination gem lamp (365 nm and 254 nm emission) commonly used by the diamond industry. UV fluorescence imaging is a useful tool to reveal growth zones, which typically contain different concentrations of impurities reflecting growth fluid changes. A DiamondView fluorescence instrument (< 230 nm) was used to image portions of the 183-carat and 296-carat stones – the large sizes restricted the possible viewing orientations in the chamber. The Constellation was imaged using a GIA-built system under illumination from a deuterium lamp (185 – 400 nm).

Figure 1: (a) The 812-carat Constellation (812.77 ct, 64 × 39 × 34 mm), the (b) 296-carat (183.41 ct, 38 × 23 × 23 mm), and (c) 183-carat diamonds originating from Karowe. Both (b) and (c) show ink markings in preparation for cutting. Photographs by Jiaxin (Jae) Liao.

Impurity concentrations were analyzed using room temperature Fourier Transform Infrared (FTIR) spectroscopy (Thermo Nicolet Nexus 6700 spectrometer) and photoluminescence (PL) at 77 K using a range of excitation sources (Renishaw confocal microspectrometer with laser excitation wavelengths of 488.0, 514.5, 632.5, and 830.0 nm).

Results and Discussion

Diamonds are commonly classified according to their nitrogen content measured by FTIR spectroscopy: Type I diamonds contain nitrogen in either isolated (Ib) or aggregated (IaAB) forms, while Type II diamonds do not contain detectable nitrogen concentrations (IIa), but may contain boron (IIb). Over the past five years at GIA, however, spectroscopic analyses of thousands of Type IaB, IIa, and IIb colorless diamonds have revealed trends that demonstrate that a defect content transition can often be detected between diamond types, rather than being clearly separate groups, with Type IIb and pure IaB bracketing Type IIa diamonds. Based on inclusions, many Type IIa as well as some IaB diamonds originate from the sublithospheric mantle, in association with metallic liquid (Smith et al. 2016). Inclusions also indicate a "superdeep," sublithospheric mantle origin for Type IIb diamonds (Smith and Wang, 11IKC-4502).

All three diamonds in this study are pure Type IaB, containing 20 ± 4 ppm B-centers (N_4V). The diamonds studied here are notable for being the largest pure Type IaB samples reported, whereas large colorless diamonds are often highlighted as Type IIa. To emphasize the rarity of Type IaB diamonds, we analyzed 5,060 colorless to faintly colored (D–Z) faceted diamonds weighing between 10.0 and 228.3 carats that were submitted for grading services at GIA. As expected, the most common diamond type was Type IaAB (73.8%). However, only 1.2% of diamonds were pure Type IaB, significantly rarer than Type IIa diamonds (24.6%).

PL spectroscopy detected emission from H4 (496 nm, thought to be N_4V_2), H3 (503.2 nm, NVN^0) and GR1 (741 nm, V^0) centers, consistent with natural Type IaB diamonds. Remarkably similar peak characteristics were observed among the suite, with comparable peak intensities and full-width half-maxima (FWHM), as shown in Figure 2. Typically natural diamonds show highly variable PL peak characteristics and combinations, such that the distinctively similar FTIR and PL results in these three diamonds provide compelling evidence that they were once part of a single diamond.

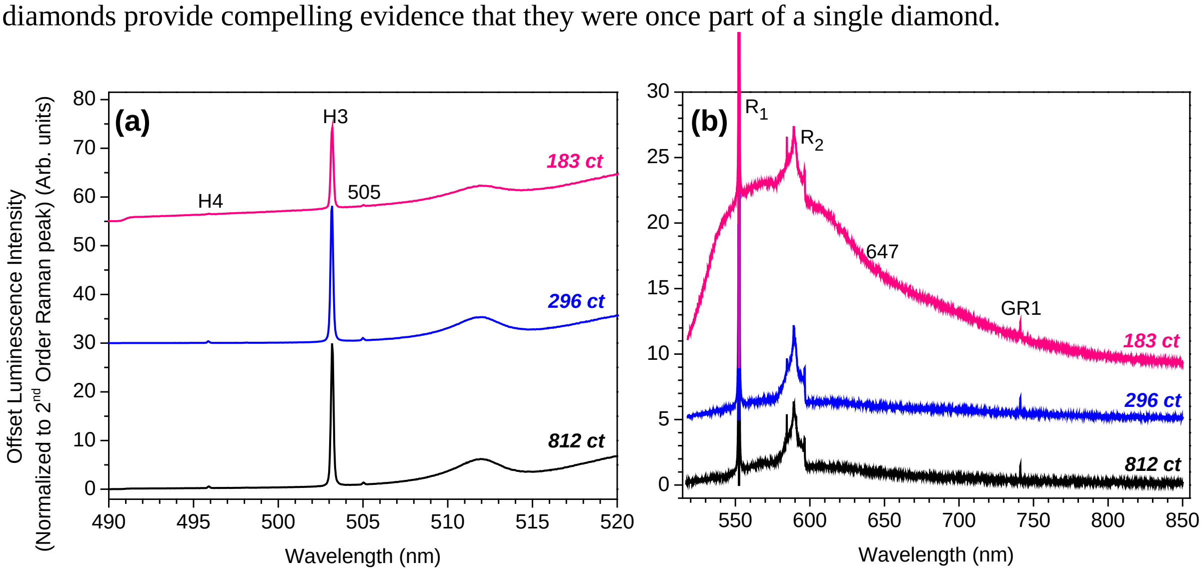

Figure 2: PL spectra collected at 77 K using (a) 488.0 nm and (b) 514.2 nm laser excitations. Data have been normalized to the corresponding 2nd-order diamond Raman peaks and offset for clarity. Spectra indicate low concentrations of luminescent defects, compared to the majority of diamonds investigated by GIA. Consistent emission from H4 (496 nm), H3 (503.2 nm) and GR1 (741 nm) centers were detected for all three diamonds. PL spectra obtained using 632.5 nm and 830.0 nm lasers (not shown) did not reveal any additional defect centers. In (b) R_1 and R_2 indicate the 1st- and 2nd-order Raman peaks. FWHM for the H3 and GR1 emission peaks were calculated for each data set, and were found to be 0.181 ± 0.006 nm and 0.36 ± 0.02 nm, respectively.

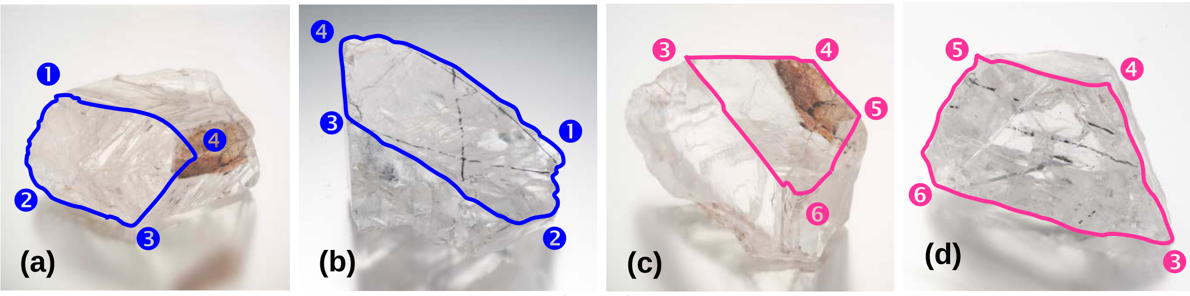

Figure 3: Images illustrating the common cleavage faces for (a, c) The Constellation and the (b) 296-carat and (c) 183-carat diamonds, with corners numbered to facilitate orientation. Outlines for the matching fractured surfaces are color-coded, with blue lines used for The Constellation and the 296-carat diamonds (a–b), and pink used for The Constellation and the 183-carat diamonds (c–d). The edge spanning labels 3 and 4 is common to all three stones. Photographs by Jiaxin (Jae) Liao.

The diamonds showed identical responses when exposed to the gem lamp: weak blue fluorescence, followed by weak blue phosphorescence to short-wave UV, and medium blue fluorescence to long-wave UV. Fluorescence imaging revealed that each sample contained at least two distinct growth zones.

The external morphologies of the stones showed primary octahedral, resorbed, and fractured faces, with both The Constellation and 296-carat diamonds featuring distinct fractures containing metallic inclusions and secondary iron-oxide staining. Minor iron-oxide staining was also observed in the 183-carat stone. The specimens were generally inclusion-free, with only a few small black or reddish-orange inclusions spanning 200–500 μm in size being observed close to fractured surfaces. Detailed inspection of their surfaces revealed shared cleavage planes between The Constellation and the 296-carat and 183-carat stones. Outlines for the matching fractured surfaces are highlighted in Figure 3. Significantly, the iron-oxide stained fractures in The Constellation and the 296-carat diamonds converge to a paired corner (labeled 4). Furthermore, the intrinsic growth structures revealed by UV-fluorescence for these specific surfaces were consistent for the two diamonds. The visual observations further support the conclusion that these three specimens originate from the same rough, which may have broken either during kimberlite eruption or mining processes.

With a combined weight of 1,291 carats, the composite of the studied diamonds would have surpassed the Lesedi La Rona. In fact, due to the similar visual characteristics and extraction dates, it is possible that all five large Karowe diamonds originated from the same rough, 2774 carats combined, although this cannot be confirmed without further inspection. Nevertheless, even without considering the unexamined Lesedi La Rona and 374-carat diamonds, this report shows how multi-technique analyses of point defects and their distributions can link multiple rough diamonds comprising a single diamond of remarkable historic and scientific significance.

References

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