The Journal of
Gemmology

Volume 36 / No. 6 / 2019

History of the Hornby and Nur al-'Ayn Pink Diamonds

Diamond Mining in Namibia

Vanadium-bearing Tourmaline from Tanzania

15th-Century Polishing Machine for Gemstones

The Journal of
Gemmology

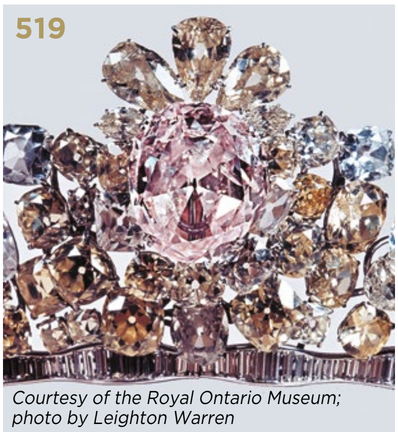
Volume 36 / No. 6 / 2019

Cover photo: *Namibian diamonds are renowned for being of high gem quality, and an article on pp. 524–532 of this issue uncovers the geology, mining and exploration of onshore and nearshore deposits lying on the south-western Namibian coast. The largest stone shown here is a yellow octahedron weighing 58.42 ct that was mined in 2011. Photo courtesy of De Beers.*

COLUMNS

Photo by B. M. Laurs

ARTICLES



Courtesy of the Royal Ontario Museum; photo by Leighton Warren

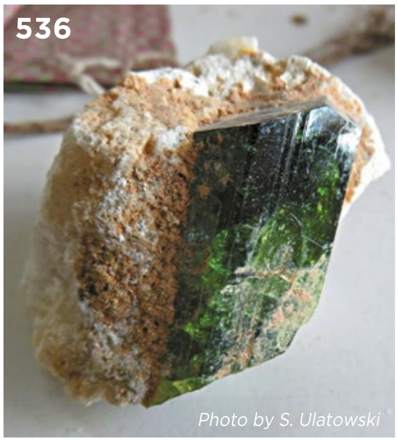


Photo by S. Ulatowski

The Journal is published by Gem-A in collaboration with SSEF and with the support of AGL.

Gem-A THE GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

SSEF SCHWEIZERISCHES GEMMOLOGISCHES INSTITUT SWISS GEMMOLOGICAL INSTITUTE INSTITUT SUISSE DE GEMMOLOGIE

AGL AMERICAN GEMOLOGICAL LABORATORIES

ISSN 1355-4565 (Print), ISSN 2632-1718 (Online), http://doi.org/10.15506/JoG.2019.36.6

The Journal of Gemmology

CONTENT SUBMISSION
The Editor-in-Chief is glad to consider original articles, news items, conference/excursion reports, announcements and calendar entries on subjects of gemmological interest for publication in *The Journal of Gemmology*. A guide to the various sections and the preparation of manuscripts is given at https://gem-a.com/index.php/news-publications/journal-of-gemmology/submissions, or contact the Editor-in-Chief.

SUBSCRIPTIONS
Gem-A members receive *The Journal* as part of their membership package, full details of which are given at https://gem-a.com/membership. Laboratories, libraries, museums and similar institutions may become direct subscribers to *The Journal*.

ADVERTISING
Enquiries about advertising in *The Journal* should be directed to advertising@gem-a.com.
For more information, see https://gem-a.com/news-publications/media-pack-2019.

DATABASE COVERAGE
The Journal of Gemmology is covered by the following abstracting and indexing services: Australian Research Council academic journal list, British Library Document Supply Service, Chemical Abstracts (CA Plus), Copyright Clearance Center's RightFind application, CrossRef, EBSCO Academic Search Ultimate, Gale/Cengage Learning Academic OneFile, GeoRef, Index Copernicus ICI Journals Master List, Mineralogical Abstracts, Cambridge Scientific Abstracts (ProQuest), Scopus and the Clarivate Analytics (formerly Thomson Reuters/ISI) Emerging Sources Citation Index (in the Web of Science).

COPYRIGHT AND REPRINT PERMISSION
For full details of copyright and reprint permission contact the Editor-in-Chief. *The Journal of Gemmology* is published quarterly by Gem-A, The Gemmological Association of Great Britain. Any opinions expressed in *The Journal* are understood to be the views of the contributors and not necessarily of the publisher.

Design & production by Zest Design, www.zest-uk.com

Printed by DG3 Group (Holdings) Ltd

ISSN 1355-4565 (Print), ISSN 2632-1718 (Online)

FSC
Mixed Sources
Product group from well-managed forests and other controlled sources
www.fsc.org Cert no. TT-COC-002454
© 1996 Forest Stewardship Council

Gem-A
THE GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

21 Ely Place
London EC1N 6TD
UK

t: +44 (0)20 7404 3334
f: +44 (0)20 7404 8843
e: information@gem-a.com
w: https://gem-a.com

Registered Charity No. 1109555
A company limited by guarantee and registered in England No. 1945780
Registered office: Palladium House, 1–4 Argyll Street, London W1F 7LD

What's New

INSTRUMENTATION

B2B MiNi 5.0 360° Photography System

Version 5.0 of the Vision360 B2B MiNi diamond photography system was released at the June 2019 JCK show in Las Vegas, Nevada, USA. This update improves on the 360° video imaging by adding brilliance, fire and scintillation characteristics. It also provides darkfield and fluorescence imaging following guidelines from 'global diamond certification authorities'. Visit https://v360.in/b2bmini_5.aspx for more information, sample images and a promotional video.

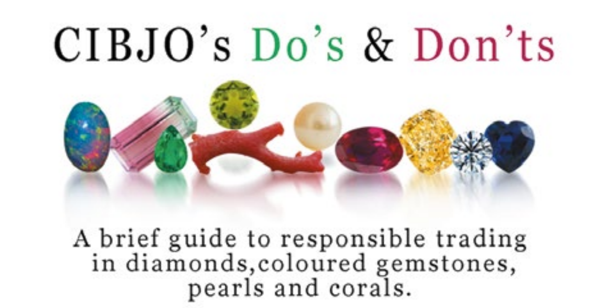
DRC Techno's New Diamond-Detection Instruments

In May 2019, DRC Techno announced the release of two new instruments—J-Detect 9000 and J-Mini—as well as an update of its J-Smart instrument (see What's New section, Vol. 36, No. 4, 2018, p. 275), called J-Smart Pro. All are designed to separate natural from CVD- and HPHT-grown synthetic diamonds. The J-Detect 9000 features a 5 × 5 inch (~13 × 13 cm) tray, scans in 15–25 seconds, and accommodates both loose and mounted diamonds (0.003 ct and larger, in primarily D–K colour). The J-Mini, weighing a mere 3 kg, is designed for smaller operations. It has a 2.5 × 3 inch (~6 × 8 cm) tray that accommodates the same size and colour ranges of both loose and mounted diamonds, with a scan speed of 10–15 seconds. It is compatible with Android mobile phones. For more information, visit http://drctechno.com/home/products.

M-Screen 4.0

Released in March 2019, M-Screen 4.0 is the newest-generation melee-screening device from HRD Antwerp. The table-top instrument uses short-wave UV illumination with a patented method to screen large amounts of diamond melee, automatically sorting round brilliant diamonds (0.005–0.20 ct, D–J colour) from synthetics and simulants at a rate of three stones per second, or up to 15,000 per hour. Visit www.hrdantwerp.com/en/equipment/detail/m-screen.

NEWS AND PUBLICATIONS



CIBJO's Ethical Trading Do's & Don'ts

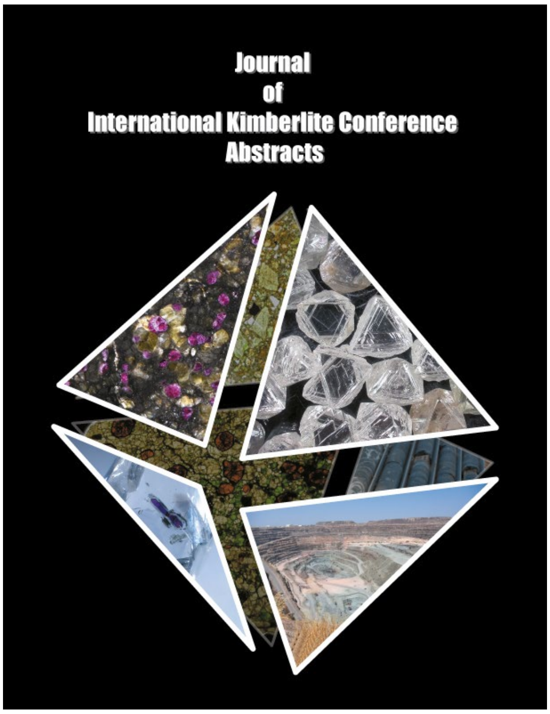
Following the release of its *Responsible Sourcing Book* in January 2019 (see What's New section, Vol. 36, No. 5, 2019, p. 397), in March 2019 CIBJO issued 'Ethically Responsible Trading in Diamonds, Coloured Gemstones, Pearls & Corals: The Do's & Don'ts'. The 11-page booklet includes a checklist of items to help members of the gem trade ensure compliance with guidelines in the CIBJO Blue Books to promote ethically responsible behaviour. It includes lists of treatments that should be disclosed, as well as appropriate terminology for 'artificial products'. Available in 11 languages, the guide can be downloaded for free in PDF format at www.cibjo.org/dos-donts-guide.

Diamond Mining Report by Trucost

Trucost is an affiliate of S&P Global Market Intelligence and assesses risks related to climate change, natural resource constraints, and broader environmental, social and governance factors. The Diamond Producers Association (DPA), which is the representative consortium for the world's seven largest diamond producers, commissioned Trucost to prepare a report titled 'The Socioeconomic and Environmental Impact of Large-Scale Diamond Mining', which was released in May 2019. The study examines the impacts of large-scale diamond mining and uses this information to identify how to minimise those impacts and optimise potential benefits, with an emphasis on greenhouse gas emissions. To download the 37-page summary report, visit https://diamondproducers.com/app/uploads/2019/05/Trucost_Socioeconomic_and_Environmental_Impact_of_Large-Scale_Diamond_Mining.pdf.

International Kimberlite Conference: Extended Abstracts

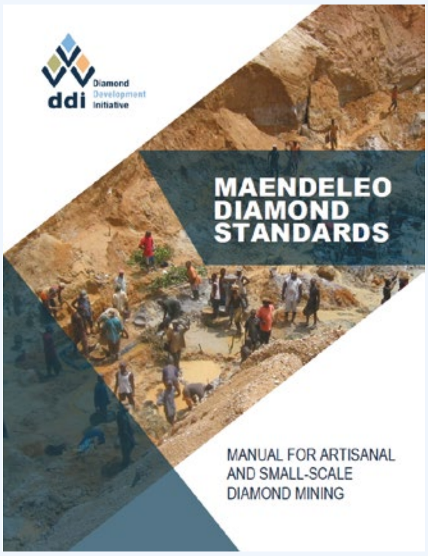
Extended abstracts from past meetings of the International Kimberlite Conference (IKC) are now freely available via the *Journal of International Kimberlite Conference Abstracts*. As stated on its website, which is hosted by the University of Alberta Libraries (Canada), 'The purpose of this journal is to create a permanent, readily accessible and citable archive of these valuable contributions, as a record of the progress in kimberlite-related research since the instigation of the first IKC in Cape Town, 1973.' So far, 11 IKCs have taken place at generally 4–5 year intervals. Topics covered by the extended abstracts include detailed geologic descriptions of various kimberlites and their geological settings worldwide, as well as information about exploration, mining and diamond characteristics. Visit http://ikcabstracts.com/index.php/ikc.



Jewelry Industry Summit 2019 Presentations

Just prior to the February 2019 gem shows in Tucson, Arizona, USA, numerous participants met for two days at the Third Jewelry Industry Summit to share concerns and raise awareness regarding ethical and sustainability issues facing the gem and jewellery industry. Several of the presentations are now available online for download (as PDF and MOV files). Topics include blockchain platforms, the Jewellery Development Impact Index, sustainable mining, due diligence and responsible sourcing. Visit www.jewelryindustrysummit.com/summit-archive.

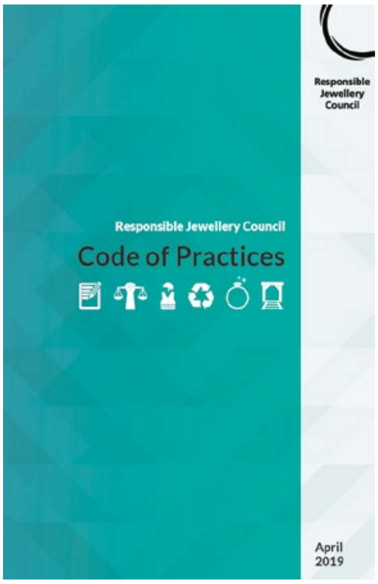
JEWELRY INDUSTRY SUMMIT



Maendeleo Diamond Standards from DDI

The Diamond Development Initiative (DDI) is a non-profit organisation that addresses social and economic issues faced by artisanal diamond miners in Africa and South America. In April 2019, DDI launched its Maendeleo Diamond Standards (MDS) to provide guidelines for their certification system to ensure that these miners are included in responsible supply chains. MDS certification allows for the responsible sourcing of diamonds from small-scale miners in Kimberley Process-approved zones. Download the MDS at http://ddiglobal.org/wp-content/uploads/2019/04/MDS_Manual_April_2019_reduxed_for_web.pdf.

RJC Code of Practices Updated



The Responsible Jewellery Council issued its latest Code of Practices in April 2019. This standard 'defines the responsible ethical, human rights, social and environmental practices that all certified RJC members must adhere to'. The Code consists of 42 provisions that cover general legal and regulatory requirements; responsible supply chains, human rights and due diligence; labour rights and working conditions; health, safety and the environment; gold, silver, platinum-group metals, diamond and coloured stone products; and responsible mining. Visit www.responsiblejewellery.com/files/RJC-COP-April-2019.pdf.

Presentations from the 7th Brazilian Symposium on Diamond Geology

Presentations from the 7^{0} Simpósio Brasileiro de Geologia do Diamante, held 4–7 November 2018, are available for download online. Topics primarily cover diamond deposits and mining in Brazil (with a single presentation on Canadian mines), as well as internal features and spectroscopy of Brazilian diamonds. In addition, the conference included general presentations on geology, exploration, mining, processing and terminology. Most presentations are in English, but some are only provided in Portuguese. To download the files (PDFs delivered in ZIP format), visit www.simposiododiamantebahia.com.br/en/presentations.

Silver Institute Publications

The Silver Institute has published its World Silver Survey annually since 1990 (see www.silverinstitute.org/all-world-silver-surveys). The 104-page 2019 report was released in April 2019, and includes international data through 2018 on silver prices, investment, mine supply, 'recycled' supply, silver bullion trade, industrial fabrication, and jewellery and silverware. Both total supply and overall demand in 2018 were higher than in 2009 but lower than in 2010, with ups and downs in the intervening years.

Also, in March 2019 the Silver Institute released its 2018 Silver Jewelry Sales Results, which presents data from an online survey of jewellery retailers that compares 2018 silver jewellery sales to those of 2017. Information is provided on overall sales, holiday sales, merchandise categories, inventories and buyer demographics. More than half of the respondents reported an increase in sales over 2017. Download the report at www.silverinstitute.org/publications, where you will also find other Silver Institute publications.

OTHER RESOURCES

Pearl Academy by Raw Pearls

Family-owned and UK-based pearl wholesaler Raw Pearls recently created the Pearl Academy to educate retail jewellery staff and better prepare them to market natural and cultured pearls to consumers. This free online educational resource consists of a series of videos, and those available up to May 2019 included: 'Introducing Pearl Academy', 'Part 1: Natural, Cultured & Fake Pearls', 'Part 2: From the Hatchery to Raw Pearls' and 'Part 3: Types of Cultured Pearl'. Parts 1–3 are accompanied by notes in PDF format. Visit www.rawpearls.com/services/pearl-training.

Podcasts from L'École School of Jewelry Arts

L'École des Arts Joailliers (Paris, France) is supported by Van Cleef & Arpels, and offers an e-library with numerous video podcasts in which experts discuss various works of jewellery art, aspects of jewellery history and specific gem materials. Topics include individual works from various genres and time periods, including Art Nouveau, Art Deco, 19th century and more. Gems discussed include opal, sapphire, ruby, emerald and biogenic gems, along with treatments and origins. Ranging from ~1–8 minutes long, some of the podcasts are in English and others are in French. Visit www.lecolevancleefarpels.com/en/go-further.

What's New provides announcements of new instruments/technology, publications, online resources and more. Inclusion in What's New does not imply recommendation or endorsement by Gem-A. Entries were prepared by Carol M. Stockton unless otherwise noted.

Gem Notes

COLOURED STONES

Anorthite from Japan

Plagioclase is a common rock-forming mineral that consists of the albite-anorthite series (i.e. ranging from $NaAlSi_3O_8$ to $CaAl_2Si_2O_8$). While gem-quality plagioclase is known to occur throughout this compositional range, end-member anorthite is only rarely encountered as a gemstone (e.g. from Fugoppe, Yoichi area, Hokaido, Japan; Bank *et al.* 1998).

During the February 2019 Tucson shows in Arizona, USA, gem dealer Dudley Blauwet (Dudley Blauwet Gems, Louisville, Colorado, USA) had rough and cut samples of anorthite from Miyake Island (Miyake-jima), a part of the Izu archipelago located ~180 km south-east of Honshu, Japan. Although anorthite from this locality is well known to mineralogists and geologists (see, e.g., Kikuchi 1888; Murakami *et al.* 1991), this is the first time that we are aware of it being available as faceted gemstones. Blauwet obtained five clean stones, ranging up to 1.5 ct, from approximately 30 pieces that were collected and cut by his supplier, Takeshi Kamitaki. The largest faceted stone in Kamitaki's inventory weighed 8 ct but was heavily included.

Blauwet loaned one rough and one cut stone for examination (Figure 1). The rough sample weighed 0.25 g and was pale yellow. Several cleavages were evident on its surface and a small area of host rock was embedded on one side. It was mostly transparent with some areas that were semi-transparent. The faceted stone was a round Portuguese cut weighing 0.43 ct, and it was extremely pale yellow and eye-clean. Microscopic observation revealed a few isolated pinpoint inclusions, two stringers composed of multiple pinpoints, and several fine, colourless needles. At the base of the stone was a small 'fingerprint' inclusion, giving the culet a slightly frosted appearance. The polariscope showed a biaxial 'bow tie' optic figure. The RIs were 1.575–1.589, yielding a birefringence of 0.014. It was not possible to record an accurate SG value due to the small size of the samples and the presence of host rock attached to the rough piece. Nevertheless, the RIs are indicative of end-member anorthite (cf. 1.575–1.588; Deer *et al.* 1992).

Raman spectroscopy of the faceted stone with a GemmoRaman-532SG instrument provided close matches for both anorthite and bytownite in the RRUFF database. Chemical analysis by energy-dispersive X-ray spectroscopy of another sample of gem-quality Miyake plagioclase from the same supplier yielded a composition of 95% anorthite and 5% albite (i.e. An_{95}). Analysis of the present faceted stone by EDXRF spectroscopy on an Amptek X123-SDD instrument showed a similar composition, as expected for the anorthite end-member indicated by the RI values.

Miyake anorthite formed as megacrysts that were ejected from an active volcano and are associated with basaltic lava (Kikuchi 1888). Similar occurrences of anorthite are known from elsewhere in the Izu archipelago, and Kimata (1995) stated that these megacrysts may be colourless, 'red-clouded' or yellow. Murakami *et al.* (1991) documented tiny platelets of native copper in 'wine red' Miyake anorthite, but such inclusions were not present in the pale yellow samples examined for this report.

Cara Williams FGA and Bear Williams FGA
(info@stonegrouplabs.com)
Stone Group Laboratories
Jefferson City, Missouri, USA

Brendan M. Laurs FGA

Figure 1: These cut (0.43 ct) and rough (0.25 g) samples of anorthite from Miyake Island, Japan, were examined for this report. Photo by B. Williams.

References

Bank, H., Henn, U. & Milisenda, C.C. 1998. Anorthit aus Japan. *Gemmologie: Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **47**, 62–63.

Deer, W.A., Howie, R.A. & Zussman, J. 1992. *An Introduction to the Rock-Forming Minerals*. 2nd edn. Longman Scientific & Technical, Harlow, Essex, 696 pp.

Kikuchi, Y. 1888. On anorthite from Miyakejima. *Journal of the College of Science, Imperial University of Tokyo*, **2**(1), 31–47.

Murakami, H., Kimata, M. & Shimoda, S. 1991. Native copper included by anorthite from the island of Miyakejima: Implications for arc magmatism. *Journal of Mineralogy, Petrology and Economic Geology*, **86**(8), 364–374, http://doi.org/10.2465/ganko.86.364.

Aquamarine from Southern Ethiopia: An Update

Figure 2: These beryls, seen during the February 2019 Tucson gem shows, are reportedly from southern Ethiopia. The largest crystal weighs 613.4 g. Photo by T. Sripoonjan.

During the February 2019 Tucson gem shows, author TS encountered some beryl crystals that were reportedly from the Shakiso region of southern Ethiopia (Figure 2). Some of them consisted of aquamarine, showing apparently hexagonal prism faces, which were relatively larger in size (up to 600+ g) than previously reported by Laurs (2012) and Laurs *et al.* (2014). The vendors, Arjit and Apurva Birani (Plum Colors, Bangkok, Thailand), informed the author that the beryl came from a recent discovery that occurred near the Shakiso emerald deposit. In addition to the rough material, they also had faceted stones, although these had all sold before the author visited their booth.

Recently, at the Plum Colors office in Bangkok, these authors saw some more of the Ethiopian aquamarine. One of the faceted stones was an attractive, consistent blue with high clarity (Figure 3). Author TS borrowed

Figure 3: This 8.16 ct Ethiopian aquamarine was recently cut in Bangkok and shows an attractive blue colour. Photo by T. Sripoonjan.

Figure 4: (**a**) Etch pits of various shapes decorate the prism face of an Ethiopian aquamarine crystal (reflected light, image width 10.0 mm). (**b**) Thin films displaying iridescent colours are arranged in planes perpendicular to the c-axis of the aquamarine (reflected light, image width 2.0 mm). (**c**) The only internal features that were visible in the faceted Ethiopian aquamarine in Figure 3 are these growth lines (darkfield illumination, image width 5.2 mm). Photomicrographs by T. Sripoonjan.

this gem and six rough samples for examination. The faceted stone weighed 8.16 ct (16.32 × 8.97 × 7.47 mm) and the rough ranged from 2.3 to 16.3 g. The samples were greenish blue to pure medium blue and showed strong pleochroism in near-colourless and blue. The RIs were 1.570–1.582 (birefringence 0.012) and the hydrostatic SG averaged 2.66. The samples were inert to both long- and short-wave UV radiation.

The aquamarine crystals exhibited obvious etch pits of various shapes on their prism faces (Figure 4a). Internal features in the rough material consisted of a complex network of parallel partially healed fissure planes, two-phase fluid inclusions, colourless mineral inclusions (0.1–0.5 mm) and especially multiple planes of thin films showing iridescence (Figure 4b). However, the faceted stone solely contained growth lines (Figure 4c).

Raman spectroscopy with a Renishaw inVia unit confirmed that the stones were beryl (aquamarine). Polarised ultraviolet-visible-near infrared (UV-Vis-NIR) spectroscopy of the faceted stone revealed two sharp peaks at 370 and 427 nm related to Fe^{3+} and a strong, broad absorption band centred at ~820 nm due to Fe^{2+} (Figure 5a). Two sidebands at ~620 and 955 nm have been attributed to Fe^{2+} intervalence charge transfer (Burns 1993). The Fe-related absorptions formed a transition window at around 480–530 nm that accounts for blue colouration in aquamarine. A peak at 1147 nm has yet to be assigned, and there were essentially no distinct absorption features in the visible region of the spectra.

Mid-infrared spectroscopy of all samples using a Thermo Scientific Nicolet 6700 FTIR spectrometer yielded consistent features in the 7400–4500 cm^{-1} region (e.g. Figure 5b). A band at around 7140 cm^{-1} was more intense than the adjacent features at 7098 and 7075 cm^{-1}. This correlates to a prevalence of type I H_2O associated with very low alkali contents in this aquamarine (cf. Saeseaw *et al.* 2014).

Energy-dispersive X-ray fluorescence (EDXRF) spectroscopy of all samples with a Thermo Scientific ARL Quant'X instrument showed distinct amounts of iron (0.40–1.40 wt.% Fe_2O_3), although substantially less than in some aquamarine reported in the literature (e.g. Canada, Adamo *et al.* 2008; Vietnam, Huong *et al.* 2011). In addition, these

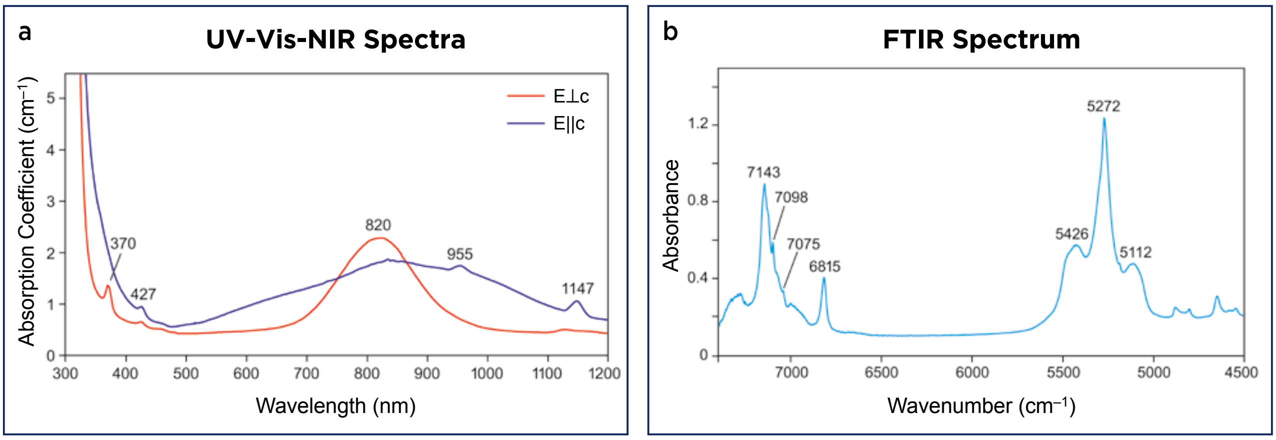


Figure 5: (**a**) Polarised UV-Vis-NIR spectra of the faceted Ethiopian aquamarine in Figure 3 show features mainly associated with iron. The path length of the beam through the sample was 7.47 mm. (**b**) A representative FTIR spectrum of the Ethiopian aquamarine reveals several bands related to type I and type II H_2O, with the former being more prevalent.

Ethiopian aquamarines were characterised by relatively high concentrations of potassium (up to 0.24 wt.% K_2O). Caesium contents were very low (averaging 0.03 wt.% Cs_2O) compared to those of aquamarine from other sources (Bocchio *et al.* 2009; Huong *et al.* 2011).

Previous articles (Laurs 2012; Laurs *et al.* 2014) supplied brief information on Ethiopian aquamarine, and this report provides additional data that may be helpful to gemmologists in case this material becomes more common in the marketplace in the future.

Tasnara Sripoonjan (stasnara@git.or.th) and
Dr Montira Seneewong Na Ayutthaya
Gem and Jewelry Institute of Thailand, Bangkok

References

Adamo, I., Pavese, A., Prosperi, L., Diella, V., Ajò, D., Gatta, G.D. & Smith, C.P. 2008. Aquamarine, Maxixe-type beryl, and hydrothermal synthetic blue beryl: Analysis and identification. *Gems & Gemology*, **44**(3), 214–226, http://doi.org/10.5741/gems.44.3.214.

Bocchio, R., Adamo, I. & Caucia, F. 2009. Aquamarine from the Masino-Bregaglia massif, central Alps, Italy. *Gems & Gemology*, **45**(3), 204–207, http://doi.org/10.5741/gems.45.3.204.

Burns, R.G., 1993. *Mineralogical Applications of Crystal Field Theory*. 2nd edn. Cambridge University Press, Cambridge, 576 pp.

Huong, L.T.-T., Hofmeister, W., Häger, T., Khoi, N.N., Nhung, N.T., Atichat, W. & Pisutha-Arnond, V. 2011. Aquamarine from the Thuong Xuan District, Thanh Hoa Province, Vietnam. *Gems & Gemology*, **47**(1), 42–48, http://doi.org/10.5741/gems.47.1.42.

Laurs, B.M. 2014. Gem Notes: Prismatic aquamarine crystals from Ethiopia. *Journal of Gemmology*, **34**(1), 8–9.

Laurs, B.M., Simmons, W.B. & Falster, A.U. 2012. Gem News International: New gem discoveries in Ethiopia. *Gems & Gemology*, **48**(1), 66–67.

Saeseaw, S., Pardieu, V. & Sangsawong, S. 2014. Three-phase inclusions in emerald and their impact on origin determination. *Gems & Gemology*, **50**(2), 114–132, http://doi.org/10.5741/gems.50.2.114.

Chrysocolla from the Ray Mine, Arizona, USA

For decades, the Ray mine near Kearny, Pinal County, Arizona, USA, has been a well-known source of copper minerals that are prized by collectors (e.g. Jones & Wilson 1983). The copper ore at this porphyry copper deposit was naturally concentrated by secondary enrichment processes, resulting in the formation of abundant chrysocolla and other secondary copper minerals. Chrysocolla has been mined as bright blue-to-green masses, vug fillings, stalactites and pseudomorphs. The mine is still being exploited for copper, and occasionally small amounts of high-quality chrysocolla specimens, gem rough and polished stones appear on the market, such as those seen by this author at the February 2019 Pueblo Gem & Mineral Show in Tucson (e.g. Figure 6). In addition to mineral specimens, there were approximately 50 cabochons that had been cut from ~3 kg of rough material produced in 2018. The largest cabochon measured 30.5 × 18.5 mm, and the chrysocolla was translucent to semi-transparent with an attractive blue to bluish green colour that was evenly distributed in most of the polished pieces.

Figure 6: This rough specimen (68.0 mm long) and cabochon of chrysocolla were recently produced from the Ray mine in Arizona. Shown for comparison is a carving (27.4 mm long) made from high-quality chrysocolla that is from elsewhere in Arizona. The rough specimen is covered by drusy quartz, and the greener portion may correspond to the presence of malachite. Photo by B. M. Laurs.

Although chrysocolla from the Ray mine is seldom seen on the market today, occasionally high-quality material is encountered, as shown by the examples documented here.

Brendan M. Laurs FGA

Reference

Jones, R.W. & Wilson, W.E. 1983. Famous mineral localities: The Ray mine. *Mineralogical Record*, **14**(5), 311–322.

Figure 7: These samples of rough and cut grossular are reportedly from the Tanga region of north-eastern Tanzania. The rough stones show various amounts of iron staining on their surfaces. The cut stone was faceted by the author and weighs 8.89 ct. Photo by V. Lanzafame, SSEF.

Grossular from Tanzania with Uncommon Inclusions

At the October 2018 mineral and gem show in Munich, Germany, rough stone dealer Fabian Kneipp (Roughstore24 GmbH, Herrsching, Germany) presented the author with some interesting grossular specimens from the Tanga region of north-eastern Tanzania (Figure 7). Kneipp reported that several kilograms of the material had recently come to the market. The author purchased several rough specimens, and Kneipp kindly donated some additional pieces containing small green colour concentrations for further study at the Swiss Gemmological Institute SSEF (Figure 8).

After a search of the literature and of the SSEF rough stone collection, it became clear that this material was not actually new to the market. Similar grossular from Tanzania was described in the 1980s (Manson & Stockton 1982; Hänni 1987) and was catalogued in 2004 in SSEF's reference collection, and material resembling this garnet was also available on the Internet dating back several years. Nevertheless, since this grossular has not yet been characterised in detail, the author analysed six samples consisting of five rough pieces (1.10–4.64 g) and one faceted stone (8.89 ct).

The rough specimens appeared water-worn and some of them showed a granular-appearing surface texture. The rough ranged from near-colourless to light yellow and orangey yellow, while the faceted stone was near-colourless (again, see Figure 7). The RI varied slightly from 1.739 to 1.741, with an average RI of 1.740. Hydrostatic SG values were 3.57–3.62 (average 3.60) and were consistent with those reported in the literature. All samples were inert to long- and short-wave UV radiation.

Chemical analysis by energy-dispersive X-ray fluorescence (EDXRF) spectroscopy with a Thermo Scientific ARL Quant'X instrument revealed a composition consistent with that of nearly pure grossular, with major amounts of Si, Al and Ca, as well as minor Fe and traces of Ti and Mn. In addition, traces of Cr were measured in the samples containing green areas.

In addition to a roiled appearance seen in the faceted stone, some of the samples contained mineral inclusions that were visible with the unaided eye or a 10× loupe. Two of them were selected for Raman microspectroscopy with a Renishaw inVia microscope equipped with a 514 nm argon-ion laser. Transparent, well-shaped crystals in one rough sample (Figure 9) were identified as titanite

Figure 8: Two of the rough grossular samples (2.40 g and 0.59 g) obtained for this study contain small green zones. Photo by V. Lanzafame, SSEF.

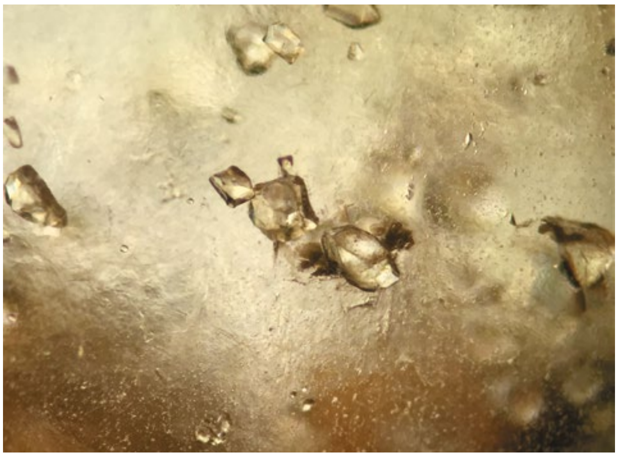


Figure 9: Raman analysis identified this group of well-formed crystals as titanite. Photomicrograph by S. Hänsel; image width 2.8 mm.

(sphene), and an eye-visible inclusion in the faceted stone (Figure 10) turned out to be anhydrite. Although so far not documented as inclusions in gem-quality grossular, both titanite and anhydrite are well known from grossular-bearing metamorphic rocks. Titanite is a common accessory mineral found together with grossular in Ca-silicate rocks (e.g. skarn-related or by metasomatism during regional metamorphism), and anhydrite has been attributed to the presence of evaporites in the genesis of gems (e.g. Feneyrol *et al.* 2012).

Sebastian Hänsel
(sebastian.haensel@ssef.ch)
Swiss Gemmological Institute SSEF
Basel, Switzerland

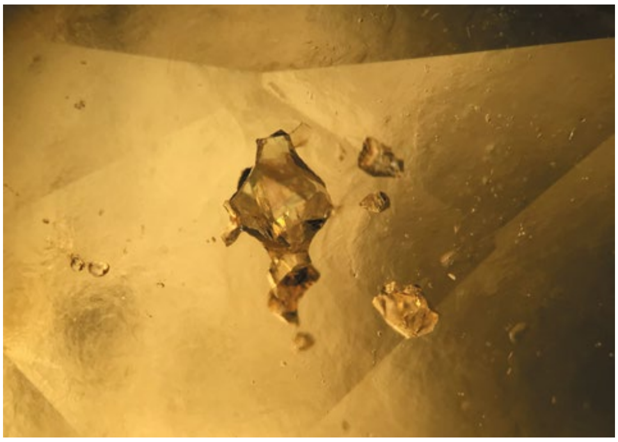


Figure 10: The largest transparent crystal with high relief shown here was identified as anhydrite by Raman analysis. Photomicrograph by S. Hänsel; image width 4.0 mm.

References

Feneyrol, J., Ohnenstetter, D., Giuliani, G., Fallick, A.E., Roillon-Bard, C., Robert, J.-L. & Malisa, E.P. 2012. Evidence of evaporites in the genesis of the vanadian grossular 'tsavorite' deposit in Namalulu, Tanzania. *Canadian Mineralogist*, **50**(3), 745–769, https://doi.org/10.3749/canmin.50.3.745.

Hänni, H.A. 1987. Garnets – a colourful gemstone family. *Swiss Watch and Jewellery Journal*, **5**, 691–694.

Koivula, J.I. & Inns, A. 2008. Lab Notes: Calcite "melt" in grossular. *Gems & Gemology*, **44**(3), 259.

Laurs, B.M. & Renfro, N.D. 2017. Gem Notes: Grossular from Tanga, Tanzania. *Journal of Gemmology*, **35**(7), 577–578.

Manson, D.V. & Stockton, C.M. 1982. Gem-quality grossular garnets. *Gems & Gemology*, **18**(4), 204–213, http://doi.org/10.5741/gems.18.4.204.

Purple Hydroxylherderite from Brazil

Hydroxylherderite [$CaBePO_4(OH,F)$] is a phosphate mineral that forms a solid-solution series with herderite in which hydroxyl (OH) is dominant over fluorine (F). The term *herderite* is commonly used to refer to both minerals of the herderite-hydroxylherderite series, although most specimens on the market are actually hydroxylherderite (www.mindat.org/min-1876.html). Mainly found in granitic pegmatites, herderite can crystallise as attractive, well-formed crystals, and is sometimes transparent enough for faceting. Most gem-quality herderite comes from Minas Gerais in Brazil (Johnson 1996; Wentzell 2004) and from northern Pakistan (Laurs & Quinn 2006). It is found in a limited range of colours, including colourless, grey, brown, pale yellow, pale green and greenish yellow, and much more rarely light blue and purple.

The 1.57 ct round brilliant-cut gemstone described in this report shows an unusually strong purple colour (Figure 11) and was therefore characterised in detail. It reportedly came from Virgem da Lapa in the Araçuaí region of Minas Gerais, Brazil. One deposit in this area, the Xanda (Xandra) mine, is a known source of hydroxylherderite—especially showing purple colour—along with other minerals such as feldspar, tourmaline, muscovite and quartz (Dunn *et al.* 1979; www.mindat.org/loc-6818.html).

Figure 11: The faceted purple hydroxylherderite from Virgem da Lapa described here weighs 1.57 ct. Photo by T. Cathelineau.

The stone showed the following properties: colour—slightly greyish purple overall, appearing greyish blue in daylight (and under 'cool white' bulbs) or slightly greyish purple to purple in incandescent light; pleochroism—strong, in purple and almost colourless (a third colour was not observed, although herderite is biaxial); diaphaneity—transparent; RIs—1.590–1.620; birefringence—0.030; hydrostatic SG—3.02; magnetism—none; Chelsea Colour Filter reaction—none; fluorescence—inert to both long- and short-wave UV radiation; and no absorption features observed with a desk-model spectroscope. These properties are consistent with those reported for herderite by O'Donoghue (2006). Microscopic examination revealed moderate doubling, as well as a few fissures and partially healed fractures.

The refractive indices of herderite vary with the F/OH ratio (Leavens *et al.* 1978), and the RIs of 1.590–1.620 measured for this sample correspond to a herderite (F) content of 43% ± 1% and thus a hydroxylherderite (OH) content of 57% ± 1%. Since this composition falls on the hydroxyl-rich side of the series, it is hydroxylherderite.

The infrared reflectance spectrum (Figure 12) was collected from the stone's table facet without regard for polarisation or orientation. The spectrum covered the 2000–400 cm^{-1} range, although Figure 12 is truncated above 1400 cm^{-1} because no features were recorded in that range. Due to the setup of the FTIR spectrometer, the water and hydroxyl region around 3600 cm^{-1} was not measured. The major bands in the ranges 1200–1000 cm^{-1} and 600–500 cm^{-1} are characteristic of the PO_4^{3-} ion, and confirm the presence of a phosphate mineral. Comparison of the spectrum to the herderite-hydroxylherderite series in the RRUFF database—although the RRUFF spectra were not collected in reflectance mode, but rather using the ATR method—and to the IR transmission spectra published by Chukanov (2014), unambiguously identified the sample as herderite-hydroxylherderite. However, without information on the bands in the 3600 cm^{-1} region it is impossible to conclude whether a sample is herderite or hydroxylherderite (Frost *et al.* 2014).

The herderite-hydroxylherderite series is optically biaxial so, as mentioned above, one might expect three colours associated with the three polarisation directions. Collecting the Vis-NIR spectrum for each of the three directions is typically not feasible for a faceted gemstone, so spectra were recorded for only two of them using a polarising filter with the beam oriented parallel to the direction of maximum pleochroism. The resulting two spectra (Figure 13) correspond to the observed pleochroic colours of purple and almost colourless. The spectrum associated with the purple colour showed a strong absorption edge in the violet region and a strong and broad absorption band at ~577 nm (yellow region), creating two transmission windows at ~470 nm (blue

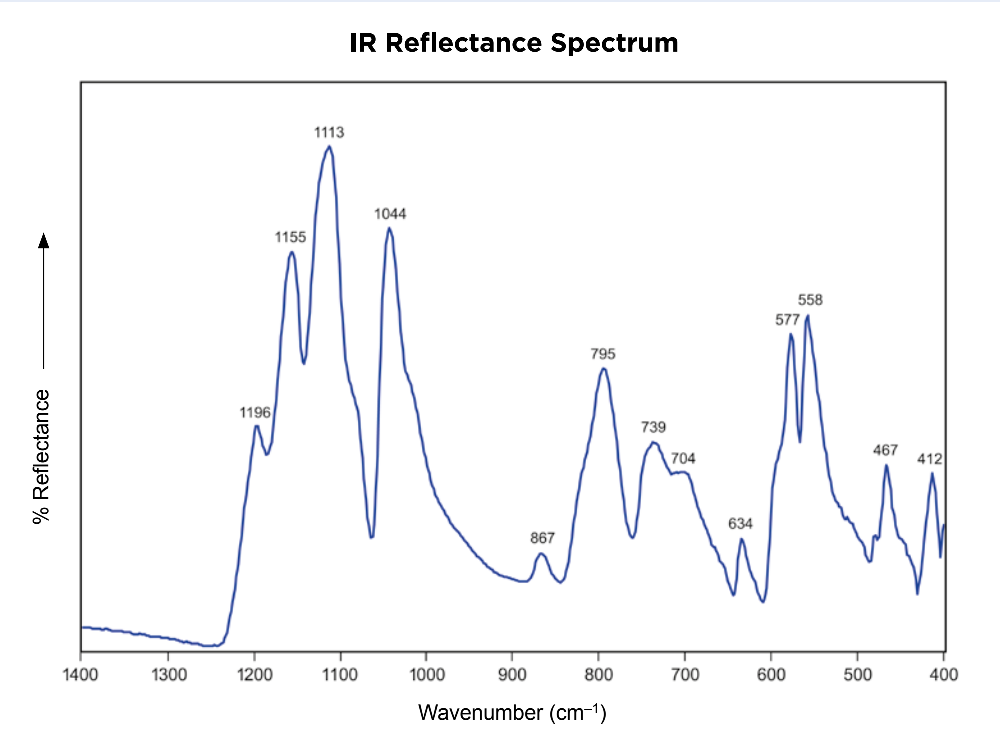


Figure 12: The IR reflectance spectrum characterises the stone in Figure 11 as a member of the herderite-hydroxylherderite series.

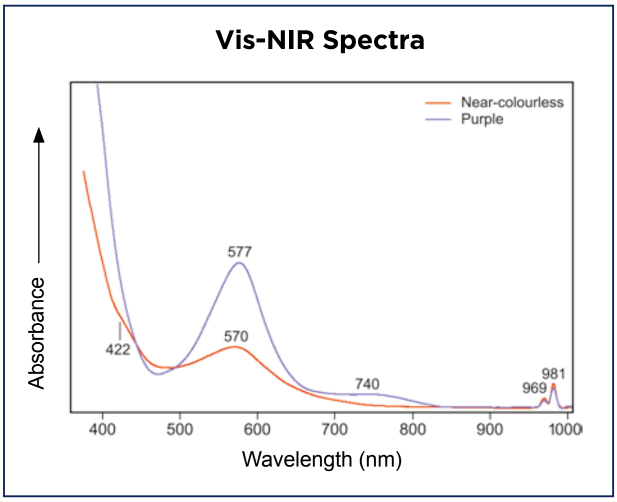


Figure 13: Vis-NIR spectra were collected for the purple and almost colourless pleochroic directions of the hydroxylherderite. Transmission windows in the blue (~470 nm) and red (~660–720 nm) regions are responsible for the purple colour of the stone, as well as its colour change. The path length of the beam through the sample was approximately 5 mm.

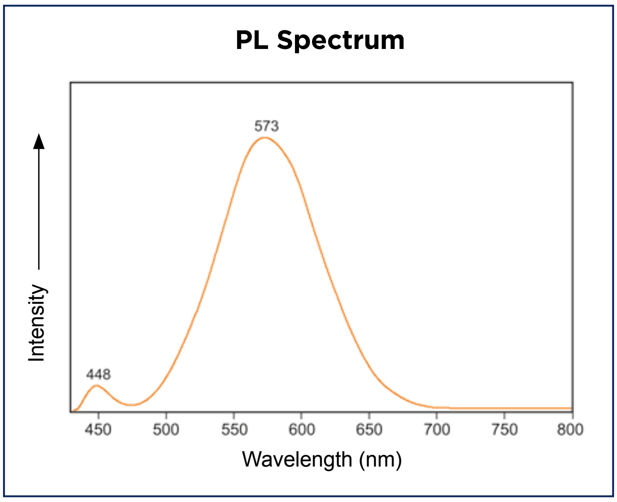


Figure 14: The PL spectrum of the purple hydroxylherderite obtained with 405 nm excitation shows a strong emission at 573 nm that is indicative of Mn^{2+}.

region) and above ~660 nm (red and NIR region). Also present were a weak but broad band centred at ~740 nm and a doublet at 969/981 nm in the NIR region (the latter being linked to the second overtone [$3\nu_{OH}$] of the OH fundamental absorptions in the 3600 cm^{-1} region; Frost *et al.* 2014). The spectrum associated with the almost colourless direction had similar—but much weaker—features, as well as a shoulder at 422 nm. The stone's purple colour is related to the transmission windows in the blue and red regions of the spectrum. Such coupled transmission windows are often responsible for colour-change behaviour, as was also seen in this hydroxylherderite.

The stone's photoluminescence (PL) spectrum was studied using four excitation sources: 254, 280, 377 and 405 nm, but only the last one gave any results. The 405 nm laser produced a main large emission peak centred at 573 nm and a weaker emission at 448 nm (Figure 14). These features are ascribed to Mn^{2+} and Eu^{2+}, respectively (Gorobets & Rogojine 2001). While it is tempting to ascribe the cause of the purple colouration to manganese, further investigations are required. The spectral pattern across the visible range shows similarities to those of pink and purple apatite (colour caused by F centres), deep violet apatite (Mn^{5+}), blue and violet fluorite (F centres), and even amethyst (radiation-induced colour centres).

Thierry Cathelineau
(thierry.cathelineau@spec4gem.info)
Paris, France

References

Chukanov, N.V. 2014. *Infrared Spectra of Mineral Species*. Springer, Dordrecht, The Netherlands, 1,726 pp [see pp 1,167–1,168, 1,194 and 1,318], http://doi.org/10.1007/978-94-007-7128-4.

Dunn, P.J., Wolfe, C.W., Leavens, P.B. & Wilson, W.E. 1979. Hydroxyl-herderite from Brazil, and a guide to species nomenclature for the herderite/hydroxyl-herderite series. *Mineralogical Record*, **10**(1), 5–11.

Frost, R.L., Scholz, R., López, A., Xi, Y., Queiroz, C. de S., Belotti, F.M. & Filho, M.C. 2014. Raman, infrared and near-infrared spectroscopic characterization of the herderite–hydroxylherderite mineral series. *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, **118**, 430–437, http://doi.org/10.1016/j.saa.2013.09.021.

Gorobets, B.S. & Rogojine, A.A. 2001. *Luminescent Spectra of Minerals*. RCP VIMS, Moscow, Russia, 215 pp [see p 135].

Johnson, M.L. 1996. Gem Trade Lab Notes: Herderite. *Gems & Gemology*, **32**(3), 208.

Laurs, B.M. & Quinn, E.P. 2006. Gem News International: Herderite from Pakistan. *Gems & Gemology*, **42**(2), 174–175.

Leavens, P.B., Dunn, P.J. & Gaines, R.V. 1978. Compositional and refractive index variations of the herderite-hydroxyl-herderite series. *American Mineralogist*, **63**(9–10), 913–917.

O'Donoghue, M. (ed) 2006. *Gems*. Butterworth-Heinemann, Oxford, 873 pp [see p 416].

Wentzell, C.Y. 2004. Lab Notes: Herderite update. *Gems & Gemology*, **40**(1), 61–62.

Dendritic Opal from Brazil

Dendritic inclusions are fairly commonly found in agate, chalcedony and other varieties of gem silica, but are less frequently encountered in opal (e.g. Milisenda *et al.* 1994). At the February 2019 Tucson gem shows, Dr Marco Campos Venuti (Sevilla, Spain) had some new dendritic opal specimens from Brazil. He obtained the rough material in August 2018 while visiting Brazil and was told that it was mined from near Teófilo Otoni in Minas Gerais State. The production consisted of about 300 kg of large blocks with a nodular appearance that contained colourless transparent-to-translucent areas and white semi-translucent material resembling opal and chalcedony, respectively. Dark brown dendritic inclusions were present in some of the transparent-to-translucent areas. So far, Dr Campos Venuti has cut and polished ~10,000 carats of the dendritic material, producing gems up to 40 mm in maximum dimension.

Dr Campos Venuti kindly donated one polished specimen to Gem-A (Figure 15), and it was studied by the author for this report. The sample weighed 11.85 ct and measured 18.69 × 15.61 × 5.50 mm. It ranged from transparent (colourless) to translucent (milky white) and had a dull waxy lustre. The RI, measured by the spot method, was ~1.44, and the hydrostatic SG value was 2.26. Dark brown dendrites were concentrated mainly in the colourless area of the stone (Figure 16). Their three-dimensional habit supports a primary origin of growth in the silica gel that formed the opal, rather than a secondary origin of two-dimensional growth along fractures after the opal solidified (Campos Venuti 2012). The stone fluoresced strong yellowish green under short-wave UV radiation and faint light blue under long-wave UV. The dendrites showed a faint greenish luminescence to long-wave UV.

Figure 15: This 11.85 ct opal contains dark brown dendrites that are probably composed of pyrolusite. Photo by A. Costanzo.

Figure 16: A closer view of the dendrites in the opal shows their intricate patterns. Photomicrograph by A. Costanzo; image width 3.0 mm.

The RI and SG values are consistent with those of opal, and this identification was confirmed by Raman analysis using a Horiba LabRam II confocal Raman microspectrometer equipped with a 532 nm laser and a high-resolution diffraction grating. Raman spectra obtained from several spots on the stone all displayed a broad band at ~330 cm^{-1} together with two weaker characteristic peaks at ~1078 and ~785 cm^{-1}; this pattern is characteristic of opal-CT (cf. Pop *et al.* 2004; Ilieva *et al.* 2007).

In general, dendritic inclusions may be composed of oxides of iron, manganese or other metals. Raman microspectroscopy of the inclusions in the present opal showed two peaks at 676 and 543 cm^{-1} that were indicative of pyrolusite (MnO_2). Although the appearance of this dendritic opal is quite similar to that from Zambia documented by Milisenda *et al.* (1994), the inclusions in that material were identified as psilomelane (another Mn-oxide mineral).

Dr Alessandra Costanzo FGA DGA
(alessandra.costanzo@nuigalway.ie)
National University of Ireland, Galway

References

Campos Venuti, M. 2012. *Genesis and Classification of Agates and Jaspers: A New Theory*. Self-published, 160 pp.

Ilieva, A., Mihailova, B., Tsintsov, Z. & Petrov, O. 2007. Structural state of microcrystalline opals: A Raman spectroscopic study. *American Mineralogist*, **92**(8–9), 1325–1333, http://doi.org/10.2138/am.2007.2482.

Milisenda, C.C., Redmann, M. & Malango, V. 1994. A new occurrence of dendritic opal in south-eastern Zambia. *Journal of Gemmology*, **24**(4), 277–280, http://doi.org/10.15506/jog.1994.24.4.277.

Pop, D., Constantina, C., Tătar, D. & Kiefer, W. 2004. Raman spectroscopy on gem-quality microcrystalline and amorphous silica varieties from Romania. *Studia Universitatis Babes-Bolyai, Geologia*, **49**(1), 41–52, http://doi.org/10.5038/1937-8602.49.1.4.

Phenakite from Carnaíba, Brazil

For decades, the Carnaíba-Socotó deposits in Brazil's Bahia State have been mined for emerald, which is associated with phlogopite schist adjacent to pegmatitic veins (Giuliani *et al.* 2019). According to Cook (2009, p. 341), 'Phenakite is also well known from the emerald deposit at Socotó, Bahia, where it is referred to as "white emerald" by the miners. Interestingly, phenakite is almost unknown in the similar emerald deposit at Carnaiba less than 50 kilometers to the southwest.'

Despite the previous rarity of phenakite at Carnaíba, starting in 2017 significant amounts of it were produced as a by-product of emerald mining there. Crystal specimens and cut stones were seen by this author during the February 2019 Tucson gem shows at the booth of Frederico de Vasconcelos (MultiGemas, Governador Valadares, Brazil). Some large phenakite crystals were produced, and a few of them contained gemmy areas that yielded faceted stones exceeding 50 ct (e.g. Figure 17). According to Vasconcelos, approximately 1,000 carats/year of phenakite were cut in 2017–2018, mostly in sizes ranging from 1–3 ct. All of the phenakite from this recent production is colourless.

Brendan M. Laurs FGA

Figure 17: Recent production of phenakite from Carnaíba, Brazil, includes this mineral specimen (9.5 cm high) and these faceted stones (46.55, 17.00 and 56.40 ct, from left to right). Courtesy of Vasconcelos Brazil; photo by Jeff Scovil.

References

Cook, R.B. 2009. Phenakite. *Rocks & Minerals*, **84**(4), 338–344, https://doi.org/10.3200/RMIN.84.4.338-344.

Giuliani, G., Groat, L.A., Marshall, D., Fallick, A.E. & Branquet, Y. 2019. Emerald deposits: A review and enhanced classification. *Minerals*, **9**(2), article 105, 63 pp, http://doi.org/10.3390/min9020105.

Quartz with Triphylite Inclusions from Brazil

Triphylite ($LiFe^{2+}PO_4$) is an anhydrous phosphate mineral that previously has been documented as elongate inclusions in quartz (Hyršl 2003). However, during the February 2019 Tucson gem shows, Dr Marco Campos Venuti had rock crystal quartz with triphylite inclusions showing a rather different appearance. He obtained the rough material in August 2018 while visiting Brazil, and it was reportedly mined from the Galiléia area in Minas Gerais State. From several kilograms of quartz blocks he cut 50–70 stones as cabochons and buff-tops containing the eye-visible inclusions; the largest gem measured 24 × 11 mm. The stones were first sold at the September 2018 Denver Gem & Mineral Show in Colorado, USA.

Dr Campos Venuti kindly donated one buff-top specimen to Gem-A (Figure 18a), and it was examined

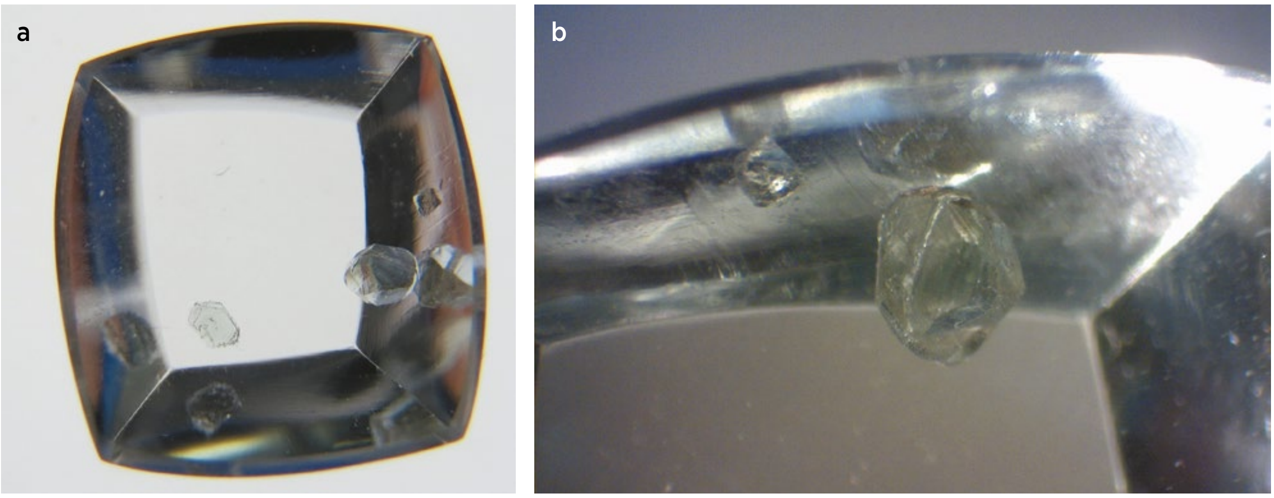


Figure 18: (**a**) The 2.70 ct buff-top quartz described here contains eye-visible inclusions of triphylite. (**b**) The inclusions are mostly equant and rather euhedral, showing pseudo-octahedral shapes (image width 5.1 mm). Photos by A. Costanzo.

by this author. It weighed 2.70 ct and measured 8.82 × 8.29 × 3.92 mm. The stone contained three inclusions that were easily visible through the table facet. Two of the crystals were roughly equidimensional (Figure 18b) and measured ~1.2 and 0.5 mm, whereas the other one was more tabular (~1 mm). Raman microspectroscopy of the inclusions using a Horiba LabRam II confocal Raman unit equipped with a 532 nm laser and a high-resolution diffraction grating confirmed they were triphylite. The main peaks were recorded at 1065.9, 999.5, 950.9 and 463.9 cm^{-1}, together with several secondary peaks (e.g. at 627.0 and 204.9 cm^{-1}).

Some additional quartz specimens from this find that contained rather large triphylite inclusions were brought to our attention by gem dealer Luciana Barbosa (Gemological Center, Weaverville, North Carolina, USA). The triphylite crystals displayed strong pleochroism in brownish green and brown (Figure 19), as well as a distinct colour change from slightly bluish green in daylight to brown in incandescent light (Figure 20). By comparison, the colour change shown by faceted triphylite from Brazil is typically much weaker (cf. Cevallos 2009). Viewed in reflected light, one of the large triphylite inclusions showed attractive iridescence (Figure 21), apparently due to thin-film interference along the boundary between the inclusion and the surrounding quartz.

Compared to the triphylite inclusions that were previously documented by Hyršl (2003), those in the present specimens are generally larger and more euhedral, and they do not commonly show cleavage breaks. In the 1990s, triphylite inclusions were also found in morganite from the Urucum mine in Minas Gerais; they occurred together with black tourmaline, near the edges of the crystals (Dr Jaroslav Hyršl, pers. comm. 2019).

Dr Alessandra Costanzo FGA DGA
and Brendan M. Laurs FGA

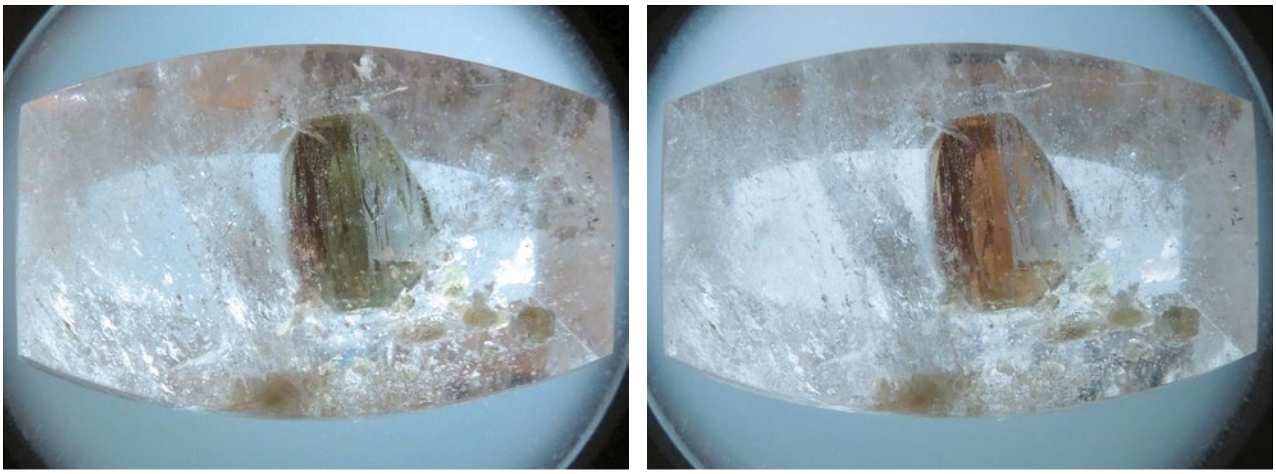


Figure 19: The large triphylite inclusion in this 73.80 ct quartz specimen displays strong pleochroism as the polariser is rotated. Photos by Luciana Barbosa.

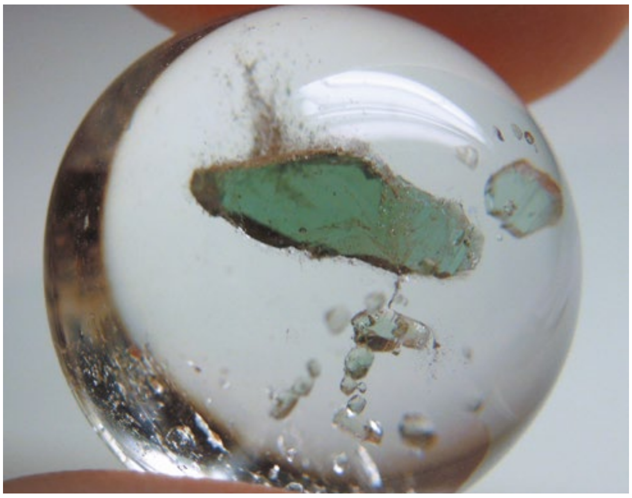


Figure 20: A distinct colour change from slightly bluish green in daylight to brown in incandescent light is shown by the large triphylite inclusion in this 31.80 ct quartz cabochon. Photos by Luciana Barbosa.

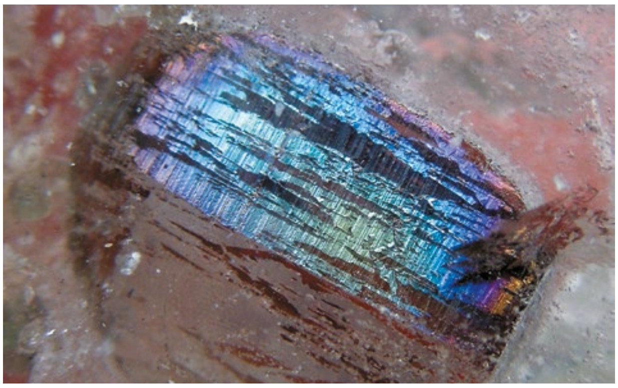


Figure 21: Viewed in reflected light, the triphylite inclusion (11.0 mm long) in the specimen shown in Figure 19 displays colourful iridescence. Photo by Luciana Barbosa.

References

Cevallos, P. 2009. Gem News International: Triphylite from Brazil. *Gems & Gemology*, **45**(3), 229–230.

Hyršl, J. 2003. Gem News International: Triphylite inclusions in quartz from Brazil. *Gems & Gemology*, **39**(1), 61–62.

DIAMONDS

Searching for the Sancy Diamond

In 1888 there were reports in the British press that the maharaja of the princely Indian state of Patiala had an immense wealth of jewels including ‘a fabulously costly diamond necklace, in which figures the famous Sancy diamond purchased from the Empress EUGENIE’ (*Sheffield Evening Telegraph*, 20 December 1888, p. 2). The supposed ownership of the Sancy diamond by the maharajas of Patiala was subsequently often noted, but was this really the historic Sancy diamond?

At the beginning of 1947, Robert M. Shipley, president of the Gemological Institute of America and the first American FGA, was preparing the fifth edition of his book, *Famous Diamonds of the World*. He wanted to know more about the Sancy diamond, so he wrote to British gemmologist Robert Webster to see if he could confirm whether it was still owned by the maharaja of Patiala (then, Yadavindra Singh, who reigned from 1938 to 1974; Figure 22) or if it had passed into other hands. To seek an answer to Shipley’s question, Webster wrote to the India Office, the London-based British government department which oversaw the administration of what was at the time British India. His letter, written on 30 January 1947, is preserved together with subsequent correspondence within old files of the India Office that are now held in the British Library in London (India Office Records and Private Papers, IOR/L/PJ/7/10870).

Webster’s letter was not directed at any named individual at the India Office, but on its arrival there it was forwarded to William Rayner, an administrative officer, with the handwritten note ‘Can you help, please? If so, perhaps you wd reply direct’. Rayner forwarded the request to Esmond Lumby, one of the principal administrators, to see if he had any idea, noting ‘I haven’t any knowledge of the Sancy diamond and certainly don't possess it!' And if Lumby didn't know, maybe 'Sir Patrick' would. It is unclear to this author who Sir Patrick was, but the letter was forwarded to him, seemingly by Miles Clauson (acting assistant secretary), with the note 'I suppose you don't happen to know the answer to this one!' 'No', was the brief written retort. So, Clauson sent it next to 'Colonel Fraser' with the note 'Can you help'. This must surely have been lieutenant colonel D. de M. S. Fraser, no less than the political *aide-de-camp* to the British Secretary of State for India. Back it came, however, with the brief note 'Sorry cannot help at all'. The next suggestion was for Clauson to try asking 'Rushbrook Williams', with the honest but revealing comment that he might have an idea of 'what is meant by SANCY'. Professor Lawrence Rushbrook Williams was a British historian with a particular interest in India who was also a consultant to the British newspaper *The Times*. So, a letter was duly sent to him at that newspaper's address repeating the enquiry, which was described as 'quite a respectable one', but inaccurately referring to it as coming from 'a firm of jewellers who simply want to have the information for inclusion in a publication on famous gems'.

Prof. Rushbrook Williams did offer some information: 'When last I saw the Sancy Diamond it was the central pendant of a great rivière in the Patiala state regalia. In all probability, it is still in the Patiala toshakhana [treasure house]. An enquiry to Malik, the Prime Minister, might settle the point.' He added a postscript: 'Indian Princes hardly ever sell jewels: they occasionally use them as security for a loan however!' This reply was forwarded to Clauson, and on 28 February he replied to Webster's original letter in true diplomatic fashion: 'Such enquiries as it has been possible to make have not indicated the likelihood of any recent change in the ownership of the Sancy Diamond.' He added that if more certainty were required, an enquiry might be made to the Patiala prime minister. Webster acknowledged this letter saying he had 'had pleasure in forwarding' their reply to GIA.

The original Shipley correspondence does not exist in the GIA archives, but a brief note titled 'Ownership of the Sancy Diamond in Question' appeared in GIA's *Gems & Gemology* in late 1947 (Anonymous 1947). This shows that Shipley had indeed written to Patiala; it said: 'a letter has lately been received by the Gemological Institute of America from the secretary of the Maharajadhiraj of Patiala, in India, saying that His Highness is the owner of the diamond'. A letter was sent back asking about the weight of this stone. A reply was received, presumably, because Shipley's fifth edition of *Famous Diamonds of the World*, published in 1948, lists two

Figure 22: Yadavindra Singh was the maharaja of Patiala at the time of the Sancy correspondence in 1947, and he was the ninth and last maharaja there. Image courtesy of Wikimedia Commons.

Sancy diamonds. One was the historic Sancy diamond now in the Louvre (Paris, France) that weighs 55.23 ct, and the other was given as the 'Patiala Sancy' weighing 60.4 ct. The history and present whereabouts of this latter stone are unclear.

The India Office correspondence recorded above sheds little light on the Sancy diamond, but is remarkable for showing that several people within the India Office, some at high level, attempted to find an answer to Shipley's question on a historic diamond, roping in a famous British historian on India and even suggesting a direct approach to the Patiala prime minister. It is especially remarkable when you consider the timing. On 20 February 1947, as the above correspondence and handwritten comments were circulating around the India Office, the British prime minister announced that Britain would grant full self-government to British India. This was the time of Indian independence. The India Office closed that summer.

Acknowledgement: The author thanks Cathy Jonathon at the GIA Library in Carlsbad, California, USA, for her assistance.

Dr Jack M. Ogden FGA *(jack@striptwist.com)*
London

Reference

Anonymous 1947. Ownership of the Sancy diamond in question. *Gems & Gemology*, **5**(12), 499.

SYNTHETICS AND SIMULANTS

Magnesio-riebeckite ('Rhodusite') Doublets from Kazakhstan

During the February 2019 Tucson gem shows, Mauro Pantò (The Beauty in the Rocks, Sassari, Italy) displayed 'rhodusite' (magnesio-riebeckite) doublets from Jezkazgan (Zhezkazgan), Kazakhstan. The material showed attractive bluish grey to greyish blue sheen in various patterns that were formed by the felty aggregates of magnesio-riebeckite (Figure 23). He obtained 26 pieces from his Russian supplier that ranged up to 26 × 33 mm. One of them showed chatoyancy (Figure 24a). Because the material is somewhat friable, the cabochons were backed by a hard polished black material (Figure 24b)—stated by Pantò's supplier as being 'black jade'—to improve their overall durability and protect their edges from chipping.

Magnesio-riebeckite, $\square Na_2(Mg_3Fe^{3+}_2)Si_8O_{22}(OH)_2$, is a sodic amphibole with Na and vacancies (□) at the A site, $Mg>Fe^{2+}$ at the Y site and OH at the W site (Hawthorne *et al.* 2012). It is usually found as fibrous 'asbestiform' masses, but only rarely are these aggregates solid enough for gem use. Magnesio-riebeckite is closely related to the sodic amphibole glaucophane (from *glaukos* 'blue sky' and *phainestrai* 'to appear'), and a bluish grey colour is typical of these amphiboles (Anthony *et al.* 1990). According to Dmitriy Belakovskiy (pers. comm. 2019), curator of the Fersman Mineralogical Museum, Moscow, the gem-quality magnesio-riebeckite from Kazakhstan comes from the Kyzyl-Barbas deposit, which has been known for several decades (since at least 1938). Gem artisans historically have used it to make ornamental boxes.

Pantò kindly donated a 12.45 ct oval specimen to Gem-A, and it was examined by this author. The cabochon measured 23.42 × 10.18 × 7.34 mm and was opaque with a silky sheen. Observed with the microscope (Figure 25), the specimen was seen to consist of intricate asbestiform aggregates composed of long, thin fibrous crystals that showed the characteristic bluish grey colouration in certain orientations. Where the light did not reflect

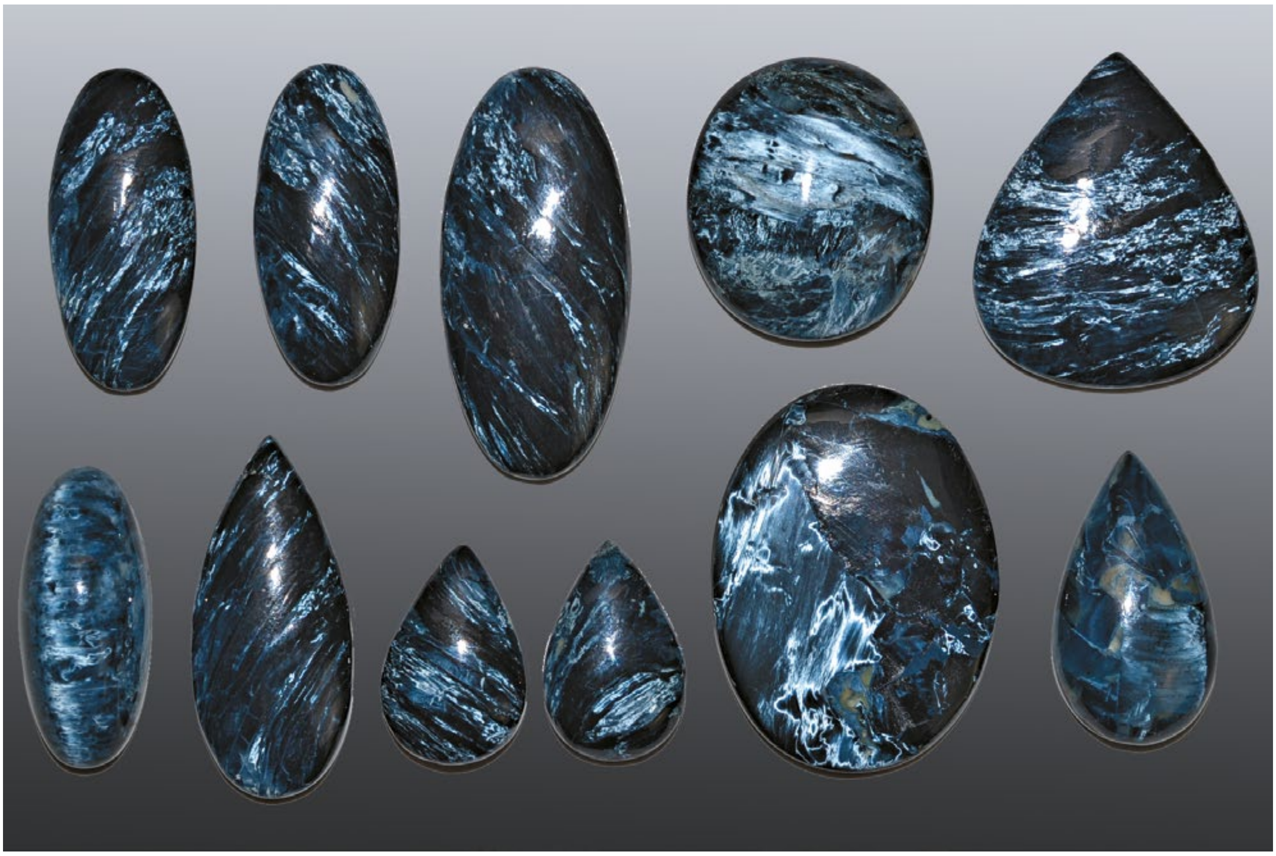


Figure 23: Rhodusite doublets were available in various shapes at the February 2019 Tucson gem shows. The specimens shown here range from 19 to 28 mm long. Photo by Mauro Pantò.

Figure 24: This 16.20 ct (26.2 × 11.4 mm) rhodusite doublet displays a diffuse cat's-eye effect. It is shown from the top (**a**) and side (**b**) views. The black backing is clearly visible in the side view. Photos by Mauro Pantò.

Figure 25: The wavy asbestiform habit of the aggregates of long, thin, fibrous crystals of magnesio-riebeckite is seen here with reflected light. Photomicrograph by A. Costanzo.

from suitably oriented fibres, the material appeared dark grey or black. Raman microspectroscopy using a Horiba LabRam II confocal Raman unit equipped with a 532 nm laser and a high-resolution diffraction grating confirmed the material was magnesio-riebeckite, with several points on the sample all yielding peaks at ~527, ~350, ~270 and ~160 cm^{-1}, which are characteristic of this amphibole species (Rinaudo *et al.* 2004). However, Raman analysis of the backing material did not yield any useful spectra.

The bluish grey to greyish blue sheen displayed by these doublets is not commonly encountered in other gem materials, and therefore they make an interesting addition to the marketplace.

Dr Alessandra Costanzo FGA DGA

References

Anthony, J.W., Bideaux, R.A., Bladh, K.W. & Nichols, M.C. 1990. *Handbook of Mineralogy: Elements, Sulfides and Sulfosalts*. Mineral Data Publishing, Tucson, Arizona, USA, 588 pp.

Hawthorne, F.C., Oberti, R., Harlow, G.E., Maresch, W.V., Martin, R.F., Schumacher, J.C. & Welch, M.D. 2012. Nomenclature of the amphibole supergroup. *American Mineralogist*, **97**(11–12), 2,031–2,048, http://doi.org/10.2138/am.2012.4276.

Rinaudo, C., Belluso, E. & Gastaldi, D. 2004. Assessment of the use of Raman spectroscopy for the determination of amphibole asbestos. *Mineralogical Magazine*, **68**(3), 455–465, http://doi.org/10.1180/0026461046830197.

MISCELLANEOUS

Figure 26: Several local gem companies displayed their products at the 56th Myanma Jade & Gems Emporium. Photo by T. Hlaing.

56th Myanma Jade & Gems Emporium

On 11–20 March 2019, the 56th Myanma Jade & Gems Emporium took place in Nay Pyi Taw. Burmese vice president Henry Van Thio opened the Emporium and visited the display room. The event was attended by 2,912 foreign merchants and 1,649 local buyers. Numerous local companies had booths there (e.g. Figure 26).

There were 6,973 ‘Jade’ lots offered, and 5,263 of them sold for a total of EUR474,141,803. The pieces included cut slabs, beads and bangles. The highest sale consisted of two sawn pieces of jadeite weighing a total of 1,380 kg that sold for EUR10,588,888. A jadeite-encrusted bed weighing 460 kg with a reserve price of EUR10,000 was not sold. Non-jade lots (26 total) included albite, quartzite, idocrase, bowenite (a variety of antigorite) and amphibole.

Of the 500 ‘Gems’ lots that were offered during this Emporium, 69 of them sold for a total of EUR1,024,243. The highest price (EUR76,531) was paid for a parcel of Mong Hsu ruby consisting of 249 pieces weighing 6.84 kg. Fifteen lots of peridot were also sold (e.g. Figure 27), with the highest one fetching EUR75,148.

There were 274 ‘Pearl’ lots offered, and 269 of them sold for EUR1,518,847. The total sales for the event were EUR476,684,893, an increase compared to ~EUR427,095,000 sold at the 55th Emporium.

Dr U Tin Hlaing (p.tinhlaing@gmail.com)
Dept. of Geology (retired)
Panglong University, Myanmar

Figure 27: Buyers examine a parcel of Burmese peridot at the 56th Myanma Jade & Gems Emporium. Photo by T. Hlaing.

Mr Hornby's Diamond: Its Travels, Diplomatic Role and Possible Equation with the Nur al-'Ayn

Jack M. Ogden

ABSTRACT: The Hornby diamond has received scant attention in the literature on gems, with writers noting merely that it was supposedly sold to a shah in Persia in the early 1800s. Detailed information about this diamond is available, however, in a book written by the British diplomat Sir Harford Jones Brydges in the 1830s. From this and other documentation it is possible to pick up the trail of this ~60 ct pink diamond, proceeding from the Iranian Shah Karim Khan to India and then to Britain, where it was put up for auction, and finally back to the Iranian court where, as a diplomatic gift, it helped thwart Napoleon's plans to invade British India. If this diamond still resides within the Iranian Crown jewels, it seems possible that it is the pink Nur al-'Ayn ('Light of the Eye'), which is estimated to weigh approximately 60 ct.

The Journal of Gemmology, **36**(6), 2019, pp. 512–522, http://doi.org/10.15506/JoG.2019.36.6.512

The Hornby diamond is little talked about. Lord Balfour, in his monumental *Famous Diamonds* (2009 and earlier editions), makes no mention of it at all. Edwin Streeter in his 1882 *Great Diamonds of the World* (p. 304) calls it 'Another Gem unknown to History' and simply quotes from the 1839 edition of John Murray's *A Memoir on the Diamond*, adding that 'Nothing further is known of this stone'. Murray, who did not mention the Hornby in his first edition (1831), was brief: 'The 'Hornby' diamond, brought from the East Indies by the Hon. William Hornby, governor of Bombay, in 1775, weighs 36 [*sic*] carats, and is now, I believe, the property of the Schah of Persia' (Murray 1839, p. 70). As shown below, he was slightly incorrect about the date, very wrong about its weight, but correct about its ownership.

In reality, by the time Murray penned his brief 1839 note on the Hornby diamond, its history had been recorded in some detail, but not in the usual gem-related volumes. To uncover its history it is necessary to start with Sir Harford Jones' (later Sir Harford Jones Brydges[1]) account of his 1807–1811 royal mission to the Persian court (Jones Brydges 1834) and the introduction to his 1833 translation of Ma'āṯer-e solṭānīya (*The Dynasty of the Kajars*). The story that unfolds from these books, contemporary press reports, and parliamentary and other sources reveals a much-travelled gem and one that played an important role in international diplomacy.

FROM TEHRAN TO LONDON

The stone that became known as the Hornby diamond was almost certainly of Indian origin and was possibly among the wealth of gems brought to Iran following Nadir Shah's sack of Delhi in 1739. When Haji Yusuf, the

[1] In the 1820s Sir Harford Jones added his grandmother's name, thus becoming Sir Harford Jones Brydges, under which name he authored his 1830s books. He is called Sir Harford Jones here in the text, but Jones Brydges in the references. For more on Harford Jones, see Perry (1989).

Figure 1: Shah Karim Khan, shown here with the Ottoman ambassador Vehbi Effendi, reputedly wore a large pink diamond in a ring. The painting is attributed to Abu'l Hasan Mustawfi, Iran, 1775. Courtesy of the David Collection (Copenhagen, Denmark), inventory no. 21/1999; photo by Pernille Klemp.

chief jeweller to Shah Lotf Ali Khan (reigned 1789–1794) was shown the gem in 1809, he said he knew it well and that Shah Karim Khan (Figure 1; reigned 1751–1779) had worn it in a ring (Jones Brydges 1834). He explained that following Karim Khan's murder in 1779, some of the women of the palace took it. Later that same year it arrived in Bombay, India, with Armenian merchants (Jones Brydges 1834). There it was purchased by an Armenian diamond merchant, a woman reportedly called 'Cross' or 'Madame Pompone', although nothing more has been found about her. She then offered the diamond to William Hornby, who was governor of the East India Company in Bombay and a successful merchant. He bought the stone jointly for 'something like £21,000' (Jones Brydges 1834, p. 14) with David Scott, a Scottish merchant in Bombay and later a director of the East India Company. Soon afterwards Hornby bought out Scott's share [2].

In 1782, Hornby's son-in-law was entrusted with carrying the diamond back from India to London, apparently without knowing the contents of the package. This was Thomas Holmes (~1751–1827), who had married

[2] One must wonder whether Hornby was suspicious about the source of the diamond. In his position as governor of the East India Company in Bombay, he had been quickly notified of the death of Karim Khan in a letter sent by the East India Company's resident in Bushehr, Iran (British Library, MSS IOR/R/15/1/3, pp. 16–18).

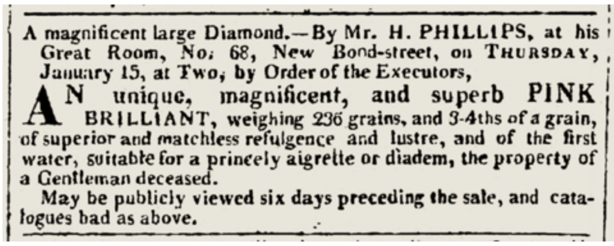
Hornby's daughter Hannah and also worked with the East India Company. Once in Britain the diamond was delivered to John Hunter, a director of the Company who had made his fortune in India before returning to Britain in the late 1770s. There was a close relationship here: Hunter had married William Hornby's widowed mother-in-law.

Hornby resigned his post, sailing from Bombay on the East India ship Raymond on 17 December 1783 and arriving home in England on 13 June 1784[3]. Upon his return he built Hook Park, an imposing country home based on the Government House in Bombay. Hornby's intention was to sell his diamond, but as with some other large diamonds brought back from India, such as the Pigot (Ogden 2009a, b), it was not easy to find a purchaser in London. So, Hunter set off to St Petersburg in Russia to offer the stone to Catherine the Great (Jones Brydges 1834). There seems to be nothing known of this trip other than that it was unsuccessful, and Hunter returned to London with the diamond. This trip must have been made prior to 1796, when Catherine the Great died. Why Hunter undertook this trip rather than Hornby is unclear; perhaps he was travelling to Russia on other business.

IN LONDON

Hornby had not managed to sell the diamond by the time he died in 1803. His lengthy and detailed will makes no specific mention of the large gem, but it was almost certainly in the 'very small Box covered with paper and sealed', which had been lodged with Messrs Herries, Farquhar & Co (a major London bank at the time), the contents of which were 'to be taken and to be considered as part of my personal estate'.[4] Unfortunately, 'the personal estate of the said *William Hornby*, exclusive of the said diamond, … [was] insufficient for the discharge of his debts and legacies'. Thus, attempts continued to be made to sell the diamond 'by private contract, and every diligence used to dispose of it, even much under its estimated value, but without success' (House of Commons 1806–1807, p. 160).

The next move was to put the diamond up for public auction, which took place at Phillips auctioneers at 68 New Bond Street, London, on 15 January 1807. Prior to the auction the stone was advertised as 'An unique, magnificent, and superb PINK BRILLIANT, weighing 236 grains, and 3-4ths of a grain [59.2 old carats, or ~61 metric carats], of superior and matchless refulgence [brightness] and lustre, and of the first water, suitable for a princely aigrette or diadem, the property of a Gentleman deceased' (Figure 2; *Morning Post*, 7 January 1807, p. 4). Another report, published after the auction, described it as 'the only Pink Brilliant ever brought to this Country of considerable size' (*Morning Post*, 22 January 1807, p. 2). A further article commented that the diamond 'is unique in brilliancy, magnitude, and weight, and has been in England 22 years, under the care of a banker in London; but during that time it has never been exposed to the air, nor has it been injured in the least. It has lately been estimated at £25,000' (*Oxford University and City Herald*, 24 January 1807, p. 3). The article also noted that the diamond sold at the auction for 5,000 guineas (£5,250) to 'a Mr. Morthbrooks'. Other reports gave the buyer's name as Mr Friedeberg (e.g. *Morning Post*, 24 January 1807, p. 3). This uncertainty over the identity of the buyer is easily explained: The diamond did not sell. When important auction lots are 'bought-in', that is unsold, it can be embarrassing for the auction house and in the past it was not unusual for them to give a fictitious buyer's name. As Hornby's son John bemoaned, it had been 'put up for sale by public auction, but no actual bidding being made, which bore any proportion to its value, it was not disposed of' (House of Commons 1806–1807, p. 160).



A magnificent large Diamond.—By Mr. H. PHILLIPS, at his Great Room, No. 68, New Bond-street, on THURSDAY, January 15, at Two, by Order of the Executors,

AN unique, magnificent, and superb PINK BRILLIANT, weighing 236 grains, and 3-4ths of a grain, of superior and matchless refulgence and lustre, and of the first water, suitable for a princely aigrette or diadem, the property of a Gentleman deceased.

May be publicly viewed six days preceding the sale, and catalogues had as above.

Figure 2: This advertisement for the sale of Hornby's 'superb PINK BRILLIANT' appeared in the *Morning Post* (7 January 1807, p. 4).

A month after the auction, on 23 February 1807, a petition from John Hornby was presented to Parliament which pointed out that, because of the high estimated value of the gem – £25,000 – 'there is no prospect of selling or disposing of the same, except by way of Lottery or Chance : And therefore praying, That leave may be given to bring in a Bill for that purpose' (House of Commons 1806–1807, p. 160). Hornby was seeking

[3] His resignation letter is in the British Library (MSS IOR/E/1/72, ff. 218–219v).

[4] British National Archives, PROB 11/1401/316.

to dispose of the gem by public lottery, something that needed parliamentary permission. There was a good precedent here, as just a few years earlier in March 1801 the 47.7 ct Pigot diamond had been disposed of by lottery when, similarly, its price was too high for a private buyer (Ogden 2009a, b). A House of Commons committee was set up to consider the matter of a Hornby diamond lottery, but nothing more is known of this. Perhaps it was refused, or it stalled with the upheaval of the change of British government a few weeks later, but another factor may have been the fortuitous intervention of Sir Harford Jones (1764–1847; Figure 3).

Sir Harford had been the East India Company assistant and factor at Basra in the Persian Gulf (1783–1794) and Company resident at Baghdad (1798–1806). In January 1807, recently home from the East and, in his words, 'being in London, and having nothing to do' he wandered into the Phillips auction house at 68 New Bond Street 'when a large brilliant diamond was offered for sale, for which the biddings were so low, that it was bought in' (Jones Brydges 1834, p. 13). After the sale he asked auctioneer Harry Phillips about the gem, and was told that it had belonged to the late William Hornby. Sir Harford realised that it was a diamond with which he 'had long been acquainted' and recounted the story of how and when it arrived in Bombay, and of its purchase by Hornby, information he must surely have gained in India (Jones Brydges 1834, p. 13). Sir Harford provided a succinct description of the gem: 'The form is what the oriental jewellers call an irregular circle, but capable of being much improved if the stone were submitted to new cutting and some loss of substance' (Jones Brydges 1834, p. 15). Its pink colour, he noted, 'is never considered by jewellers to deteriorate the value of a diamond' (Jones Brydges 1834, p. 15).

BACK TO IRAN

Sir Harford knew the East well and spoke Persian fluently, and so, as the Napoleonic wars raged on in the early 1800s, he was a good choice to lead a British mission to Iran to try to persuade the shah to favour the British

Figure 3: Sir Harford Jones carried the Hornby diamond from Britain back to Iran as a diplomatic gift in 1807–1808. Portrait by Thomas Lawrence; photo © John Lucas-Scudamore Collection/Bridgeman Images.

rather than the French, and thus to stall Napoleon's feared overland attack on British India. So, in February 1807 Sir Harford was appointed 'Envoy Extraordinary and Minister Plenipotentiary to the Court of Tæheran' and was to head East on his mission as soon as possible (Jones Brydges 1834, title page and *passim*). At this point he must have realised the huge potential diplomatic bargaining value of the diamond he had seen a few weeks earlier. He negotiated with Henry Fawcett of Bruce, Fawcett & Co, a well-established trading house now handling the stone, and it was agreed that the gem would be transported by them to Bombay and taken into the care of that company's offices there. Once Sir Harford was himself in Bombay and about to set off for Tehran, he would take the diamond with him, at the risk of the owner and with sole discretion as to how it was disposed of in Iran. From what was later stated, it would seem that the inheritors of the Hornby diamond would now accept the sum of £10,000 for it (Jones Brydges 1834, Note II following p. 472).

A change in the British government meant that there was a few months' delay before Sir Harford's appointment was confirmed by the new government, in the summer of 1807. In August he was made baronet, a status befitting the important role he was to play (*Morning Chronicle*, 24 August 1807, p. 2) and then, on 27 October 1807, he sailed from Portsmouth on the Sapphire. Sir Harford arrived in Bombay on 26 April 1808 and headed to Iran, with the Hornby diamond, arriving at the Persian Gulf trading port of Bushehr on 14 October 1808 (Jones Brydges 1834). Then with his colleagues, including James Morier as private secretary and Thomas Henry Sheridan as political assistant, he set off on the 2,000-km overland journey north to Tehran.

In Shiraz, where they arrived on 30 December 1808, Sir Harford was reacquainted with the jeweller Haji Yusuf,[5] whom he knew from his earlier days in the region and who had been chief jeweller to Lotf Ali Khan, the last shah (reigned 1789–1794) of the Zand dynasty (Jones Brydges 1834). Sir Harford showed him the diamond and '"Oho!" cried he, "this is an old acquaintance of mine"' (Jones Brydges 1834, p. 143). The jeweller conveyed its history, of it being worn by Shah Karim Khan (1751–1779) in a ring 'which, through the hands of some of the women, it was conveyed out of the palace, on his death'. He also explained that since that loss, subsequent shahs Ali Murad Khan (1781–1785), Jafar Khan (1785–1789) and Lotf Ali Khan (1789–1794) had all requested him to look for it. Haji Yusuf gave the diamond's value as 20,000 tomans, 'that is about £20,000 sterling' (Jones Brydges 1834, pp. 143–144).

In early February 1809 there was a potential delay occasioned by Abdullah Khan, the governor in Isfahan, which Sir Harford neatly circumvented by explaining that 'if you stop me here, you will prevent my delivering to the King of Persia the magnificent diamond with which I am charged from my sovereign' (Jones Brydges 1834, p. 171). He showed him the Hornby diamond; he specifically called it that. The astonished governor, who supposedly 'lost his balance and fell back from his seat quite out of breath' (Eastwick 1864, p. 119), asked if he might make a note of its size. Sir Harford agreed, guessing that this information would be sent rapidly ahead to the shah. Abdullah Khan did this by placing the diamond on a piece of paper and cutting around it with 'a clumsy pair of scissors' (Jones Brydges 1834, p. 172). Not surprisingly, the result was an oversized reproduction. As Sir Harford sagely noted, 'it was his representation, not mine; so that had he made it as large as the largest of the jewels which the Genus of the lamp presented Aladeen, he alone was answerable for the mistake' (Jones Brydges 1834, p. 172). General Sir James Sutherland, who was present at this meeting, is reported as saying that the diamond was in a ring which Sir Harford produced from his waistcoat pocket (Eastwick 1864), although there is no corroborating evidence that it was then mounted in that way.

Finally, on 17 February 1809, the Mission was received by Fath Ali Shah in Tehran. The occasion was recorded in an oil painting by the English artist Robert Smirke (Figure 4). The diamond, which Sir Harford suggested was worth more like £25,000, was presented along with other gifts which, Thomas Sheridan noted, included 'a gold-enamelled snuff-box, on the lid of which was the king's picture set round with large brilliants; and a small ebony box, on the lid of which a representation of the Battle of Trafalgar was beautifully cut in ivory; and some other smaller things which I forget' (Jones Brydges 1834, p. 186). These 'other things' included another wooden box, this one with an ivory carving of Windsor Castle, and 'a small blood-stone Mosaic box for opium' (Morier 1812, pp. 186–187). The boxes with the carvings of the Battle of Trafalgar and Windsor Castle were an unsubtle reminder to the shah of Britain's supremacy over the French and

[5] Sir Harford refers to him as 'Hajee Eusoof' in his 1834 account of the Mission, and as both 'Hajy Eusoph' and 'Hajy Eusoof' in his 1833 translation of *The Dynasty of the Kajars*, where he describes him as principal jeweller to Lotf Ali Khan (Jones Brydges 1833, 1834).

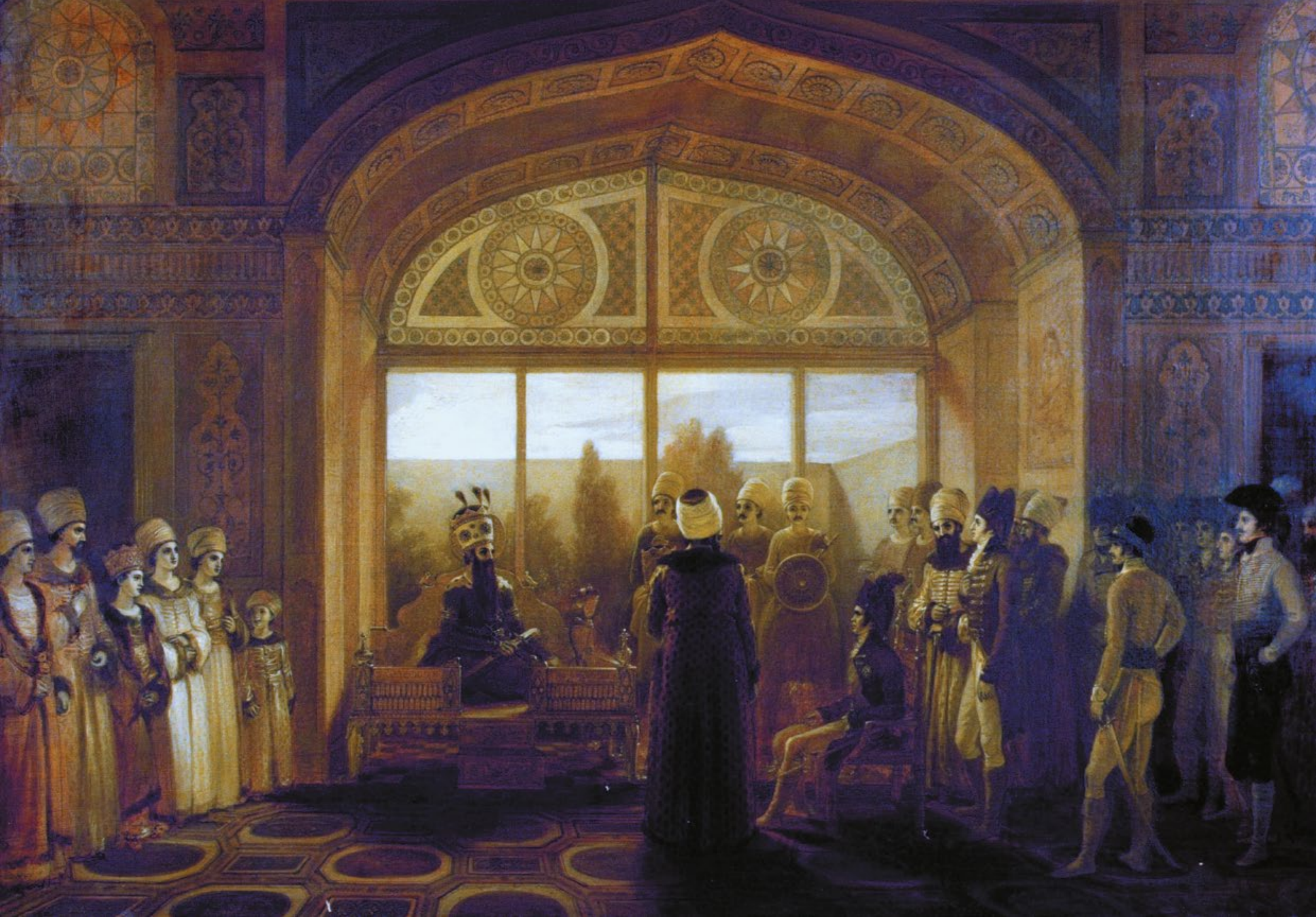


Figure 4: This painting depicts Fath Ali Shah (the shah of Persia in 1797–1835) meeting with Sir Harford Jones (seated). Painting by Robert Smirke (1752–1845); courtesy of a private collection/Bridgeman Images.

the power of the British monarchy. A long letter to the shah from British King George III ended with 'may the friendship and interests of England and Persia henceforward become inseparable' (Morier 1812, p. 190).[6]

It worked. In his journal, Thomas Sheridan recorded that the Mission was told the shah was pleased 'with all the gentlemen, and delighted with the presents, and that His Majesty swears he will never again have any thing to do with the French' (Jones Brydges 1834, pp. 189–190). The French Mission was expelled from the country. An anonymous 'officer', who was with Sir Harford's Mission, sent a letter from Tehran dated 22 May 1810 saying that 'the diamond estimated at twenty five thousand pounds, was of finer water than any the Persian Monarch possessed. He had it immediately set, and wore it as a ring the next day' (*Evening Mail*, 22 August 1810, p. 3). Apparently, the shah also more privately noted his surprise and admiration 'that Sir Harford, when there was nobody to detect him, had not substituted another [diamond] in its place' (Jones Brydges 1834, p. 209).

The formal treaty that Sir Harford concluded with the shah on 12 March 1809 laid down that no European force other than Britain could pass through Iran and that, should any European force invade Iranian territories, Britain would come to Iran's aid (Hobhouse 1839). Napoleon, who it was believed had ambitions to create a base in Iran from which he could launch an attack on

[6] There is a large collection of Sir Harford Jones' correspondence and related manuscripts in the British Library that is not indexed. An examination of those papers most obviously dealing with the 1807–1811 Mission revealed no further information about the diamond. A collection of more than 3,000 of his personal and official papers were sold at Sotheby's London in 2009 (auction of 'English Literature, History, Children's Books & Illustrations', 14 July 2009, lot 6; see www.sothebys.com/en/auctions/ecatalogue/2009/english-literature-history-children39s-books-illustrations-l09773/lot.6.html). According to Sotheby's summary of the contents, the correspondence reveals that Jones was involved in the 'sale' of the Hornby diamond to the shah, which suggests that the summary does not provide much detail about this incident. There is also a collection of correspondence from Sir Harford Jones in The Huntington Library, San Marino, California, USA (Mss HJ 1-88), but it was not possible for the author to access it for this study.

British India, abandoned any such plan (Dodwell 1929).

Sir Harford later noted that 'I could not foresee such a "God-send" as this diamond, by which the Company, at the expense of £10,000, gave the Shah that which he estimated at £20,000*l*. or £25,000*l*' (Jones Brydges 1834, Note II following p. 472). More than 50 years later, the orientalist, diplomat and conservative member of Parliament Edward Backhouse Eastwick (1814–1883) commented (House of Commons 1872, col. 1088):

> The truth was, then, that the Royal Envoy [Sir Harford] would have been sent back by the Persians from Shiraz…had it not been for a subtle device of Sir Harford, who had been long enough at Bagdad to take the exact measure of the Persian Court. With a view to the difficulty he would have to encounter, Sir Harford had provided himself with a magnificent diamond which had been in the signet ring of Karim Khan.

The shah seemed oblivious to the fact that he was receiving back a diamond stolen from one of his predecessors. And sensibly, Sir Harford did his best to ensure secrecy. He asked Haji Yusuf, the jeweller who had recognised the gem and knew its history, for a favour: '… never to mention that you have seen this stone, or that it belonged to Kerim Khan. Of this latter circumstance, they must be ignorant at Tæheran' (Jones Brydges 1834, p. 144). The only other person who might have had some earlier knowledge of the stone was the man he called 'Meerza Bozurg', that is Mīrzā 'Abbās Nūrī, known as Mīrzā Bozorg, a prominent Iranian government official then in Tehran. Sir Harford called him an 'old and powerful friend' and a 'great pillar of confidence', and was certain he could 'easily procure his silence' with regard to the history of the gem (Jones Brydges 1834, pp. 31, 38 and 144).

The realisation in Tehran that, with the presentation of the Hornby diamond, Britain had simply given them their own gem back probably came no later than 1834 when Sir Harford published his account. This does not seem to have caused a diplomatic scandal, and it is even possible that the Hornby diamond briefly returned to Britain. In 1873 Shah Naser al-Din (1848–1896) visited England, travelling overland through Russia, Germany and Belgium. Press reports talk of the 'blaze' of diamonds he wore, although the only diamond that was specifically named was the square pink Daryā-ye Nur, which 'glittered' in his belt on one occasion and 'hung from his button-hole' on another (*Essex Herald*, 11 February 1873, p. 7; *The Graphic*, 2 July 1873, p. 10).[7] This ties in closely with a statement made by Malecka (2018, p. 73), based on Iranian sources, that Naser al-Din wore the Daryā-ye Nur as a belt buckle and on his watch chain.[8]

SUBSEQUENT WHEREABOUTS

Sir Harford returned to Britain in 1811, but what of the Hornby diamond he had left in the appreciative hands of the shah?

A report that the Hornby diamond travelled to France appeared widely in the press in 1851 (e.g. *The Observer*, 18 May 1851, p. 4). This rumour was seemingly in the context of the Great Exhibition held in London from May to October that year. At the Exhibition there was a small showcase in the 'British Department' in which were exhibited crystal models of 'all the largest diamonds in the world' (*London Evening Standard*, 17 June 1851, p. 3).[9] One was 'an English gem, called the Hornby diamond, sold to Persia for £8,000, and afterwards obtained by France' (*ibid.*). There seems to be no further substantiation that the Hornby went back to France, and there may have been confusion with the Pitt or Regent diamond which was indeed in France.[10] When Edward Eastwick, secretary to the British legation in Iran from 1860 to 1863, saw the shah's amazing jewels, he specifically mentioned just three large diamonds: the ~180 ct Daryā-ye Nur, one he called the 'Táj i Humá' (presumably the Taj-i-Mah of ~114 ct) and, in a ring, 'the

[7] *The Graphic*, 2 July 1873, was a special issue devoted to 'The Progress of His Majesty NUSSER-OOD-DEEN Sovereign of Persia (Shah-in-Shah, King of Kings) from Teheran to Great Britain'.

[8] The large 'Darria-i-Noor' diamond exhibited in the 'Indian Department' at the 1851 Great Exhibition in London was a very different gem (Anonymous 1851, p. 115; Singh & Singh 1985, p. 103).

[9] The author could find no further information about the simulated diamonds, although it is possible that they were lead-crystal models made by the celebrated glass company Apsley Pellatt, which manufactured models of the Koh-i-Noor and 'its two attendant gems' that were shown at the Great Exhibition (for the Koh-i-Noor model, see Tarshis 2000). The author cannot recollect ever having seen a model of the Hornby diamond among the many glass models that have been made for famous diamonds.

[10] The implausibility that the Pitt diamond had travelled to Iran and back was raised by a correspondent to *Notes and Queries* (No. 122, 30 April 1864, pp. 357–358), with the editor suggesting that the diamond was surely not the Pitt itself but one of the 'fragments taken off in the cutting of [the] diamond'. This unconvincing explanation was nevertheless widely repeated over the succeeding years.

Figure 5: (**a**) The ~60 ct Nur al-'Ayn diamond was set in the centre of a tiara designed by Harry Winston for Farah Diba to wear at her marriage to Shah Mohammed Reza Pahlavi in 1958. The tiara resides in The Treasury of National Jewels in the Central Bank of Iran in Tehran. Courtesy of the Royal Ontario Museum; photo by Leighton Warren. (**b**) This image of the diamond was digitally isolated from the crown by the author to show it in more detail.

famous Pitt diamond sent by George IV [*sic*] to Fath Ali Shah' (Eastwick 1864, pp. 115, 119).[11] This appears to show both a confusion with the Pitt diamond and that the Hornby diamond was still in Iran at least as late as the 1860s. Eastwick said he was told about the arrival of this diamond in Iran by Sir James Sutherland, who had been present with Sir Harford in Isfahan. So perhaps this confusion of Hornby's diamond with the Pitt stems from Sutherland's faulty recollections or from Sir Harford's deliberate obfuscations among his colleagues at the time of his Mission, when he did not want the true origin of the gem known too widely.

The Hornby diamond may have been sold or given away by one of the subsequent shahs. Such things did happen. Lotf Ali Khan Shah briefly considered selling two of his largest diamonds, the pink Daryā-ye Nur and the Taj-i-Mah (Jones Brydges 1833, p. cxxv). In 1935 it was announced that an exceptionally fine pink diamond of 14 ct was on the market that had been 'presented to Catherine the Great of Russia by the Shah of Persia about 1780' (*Warwick and Warwickshire Advertiser*, 19 January 1924, p. 6). Reputedly, it had been brought to Britain after the Russian Revolution by the Grand Duchess Michael, hidden in her clothing. Another pink diamond that had supposedly once belonged to the shah was a 10 ct stone that was noted in a Bond Street, London, shop in 1901 (*Manchester Courier*, 11 November 1901, p. 4). It was supposedly named 'Nur-ed-din'. If two relatively small pink diamonds that had reached Europe from Iran were noted in the press, it seems unlikely that the arrival of an ~60 ct pink diamond would not have been noted and therefore would not have remained unknown for more than a century. The shahs also continued to buy diamonds. One report from Paris in 1859 explains how Napoleon III, on a tip-off from the French consul in Tehran, had sent a 'trusted person' there to buy a magnificent diamond that a Portuguese jeweller had taken to that country to sell to the shah (reported in *Warschauer Zeitung*, 12 October 1859, pp. 642–643).[12] It had presumably just come from India, since its previous owner was said to be a Jewish person from Goa.

POSSIBLE EQUATION WITH THE NUR AL-'AYN

In the absence of clear evidence that the Hornby pink diamond left Tehran, could it still be there? There is indeed a large oval brilliant-cut pink diamond in The Treasury of National Jewels in the Central Bank of Iran in Tehran that weighs an estimated 60 ct. This is the Nur al-'Ayn (the 'Light of the Eye'), and it is set in the centre of a tiara (Figure 5) that was designed by Harry Winston which Farah Diba wore at her marriage to Shah Mohammed Reza Pahlavi in 1958. Victor Meen and Arlotte Tushingham, who examined this gem in the 1960s, described it as 'the world's [then] largest recorded rose-pink diamond', a 'Slightly drop shaped,

[11] A widely repeated statement in the British press in the summer of 1810 that 'A superb diamond ring, the centre brilliant of which is valued at 3000 guineas, is made as a present for his Majesty the Emperor of Persia' (e.g. *Morning Post*, 28 June 1810, p. 3) probably refers to a different ring.

[12] The author is grateful to Anna Malecka for bringing this to his attention.

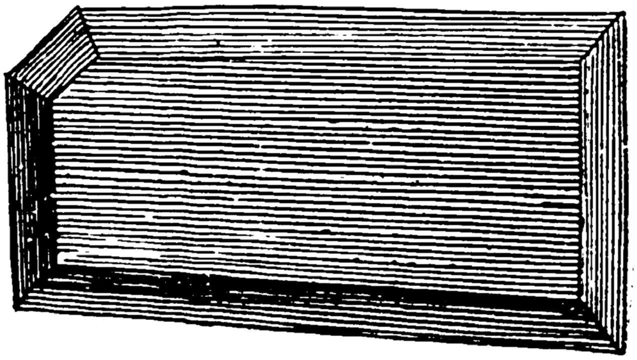


Figure 6: The Great Table diamond, here as illustrated by Jean Baptiste Tavernier in the first edition of his *Voyages* (Tavernier 1676), is a possible source of the material from which the Nur al-'Ayn diamond was cut.

oval brilliant, 30 × 26 × 11 mm (est. 60 carats), pink, very limpid' (Meen *et al.* 1967; Meen & Tushingham 1968, p. 139). They also describe it as having 'asymmetric shoulders': one rounded, one square (Meen *et al.* 1967, p. 1,007; Meen & Tushingham 1968, p. 28). This does sound like the brilliant-cut pink diamond, an 'irregular circle' weighing ~60 ct and of high clarity, which had been brought to England by William Hornby.

A counter argument against the Hornby diamond and the Nur al-'Ayn diamond being one and the same is the quoted history of the latter stone. This history has been examined in some depth recently (Malecka 2014). In brief, from the 18th century come accounts that Nader Shah brought a diamond called the Nur al-'Ayn from India following his sack of Delhi in 1739 (Malecka 2014, 2018). Then, according to the 19th-century Ottoman scholar Ahmed Cevdet Pasa, it was stolen following Nader Shah's murder in 1747 and subsequently sold in Constantinople to the Ottoman Sultan Selim III (reigned 1789–1807; Malecka 2014). If true, then this diamond cannot be the Hornby, which was worn by Karim Khan up to 1779 and then owned by William Hornby through the 1780s and 1790s. However, Cevdet Pasa also said that the Nur al-'Ayn was a pyramid-shaped rough weighing ~60 ct when it was taken to the Ottoman court in the 1700s; if he was correct, then it cannot be the ~60 ct pink brilliant-cut diamond in Tehran that now bears the name Nur al-'Ayn (Malecka 2014). Malecka (2014) pointed out that there is seemingly no mention of the Nur al-'Ayn in 19th-century Iran before 1834. This, coincidentally, is the year in which Sir Harford's account of his Mission was published and the history of the Hornby diamond was made public. The stories of the original ~60 ct Nur al-'Ayn being stolen from the murdered Nader Shah in 1747 and the ~60 ct pink diamond being stolen from the murdered Karim Khan in 1779 are remarkably similar. Is it possible that, when it became known in Tehran that the diamond presented by Sir Harford in 1809 had been stolen from an earlier shah, this diamond was wrongly assumed to be Nader Shah's Nur al-'Ayn and has borne that name ever since?

There is another argument for the Hornby and Nur al-'Ayn not being the same gem. Meen *et al.* (1967) showed that two large pink diamonds in Tehran—the Nur al-'Ayn and the rectangular Daryā-ye Nur—could have both come from the large diamond illustrated by Jean Baptiste Tavernier and which, since the 1860s at least, has been called the 'Great Table' (Figure 6; Tavernier 1676, pp. 334–335 and figure 3 facing p. 334; King 1865, p. 414; Streeter 1877; Meen *et al.* 1967). The end could have cleaved off, or been cleaved off, the Great Table. The investigation by Meen *et al.* (1967) of the crystallographic orientation of the Daryā-ye Nur and the presence of a cleavage flaw in the Nur al-'Ayn showed this to be feasible. Indeed, they demonstrated how cutting the Nur al-'Ayn from the cleaved-off portion of the Great Table 'accounts for the slight drop-shape of the stone, the one nicely rounded shoulder and the other rather square shoulder' (Meen *et al.* 1967, p. 1,007). Their proposition is shown in Figure 7, based on measurements and models published by Meen e*t al.* (1967). This raises a problem in identifying the Hornby with the Nur al-'Ayn because Sir Harford says he was shown the Great Table intact in Tehran in 1791, while the Hornby was in Britain.

Sir Harford was invited by Shah Lotf Ali Khan (reigned 1789–1794) to give advice on the potential sale of two of his largest diamonds, and he recognised that one of them, the Daryā-ye Nur, 'perfectly agreed' with Tavernier's drawing of the Great Table, a copy of which he conveniently had with him.[13] There was a weight discrepancy, however, since Tavernier gave the weight of the Great Table as '176 1/8 mangelins [an old Indian weight unit for gems] which are of our carats 242 5/16', whereas Sir Harford was told by 'Mirza Jaunee… a very tolerable lapidary', that the diamond he saw was just over 176 'Persian carats' (Tavernier 1676, pp. 334–335; Jones Brydges 1833, p. cxxxvi). He mulled

[13] The images of the Great Table shown in different editions of Tavernier vary in their orientation. Some have the cut corner upper right, some upper left. The drawing shown in Figure 6 is from the first edition (Tavernier 1676, facing p. 334).

over this discrepancy and even 'began to doubt whether it could be the same stone' but concluded that they were indeed identical (Jones Brydges 1833, p. cxxxvi). However, a strong indication that he was mistaken—that the Daryā-ye Nur he was shown was the larger section of the Great Table, not the whole of it—comes from his own report. That same skilled lapidary assured Sir Harford that 'the Dereya-noor had substance enough to allow of facets being cut from a girdle; which when effected, would give the stone pretty much the form and lustre of a properly-proportioned brilliant' (Jones Brydges 1833, p. cxxxvi). Sir Harford, experienced with diamonds, would not take seriously the proposal that a diamond with the attenuated tablet shape of the original Great Table—nearly twice as long as it was wide—would be easy to facet into a properly proportioned brilliant. The coincidence of Sir Harford being told the Daryā-ye Nur weighed '176 carats and a small fraction' and Tavernier's weight for the Great Table of 176 1/8 mangelins was not lost on Meen and his colleagues, but coincidence it may be (Meen *et al*. 1967, p. 1,004).

Recent research by Malecka (2018) into the Daryā-ye Nur based on textual and pictorial sources has also concluded that the Great Table was divided well prior to Sir Harford's viewing in 1791. If so, then there is no clear argument against the Nur al-'Ayn now in Tehran and the Hornby diamond being the same gem other than Cevdet Pasa's statements about a gem named the Nur al-'Ayn being in Ottoman Turkey. The weight details he gives, however, do not match with either the Nur al-'Ayn now in Tehran or the Hornby, and it is not improbable that he was referring to a different gem—perhaps a diamond where the name meaning 'light of the eye' was more appropriate than it would seem to be for a pink one. So although we may never know for certain whether Hornby's diamond is the Nur al-'Ayn now in Tehran, it does seem improbable that there would two slightly asymmetric, ~60 ct brilliant-cut pink diamonds in Iran in the 19th century. If there had been such extraordinarily rare twins there, surely those privileged to view the treasury would have mentioned them. Indeed, a description of the Iranian royal treasury from 1893 (though possibly based on an earlier report) notes that the two finest diamonds among the 51,355 gems in the treasury were the Daryā-ye Nur and the one 'sent by George IV [*sic*], as a present to Fath Ali Shah' (*Hampshire Telegraph*, 25 February 1893, p. 11). It is also highly unlikely that one of a unique pair would be disposed of intentionally, because a pair would be more highly valued than two singletons.

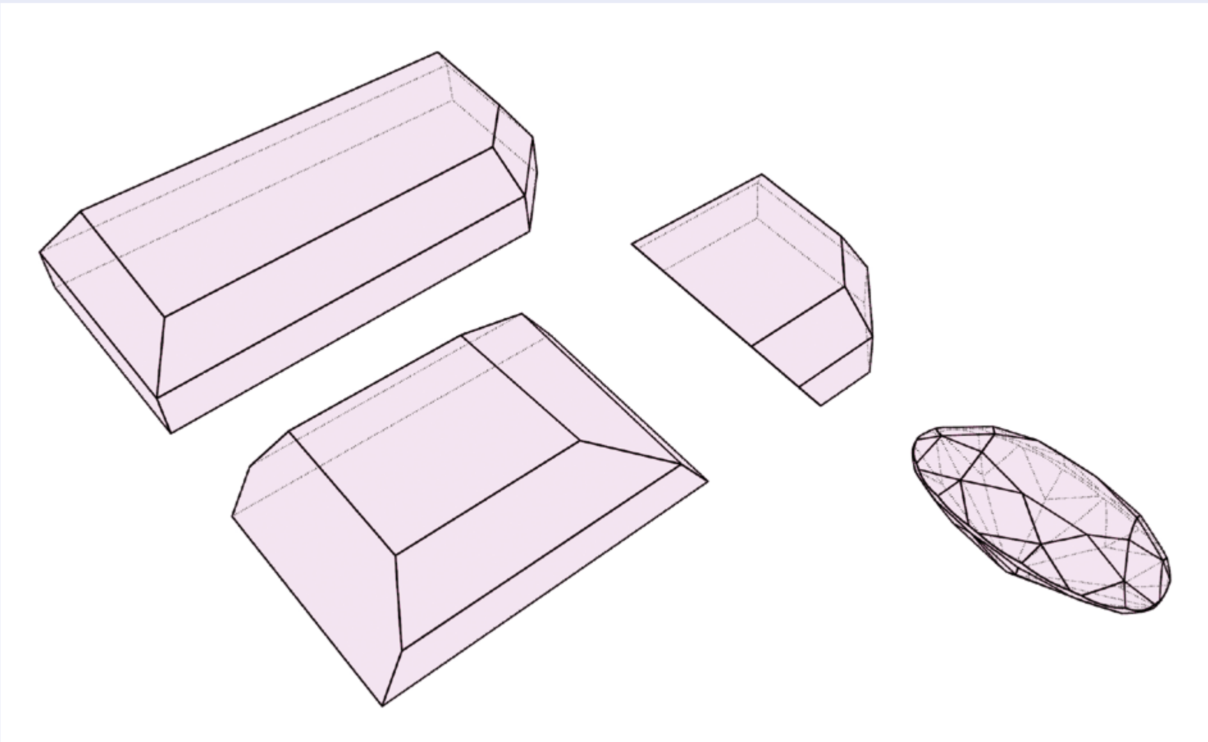


Figure 7: This drawing shows how the Great Table diamond could have cleaved to produce the starting material for cutting the Daryā-ye Nur (left) and the Nur al-'Ayn (right) diamonds, based on drawings and measurements in Meen *et al.* (1967). Drawing © J. Ogden.

CONCLUSIONS

This article sheds some light on the ~60 ct Hornby pink diamond, which Edwin Streeter had described as a 'Gem unknown to History' (Streeter 1882, p. 304). Various documentation traces it from its theft from Iran in 1779 to Britain, into a London auction in 1807, and then back to Iran in 1809 as a diplomatic gift from the British Crown to Fath Ali Shah which arguably changed the course of the Napoleonic Wars. The close similarities of weight, shape and colour strongly suggest that the Hornby diamond may be one and the same as the celebrated Nur al-'Ayn diamond.

If the Nur al-'Ayn and Hornby diamonds are the same, then Phillips, the auctioneers of the latter stone in London in 1807, were remarkably prophetic. They called the Hornby diamond 'suitable for a princely aigrette or diadem' (*Morning Post*, 31 December 1896, p. 4). The Nur al-'Ayn was set in the centre of a tiara (again, see Figure 5), and today it resides in The Treasury of National Jewels in the Central Bank of Iran in Tehran.

REFERENCES

Anonymous, 1851. *A Guide to the Great Exhibition*. George Routledge and Co., London, viii + 231 pp.

Balfour, I. 2009. *Famous Diamonds*. 5th edn. Antique Collectors' Club, Woodbridge, Suffolk, 335 pp.

Dodwell, H.H. 1929. Exclusion of the French, 1784–1815. *In:* Dodwell, H.H. (ed) *The Cambridge History of the British Empire*, Vol. 4, British India, 1497–1858. Cambridge University Press, London, 322–332.

Eastwick, E.B. 1864. *Journal of a Diplomate's Three Years' Residence in Persia*, Vol. 2. Smith, Elder & Co., London, 339 pp.

Hobhouse, J. 1839. *Treaties with Persia. Indian Papers, No. 2, Treaties.* J. Harrison and Son, London, 7 + 19 pp.

House of Commons 1806–1807. *Journals of the House of Commons*, Vol. 62. Cornelius Buck, London, 979 pp.

House of Commons 1872. *Hansards Parliamentary Debates*, 3rd Series, Vol. 212. Commons Sitting of 12 July 1872, cols. 1,088–1,089.

Jones Brydges, H. 1833. *The Dynasty of the Kajars*. J. Bohn, London, 448 pp.

Jones Brydges, H. 1834. *An Account of the Transactions of His Majesty's Mission to the Court of Persia, in the Years 1807–11*, Vol. 1. James Bohn, London, 238 pp.

King, C.W. 1865. *The Natural History, Ancient and Modern, of Precious Stones and Gems, and of Precious Metals*. Bell and Daldy, London, 442 pp.

Malecka, A. 2014. The mystery of the Nur al-'Ayn diamond. *Gems&Jewellery*, **23**(7), 20–22.

Malecka, A. 2018. Daryā-ye Nur: History and myth of a crown jewel of Iran. *Iranian Studies*, **51**(1), 69–96, http://doi.org/10.1080/00210862.2017.1362952.

Meen, V.B. & Tushingham, A.D. 1968. *Crown Jewels of Iran*. University of Toronto Press, Toronto, Ontario, Canada, 159 pp.

Meen, V.B., Tushingham, A.D. & Waite, G.G. 1967. The Darya-i Nur diamond and the Tavernier "Great Table". *Lapidary Journal*, **21**(8), 1,000–1,009.

Morier, J.J. 1812. *A Journey Through Persia, Armenia, and Asia Minor, to Constantinople, in the Years 1808 and 1809* […]. Longman, Hurst, Rees, Orme, and Brown, London, 438 pp.

Murray, J. 1839. *A Memoir on the Diamond: Including Its Economical and Political History*. 2nd edn. Relfe & Fletcher, London, 84 pp.

Ogden, J. 2009a. England's largest diamond. Part 1: The gamble. *Gems&Jewellery*, **18**(2), 30–33.

Ogden, J. 2009b. England's largest diamond. Part 2: From Pall Mall to the pyramids. *Gems&Jewellery*, **18**(3), 36–37.

Perry, J. 1989. Brydges, Harford Jones. *Encyclopaedia Iranica*, **4**(5), 488–489.

Singh, B.N. & Singh, K. 1985. *History of Koh-i-Noor, Darya-i-Noor, and Taimur's Ruby*. Atlantic Publishers & Distributors, New Delhi, India, 180 pp.

Streeter, E.W. 1877. *Precious Stones and Gems, Their History and Distinguishing Characteristics*. Chapman & Hall, London, ix + 264 pp.

Streeter, E.W. 1882. *The Great Diamonds of the World. Their History and Romance*. George Bell & Sons, London, xxiii + 321 pp.

Tarshis, D.K. 2000. The Koh-i-Noor diamond and its glass replica at the Crystal Palace Exhibition. *Journal of Glass Studies*, **42**, 133–143.

Tavernier, J.-B. 1676. *Les Six Voyages de Jean Baptiste Tavernier (…) en Turquie, en Perse, et aux Indes (…)*, Vol. 2. Gervais Clouzier et Claude Barbin, Paris, France, 527 pp.

The Author

Dr Jack M. Ogden FGA
55 Florin Court, Charterhouse Square,
London EC1M 6EU
Email: jack@striptwist.com

Figure 1: Placer deposits along the south-western coast of Namibia are an important source of diamonds, most of which (95%) are gem quality. The stones shown here range from ~0.5 to 10 ct. Photo courtesy of De Beers.

Onshore and Nearshore Diamond Mining on the South-Western Coast of Namibia: Recent Activities and Future Exploration Techniques

Jana Jacob and Gottfried Grobbelaar

ABSTRACT: Diamond mining along the onshore and nearshore zones of south-western Namibia has been active for the past 90 years. A high proportion (95%) of the diamonds are gem-quality. This mega-placer is the result of a weathering and conveyor system that liberated diamonds from kimberlite pipes in the interior of southern Africa and transported them along the Orange River drainage system to the Atlantic Ocean. The onshore marine component of the placer is virtually mined out. However, new techniques of processing and interpreting geophysical datasets that were recently acquired from both onshore and offshore sectors of the deposit have revealed controls on the diamondiferous gravels that provide much-needed guidance for future mining operations, and should help extend the exploitation of the nearshore deposits for decades to come.

The Journal of Gemmology, **36**(6), 2019, pp. 524–532, http://doi.org/10.15506/JoG.2019.36.6.524

The south-western coast of Namibia is renowned for its deposits of high-quality gem diamonds (Figure 1). Since the discovery of the first diamond near Lüderitz in 1908, mining activities have taken place in the region for more than a century (nearly continuously for the past 90 years). The placer deposit, which in this context constitutes a secondary concentration of diamonds through sedimentary transport processes, is situated in the *Sperrgebiet* ('restricted area'), a coastal region roughly 80 km wide that extends mainly from the mouth of the Orange River to Lüderitz (Figure 2). In 2008, the Tsau //Khaeb National Park was established in the *Sperrgebiet* area and provides restricted access for tourism. However, much of the historic diamond mining areas—and all of the active operations—remain closed to visitors, and access is strictly controlled by Namdeb (a 50/50 joint venture between the Namibian government and De Beers Group).

The coastal strip between the mouth of the Orange River and Chameis Bay (again, see Figure 2) has been the mainstay of diamond production, having yielded more than 63 million carats since 1928. The largest diamond recovered from this area to date weighed 246 ct. Annual diamond production peaked in the 1970s at 2 million carats, and currently about 300,000 carats are mined per year. Bedrock gullies created effective trap sites for diamondiferous gravels during marine concentration and upgrading processes (Jacob *et al.* 2006). However, the vast majority of onshore beaches along this roughly 100-km-long coastal strip have been mined out. Submerged beaches extending just offshore (in waters too shallow for ship-based mining) are currently being sampled and mined through the use of

Figure 2: The marine component of the Namibian diamond mega-placer extends from the mouth of the Orange River at Oranjemund northward to Lüderitz, in both onshore and offshore deposits. This map shows the location of the Southern Coastal Mines (previously known as Mining Area 1) within the *Sperrgebiet*.

innovative technology. This article gives an overview of the diamond emplacement model, and briefly describes progress in geophysical data processing and exploration techniques, as well as recent and future mining activities in Namibia's onshore and nearshore diamond deposits. Reclamation and environmental activities in the mined-out areas are also described.

DIAMOND MEGA-PLACER

A diamond mega-placer is defined as a deposit containing at least 50 million carats of 95% or higher gem-quality stones (Bluck *et al.* 2005). The diamond population mined along the south-western coast of Namibia yields 95% gem-quality diamonds and has one of the highest dollar-per-carat values in the world. The reason for the high gem quality stems from the extensive transport of the diamonds from kimberlite pipes some 1,000+ km in the interior of southern Africa to the coastal placer (Gurney *et al.* 1991; Bluck *et al.* 2005). During this long journey the relatively weaker non-gem and inclusion-bearing diamond fraction was mostly broken down.

The diamond mega-placer in Namibia comprises a fluvial component along the lower Orange River, a marine component along the Atlantic coastline and a deflation/aeolian component (i.e. formed by wind action) in the northern half of the *Sperrgebiet*. These areas are covered by Namdeb's Orange River Mines, Southern Coastal Mines (previously known as Mining Area 1) and Northern Coastal Mines, respectively. The formation of this mega-placer relied on four key elements.

The first is the Orange River system, which drains the interior of southern Africa and has been active for the past 100 million years (Ma; see Bremner *et al.* 1990; Brown *et al.* 1995; Aizawa *et al.* 2000). The drainage basin of the Orange River system includes the Vaal River, a major tributary of the Orange, which drained areas containing many of the diamondiferous kimberlite pipes in the Kaapvaal craton (de Wit 1999). The river evolved from a free-meandering system to confined channel flow during the early Tertiary period (~60 Ma; see Ward *et al.* 2002; Bluck *et al.* 2005, 2007). Phillips & Harris (2009) showed that 80% of the diamonds were less than 300 million years old. This is consistent with palaeo-drainage reconstructions, suggesting that Cretaceous Group I and Group II kimberlites in southern Africa were the most likely sources of the Namibian alluvial diamonds.

The second key element in the formation of the Namibian mega-placer was early Tertiary uplift of the interior of southern Africa (Aizawa *et al.* 2000), which led to increased erosional capacity of the Orange River system. As a result, material eroded from the kimberlite pipes was effectively transported to the Atlantic Ocean. Third, after the diamondiferous sediment load of the Orange River system reached the Atlantic Ocean, longshore currents transported the diamondiferous gravel northward along the coast (Spaggiari *et al.* 2006). And fourth, a predominantly southerly wind regime created the diamondiferous deflation and aeolian deposits in coastal environments near Bogenfels and Lüderitz (Figure 2).

Figure 3 illustrates approximate changes in diamond input through time in the sedimentary system.

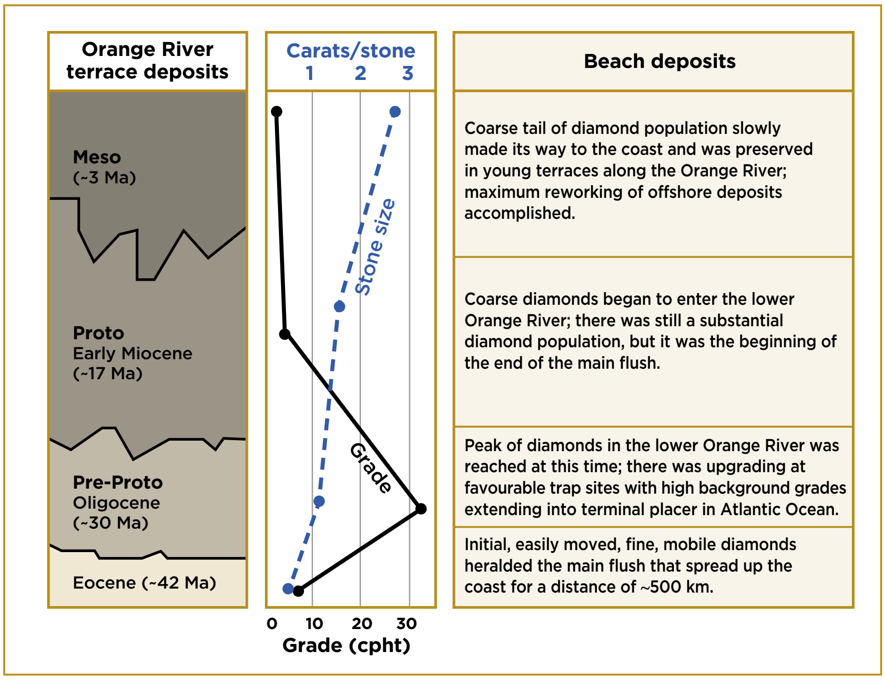


Figure 3: This diagram schematically illustrates a section through the lower Orange River terraces, together with variations in diamond grade (in carats per 100 tonnes) and stone size. Characteristics are also given for diamond placers hosted by beach deposits of equivalent ages to the terraces. After Jacob *et al.* (2006).

Figure 4: In this satellite image from Google Earth (imagery date 18 October 2017, viewed from approximately 7,660 m elevation), the high-water line for the year 2000 is shown in blue, illustrating areas where the land has been extended up to 500 m seaward since that time. A series of flooded mining pits are present along the coastline. The Orange River is visible on the far right, and the town of Oranjemund is seen as the dark area in the upper part of the image.

Overall, there is an increase in diamond size from initially smaller stones in the Eocene (~42 Ma) to coarser diamond populations in the younger meso-terraces (~3 Ma) of the Orange River (Jacob *et al.* 1999; Bluck *et al.* 2005). Diamond grades also show significant variations, and the highest grades are associated with Pre-Proto Oligocene (~30 Ma) terraces. Subsequently there was a decrease in diamond grade. Since Eocene time, multiple transgression and regression cycles resulted in various sea level stands. Generally, regressions resulted in the formation of currently drowned (i.e. below present sea level) diamondiferous beaches, while transgressions caused the raised beaches that are now present up to 200 m above sea level. Well-developed Plio-Pleistocene (prior to ~2 Ma) raised beaches have been the mainstay of diamond production in the *Sperrgebiet* since 1928 (Figure 4).

RECENT EXPLORATION METHODS IN THE SOUTHERN COASTAL MINES

Enhanced understanding of regional controls affecting the offshore extent and morphology of the submerged marine placer has recently been achieved through a thorough integration of airborne (electromagnetic and magnetic) and marine (seismic) geophysical datasets with historical mining data generated over the 90 years of onshore mining history (Kirkpatrick & Green 2018; Kirkpatrick *et al.* 2019a, b). These studies revealed that in the onshore area, diamond grade is controlled by the gradient of the bedrock and the width of wave-cut platforms, and such relationships can be extended to the offshore environment and used to develop a targeted exploration strategy for the inner shelf.

The newly developed composite geophysical model has been successfully tested using various drilling and sampling techniques, including a probe drill platform (PDP), a 2.5-m-diameter sampling tool (called BG36) and a small-diameter sonic drilling tool (Figure 5). The PDP is a custom-built jack-up platform fitted with a probe drill that is used to gather geological information regarding gravel occurrence, bedrock conditions and overburden thickness. It is designed to withstand winds up to 144 km/hour and ocean swells up to 5 m high, and can operate in the surf zone in up to 7 m water depth during relatively calm seas. The large-diameter BG36 sampling tool is used to assess the diamond content of the gravel horizons. The highly mobile, small-diameter sonic drill is used to gather the same geological information as the PDP but operates between the high- and low-water lines. These techniques and the new information they provide will be used to extend the estimated mine life for decades to come.

Figure 5: Three exploration tools currently being employed at the Southern Coastal Mines are visible here (left to right): a probe drill platform, a large-diameter sampling tool known as BG36 and a small-diameter sonic drilling tool. Photo by Edmund Nel.

MINING TECHNIQUES IN THE SOUTHERN COASTAL MINES

Laurs (2018) briefly described some of the mining techniques in use in the Southern Coastal Mines (SCM). Here, the mining methods are described in more detail, and further information and new developments pertaining to mining techniques at the SCM were provided by Kirkpatrick & Mukendwa (2019).

Figure 6 shows a typical exploitation site in the SCM, following the removal of overburden sand to expose gravel and bedrock. The bedrock underlying the diamondiferous gravel in the SCM typically contains well-developed gullies varying from less than 1 m to 7 m in depth. However, some areas are underlain by a soft clay footwall with a relatively flat surface that has a much lower potential for diamond entrapment.

Since nearly all of the onshore diamondiferous gravel has been mined out, current activities take place below sea level through a deliberate beach accretion process (Figure 7), in which overburden sand is deposited on the high-water line using dump trucks and conveyor belts

Figure 6: Diamondiferous marine gravel trapped in bedrock gullies has been exposed by the mining process. The rounded cobbles show where the gravel is located within a gully in the schist bedrock. The blue machines seen at the upper right are transvac units. Photo by Jennifer Nehoya.

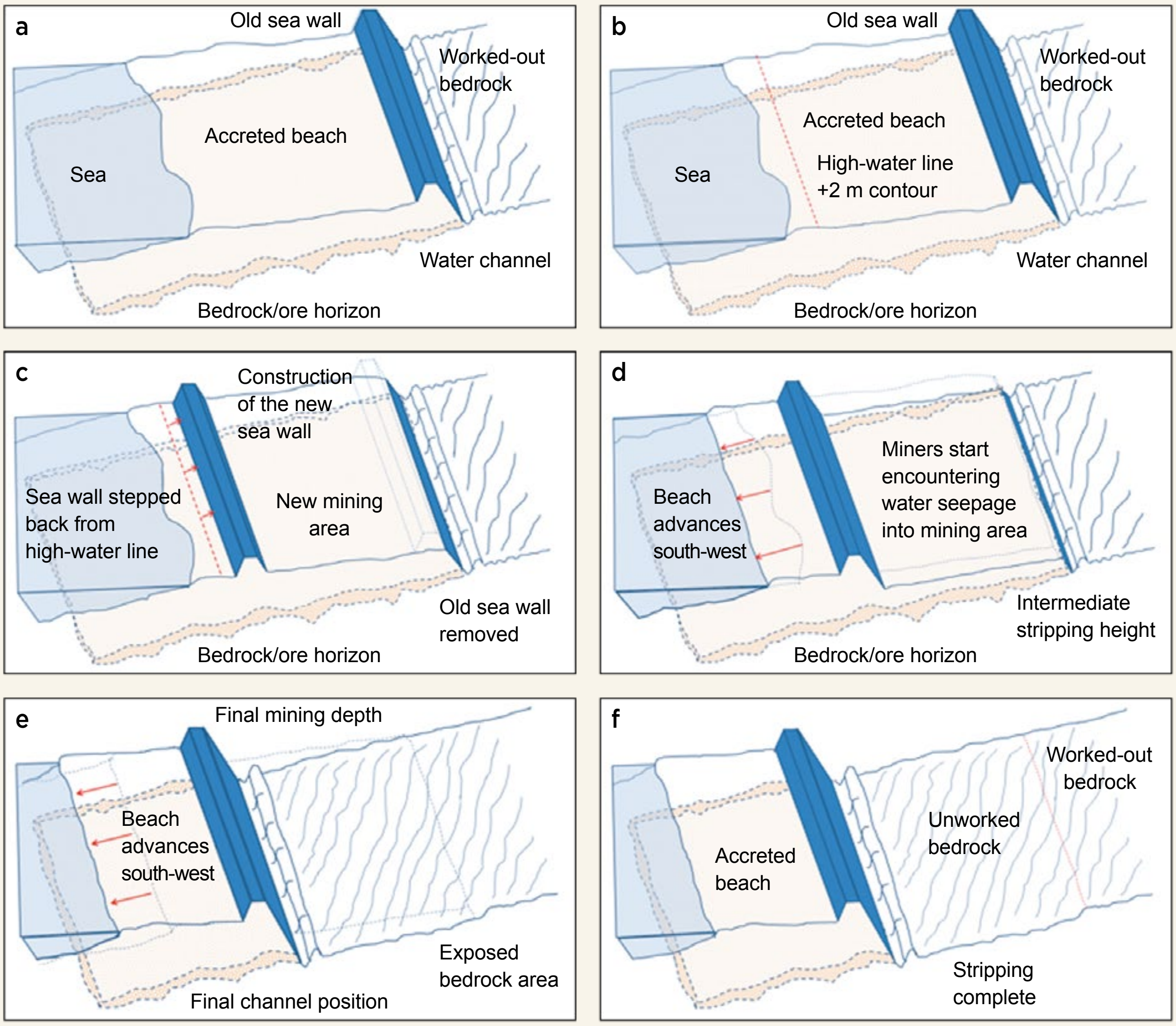


Figure 7: These drawings depict the beach accretion and mining process. Sand is dumped on the seaward side of the sea wall (**a**) until it reaches 2 m above the high-water line (**b**). A new sea wall is set back at least 25 m from the +2 m contour (**c**), and sand overburden is removed from behind the sea wall and is used for further beach accretion (**d**). Seawater seepage is routed to a channel along the eastern toe of the sea wall as the bedrock is exposed (**e**), and diamondiferous gravels are removed from gullies and other trapsites in the bedrock (**f**). After Kirkpatrick & Mukendwa (2019).

(Figure 8). This allows submerged beaches to become accessible for extraction using conventional land-based mining techniques. The extent of beach accretion since 2000 can be seen in Figure 4. In some places the land has been extended up to 500 m seaward, making substantial areas available to onshore mining.

Beach accretion advances the mining area seaward (south-west) in a series of steps, as shown in Figure 7. Sea walls constructed along the seaward side (Figures 7a and b) protect the pits from storm events. Prior to opening a new pit, a new sea wall is constructed to a typical height of 7–10 m above sea level (Figure 7c), with a width of at least 20 m. To further mitigate the risk of storm damage, sea walls are set back at least 25 m north-east of the +2 m contour above the high-water line (Figures 7b and c) and are often widened to more than 30 m. On completion of the sea wall and enclosing side walls, the stripping fleet—consisting of 80-tonne excavators and 40-tonne articulated dump trucks—focuses on removing overburden sand from the newly protected mining area and dumping it on the beach to the south-west of the sea wall (Figure 7d). In the past, the sand was also removed by cutter suction dredges, in which a rotating cutter head mobilises the sand which is then sucked up by the dredge pump and discharged through a floating pipeline.

Figure 8: In order to increase the land surface, beach accretion takes place by moving sand from the interior onto the beach. Wave action aids in transporting the sand along the beach. Photo by J. Jacob.

Overburden material laying close to the original surface is generally dry, but at deeper levels water seepage from the sea eventually ingresses into the pit, resulting in much wetter overburden material and, consequently, the need for water management. A channel is constructed along the north-eastern toe of the sea wall (Figure 7e) to move water to a sump where it is pumped out of the pit. Channels and sumps are deepened as mining progresses downward. Once excavators 'hit bedrock' (i.e. the excavator bucket starts to scrape against the highest bedrock points), the stripping operation is complete (Figure 7f), and bedrock teams then move in to start removing the diamondiferous gravel (again, see Figure 6).

The gravel is bulldozed into piles and then loaded onto trucks. Final clean-up of the remaining gravel from the irregular, creviced bedrock is done using large mobile vacuum cleaners ('transvacs') and hand lashing (i.e. using brushes to remove trapped gravel from bedrock trapsites where needed). The gravel is then taken to processing plants where it is sized, sorted and put through a dense-medium separation (DMS) process. DMS processing generates a high-density diamondiferous concentrate that is routed to X-ray luminescence sorters, and finally the diamonds are removed by hand.

ENVIRONMENTAL IMPACT AND RECLAMATION ACTIVITIES

The SCM area is located in the Tsau //Khaeb (Sperrgebiet) National Park (Figure 2), which is earmarked for mining-based tourism. Rehabilitation of mined-out areas is primarily focused on the removal of material introduced during mining processes (e.g. redundant infrastructure such as equipment, fences, roads, etc., for which no alternative uses are identified after the termination of mining activities). This includes removal of steel via a joint venture with a scrap merchant. Since 2008 more than 100,000 tonnes of steel have been removed from Namdeb's mining licences, mostly from the SCM area.

Landscape rehabilitation of mine dumps is done by using the tailings for the beach accretion process. Ponds containing seawater often remain after the mining process has been completed (Figure 4), and they are currently being assessed for their ecological value, inclusive of salt marshes, birds, fish, plankton and benthic (seabed-associated) organisms. Natural processes mostly drive revegetation of the area. Seeds are placed at selected sites, and the prevailing southerly winds together with the availability of coastal fog allow for the natural re-establishment of plants in the area.

Namdeb continues to engage with government and non-government organisations on activities in the SCM area via the Annual Environmental Stakeholders Forum. The rehabilitation plans are frequently reviewed in consultation with external and internal stakeholders. Key stakeholder engagements include the Ministry of Environment and Tourism (end land user of the park) and the Ministry of Fisheries and Marine Resources. Monitoring programmes are aligned with mining activities and discussed at Namdeb Marine Scientific Advisory Committee meetings. This committee consists of reputable scientists (independent of Namdeb) in southern Africa who provide guidance on the design- and impact-monitoring programmes. Namdeb is ISO14001:2015 certified, which provides additional guidelines for the type of mining that takes place along the SCM coastline. In addition, other assurances regarding the environmental impact are provided by Anglo American and De Beers Groups.

SUMMARY OF DIAMOND PRODUCTION CHARACTERISTICS

From the mouth of the Orange River, which is the point source for diamondiferous gravel delivered to the marine system, there is a progressive decrease in the size of diamonds deposited northward (as they are moved by longshore currents) along the coast. In general, larger diamonds (1–2 ct per stone) are deposited closest to the Orange River mouth, with a decrease in stone size to about 0.40 ct per stone at Chameis Bay located 100 km up the coast (Figure 9). There is an additional decrease in stone size further north in the deflation and aeolian placers, and finally the average stone size drops to 0.10 ct per stone north of Lüderitz (see Figure 2).

The diamond mega-placer of the *Sperrgebiet* is renowned for its high proportion of gem-quality stones, which are popular with manufacturers because of their very high yield (i.e. their lack of inclusions results in less waste during cutting). A high proportion of the stones are dodecahedral in shape, but twinned diamonds (macles) and octahedra are also present (Figures 10 and 11). Blocky, sawable shapes also occur. The diamonds typically range from colourless through strong fancy yellows.

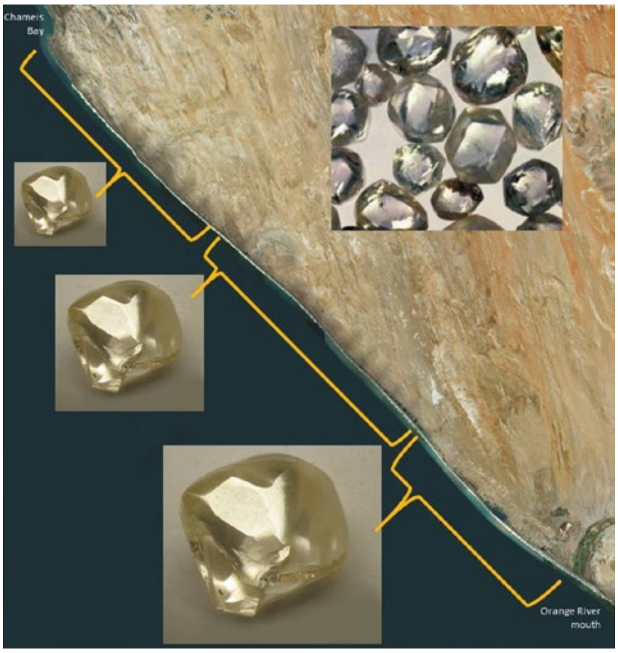


Figure 9: This schematic illustration shows how diamond size decreases northward along the shore away from the mouth of the Orange River. The average stone size is generally 1–2 ct near the Orange River mouth and 0.40 ct at Chameis Bay. The inset shows the typical appearance of diamonds from the SCM. Diamond photos by Elana Groenewald and satellite image from Google Earth.

CONCLUSIONS

The key to 90 years of sustained onshore mining of the south-western Namibian mega-placer has been ongoing innovation and perseverance. The remote desert location adds to the techno-economic challenges of mining this 95% gem-quality diamond resource. The onshore marine component of the placer has been virtually mined out, so targeted beach accretion, at an appropriate scale, is being employed to access the submerged beaches, which are naturally covered by overburden sand. This process makes previously inaccessible areas available for land-based mining. Developments in iterative and integrated geophysical processing and interpretation now provide much-needed guidance for the strategic extension of mining operations into nearshore areas that are too shallow for sea-based mining. Continued exploration work remains key to expanding the mining activities in these deposits, which are expected to produce diamonds for decades to come.

Figure 10: A selection of diamonds from the southern part of the SCM illustrates a range of shapes and sizes (scale in millimetres) that are recovered from this area. Photo by Elana Groenewald.

Figure 11: These diamonds (2–10 ct) from Namibia show the high gem quality that is typical of stones from this alluvial deposit. Photo courtesy of De Beers.

REFERENCES

Aizawa, M., Bluck, B., Cartwright, J., Milner, S., Swart, R. & Ward, J. 2000. Constraints on the geomorphological evolution of Namibia from the offshore stratigraphic record. *Communications of the Geological Survey of Namibia*, **12**, 383–393, www.mme.gov.na/files/publications/ef3_Aizawa%20et%20al_Offshore%20stratigraphy.pdf.

Bluck, B.J., Ward, J.D. & de Wit, M.C.J. 2005. Diamond mega-placers: Southern Africa and the Kaapvaal craton in a global context. *In*: McDonald, I., Boyce, A.J., Butler, I.B., Herrington, R.J. & Polya, D.A. (eds) *Mineral Deposits & Earth Evolution*. Geological Society, London, Special Publications, **248**, 213–245, http://doi.org/10.1144/gsl.Sp.2005.248.01.12.

Bluck, B.J., Ward, J.D., Cartwright, J. & Swart, R. 2007. The Orange River, southern Africa: An extreme example of a wave-dominated sediment dispersal system in the South Atlantic Ocean. *Journal of the Geological Society*, **164**(2), 341–351, http://doi.org/10.1144/0016-76492005-189.

Bremner, J.M., Rogers, J. & Willis, J.P. 1990. Sedimentological aspects of the 1988 Orange River floods. *Transactions of the Royal Society of South Africa*, **47**(3), 247–294, http://doi.org/10.1080/00359199009520243.

Brown, L.F., Benson, J.M., Brink, G.J., Doherty, S., Jollands, A., Jungslager, E.H.A., Keenan, J.H.G., Muntingh, A. & van Wyk, N.J.S. 1995. *Sequence Stratigraphy in Offshore South African Divergent Basins*. American Association of Petroleum Geologists, Tulsa, Oklahoma, USA, 184 pp.

de Wit, M.C.J. 1999. Post-Gondwana drainage and the development of diamond placers in western South Africa. *Economic Geology*, **94**(5), 721–740, http://doi.org/10.2113/gsecongeo.94.5.721.

Gurney, J.J., Levinson, A.A. & Smith, H.S. 1991. Marine mining of diamonds off the west coast of southern Africa. *Gems & Gemology*, **27**(4), 206–219, http://doi.org/10.5741/gems.27.4.206.

Jacob, J., Ward, J.D., Bluck, B.J., Scholz, R.A. & Frimmel, H.E. 2006. Some observations on diamondiferous bedrock gully trapsites on Late Cainozoic, marine-cut platforms of the Sperrgebiet, Namibia. *Ore Geology Reviews*, **28**(4), 493–506, http://doi.org/10.1016/j.oregeorev.2005.03.010.

Jacob, R.J., Bluck, B.J. & Ward, J.D. 1999. Tertiary-age diamondiferous fluid deposits of the lower Orange River valley, southwest Africa. *Economic Geology*, **94**(5), 749–758, http://doi.org/10.2113/gsecongeo.94.5.749.

Kirkpatrick, L.H. & Green, A.N. 2018. Antecedent geologic control on nearshore morphological development: The wave dominated, high sediment supply shoreface of southern Namibia. *Marine Geology*, **403**, 34–47, http://doi.org/10.1016/j.margeo.2018.05.003.

Kirkpatrick, S. & Mukendwa, J. 2019. Operational changes enable Namdeb's Southern Coastal Mining team to reduce risk and increase productivity as we advance deeper into the Atlantic Ocean. *Journal of the Southern African Institute of Mining and Metallurgy*, **119**(2), 105–112, http://doi.org/10.17159/2411-9717/2019/v119n2a2.

Kirkpatrick, L.H., Green, A.N. & Pether, J. 2019a. The seismic stratigraphy of the inner shelf of southern Namibia: The development of an unusual nearshore shelf stratigraphy. *Marine Geology*, **408**, 18–35, http://doi.org/10.1016/j.margeo.2018.11.016.

Kirkpatrick, L.H., Jacob, J. & Green, A.N. 2019b. Beaches and bedrock: How geological framework controls coastal morphology and the relative grade of a southern Namibian diamond placer deposit. *Ore Geology Reviews*, **107**, 853–862, http://doi.org/10.1016/j.oregeorev.2019.03.029.

Laurs, B.M. 2018. Gem Notes: Diamond mining at Namdeb's Southern Coastal Mines, Namibia. *Journal of Gemmology*, **36**(1), 16–18.

Phillips, D. & Harris, J.W. 2009. Diamond provenance studies from $^{40}Ar/^{39}Ar$ dating of clinopyroxene inclusions: An example from the west coast of Namibia. *Lithos*, **112**, 793–805, http://doi.org/10.1016/j.lithos.2009.05.003.

Spaggiari, R.I., Bluck, B.J. & Ward, J.D. 2006. Characteristics of diamondiferous Plio-Pleistocene littoral deposits within the palaeo-Orange River mouth, Namibia. *Ore Geology Reviews*, **28**(4), 475–492, http://doi.org/10.1016/j.oregeorev.2005.03.011.

Ward, J.D., Jacob, R.J., de Wit, M.C.J., Spaggiari, R.I. & Bluck, B.J. 2002. *Post-Gondwana Evolution of the Vaal-Orange Drainage System: Economic Implications*. Excursion Guide, 16th International Sedimentological Conference, Rand Afrikaans University, Johannesburg, South Africa, 75 pp.

The Authors

Dr Jana Jacob and Gottfried Grobbelaar
Namdeb Diamond Corporation (Pty) Ltd,
P.O. Box 35, Oranjemund 9000, Namibia
Email: jana.jacob@namdeb.com

Acknowledgements

The authors thank De Beers, Anglo American and the Namdeb Mineral Resource Department for their support, providing access to data and permission to publish this work. The authors appreciate the comments and helpful suggestions from the reviewers.


The Sisk Gemology Reference
The Sisk Gemology Reference
The Sisk Gemology Reference
SGRPE
$199.99

Vanadium-bearing Tourmaline from the Commander Mine, Nadonjukin, Tanzania

Clemens Schwarzinger, Manfred Wildner, Steve Ulatowski and Marsha Sawyer

ABSTRACT: In 2016, fine intense green and bicoloured brown-green V-bearing tourmaline was found at what became known as the Commander mine in Nadonjukin, Tanzania. Although dubbed *chrome dravite* by the gem trade, this material proved to be a mixture of dravite and uvite, with Cr present only in small amounts. Multicoloured crystal sections analysed with various techniques identified the chromophores V and minor Cr in the green parts, and Fe and Ti in the brown portions. Heat treatment produced no changes in colouration, which is consistent with the presence of iron in the brown tourmaline as Fe^{2+}, as indicated by optical spectroscopy.

The Journal of Gemmology, **36**(6), 2019, pp. 534–543, http://doi.org/10.15506/JoG.2019.36.6.534

In 2016, intense 'chrome' green (Figure 1) and bicoloured green-brown tourmalines were found near Nadonjukin, Tanzania, roughly 70 km south of Arusha. The material was discovered in previously abandoned diggings by a miner named 'Kamanda', which led author SU to refer to the locality as the Commander mine. This author was among the first to see this incredible find, and he acquired some of the production. A total of approximately 25 kg of the tourmaline was found as fragments and crystals ranging up to 10 cm long. About 11 kg of the material was set aside as crystals or specimens, from which author SU procured 8 kg. Less than 600 g of the total production was of faceting quality, and the remainder was suitable for cabbing or beading.

Figure 1: (**a**) The Commander mine in Tanzania is the source of this 14-mm-long tourmaline of pure green colour. (**b**) Faceting of this crystal by author CS yielded a 2.13 ct gemstone with the table oriented parallel to the c-axis. Photos by C. Schwarzinger.

A first note on this material by Williams *et al.* (2017) reported RIs of 1.620–1.638 (birefringence 0.018) and an SG value of 3.06. Energy-dispersive X-ray fluorescence analysis suggested the tourmaline was mainly dravite with a lesser uvite component, and contained the chromophores Ti, V, Cr, Fe and Mn. Rossman (2017) described V rather than Cr as being primarily responsible for the green colour, with V/(V + Cr) = 86% in the darker rim and 83% in the lighter core.

To investigate further how different elements contribute to the colouration of this tourmaline, we analysed slices cut perpendicular and parallel to the c-axis displaying brown, intense green and pale green zones with laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). We compared the LA-ICP-MS results to chemical data obtained by X-ray photoelectron spectroscopy. In addition, we performed Fourier-transform infrared (FTIR) microscopy and polarised ultraviolet-visible-near infrared (UV-Vis-NIR) spectroscopy, and also conducted experiments to see if the brown colour could be modified by heat treatment.

BACKGROUND

According to local miners (e.g. Figure 2a), the deposit that is now known as the Commander mine was first worked in 1997. It is located about 14 km from a small village called Nadonjukin in the Simanjiro area of north-east Tanzania, and is accessible by a two-hour drive on back roads from Arusha. Initial work yielded so little production that the mine was soon abandoned. On a whim, in late August 2016, the miner called 'Kamanda' decided to explore the deposit once again (Figure 2b). Good luck came to him, as he hit a pocket containing about 5 kg of mine-run material (e.g. Figure 3a). Some fine crystal specimens were recovered, but unfortunately for mineral collectors many of the best pieces were broken up to obtain highly valued facet-grade rough.

A second, larger, pocket was discovered in September 2016, and the miners were advised by a partner of author SU not to break up any well-formed crystals because they were just as valuable as the gem rough. Careful extraction of this pocket yielded 3 kg of the best crystals from the new find, as well as several kilograms of lower-grade material. Author SU was able to secure most of the production from this second pocket (e.g. Figure 3b).

While the first and second pockets were found in soft clayey material, the miners subsequently encountered hard rock, making it much less likely that the tourmalines could be extracted without damaging them. Production then slowed down so much that the miners moved on to other locations. It therefore seems likely that there will not be any additional availability of crystals or facet rough from the Commander mine in the foreseeable future.

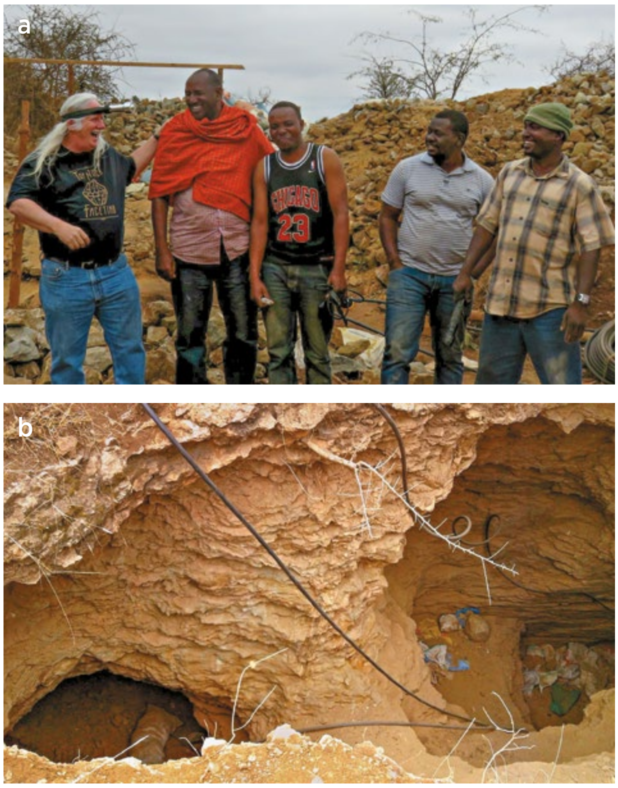


Figure 2: (**a**) One of the authors (SU) shares a light moment with local miners at the Commander mine in 2016. (**b**) This view shows some of the underground mine workings. Photos by Khai Thanoonil (a) and S. Ulatowski (b).

MATERIALS AND METHODS

We examined one gem-quality crystal (Figure 4) and analysed polished slices from four crystals for this research. Three bicoloured tourmaline crystals were sliced into 1–3 mm thick sections perpendicular to the c-axis, and one bicoloured crystal was sliced parallel to the c-axis. The slices from two of the crystals are shown in Figure 5, but the other samples were so heavily fractured that no complete slices remained intact. The sawn areas were polished with diamond powder and, for X-ray photoelectron spectroscopy (XPS; see below), surface cleaning was done by argon bombardment.

Polarised UV-Vis-NIR spectra (Figure 6) were obtained from two bicoloured samples: first, slab 1c in Figure 5 containing the crystallographic c-axis (allowing the measurement of polarised spectra with E⊥c and E||c, the latter of which were used for Figure 6); and second, a thin slice cut perpendicular to the c-axis (not pictured;

Figure 3: (**a**) Only rarely were tourmaline matrix specimens recovered, such as this 40 × 30 × 20 mm sample. (**b**) Most of the tourmaline production consisted of bicoloured crystals such as this 37 × 11 mm example. Photos by S. Ulatowski (a) and C. Schwarzinger (b).

Figure 4: A gem crystal (14 × 8 mm) from the Commander mine is shown here perpendicular to the c-axis with the polarising filter in 0° (left) and 90° (right) positions. Photos by C. Schwarzinger.

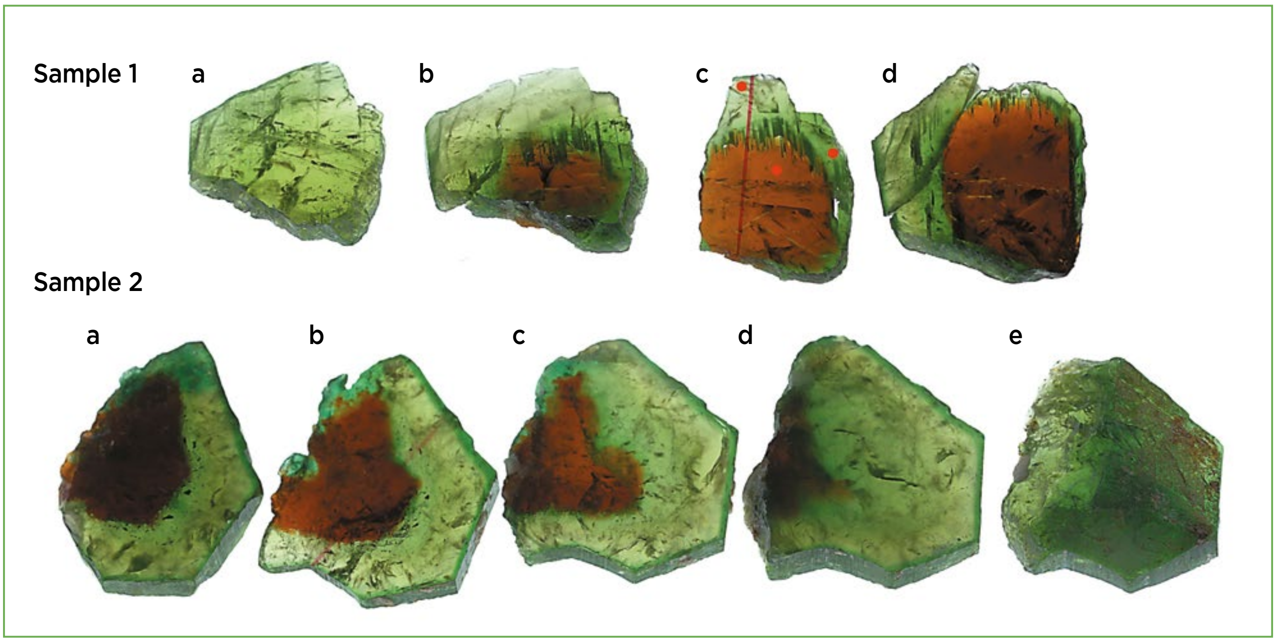


Figure 5: These slices were sawn from two different bicoloured tourmaline crystals. Sample 1 was sliced parallel to the c-axis (which in all slabs runs north-south) from the rim (left) to the core (right) of the crystal. Sample 2 was cut perpendicular to the c-axis from the bottom (left) to the top (right) of the crystal. On sample 1c, the red line shows the location of the LA-ICP-MS point traverse and the red dots indicate the positions where UV-Vis-NIR spectra were collected. The maximum dimension of the slices is 25 mm. Photo by C. Schwarzinger.

allowing the measurement of spectra with E⊥c with unpolarised light, which were also used for Figure 6). With a spot size of 250 μm in diameter, the spectra were acquired from the pale green, intense green and brown parts of each sample. Spectra were collected at room temperature in the range 33000–6500 cm^{-1} (~300–1550 nm) with a Bruker IFS 66v/S FTIR spectrometer coupled with a mirror-optics IR-ScopeII microscope. A quartz beam splitter and appropriate combinations of light sources (xenon or tungsten lamp) and detectors (GaP, Si or Ge diode) were used to cover the desired spectral range. Hence, each full spectrum was a combination of three partial spectra: 33000–20000 cm^{-1} (300–500 nm), spectral resolution 40 cm^{-1}, averaged from 1,024 scans; 20000–10000 cm^{-1} (500–1000 nm), spectral resolution 20 cm^{-1}, averaged from 512 scans; and 10000–6500 cm^{-1} (1000–1550 nm), spectral resolution 20 cm^{-1}, averaged from 256 scans. For the polarised measurements, a calcite Glan prism was used as a polariser. The final absorption spectra were displayed as wavelength (nm) vs. linear absorption coefficient (cm^{-1}).

LA-ICP-MS chemical analysis was performed on three of the slices (two bicoloured and one pure green: samples 1c, 2b and 2e in Figure 5) using a Teledyne Cetac LSX-213 G2+ laser ablation system coupled to a Thermo Scientific XSeries 2 ICP-MS. Tuning and calibration were carried out using NIST 610, 612 and 614 glass standards; reference values were taken from Jochum *et al*. (2011). The laser was operated with two different settings. The first used a 100 μm spot size, a laser energy of 10% and a repetition rate of 10 Hz; 130 shots were made on each spot, and the ablated products were transferred to the ICP-MS in He gas with a flow rate of 500 mL/min. The second setting used 20% laser energy, 230 shots on each spot and an He flow rate of 600 mL/min. The spot size and repetition rate were the same as the first setting, as it could be shown that the signal-to-noise ratio could be improved without losing linearity. Each slice was measured in a line of points (35–45 each) across the sample, for a total of 278 individual analyses. To ensure reproducibility of the data, duplicate analyses were performed on nearby spots for all samples.

X-ray photoelectron spectroscopy (XPS) is a technique that is used to determine the chemical composition of a solid's surface, and is similar to energy-dispersive X-ray (EDX) spectroscopy. X-rays are used to excite the inner electrons, causing them to leave the atom, and from their kinetic energy the binding energy (which is specific to each element) can be determined. The benefit of XPS is that the sample does not have to be electrically conductive (as is necessary for EDX), which means that insulating materials (e.g. non-metallic substances such as tourmaline) do not have to be coated with gold or carbon. Additionally, XPS is capable of detecting all elements, including the light elements H, Li, Be, etc. XPS measurements

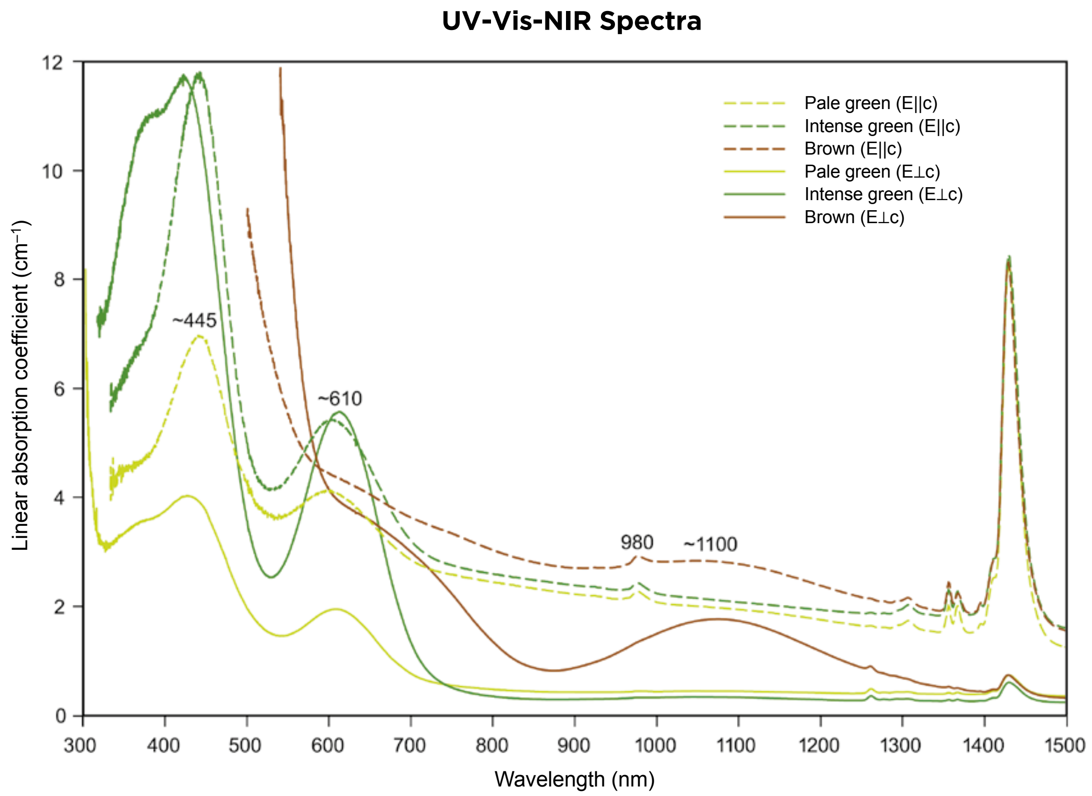


Figure 6: Polarised UV-Vis-NIR spectra are shown for pale green, intense green and brown areas of the tourmaline with E||c (dashed lines; obtained from sample 1c that was sliced parallel to the c-axis; measurement positions are indicated by the red dots in Figure 5) and with E⊥c (solid lines; measured from a second crystal cut perpendicular to the c-axis).

were performed with a Thermo Scientific Theta Probe device, which used a monochromatic Al(*K*α) X-ray source with a photon energy of 1486.6 eV and a dual flood gun for surface charge neutralisation. The surface X-ray spot was 400 μm in diameter. The survey spectra were recorded using a pass energy of 200 eV and an energy step width of 1 eV.

Infrared spectral mapping was done on sample 2b in Figure 5 in order to investigate whether this technique can be used to trace any compositional features that influence colour. The experiments were carried out with a Thermo Scientific Nicolet iN10 MX FTIR microscope in reflection mode. Spectra were collected in the range 4000–680 cm^{-1} with a resolution of 8 cm^{-1}; 16 scans were averaged for each spectrum. A total of 4,384 points were measured on the slice with a step size of 100 μm in the x and y directions.

Inclusions in the tourmaline samples were analysed with confocal Raman spectroscopy, using a Thermo Fisher Scientific DXR Raman microscope equipped with a 780 nm laser, a standard grating and a 10 × objective.

Heat treatment experiments were performed on the bicoloured slices in an attempt to change the brown colour. The samples were heated in a muffle furnace to 500°C and in a second run to 600°C. The samples were placed into charcoal to create a reducing atmosphere.

RESULTS AND DISCUSSION

Colouration

The tourmalines from the Commander mine mostly show distinct colour zoning that typically consists of an intense green cap (antilogous pole) and a brown base (analogous pole). When viewed with polarised light perpendicular to the c-axis, the basal (brown) portion of the crystals showed strong pleochroism from a deep brown to a pale orange (Figure 4) as the polariser was rotated.

In general, the sequence of slices that were cut from the bicoloured crystals showed the same colouration trends: a brown basal (or core) zone that was overgrown by a sequence of intense green and pale green layers of varying thicknesses (Figure 5). The boundary between the brown and green portions contained hollow growth tubes oriented parallel to the c-axis; these were particularly evident in sample 1.

UV-Vis-NIR Spectroscopy

UV-Vis-NIR spectra of the pale green and intense green areas of the two slabs were similar (Figure 6), with two intense bands at ~445 and 610 nm. The main difference in the spectra was an OH-related peak at around 980 nm that was only seen in the E||c spectra (cf. Rossman *et al.* 2016). The two major bands at ~445 and 610 nm are well in agreement with V^{3+} bands as described by Schmetzer *et al.* (2007), and indicate that V is the major chromophore, as Cr bands would be expected at lower wavelengths (417 and 588 nm; Schmetzer *et al.* 2007).

The spectrum of the brown area of each sample was dominated by a spectral cutoff at 500–600 nm with a shoulder at around 650 nm (due to the underlying V^{3+} band) and a broad band at roughly 1100 nm. An intense band centred at 445 nm has been assigned to Ti^{4+}–Fe^{2+} intervalence charge transfer, as found in dravite, and the broad band between 550 and 900 nm has been ascribed to Fe^{2+}–Fe^{3+} intervalence charge transfer; these Fe^{2+}/Fe^{3+} systems are known to be strongly polarised in anisotropic minerals, thus causing distinct pleochroism (Smith 1977; Taran *et al.* 2015). Finally, the broad band at ~1100 nm was attributed by Smith (1978) to a single-ion d-d transition of Fe^{2+} when polarised with E||c, and to an intensified Fe^{2+}-transition of nearest neighbour Fe^{2+}–Fe^{3+} pairs when polarised with E⊥c.

Chemical Composition

Williams *et al.* (2017) reported that Commander mine tourmaline is a mixture of mainly dravite with some uvite, as analysed by energy-dispersive X-ray spectroscopy. The contents of dravite [$NaMg_3Al_6(Si_6O_{18})(BO_3)_3(OH)_3OH$] and uvite [$CaMg_3(MgAl_5)(Si_6O_{18})(BO_3)_3(OH)_3OH$] are best evaluated with the molar ratio of Na and Ca, in accordance with the chemical formulae of these tourmaline species. In the present samples, Ca/Na molar ratios of about 1:1 were determined by XPS and confirmed by LA-ICP-MS. Higher concentrations of Ca (and therefore greater uvite contents) were found in the brown core, while more Na (dravite) was measured in the green outer rim, with Ca/Na ratios ranging from 0.7 to 1.7 in the three bicoloured slices and 0.54–0.91 in the pure green sample. XPS also revealed the presence of about 1 at.% fluorine. Chromium was not detected by XPS. However, subsequent analyses with LA-ICP-MS revealed 150–1200 ppmw (parts per million by weight) Cr, with one value attaining 1700 ppmw. Nevertheless, the abundance of V over Cr (see Table I) indicates that the name *chrome dravite* is a misnomer.

Chemical data obtained by LA-ICP-MS are summarised in Table I, and selected minor and trace elements are plotted in Figures 7–9. Figure 7 shows the analyses of a bicoloured slice from the basal portion of a crystal cut

Table I: Minimum and maximum values of some minor and trace elements by LA-ICP-MS for the dravite-uvite slices in Figures 7–9.[a]

Sample no.	2b		2e		1c	
Sample orientation	⊥ c-axis		⊥ c-axis		|| c-axis	
Analyses[b]	Scan 1	Scan 2	Scan 1	Scan 2	Scan 1	Scan 2
Minor elements (wt.%)						
Na	1.6–2.0	1.5–1.9	0.9–1.4	1.6–1.9	1.4–2.0	1.1–1.9
Ca	2.3–3.1	2.1–3.0	1.1–1.9	1.8–2.5	2.1–3.9	2.2–3.5
Ti	1.3–1.6	0.9–1.2	0.3–0.7	0.5–1.0	1.2–1.7	0.9–1.3
Trace elements (ppmw)						
V	2300–12800	1500–10500	850–3200	1300–4200	1900–14000	2000–12500
Cr	390–1200	300–960	150–640	240–800	200–1700	160–810
Mn	125–380	91–260	36–70	66–120	160–350	100–270
Fe	170–4900	120–3600	46–93	83–160	145–5500	170–4000
Zn	40–230	24–230	13–27	23–41	45–240	38–200
Ga	130–200	92–160	39–66	69–106	120–240	98–160
Sr	3400–4700	2300–3400	900–2000	1350–2700	3300–5400	2600–3800

[a] Sc was below 55 ppm, and Li, Ni, Zr and Ba were below 25 ppm; Be, Co, Cu and Ge were not detected in the samples analysed.
[b] Scan 1 and Scan 2 represent near-duplicate traverses across the samples, with analyses done in slightly different positions.

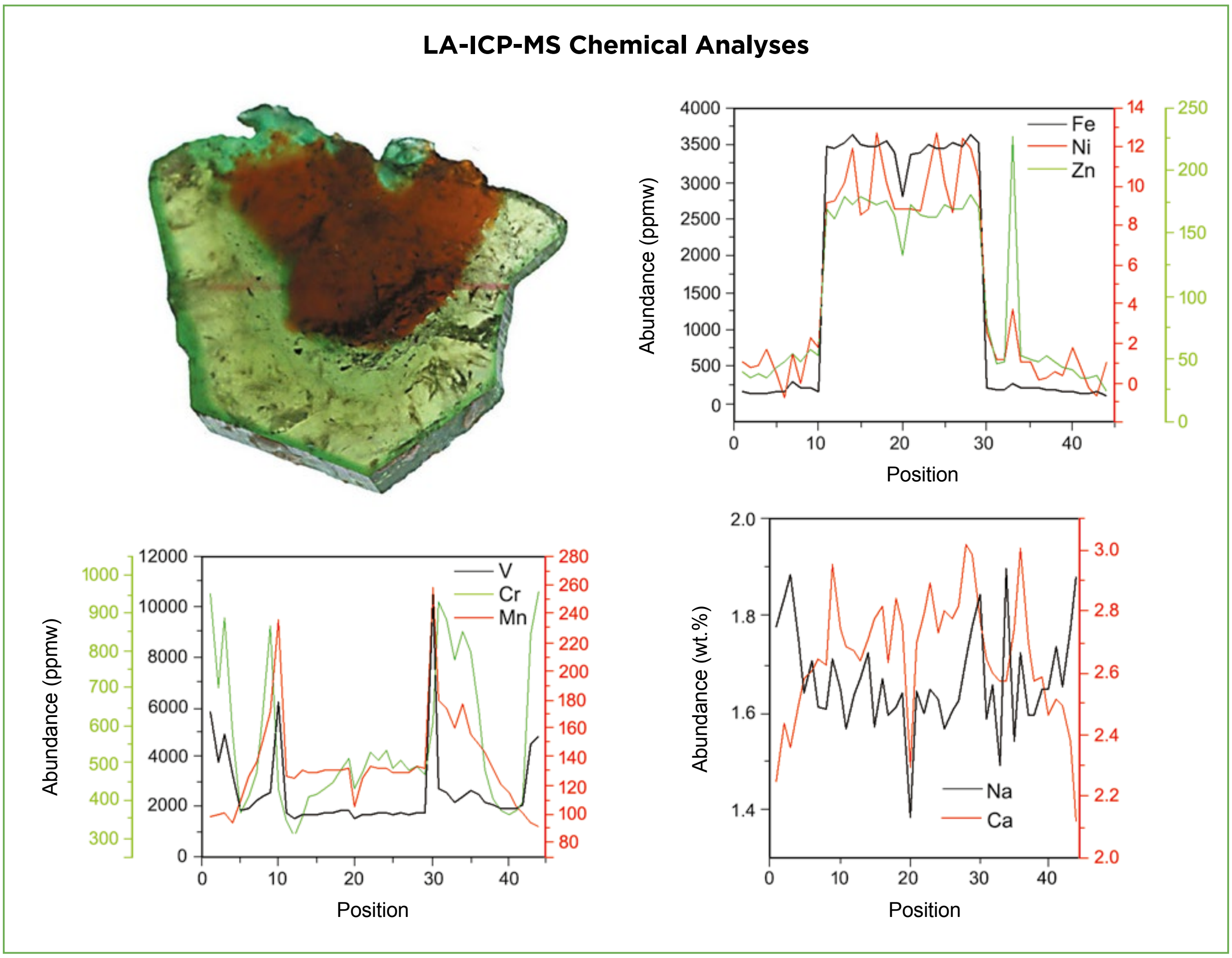


Figure 7: LA-ICP-MS chemical analyses of sample 2b were done from left to right along the red line that is marked on the slice. The plots show the concentrations across the sample of Fe, Ni and Zn; V, Cr and Mn; and Na and Ca. Photo by C. Schwarzinger.

perpendicular to the c-axis (sample 2b in Figure 5). The brown core had relatively high Fe, which dramatically decreased in the green areas. Ni and Zn followed the same profile, but their concentrations were much lower. The intense green zones adjacent to the brown zone and along the outer rim were characterised by relatively high contents of V and Cr, with V being the dominant chromophore. The V/(V + Cr) content of 83–86% determined by Rossman (2017) was confirmed on average, with individual values ranging from 73% to 95%. Between the intense green zones was a yellowish green area containing higher traces of Mn and Ga (although still lower than Cr). Along the outer rim of the crystal we measured greater Sc and Ba with maximum concentrations of only about 50 and 10 ppm, respectively. Ti and Sr were both relatively enriched at ~1 wt.% and 3000 ppm, respectively; however, no trends were evident for these elements along the traverse analysed. Plotting Ca and Na concentrations confirmed the XPS data, but care must be taken as these elements (and also Al and Si) could not be calibrated well for LA-ICP-MS analysis because their concentrations were too similar in all three NIST glass standards. Also, elements present in the weight percent range (i.e. B, Mg, Al and Si) are typically outside the linear range of the detector and are therefore subject to large errors. In addition, K was hard to measure due to strong interference from adducts of O + Na, and from Ar (used as plasma gas).

The next slice analysed (sample 2e in Figure 5), which did not show any brown colouration, was the top section of the same crystal (Figure 8). As expected, Fe was low (about 150 ppm) and did not vary across the analysed area. Vanadium and Cr were enriched in the rim (which was intense green, although not visible in Figure 8), but not in an adjacent pale green area. A similar trend was found for Sc and Ba, while Ti and Sr had maximum concentrations near the border between the pale and intense green zones. Mn was concentrated in the centre portion of the crystal and decreased towards the rim.

The third slice (sample 1c in Figure 5) was cut parallel

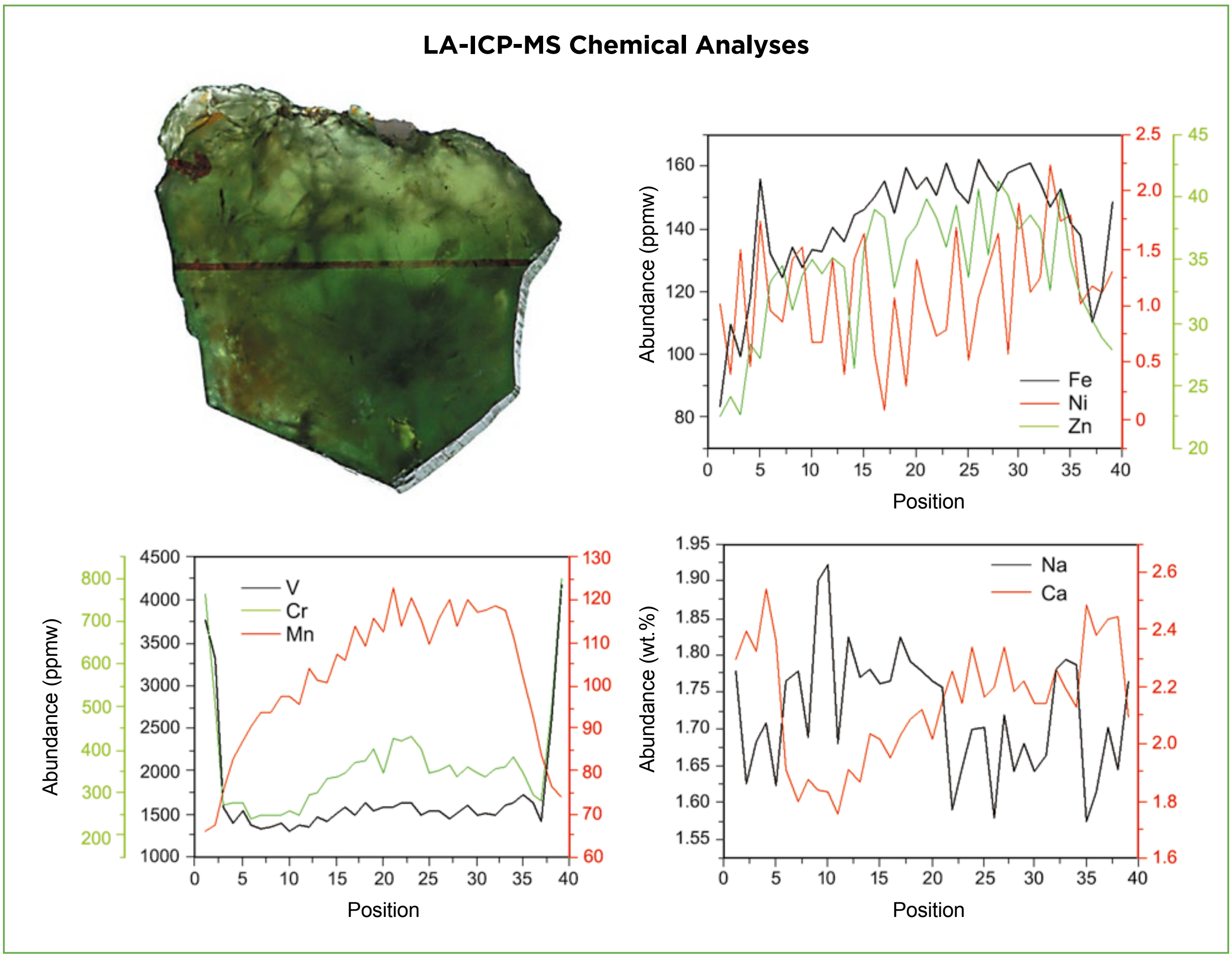


Figure 8: LA-ICP-MS chemical analyses of sample 2e were done from left to right along the red line marked on the slice. The plots show the concentrations across the sample of Fe, Ni and Zn; V, Cr and Mn; and Na and Ca. Photo by C. Schwarzinger.

to the c-axis through the core of the crystal, from the brown base to the green tip (Figure 9). The elemental trends according to colour were the same as described above for the other slices, with the brown zone having relatively high Fe concentrations that decreased in the green portion. Vanadium was greatest in the intense green zone adjacent to the brown core and then decreased in the pale green area. Chromium and Mn were also greatest in the intense green part but decreased gradually towards the tip of the crystal. Sodium increased from an average of ~1.5 wt.% in the brown area to ~1.7 wt.% in the green part, while Ca decreased from ~1.8 wt.% in the brown zone to ~1.4 wt.% in the green section (i.e. the brown areas were richer in the uvite component).

The chemical data support the results from UV-Vis-NIR spectroscopy that Ti^{4+}–Fe^{2+} and also Fe^{2+}–Fe^{3+} intervalence charge transfer were responsible for the brown colour, and V (along with some Cr) caused the intense green colour. By comparison, the pale green tourmaline had relatively low Fe, Cr and V but more enriched Mn.

Infrared Microscopy

In general, the infrared spectra of the analysed slice (sample 2b) resembled those of both dravite and uvite, which are very similar (Figure 10; cf. Lafuente *et al.* 2015).

The infrared spectral map in Figure 10 shows the relative intensity of the 1370 cm^{-1} band (darker orange indicates a higher concentration, while green indicates the background), which was assigned to a BO_3 stretching vibration by Frost *et al.* (2007). This band was slightly more pronounced in the brown core than in the surrounding green zones, but otherwise no differences could be found in the FTIR spectra according to colour. The green-appearing spots within the infrared map are hollow tubes that surround the brown core.

Heating Experiments and Cutting

We observed no changes in the colouration of the samples after heating, which provides a further indication that iron in the brown zones is already in the bivalent charge state and therefore cannot be reduced further.

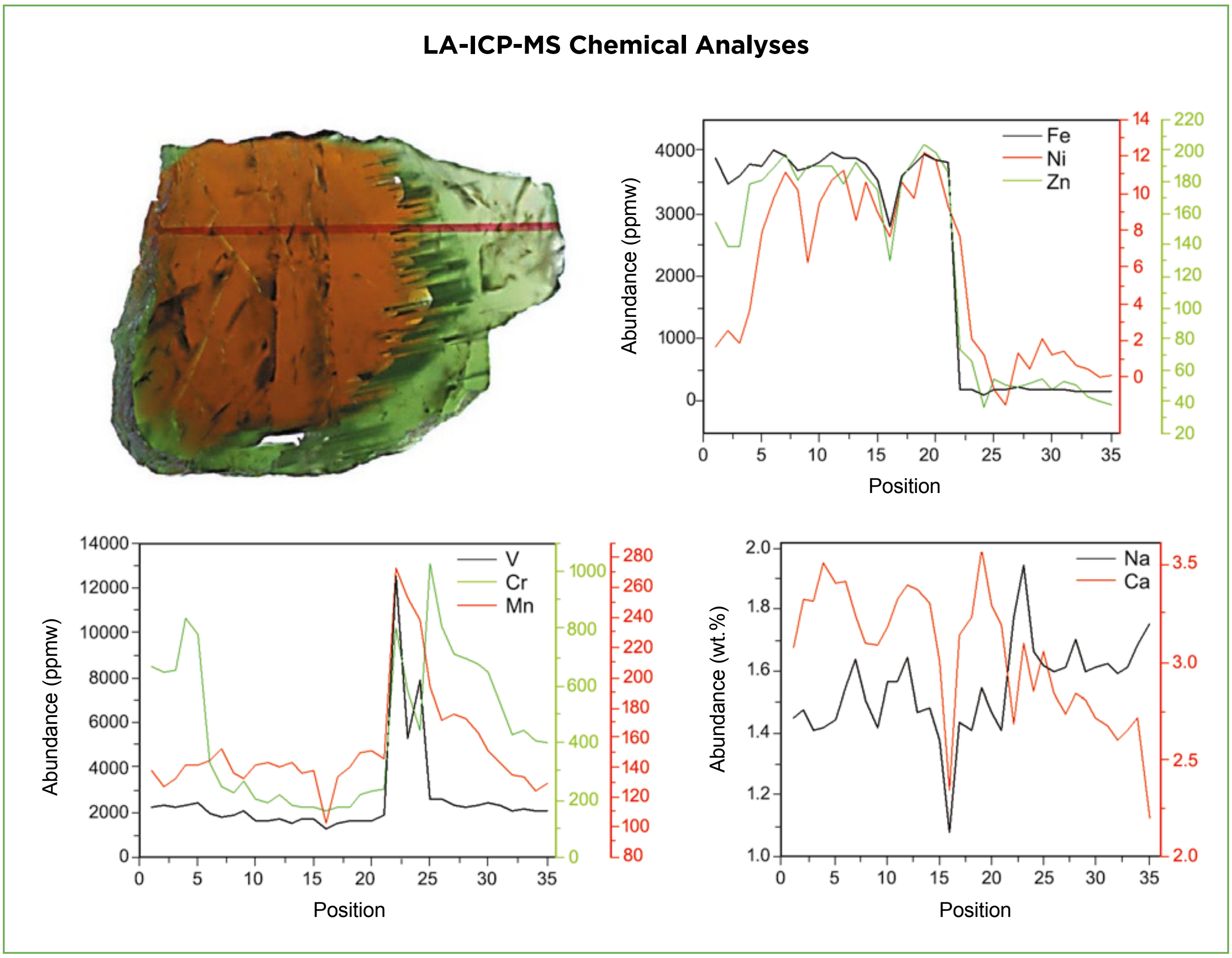


Figure 9: LA-ICP-MS chemical analyses of sample 1c were done from left to right (bottom to top of the crystal) along the red line marked on the slice. The plots show the concentrations across the sample of Fe, Ni and Zn; V, Cr and Mn; and Na and Ca. Photo by C. Schwarzinger.

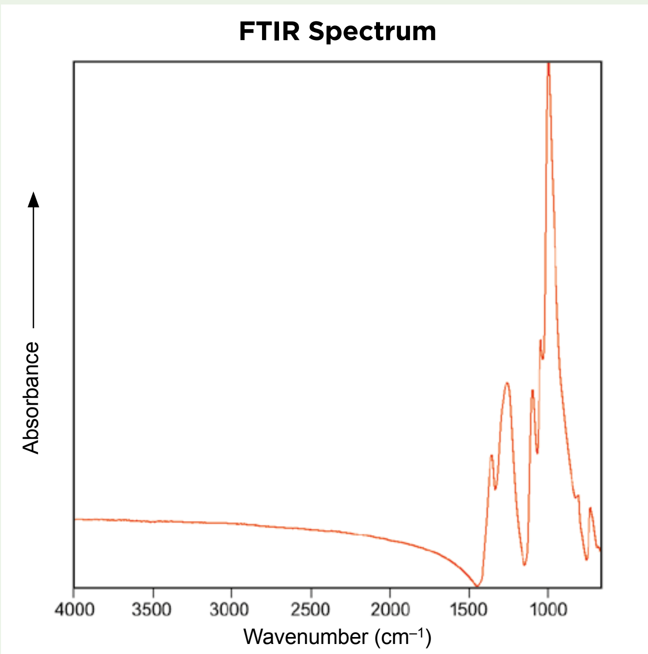
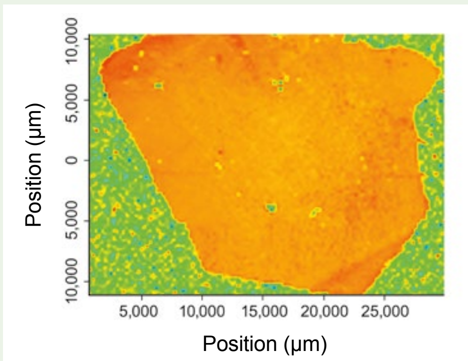


Figure 10: A representative infrared spectrum (collected from the green part of sample 2b) is shown with the infrared spectral map of this tourmaline slice displaying the relative intensity of the 1370 cm^{-1} band. This band is slightly less intense in the brown core region of the sample.



A special note to lapidaries: As with tsavorite from this region, the Commander mine tourmaline produces an unpleasant smell when cut, which is easily recognisable as a sulphur compound. A first hypothesis, based on the findings of Feneyrol *et al.* (2013) for tsavorite and Rankin *et al.* (2014) for tanzanite, is that liquids containing H_2S-S_8 might be trapped as inclusions in the crystals, but this could not be confirmed by confocal Raman spectroscopy. However, LA-ICP-MS revealed a sulphur content of several hundred to thousand parts per million throughout the crystal sections. So, either the hydrogen sulphide is homogenously distributed throughout the crystal, or during cutting the sulphur content undergoes a reaction with water that is catalysed or, more specifically, accelerated by the heat generated from friction on the lap.

CONCLUSIONS

In 2016, a remarkable find of tourmaline was made near Nadonjukin, Tanzania. Many of these tourmalines were bicoloured, with Ti^{4+}–Fe^{2+} and Fe^{2+}–Fe^{3+} intervalence charge transfers producing the brown colour, and V as well as minor Cr being responsible for the green colour. *Chrome dravite* is a misnomer for this tourmaline, as chemical analyses showed unambiguously that the crystals are uvite-dravite mixtures with a tendency towards dravite in the green parts, and thus the correct nomenclature is *vanadium-bearing dravite* or *vanadium-bearing dravite-uvite*. Although most of the tourmaline production was sold as crystals, some faceted gems are available that display a rich green colour.

REFERENCES

Feneyrol, J., Giuliani, G., Ohnenstetter, D., Fallick, A.E., Martelat, J.E., Monié, P., Dubessy, J., Rollion-Bard, C., Le Goff, E., Malisa, E., Rakotondrazafy, A.F.M., Pardieu, V., Kahn, T., Ichang'I, D., Venance, E., Voarintsoa, N.R., Ranatsenho, M.M., Simonet, C., Omito, E., Nyamai, C. & Saul, M. 2013. New aspects and perspectives on tsavorite deposits. *Ore Geology Reviews*, **53**, 1–25, http://doi.org/10.1016/j.oregeorev.2013.01.016.

Frost, R.L., Wain, D.L., Reddy, B.J., Martens, W.N. & Kloprogge, J.T. 2007. Spectroscopic characterization of Mn-rich tourmalines. *Vibrational Spectroscopy*, **44**(1), 42–49, http://doi.org/10.1016/j.vibspec.2006.07.010.

Jochum, K.P., Weis, U., Stoll, B., Kuzmin, D., Yang, Q., Raczek, I., Jacob, D.E., Stracke, A., Birbaum, K., Frick, D.A., Günther, D. & Enzweiler, J. 2011. Determination of reference values for NIST SRM 610-617 glasses following ISO guidelines. *Geostandards and Geoanalytical Research*, **35**(4), 397–429, http://doi.org/10.1111/j.1751-908X.2011.00120.x.

Lafuente, B., Downs, R.T., Yang, H. & Stone, N. 2015. The power of databases: The RRUFF project. *In*: Armbruster, T. & Danisi, R.M. (eds) *Highlights in Mineralogical Crystallography*. Walter de Gruyter GmbH, Berlin, Germany, 1–30, http://doi.org/10.1515/9783110417104-003.

Rankin, A., Taylor, D. & Treloar, P. 2014. Gem Notes: Mercaptans in tanzanite from Merelani, Tanzania—A new type of stinkstone? *Journal of Gemmology*, **34**(1), 11–13.

Rossman, G.R. 2017. Gem Notes: Colouration of green dravite from the Commander mine, Tanzania. *Journal of Gemmology*, **35**(7), 574–575.

Rossman, G.R., Ma, C. & Laurs, B.M. 2016. Gem Notes: Yellow dravite from Tanzania. *Journal of Gemmology*, **35**(3), 190–192.

Schmetzer, K., Bernhardt, H.-J., Dunaigre, C. & Krzemnicki, M. 2007. Vanadium-bearing gem-quality tourmalines from Madagascar. *Journal of Gemmology*, **30**(7–8), 413–433, http://doi.org/10.15506/JoG.2007.30.7.413.

Smith, G. 1977. Low-temperature optical studies of metal-metal charge-transfer transitions in various minerals. *Canadian Mineralogist*, **15**(4), 500–507.

Smith G., 1978. A reassessment of the role of iron in the 5,000–30,000 cm^{-1} region of the electronic absorption spectra of tourmaline. *Physics and Chemistry of Minerals*, **3**(4), 343–373, https://doi.org/10.1007/bf00311847.

Taran, M.N., Dyar, M.D., Naumenko, I.V. & Vyshnevsky, O.A. 2015. Spectroscopy of red dravite from northern Tanzania. *Physics and Chemistry of Minerals*, **42**(7), 559–568, http://doi.org/10.1007/s00269-015-0743-z.

Williams, C., Williams, B., Laurs, B.M., Falster, A.U. & Simmons, W.B. 2017. Gem Notes: Tourmaline (dravite) from Simanjiro District, Tanzania. *Journal of Gemmology*, **35**(6), 481–482.

The Authors

Dr Clemens Schwarzinger
Center of Scientific Gemology, Institute for Chemical Technology of Organic Materials, Johannes Kepler University Linz, Altenberger Strasse 69, 4040 Linz, Austria
Email: Clemens.Schwarzinger@jku.at

Dr Manfred Wildner
Institute for Mineralogy and Crystallography, University of Vienna, Althanstrasse 14, 1090 Vienna, Austria

Steve Ulatowski and Marsha Sawyer
New Era Gems, 14923 Rattlesnake Road, Grass Valley, California, 95945, USA

Acknowledgements

The authors thank Jiri Duchoslav of the Center for Surface and Nano Analysis at Johannes Kepler University Linz for recording and discussing the XPS spectra.

A 15th-Century Polishing Machine for Gemstones Attributed to Henri Arnaut

Karl Schmetzer

ABSTRACT: The Late Middle Ages, spanning from the 12th to the 15th centuries, witnessed a transition in the techniques used to fashion gemstones from handheld tools to mechanised equipment. A concomitant shift arose from simple shaping, smoothing and polishing to faceting in regular patterns. Notable in this progression were three instruments employing manually driven rotating wheels depicted in 15th-century Latin codices. Descriptions of two of these have appeared in multiple publications. The third, the design of which has been attributed to Henri Arnaut and most likely dated between 1432 and 1454, has received minimal attention and is the subject of this study. Also outlined briefly are further developments that were bridged by these 15th-century instruments and occurred towards the early 17th century.

The Journal of Gemmology, **36**(6), 2019, pp. 544–550, http://doi.org/10.15506/JoG.2019.36.6.544

Gemstone fashioning initially relied on simple handheld tools. Early descriptions are found in texts such as one referred to as *Upon Various Arts* by the monk Theophilus (dated about 1120; see English translations by, e.g., Hendrie 1847 and Dodwell 1961) and another designated *Manuscripts of Eraclius* (dated to the 12th or 13th century; see English translation by Merrifield 1849, and for additional parts see also Richards 1940). These documents reference shaping and polishing of the irregularly shaped natural surfaces of rough gem materials, 'thereby bringing out its potential colour and clarity' (Bol 2019, p. 225).

In general, the stones were rubbed on flat, smooth, fixed plates, frequently in contact with fine-grained abrasives. Theophilus further noted that the gems could be attached with 'tenax' to handheld wooden sticks for the manual polishing operations. An alternative technique for polishing engraved gems that involved rotating a stylus, with or without abrasives, was also described in a 13th-century manuscript known as the *Doctrina Poliendi Pretiosos Lapides* (see French translation and discussion by Grassin 1999). A detailed summary and discussion of these texts with respect to gemstone shaping and polishing techniques was given recently by Bol (2019).

Evidence of further developments can be found in 13th- and 14th-century European jewellery. A limited number of faceted coloured stones with planar faces have been documented in pieces from the era (Falk 1975; Lightbown 1992; Content 2016), and the beginning of gem faceting in Europe is thought to date from this period. As time progressed, examples with a symmetrical cut design and a regular facet arrangement began to appear, and they were featured in 14th- and 15th-century royal regalia such as the crown of the Holy Roman Emperor Charles IV—made originally in 1347 and reworked several times prior to Charles IV's death in 1378 (Hyršl & Neumanova 1999)—and the crown of Blanche of Lancaster (Gray 1989, first mentioned in two English inventories dated 1398/1399; see Figure 1).

From solely handheld tools, the techniques then turned to the use of manually driven rotating wheels or discs for shaping, smoothing or polishing gemstones, as first described in the 15th century. Three notable instruments of the type are depicted in two mid-15th-century manuscripts: the *Codex Latinus Monacensis 197* by an anonymous author, archived at the Bayerische

Figure 1: This faceted blue sapphire (14 × 10 mm) is set in the late 14th-century crown of Princess Blanche of Lancaster, kept in the Munich Residence Museum, Germany. Photo by K. Schmetzer.

Staatsbibliothek (Bavarian State Library) in Munich, Germany (one device; see Hall 1971, 1979), and the Latin 7295 codex attributed to Henri Arnaut and others, archived at the Bibliothèque Nationale de France (National Library of France) in Paris (two devices; see also Le Cerf & Labande 1932).[1]

Two of the three tools have been covered in several publications (e.g. Feldhaus 1914; Schroeder 1930; Gille 1966; Fischer 1968; Hall 1971, 1979; White 1978; Samuel 1980; von Stromer 1993; Ogden 2018), as well as in recent work on faceting history available online (Prim 2018a, b). These were relatively simple instruments. The polishing device illustrated in the *Codex Latinus Monacensis 197* (Figure 2), for instance, shows no mechanism for holding and adjusting the stone. By comparison, the third such instrument was more complex and has, to the author's knowledge, only been addressed briefly by Ogden (2018). The present study thus seeks to examine this apparatus in more detail.

Such manually driven devices would eventually give way to those relying on external power sources. It has been speculated that the use of water-driven sandstone wheels for shaping and polishing quartz in the vicinity of Idar-Oberstein, Germany, dates back as far as the documented start of gem cutting in the region in the first half of the 15th century, around 1434 (Jerusalem, 2003). However, the extant written record offers unambiguous confirmation of the use of watermills for gem fashioning in the area only as of the 16th century, specifically in 1531 (Fischer 1957; Jerusalem 2003) or before 1544 (Lange 1868). Somewhat earlier usage of a watermill in this regard (in the second half of the 15th century) can be verified for other areas of Germany, such as the cities of Freiburg, Zweibrücken and Saarbrücken (Fischer 1956, 1957, 1968; Wild 1959; Jerusalem 2003).

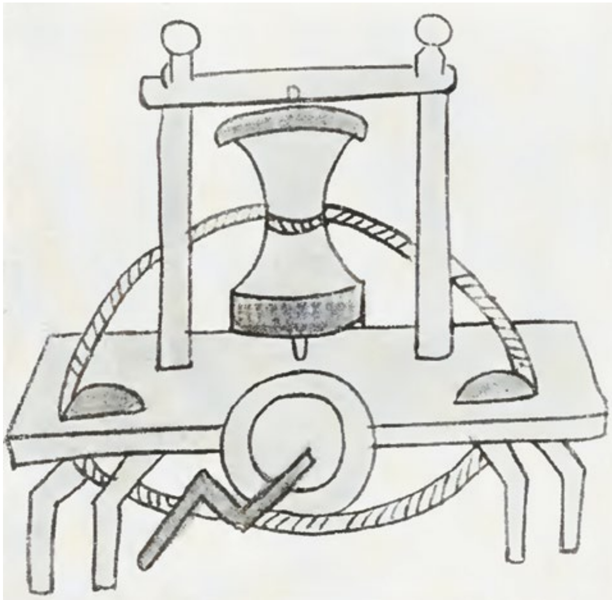


Figure 2: An instrument for polishing gemstones was depicted in the 15th-century *Codex Latinus Monacensis 197* by an anonymous author. From Feldhaus (1914).

HENRI ARNAUT DE ZWOLLE AND THE LATIN 7295 CODEX

The two gemstone-fashioning devices premised on manually driven rotating wheels or discs depicted in the Latin 7295 codex have been attributed to Henri Arnaut: one simpler type that is briefly summarised below, and another more complicated tool, which is the focus here. The life of Henri Arnaut de Zwolle (alternately Henricus Arnault/Arnold/Arnoldus) was the subject of a work by Le Cerf and Labande (1932), who also edited part of the Latin 7295 codex.

[1] The information available on the website of the Bibliothèque Nationale de France about the Latin 7295 codex originates from *Catalogus Codicum Manuscriptorum Bibliothecae Regia* (1744) but is not so cited. Such information, at least in part, is inconsistent with more recent literature (e.g. Le Cerf & Labande 1932).

Arnaut was born in Zwolle (located east of Kampen, The Netherlands) around 1400 and died of the plague in Paris in 1466. He studied in Paris and became a doctor of medicine, but he additionally trained under the instrument maker Jean de Fusoris. Arnaut served as physician, astronomer, astrologer and organist to Philip the Good, Duke of Burgundy (1396–1467) in Dijon and, later, to the French kings Charles VII (1403–1461) and Louis XI (1423–1483) in Paris.

The Latin 7295 codex contains treatises on musical instruments, astronomical devices and various technical objects, and the texts were written by Arnaut and three other known authors (Jean de Muris, Jean de Linières and Jean de Fusoris) whose work Arnaut apparently either used or copied, as well as by several anonymous contributors. Although specific dates for the penning of different portions of the manuscript are uncertain, it has been assumed that part of the text was written in Dijon, where Arnaut most likely lived between 1432 and 1454.

Folio 137 recto and verso (front side and back side) depict two different cutting and polishing mills for gemstones. According to Le Cerf and Labande (1932), the accompanying text written on the front side of folio 137 is from an anonymous hand, but the text written on the back side is attributed to Arnaut.

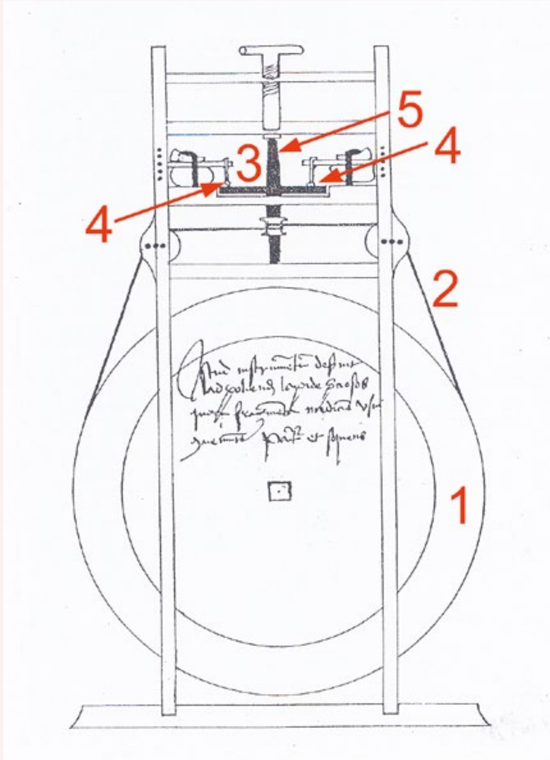


Figure 3: An instrument for polishing gemstones was depicted in the Latin 7295 codex, archived at the Bibliothèque Nationale de France (National Library of France) in Paris, on the front side of folio 137. The numbered parts are described in the text of this article. After von Stromer (1993).

The Instrument for Polishing Gemstones on Folio 137 Recto

The device illustrated on the front side of folio 137 of the Latin 7295 codex (Figure 3), which has already been described in several publications, shows a large wheel (1) attached via a pivot to a horizontal spindle used as a drive shaft and turned by a crank handle (not visible).

A transmission belt (2) drives a smaller faceting and polishing wheel (3) that rotates on a vertical shaft (5). Gemstones (4) are affixed to a stylus and pressed to the wheel (3). This apparatus offered little flexibility in orienting the stone, and applying the necessary pressure would have been laborious.

The Instrument for Polishing Gemstones on Folio 137 Verso

The instrument depicted on the back side of folio 137 of the Latin 7295 codex is shown in Figure 4. The Latin text explains that the instrument is used for smoothing and polishing the pre-formed facets of a gemstone. It is said that by means of the separate 'quadrat' with the (vertical) axis *AB* it is possible to position the pre-formed stone ideally for the polishing process. The Latin text reads:

> *Notandum circa istum quadratum quod bonum est quod axis AB. Fiat etiam flexibilis ita quod B possit aliquando dextri ad sinistrum et hoc ea de causa ut post sculpturam lapidis ad poliendum etiam possit perfectum adaptari. Ad facies suas iam sculptas quod alias non bene fieri poterit.*

And is translated to:

> It has to be taken into account that the quadrat is good because of the axis AB. In that way B becomes flexible at any time from right to left, and this is because after shaping the gemstone can be perfectly adapted to polish the already shaped faces, because this is not rightly done in another way.

Using this information, it is feasible to discuss the operation of the tool's various components (Figure 5). A large wheel (1) is attached via a pivot to a horizontal spindle used as a drive shaft and turned by a crank handle (2). A transmission belt (3) drives a smaller polishing wheel (4), which likewise rotates on a horizontal shaft. Such construction transmits power to the smaller polishing wheel while at the same time increasing the rotational speed, compared to the driving wheel, thus achieving a rate sufficient for gemstone smoothing and polishing.

The component referenced in the Latin text as a quadrat (5) shows two loop bearings (6) that are placed along a vertical axis *AB*. The two loops (6), which function as guide sleeves, attach the quadrat (5) to a vertical shaft (7) and enable the quadrat to pivot on the shaft. The shaft (7) is supported by a horizontal arm (8). A pre-formed gemstone (9) can be affixed to a metallic or wooden stylus (10), which is guided at its opposite end by a groove (11) in the quadrat. This feature allows the stone to be held at a precise inclination. Consistent with such functionality, Ogden (2018) recently referred to the quadrat as an 'angle gauge'. Moreover, in further augmenting the adaptability of the device, it is likely that the arm (8) carrying the quadrat (5) and the shaft (7) can also be shifted horizontally (see arrow in Figure 5).

Nonetheless, although the general principles of the instrument's construction seem deducible, some details of the exact use and alignment of the machine remain unclear. Yet the basic technology of the apparatus, using a round wheel with a horizontal shaft for smoothing and polishing (as depicted and described in the short Latin text), was applied later in Idar-Oberstein for faceting gemstones using somewhat larger sandstone wheels.

CONCLUSIONS AND CONTINUING DEVELOPMENTS

The design of the instrument depicted on the back side of folio 137 of the Latin 7295 codex incorporates multiple adjustments facilitating orientation of a pre-formed gemstone with respect to a polishing wheel (again, see arrows in Figure 5). As such, Arnaut's instrument joins other known belt-driven devices that represent a shift from simple handheld tools to modern faceting and polishing equipment for coloured stones and diamonds

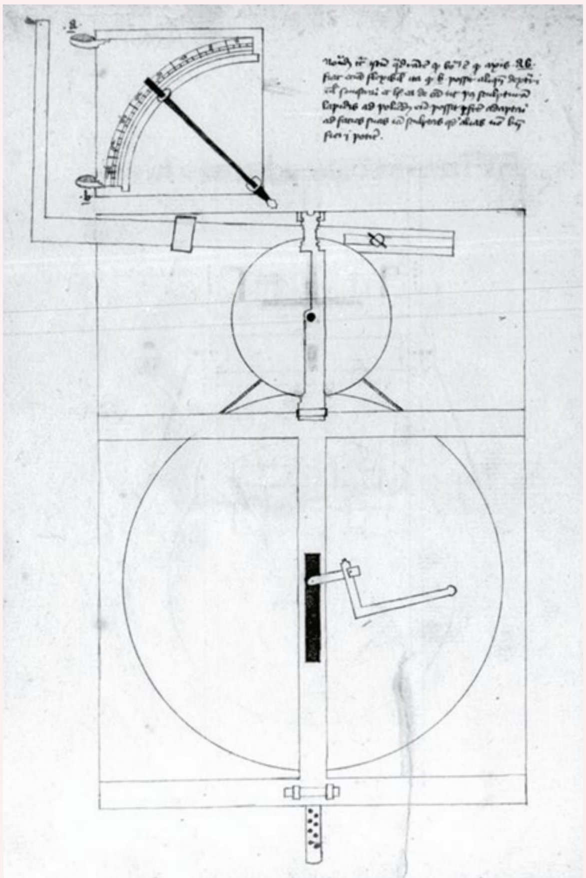


Figure 4: Another instrument for polishing pre-formed gemstones was depicted in the Latin 7295 codex on the back side of folio 137. Also slightly visible through the page are the darkest parts of the other instrument shown on the front side of folio 137. Courtesy of Bibliothèque Nationale de France, Paris; reproduced by permission.

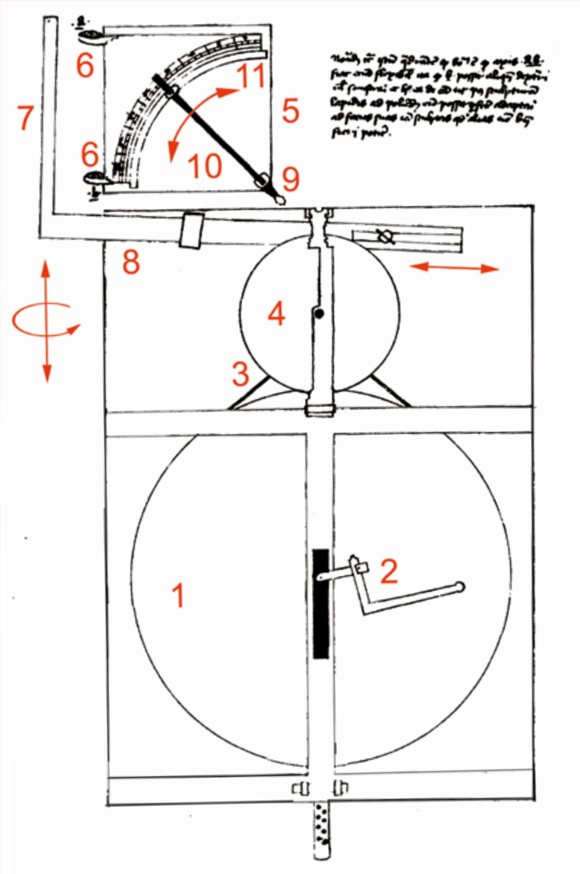


Figure 5: The instrument in Figure 4 is shown here with reference numerals added by the present author to facilitate explanation of the device's various components (see text for details).

with regular cuts, bridging the technological transition from the Late Middle Ages to the Renaissance.

At present it is unknown if the devices attributed to Arnaut in the Latin 7295 codex were widely distributed and applied in practice. The historical record suggests that progress thereafter might have been sporadic and nonlinear. For example, the tool for cutting gemstones depicted in Volmar's *Steinbuch* (1498) still shows only a rotating disc, with no device to hold and adjust the gemstone (Figure 6). Some further developments in faceting and polishing technologies were described in a treatise by Peder Månnson, written (in Swedish) around 1520. This work was translated by Johannsen (1941), who also reconstructed the instruments in operable form, and the various tools were more recently reprised by Bol (2019).

Figure 6: A disc for shaping and polishing gemstones was depicted in Volmar's *Steinbuch* (1498).

Yet another example in the ongoing experimentation appeared in a book by Rößlin (1550) describing plants, animals, minerals and gemstones. A scene in this book depicts a large, hand-cranked wheel used as a power source for polishing gems (Figure 7). In that arrangement, a horizontal driving wheel (1) is attached to a vertical spindle used as a drive shaft. A transmission belt (2) drives a smaller polishing wheel (3), which likewise rotates on a vertical shaft. The shaft of the driving wheel (1) is connected by gears (4) to a large horizontal shaft (5). That shaft (5) is connected by another transmission belt (6) to a wheel (7) rotated by manpower using a crank handle (8).

A stronger link with modern faceting technologies can be traced to the beginning of the 17th century in the treatise on mineralogy and gemmology by Anselmus Boëtius de Boodt, published first in Latin in 1609. The faceting devices described there are discussed in detail by Theobald (1984) and also illustrated by Prim (2018a). The primary novelty in their construction was the application of two parts (Figure 8), namely, a horizontal wheel with a vertical shaft for faceting and polishing, and a mechanism with another vertical shaft for setting a precise inclination of the gemstone to the flat side of the wheel.

In de Boodt's apparatus, a large wheel (A) is attached to a vertical spindle used as a drive shaft and turned by a crank handle (B). A transmission belt drives a smaller faceting and polishing wheel (C), which likewise rotates

Figure 7: An apparatus for polishing gems was depicted in a book about plants, animals, gemstones and minerals written by Eucharius Rößlin in 1550. The large wheel used as the power source (7) is seen in the background, and the horizontal driving wheel (1) for the smaller polishing wheel is at the right. See text for an explanation of the numbers and parts. After Rößlin (1550).

on a vertical shaft. A mechanism (E) to hold and adjust the gemstone (K) is shown at the upper right, enlarged but still placed in the correct orientation to the faceting wheel (C). That mechanism (E) is attached by a block (B) to another vertical shaft (D) and supports a stylus (I) holding the gemstone (K) at a precise inclination. The stylus (I) is affixed by two wooden blocks (G and H) and guided in a groove. A more detailed description is given by Theobald (1984).

As such, the apparatus depicted by de Boodt incorporated both a vertical shaft for the faceting and polishing wheel (which enabled contact with the gemstone to occur on the flat side of the wheel), and an adjustable mechanism for orienting the stone. De Boodt's work can thus be described in theory as a combination of the two beneficial features already shown separately by Arnaut. This combination, in turn, was pivotal in the progression towards modern fashioning technology.

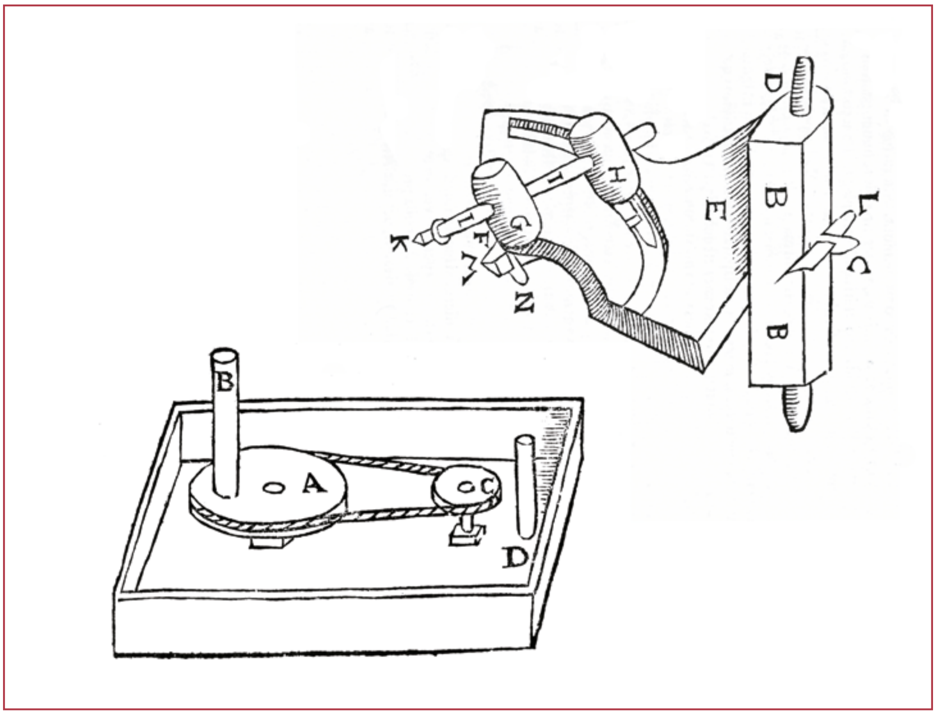


Figure 8: An instrument for faceting and polishing gemstones was depicted in the treatise on mineralogy and gemmology by Anselmus Boëtius de Boodt (1609). The mechanism (E; upper right) for orienting the gemstone, generally affixed to the vertical shaft (D), is enlarged compared to the principal tool (lower left) with driving and faceting wheels (A and C). See text for further explanation of the numbers and parts. After de Boodt (1609).

REFERENCES

Bol, M. 2019. *Polito et Claro*: The art and knowledge of polishing, 1100–1500. *In*: Bycroft, M. & Dupré, S. (eds) *Gems in the Early Modern World: Materials, Knowledge and Global Trade, 1450–1800*. Palgrave Macmillan, Cham, Switzerland, 223–257, https://doi.org/10.1007/978-3-319-96379-2_9.

Catalogus Codicum Manuscriptorum Bibliothecae Regiae. Pars Tertia. Tomus Quartus. 1744. E Typographia Regia, Parisiis, 336–337, https://books.google.com/books?id=5Hck35MEbLoC.

Content, D.J. 2016. *Ruby, Sapphire & Spinel: An Archaeological, Textual and Cultural Study, Part I: Text*. Brepols Publishers, Turnhout, Belgium, 191 pp.

de Boodt, A.B. 1609. *Gemmarum et Lapidum Historia*. Typis Wechelianis apud Claudium Marnium & heredes Ioannis Aubrii, Hanoviae, 294 pp, https://books.google.com/books?id=upxkAAAAcAAJ.

Dodwell, C.R. 1961. *Theophilus, De Diversis Artibus (The Various Arts)*. Thomas Nelson and Sons, London and Edinburgh, 178 pp.

Falk, F. 1975. *Edelsteinschliff und Fassungsformen im späten Mittelalter und im 16. Jahrhundert: Studien zur Geschichte der Edelsteine und des Schmuckes*. Verlag Wilhelm Kempter KG, Ulm, Germany, 150 pp.

Feldhaus, F.M. 1914. *Die Technik der Vorzeit, der geschichtlichen Zeit und der Naturvölker. Ein Handbuch für Archäologen und Historiker, Museen und Sammler, Kunsthändler und Antiquare*. Verlag von Wilhelm Engelmann, Leipzig und Berlin, 1,400 columns, https://archive.org/details/dietechnikdervor00feld/page/n4.

Fischer, W. 1956. Zur Geschichte der Idar-Obersteiner Edelsteinindustrie. *Aufschluss*, **3**, 49–59.

Fischer, W. 1957. Die Vorgeschichte der Idar-Obersteiner Achatschleiferei. *Heimatkalender des Kreises Birkenfeld (Nahe)*, **2**, 163–171.

Fischer, W. 1968. Zur Entwicklung der Schleiftechnik. *Aufschluss*, **18**, 21–67.

Gille, B. 1966. *The Renaissance Engineers*. Lund Humphries, London, 256 pp.

Grassin, G. 1999. Le travail des gemmes au XIIIe siècle dans la *Doctrina Poliendi Pretiosos Lapides*. *Cahiers de Civilisation Médiévale*, **42**(166), 111–137, http://doi.org/10.3406/ccmed.1999.2750.

Gray, A. 1989. A fourteenth century crown. *Journal of Gemmology*, **21**(7), 431–432, http://doi.org/10.15506/JoG.1989.21.7.431.

Hall, B.S. 1971. *The so-called "Manuscript of the Hussite Wars' Engineer" and its technological milieu: A study and edition of Codex Latinus Monacensis 197, Part 1*. Ph.D. thesis, University of California, Los Angeles, California, USA, 472 pp.

Hall, B.S. 1979. *The Technological Illustrations of the So-Called "Anonymous of the Hussite Wars": Codex Latinus Monacensis 197, Part 1*. Reichert, Wiesbaden, Germany, 221 pp.

Hendrie, R. 1847. *An Essay Upon Various Arts, in Three Books, by Theophilus, Called also Rugerus, Priest and Monk, Forming an Encyclopaedia of Christian Art of the Eleventh Century*. John Murray, London, 447 pp.

Hyršl, J. & Neumanova, P. 1999. Eine neue gemmologische Untersuchung der Sankt Wenzelskrone in Prag. *Gemmologie: Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **48**(1), 29–36.

Jerusalem, D. 2003. Wasserkraft-Mensch-Edelstein. *In:* Jerusalem, D. & Wild, M. (eds) *Wasserkraft und Edelstein – 30 Jahre Deutsches Edelsteinmuseum Idar-Oberstein*. Stiftung Deutsches Edelsteinmuseum, Idar-Oberstein, Germany, 10–30.

Johannsen, O. 1941. Steinschneidekunst. *In: Peder Månnsons Schriften über technische Chemie und Hüttenwesen. Eine Quelle zur Geschichte der Technik des Mittelalters*. VDI-Verlag GmbH, Berlin, Germany, 139–162.

Lange, G. 1868. *Die Halbedelsteine aus der Familie der Quarze und die Geschichte der Achatindustrie*. Druck und Verlag von R. Voigtländer, Kreuznach, Germany, 101 pp.

Latin 7295 codex, attributed to H. Arnaut and others, first half of the 15th century. Bibliothèque Nationale de France, Paris, https://gallica.bnf.fr/ark:/12148/btv1b90725989.

Le Cerf, G. and Labande, E.-R. 1932. *Les traités d'Henri-Arnaut de Zwolle et de divers anonymes*. Reprinted 1972, Bärenreiter, Kassel, Germany, pp. V–XVII.

Lightbown, R.W. 1992. *Mediaeval European Jewellery with a Catalogue of the Collection in the Victoria & Albert Museum*. Victoria & Albert Publications, London, 589 pp.

Merrifield, M.P. 1849. *Original Treatises Dating from the XIIth to XVIIIth Centuries, on the Arts of Painting*, Vol. I. John Murray, London, 166–257, https://archive.org/details/originaltreatis00merrgoog/page/n6.

Ogden, J. 2018. *Diamonds: An Early History of the King of Gems*. Yale University Press, New Haven, Connecticut, USA, and London, 408 pp.

Prim, J.K. 2018a. Lapidary Technology Through the Ages: Laps and Polish. https://medium.com/justin-k-prim/lapidary-technology-through-the-ages-laps-and-polish-59c29f05a11a, accessed 31 March 2019.

Prim, J.K. 2018b. The Rise of Gem Cutting and the Occult in Renaissance Europe. https://medium.com/justin-k-prim/the-rise-of-gem-cutting-and-the-occult-in-renaissance-europe-f3535b78599b, accessed 31 March 2019.

Richards, J.C. 1940. A new manuscript of Heraclius. *Speculum*, **15**(3), 255–271, http://doi.org/10.2307/2855203.

Rößlin, E. 1550. *Kreuterbuch / Von naürlichem Nutz / und gründlichem Gebrauch der Kreutter / Bäum / Gesteud / unnd Früchten / fürnemlich Teutscher Lande. Deßgleichen der Gethier / Edlen gesteyn / Metal / und anderer Simplicien und Stucken der Artznei*. Christian Egenolff, Frankfurt, 263 ff.

Samuel, E.R. 1980. The invention of diamond polishing. *Industrial Diamond Review*, **40**(1), 5–7.

Schroeder, A. 1930. *Entwicklung der Schleiftechnik bis zur Mitte des 19. Jahrhunderts*. Dissertation, Technische Hochschule Braunschweig, 191 pp.

Theobald, W. 1984. *Technik des Kunsthandwerks im zwölften Jahrhundert des Theophilus Presbyter Diversarum Artium Schedula*. VDI-Verlag GmbH, Düsseldorf, Germany, 470–478.

Volmar 1498. *Wahrhaftig Büchlein von der Tugend und Kraft der Edelsteine*. Hans Spörer, Erfurt, Germany, 19 pp.

von Stromer, W. 1993. Modell der Edelstein-Schleifmaschine des Heinrich Arnold aus Zwolle von 1439. *In:* Ebert-Schifferer, S. & Harms, M. (eds), *Faszination Edelstein: Aus den Schatzkammern der Welt: Mythos, Kunst, Wissenschaft*. Hessisches Landesmuseum, Darmstadt, Germany, 120–121.

White, L.T. 1978. *Medieval Religion and Technology: Collected Essays*. University of California Press, Berkeley, California, USA, 360 pp.

Wild, K.E. 1959. *Zur Geschichte der Schmucksteinschleiferei im Gebiet der oberen Nahe und Saar*. Mitteilungen des Vereins für Heimatkunde im Landkreis Birkenfeld, Sonderheft 2, Verein für Heimatkunde im Landkreis Birkenfeld, Idar-Oberstein, Germany, 71 pp.

The Author

Dr Karl Schmetzer
Taubenweg 16, 85238 Petershausen, Germany
Email: SchmetzerKarl@hotmail.com

Acknowledgements

The author is grateful to Oliver Teufer (Limburg, Germany) for his help with deciphering and translating the Latin text.

Conferences

SECOND WORLD EMERALD SYMPOSIUM

The Second World Emerald Symposium took place 12–14 October 2018 in Bogotá, Colombia, three days prior to and in conjunction with the annual World Jewellery Confederation (CIBJO) Congress. The first time this emerald conference took place was in 2015, also in Bogotá. It was organised by Fedesmeraldas, the Colombian National Emerald Trade Association, to coincide with their 20th anniversary.

The symposium provided a comprehensive analysis of all elements of the emerald industry, across the entire supply chain from mine to market, and was well attended by about 300 people. One focus was on how blockchain technology could help the emerald industry, with an emphasis on traceability, and how corporate responsibility could help improve social conditions while strengthening confidence in emerald in Colombia. This also included branding and retailing in the new millennium, and using social media alongside the 'red carpet' to boost the Colombian emerald brand. It was stressed that artisanal miners need more support and should have a greater voice and more participation in the industry, as well as a legitimate chain of distribution. At the same time, the promotion of responsible practices should not disadvantage small enterprises. In general, it became clear that the Colombian government is seriously committed to supporting and legalising the emerald sector.

Several gemmological topics were covered on the first day of the conference, and below are highlights of some of the many worthwhile contributions, which were presented simultaneously in Spanish and English.

Dr Gaston Giuliani (Centre de Recherches Pétrographiques et Géochimiques [CRPG], Nancy, France) gave a comprehensive overview of emerald formation, with about 30% of the world's production coming from black shales in Colombia, and 70% from granite-related deposits that occur in many countries around the globe. Geologically, the Colombian emerald deposits are unique, with the erosion of ultramafic rocks providing sources of V and Cr in the shales, and halokinesis (movement of salt and salt bodies) playing a key role in mobilising the elements necessary to form emerald.

Charles Burgess (Minería Texas Colombia, Boyacá, Colombia) elaborated on the modernisation of the emerald industry in Colombia. After privatisation of the emerald mines in the 1970s, violent conflicts and intense competition increased, preventing investment. Change has been dramatic since 2009, when his company obtained mining rights to the Muzo mine. They are complying with new rules (including environmental standards and safety procedures), progress is being made in the local cutting industry, professional laboratories are operating, social responsibility is an integral part of their mining operation, and marketing and sales have improved.

Dr Lee Groat (University of British Columbia, Vancouver, Canada) discussed the challenges of exploration for emeralds in Canada, which has a number of occurrences in the Yukon and Northwest Territories. In these vast, remote areas with low population density, there are only three months of the year (June through August) that are amenable to exploration activities. Drones are increasingly being used as exploration tools, which can save 80% of the time spent in the field. Interestingly, near Mountain River, Northwest Territories, a discovery of green beryl in sediments shows some resemblance to Colombian-type mineralisation. Investigating black shale units in north-western Canada hopefully will result in additional emerald discoveries.

Gabriel Angarita (CDTEC Gemlab, Bogotá, Colombia) introduced a new resin, called Naturalys, to enhance the clarity of emeralds (Figure 1). After discussing the advantages and disadvantages of oils and resins, he explained the properties of Naturalys, which is a colourless natural product with an RI very close to that of emerald. It is reportedly easy to remove and possesses excellent stability, with minimal or even invisible changes over time (guaranteed for more than 12 years). Since the resin is not hardened, it does not glue the stone together.

Dr Taijin Lu (National Gemstone Testing Center [NGTC], Beijing, China) introduced the Chinese national standard of emerald grading, which is applied by NGTC's nine laboratories in China. It includes grading of colour, clarity, clarity enhancement, cut and brilliance ('4 Cs and a B'). The international standards of the Laboratory Manual Harmonisation Committee are followed with regard to clarity enhancement. He reported they also issue opinions on the geographic origin of emerald, using

Figure 1: Gabriel Angarita introduces a new type of natural resin called Naturalys for the clarity of enhancement of emeralds. Photo by J. C. Zwaan.

isotope analysis as well as spectroscopy, trace-element fingerprinting, optical properties, internal features and luminescence.

Vincent Pardieu (Bahrain Institute for Pearls and Gemstones—DANAT, Manama, Bahrain) elaborated on emeralds from Madagascar and on geographic origin determination. Trace-element chemistry using LA-ICP-MS has become very useful for assessing emerald localities, but it is still not easy and not cheap, and the interpretation of the data depends on the availability of a reliable reference collection. As origin determination is a major concern—auction houses are asking for origin reports, because origin strongly influences price—it is therefore important to collect reference materials at the sources where emeralds are found.

Olivier Segura (L'École des Arts Joailliers [The School of Jewelry Arts], Paris, France) described his introductory school for the general public that was launched in 2012 and supported by Van Cleef & Arpels. The school includes a design studio where one can learn gouache techniques (technical jewellery drawing), a jewellery workshop, a gemmology lab, a lacquer and enamelling facility, two classrooms dedicated to the history of jewellery and art, a lecture hall and a library. The 20 courses currently offered are intended mainly for adults, and each lasts 2–4 hours. Segura advocated education as the most powerful tool to make consumers appreciate jewellery.

Andy Lucas (Guild Institute of Gemmology, Hong Kong and Shenzhen, China) described how education is the gateway to the huge Chinese market. According to him, there is very little availability of online (or offline) education about gems and jewellery in China, which results in a lack of trust for buyers. He is working on a mine-to-market education programme to help build consumer confidence. This will include first-hand information from gem traders and visits to mines, explaining what it takes to find gemstones, the value-added skills that are required in the pipeline for cutting and designing, and the role of middlemen and brokers. The consumer will then appreciate better what goes into choosing the right stones and why (sometimes huge) differences in value exist.

Doug Hucker (American Gem Trade Association, Dallas, Texas, USA) emphasised that when looking for strategies to sell more emeralds, the international community should take an active part in improving mining conditions and giving a fair share of their profits for the welfare of local communities that depend on the recovery and trade of emeralds. He provided some examples of concrete actions that show this is real, not just posturing. Only then can customers continue to fall in love with emeralds, knowing that they are 'doing good' when purchasing such stones.

At the end of this long day, two panel sessions were held. One of the sessions was on emerald treatments with **Ronald Ringsrud** (Ronald Ringsrud Co., Saratoga, California, USA), **Dr Laurent Cartier** (Swiss Gemmological Institute SSEF, Basel, Switzerland), **Gagan Choudhary** (Gem Testing Laboratory, Jaipur, India) and **Rodrigo Giraldo** (Laboratorio de Gemología RG, Bogotá). One particular issue they discussed at length was the quantification of clarity enhancement. Because (for good reasons) the terms 'minor', 'moderate' and 'significant' clarity enhancement are not very precise, well-defined terms, Ringsrud suggested putting the word 'approximate' in front of them. Giraldo advocated for an adjustment of the current system with a few more categories, encompassing none (NE), insignificant (E1), minor (E2 or E3), moderate (E4 or E5) and significant (E6). The other panel session covered challenging laboratory issues pertaining to emeralds.

More information on the Second World Emerald Symposium was published in a special issue of *InColor* magazine (No. 40, 2018), which is freely downloadable from www.gemstone.org/incolor/40.

Dr J. C. (Hanco) Zwaan FGA
(hanco.zwaan@naturalis.nl)
Netherlands Gemmological Laboratory
Naturalis Biodiversity Center
Leiden, The Netherlands

GEM-A MIDLANDS CONFERENCE

On 23 February 2019, Gem-A's Midlands branch held its conference in Birmingham. With more than 60 guests attending, it had the feel of a professional conference, but with a casual atmosphere and an intimacy that allowed old friends and acquaintances to catch up, as well as meet and interact with new people. The event featured six speakers and was organised by the Gem-A Midlands branch committee (Figure 2).

Gem-A Midlands president **Gwyn Green** and chairperson **Louise Ludlam-Snook** opened the conference. The speakers programme began with **Amanda Good** (G.F. Williams & Co., London), a stone dealer with more than 35 years' experience and a Gem-A practical examiner for 20 years. Her talk—'Emeralds – Their history, properties and treatments'—started with a review of the world's major emerald deposits and their significance in the market, including Zambia as producing the largest quantity and Colombia as having the highest value. She also discussed the processes of cutting, faceting and treating emeralds, detailing a new enhancement called Permanente that has been introduced in Colombia and takes 5–7 days to perform. Resin, with a hardener, is impregnated into the stones under vacuum. It can fill larger cracks and stabilise material previously unsuitable for faceting. Additional aspects of her talk included synthetics, trading practices and historical emeralds.

Maggie Campbell Pedersen (Gem-A president, London) presented 'Ivory and tortoiseshell – Past uses and present emotions'. She discussed the use of these biogenic materials for ornamentation and adornment, and continued with other animal products that have been used for various purposes, including kingfisher feathers to decorate Chinese screens, hornbill casques for carved ornaments and rhino horns thought to have medicinal properties such as reducing fever in children. The talk also covered historical and modern information on different types of biogenic materials, with advice on how to identify them. These included elephant and walrus ivory, hippo and sperm whale teeth, vegetable 'ivory', bone and narwhal tusk, the last of which was once thought to be derived from unicorns and to be a cure for poisons. Campbell Pedersen also discussed the coming new laws in the UK for the sale of elephant ivory, and the various exemptions that will allow some trade in a few specific items. As of 2013, it was illegal to sell any ivory that had not been significantly altered from its raw state.

Craig O'Donnell (SafeGuard Valuations at Birmingham Assay Office), a jewellery valuer and antiques dealer with more than 25 years' experience, was the final speaker of the morning with his talk on 'The Joy of Text, Original Catalogues and Design Books'. His slides featured jewellery trade catalogues and design books and their illustrations. Giving overviews of jewellery designs from 1900 to 1950, he showed how fashion trends in subject matter, materials, gemstones and styles have changed over the decades, and he gave examples of what instigated these changes. For example, at the turn of the 20th century, jewellery items commonly featured tennis rackets, bicycles, cars, and art and leisure activities, which were all popular themes at the time. Some items were fashionable for only short periods, such as 19th-century 'Dearest' jewellery that was named for the multiple gem varieties it contained (i.e. **d**iamond, **e**merald, **a**methyst, **r**uby, **e**merald, **s**apphire and **t**opaz).

Figure 2: Gem-A Midlands branch committee members and conference speakers gather for a group photo. From left to right: standing—Gwyn Green, Georgina Southam, Amanda Zhang, Ann Phillips, Louise Ludlam-Snook, Andrew Fellows, Paul Phillips, Amanda MacKinnon and Stephen Alabaster; sitting—Amanda Good, Rosamond Clayton, Maggie Campbell Pedersen, David Callaghan and Craig O'Donnell. Photo courtesy of Paul Phillips.

Rosamond Clayton (independent jewellery valuer with the London Diamond Bourse) kicked off the afternoon with her presentation titled 'Jade – The Stone of Heaven'. She gave a brief overview of the use of jade in Chinese history, in which the Qianlong period (18th century) was the high point of jade carving. She covered the quality factors that should be considered when evaluating jade, including colour, texture, translucency, distribution and intensity of colour, and overall appearance. Clayton also showed slides of jade jewellery from different periods and discussed the meaning of some of the carvings. She talked of the complexities when dealing in jade. Buying jade rough is a huge gamble because only a few small areas of a boulder's surface are typically polished for the buyer to assess the quality of the interior.

Andrew Fellows (School of Jewellery, Birmingham City University) kindly delivered a presentation titled 'Synthetic Diamonds' as a replacement for **Miranda Wells** (also from the School of Jewellery), who was scheduled to discuss 'The Changing Face of Tourmaline' but could not attend due to illness. Fellows made an impressionable entrance wearing a Sherlock Holmes outfit complete with a pipe. He then gave a brief history of synthetic diamonds, and covered the size ranges, colours and cuts of gem-quality material. He also discussed the standard tests used to identify synthetic diamonds, such as examination of inclusions, reaction to UV radiation and strain patterns seen with crossed polarising filters. Finally, he explained how advanced instrumentation can help identify synthetic diamonds, including the Raman spectrometer and various instruments developed by De Beers such as the DiamondView, PhosView and SYNTHdetect. In addition, he covered Yehuda's 'Sherlock Holmes' device (which prompted his attire), which uses mobile phone technology and short-wave UV illumination to identify natural vs. synthetic diamonds.

The final speaker of the day was **David Callaghan** (former senior director of Hancocks, London). He spoke on 'Design – A Look at the Works of René Lalique and Andrew Grima', giving a colourful and visual tribute to the enormous range of designs and objects produced by these two artists during their lifetimes. He compared the two men and their work—both of whom were great observers of nature, skilled at pencil drawing, produced hundreds of designs and stuck to their own ideas, such that their designs influenced trends. Lalique often used less conventional materials such as horn, amber and ivory imitations in combination with gold, gems and diamonds. As for Grima, in 1969 Omega offered him a budget of £1 million to design watches set in rings.

Figure 3: Emily Jones and Paul Haywood were the recipients of the Doug Morgan Award and the Gwyn Green Award, respectively. Photo by Paul Phillips.

These Cerini timepieces often had citrine watch glasses and featured eccentric shapes.

The day finished with a celebration dinner, which included award presentations to Midlands-area Gem-A students who attained the highest marks in the 2018 diploma exams. The Doug Morgan Award (Gemmology Diploma) was presented to **Emily Jones** and the Gwyn Green Award (Diamond Diploma) was awarded to **Paul Haywood** (Figure 3). A further presentation was made to **Gwyn Green** for her outstanding contributions to gemmology for more than 30 years.

Gwyn Green FGA DGA *and Louise Ludlam-Snook*
(gemamidlands@gmail.com)
Gem-A Midlands Branch, Birmingham

DANISH GEMMOLOGICAL SOCIETY SYMPOSIUM

Over the weekend of 23–24 March 2019, the Danish Gemmological Society held its first symposium. The venue was the historic Odd Fellows Mansion in the centre of Copenhagen, and the symposium was attended by about 70 delegates, mostly from Scandinavia. All presentations were in English. The event was organised by the Society under the leadership of its president, **Niels Ruddy Hansen**, who is a diamond expert, Danish representative of CIBJO and former chair of CIBJO's Sector A. He opened the symposium with a brief history of the Danish Gemmological Society, which was founded in 1955 as a forum for gemmologists and anyone interested in gemstones.

Figure 4: The panel discussion gave participants of the Danish Gemmological Society Symposium an opportunity to present questions to the speakers and discuss issues affecting the jewellery and gem industry. Photo courtesy of Niels Ruddy Hansen.

Dr Gaetano Cavalieri, president of CIBJO (Milan, Italy), was the keynote speaker. He spoke about CIBJO's global role in the gem and jewellery industry, how CIBJO evolves and changes with the times, the importance of transparency in the jewellery supply chain, and how essential it is that the industry be seen today as ethical.

Dr Claudio Milisenda (DSEF German Gem Lab, Idar-Oberstein, Germany) reviewed the identification of coloured stone enhancements and the various methods used, both in the past and today, as well as what is acceptable in the trade. In a separate presentation he described rubies from Mozambique, including their identifying features (e.g. their UV fluorescence is much weaker than that seen in rubies from Mogok, Myanmar).

Dr Ulrich Henn (DSEF German Gem Lab) also gave two talks. The first was on the treatment of corundum, and the second was about synthetic diamonds and their manufacture, and the treatment of natural ones. He pointed out that the jewellery trade represents only a small part of the whole diamond industry, and that the larger market (i.e. for technological and industrial uses) wants and needs synthetics.

This author discussed ivory and tortoiseshell, noting the popularity of these materials and their numerous and diverse uses through the ages, the plight of the animals involved, and the laws and emotions surrounding their use today. She also mentioned the conservation status of the corals used in the jewellery trade, most of which are today covered by quotas rather than outright bans.

Hayley Henning (Greenland Ruby, New York, New York, USA; part of LNS Group, a Norwegian company) described rubies from Greenland. She stated that with an inferred age of 3 billion years this is the world's oldest ruby deposit, yet Greenland Ruby is one of the most recent mining ventures.

Carolina Santiago (Centro de Tecnologia Mineral, Rio de Janeiro, Brazil, and University of Bremen, Germany) gave a fascinating talk about the geological formation of gems and their classifications. She also described the past, present and future of Brazilian gems.

Anette Juul-Nielsen (Ministry of Mineral Resources and Labour, Nuuk, Greenland) reviewed the gems of Greenland, and covered the geology of the country and its various rock formations, which are some of the oldest in the world. Among the many gems that can be found there are corundum, diamond, tugtupite, chalcedony and garnet.

Erik Jens (FinTech, Amsterdam, The Netherlands, and DiamHolding, New York, New York, USA) spoke on a completely different subject area, one which is of importance to anyone in the trade: sustainability, innovation and bankability. He emphasised the need for 'CSR' (corporate social responsibility) to be part of any successful company's business strategy today.

The symposium finished with a panel discussion (Figure 4) moderated by **Niels Ruddy Hansen** in which delegates had the opportunity to ask questions of the speakers. The main topics were how to ensure a successful business in the jewellery industry, and how to convince consumers—now and in the future—that jewellery and gems are relevant in today's world.

Maggie Campbell Pedersen FGA
(maggiecp@btinternet.com)
Gem-A, London

16TH ANNUAL SINKANKAS SYMPOSIUM—PEARL

On 27 April 2019, the 16th Annual Sinkankas Symposium was held at the Gemological Institute of America (GIA) in Carlsbad, California, and was co-hosted by the Gemological Society of San Diego. The theme of this year's event was 'Pearl', and approximately 150 attendees heard presentations by eight speakers (Figure 5). There was also an impressive display of pearl and shell specimens and jewellery that was assembled for the event. As at past Sinkankas symposia, each participant received a colourful proceedings volume (reviewed on p. 570 of this issue of *The Journal*).

The symposium was introduced and moderated by **Robert Weldon** (GIA, Carlsbad), who also delivered a poem that he wrote specifically for the event. Then, **Douglas McLaurin-Moreno** (Perlas del Mar de Cortez, Guaymas, Sonora, Mexico) described the history and production of natural and cultured pearls from Baja California, Mexico. This region has been a source of pearls since the 16th century, but commercial production ended by 1940 when the fishery was exhausted due to overfishing and a major die-off event; gathering natural pearls has been banned since then. McLaurin-Moreno has been culturing pearls at his Guaymas farm since the 1990s, and currently he has approximately 300,000 rainbow-lipped *Pteria sterna* molluscs and 25 employees. The farm produces about 4,000 cultured pearls annually using sustainable methods.

Blaire Beavers (Designs by Blaire, San Diego, California) reviewed the history of pearls. Two important ancient pearling areas were the Persian Gulf (with Basra being the trading centre) and the Gulf of Mannar between

Figure 5: Speakers and organisers of the 16th Annual Sinkankas Symposium assemble with a life-size bronze sculpture of Richard T. Liddicoat Jr. From left to right: Bill Larson, Robert Weldon, Stuart Robertson, Betty Sue King, Douglas McLaurin-Moreno, Dona Dirlam, Hisano Shepherd, Jeremy Shepherd, Blaire Beavers, Donna Beers, Elisabeth Strack and Chunhui Zhou. Photo by B. M. Laurs.

India and Ceylon. Beavers also chronicled the use of pearls and shells in jewellery through the ages until the present time.

Betty Sue King (King's Ransom, Sausalito, California) described the evolution of her career as a pearl dealer, and stressed the importance of hard work and networking for success in the industry. She uses her background as a teacher to educate her buyers, as well as reach out to the public through various activities.

Elisabeth Strack (Gemmologisches Institut Hamburg, Germany) surveyed the varieties and sources of freshwater and saltwater pearls, both natural and cultured. She described the evolution of freshwater pearl culturing methods in China, including mantle growth (producing the 'fireball' variety) and in-body growth (yielding the 'Edison' type). She also noted a growing popularity of 'exotic' natural pearls during the past 15 years, such as those from gastropods (abalone and other marine snails) and from marine bivalves other than *Pinctada* and *Pteria* genera (e.g. lion's paw scallops, pen shells, etc.).

Bill Larson (Pala International, Fallbrook, California) described his experience with collecting rare and unusual natural pearls, particularly those from Baja California. He pointed out that natural pearls from *Pinctada mazatlanica* in the La Paz area are most commonly white, but may also be 'golden', 'copper' and grey-black, which are desired by collectors. He also highlighted several books that are excellent resources for gaining knowledge about pearls and their history.

Chunhui Zhou (GIA, New York, New York, USA) reviewed the history of pearl publications in *Gems & Gemology*. Various articles since the journal's inception in 1934 have documented an evolution in identification techniques from simple observations such as 'candling' to the use of endoscopy, X-ray radiography/fluorescence, X-ray computed microtomography, radiocarbon dating, DNA testing and trace-element analysis.

Stuart Robertson (Gemworld International Inc., Glenview, Illinois, USA) reviewed market and pricing trends. He indicated that 95% of the pearls on the market are cultured, so those have been the main focus of his research. They represent a vibrant sector of the gem industry, and range from affordable to very expensive, yet they constitute only about 2% of retail jewellery sales. Robertson ascribed this underperformance to the fact that the marketing of cultured pearls 'is not keeping up with the product'. He stated that the current market is less focused on strands and prefers single cultured pearls that make a statement for the designer and consumer.

Hisano Shepherd (little h jewelry, Los Angeles, California) described how she is reinventing pearl jewellery design through her various custom collections. Many of her pieces feature cultured pearls that she has sawn or carved and then set with various gems and seed pearls (see, e.g., the Gem Notes section of *The Journal*, Vol. 34, No. 8, 2015, p. 677).

The symposium ended with a special viewing of a new documentary film by Ahbra Perry and Taylor Higgins called 'Power of Pearl'. The screening was introduced by **Jeremy Shepherd** (Pearl Paradise, Los Angeles), who was one of the film's producers. Taking the viewer to pearl farms in Australia, the Philippines and Indonesia, the film documents various challenges to pearl fisheries created by environmental impacts attributed to climate change and other human-induced factors.

Brendan M. Laurs FGA

SWISS GEMMOLOGICAL SOCIETY CONFERENCE

On 28–30 April 2019 the Swiss Gemmological Society (SGS) held its 77th annual conference in Meisterschwanden on beautiful Lake Hallwil in Switzerland (Figure 6). As in the past, the conference was well attended with about 90 Society members and guests. This year the main topic was jade: its mineralogy, deposits, historical and cultural significance, quality assessment and trade. The conference was chaired by **Hans Pfister** (SGS president), **Dr Michael Krzemnicki** (Swiss Gemmological Institute SSEF director) and **Michael Hügi** (SGS director).

Richard Hughes (Lotus Gemology, Bangkok, Thailand) gave the keynote presentation on the cultural significance and use of jade in China. He described the historically important 'mutton-fat jade' (nephrite) deposits of Khotan in western China. Then he showed some impressive modern Chinese jade carvings displaying incredibly fine workmanship and artistic craftsmanship, along with the masters who designed and carved them. In a separate presentation, Hughes focused on the colour red. His lecture revealed the power of this colour and how it has connected emotions, beliefs and behaviour since early human history. The colour red continues to be important today, and ruby is the most appreciated red gem variety worldwide.

Prof. Dr Henry Hänni (GemExpert GmbH, Basel) presented an overview of the mineralogical characteristics and classification of jade (i.e. jadeite and nephrite), pointing out its highly complex mineralogical

Figure 6: Some of the speakers for the 2019 SGS conference gather at Lake Hallwil. From left to right: Michael Hügi, Richard Hughes, Prof. Dr Henry Hänni, Dr Michael Krzemnicki, Hans Pfister, Helen Molesworth, Roland Schluessel and Dr Lore Kiefert. Photo by Daniela Bellandi.

composition, as well as the different meanings of the historical term 'jade' in Asia and the Western world. In a second lecture, Prof. Hänni described a specimen of nearly colourless tourmaline from Madagascar that showed red haloes around dark grey inclusions. These inclusions were identified as columbite-tantalite with a relatively high content of uranium. The radioactivity caused the red spots in the host tourmaline via localised natural irradiation.

Helen Molesworth (Gübelin Academy, Lucerne, Switzerland) gave an extensive overview of the history of jade. She covered the ancient, millennia-old use of jade in China, through the famous burial masks of the Maya culture, to the medals of the 2008 Summer Olympic Games in China that incorporated nephrite.

To round off the jade topic, **Roland Schluessel** (Pillar & Stone International Inc., San Francisco, California, USA) presented trade aspects of Burmese jadeite, focusing on the assessment of quality and value using a complex grading system of colour, texture, transparency, etc. This system requires a lot of experience but is very helpful for carrying out appraisals of jadeite jewellery and artwork.

Two lectures were given on spinel. **Myint Myat Phyo** (University of Basel) gave an extensive overview of inclusions in spinel from Mogok, Myanmar. A large variety of mineral inclusions have been observed in Burmese spinel, many of them for the first time (see article in *The Journal*, Vol. 36, No. 5, 2018, pp. 418–435). **Dr Thomas Hainschwang** (GGTL Laboratories, Balzers, Liechtenstein) presented the results of his research on the heat treatment of blue, pink and purple spinels. He concluded that the treatment may have a positive effect on clarity but generally not on colour, thus confirming previous studies on this topic.

Dr Bertalan Lendvay (University of Zurich, Switzerland, in collaboration with SSEF) described a cutting-edge approach for identifying precious coral species. By using quasi-non-destructive sampling methods, it is now possible to carry out genetic (DNA) analysis with forensic validation on pearls and corals processed and used in jewellery. This new methodology will eventually contribute towards enforcing CITES regulations.

Dr Michael Krzemnicki reviewed current research at SSEF and highlighted some exceptional specimens tested in recent months. This included radiocarbon age

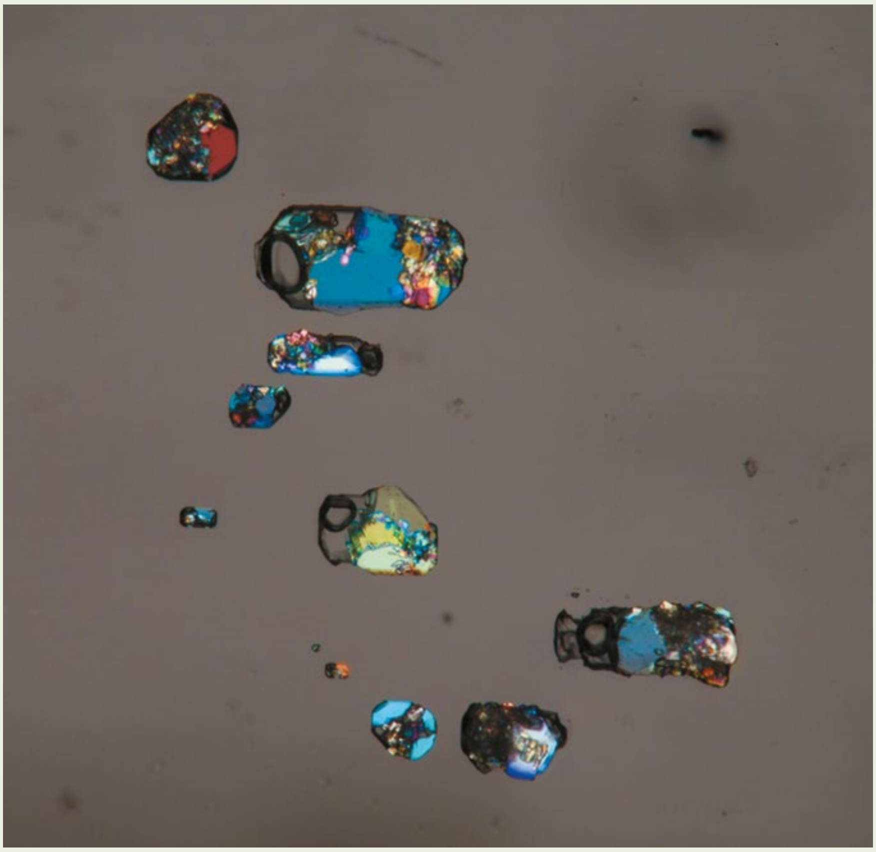


Figure 7: A group of three-phase fluid inclusions in an aquamarine from Pakistan contain mineral grains of muscovite and quartz, which show bright interference colours in cross-polarised illumination. Photomicrograph by M. Hügi; magnified 100×.

dating of the historic 'Ana Maria Pearl' and SSEF's new GemTrack service for documenting a gemstone's journey from rough to cut to jewellery.

Dr Lore Kiefert (Gübelin Gem Lab, Lucerne, Switzerland) gave an insight on sapphires heated with pressure to enhance their colour. This method is similar to traditional heating processes but involves a much shorter treatment time. As there is no diffusion from external sources, the colour improvement strongly depends on trace-element concentrations in the starting material. The presentation was the result of a joint study by 10 international laboratories, and further information can be found online at www.lmhc-gemmology.org/news.

Michael Hügi (Swiss Gemmological Society, Bern) presented a series of photomicrographs of inclusions in quartz, pegmatite gems (e.g. Figure 7) and natural glasses. He explained how to derive important information on the authenticity, formation and origin of a gem by 'squeezing out' all possible deductions when observing inclusions.

As in past years, the conference also featured presentations on the condition of the gem market. **Antoinette Starkey** (Antoinette Starkey Pierres Précieuses, Geneva, Switzerland) reported on the recent evolution of the coloured stone trade, highlighting the pros and cons of the considerable price increases for high-quality ruby, sapphire, spinel and emerald in recent years. Concerning the market situation for cut diamond, **Corina Muff** (Muff Fine Diamonds, Muri AG, Switzerland) described a shift in the demand for certain qualities: while stones of top colour and clarity (D/IF) are currently weaker in demand (and price), her company's customers increasingly ask for more commercial qualities such as F–G colour and VS–SI clarity in order to obtain a better size-to-price ratio.

In addition to hearing the presentations, the participants had plenty of time for discussions and networking. As with past SGS conferences, the main social event was a special highlight, and this year featured a boat trip on Lake Hallwil for a night of dinner and dancing.

Michael Hügi FGA
(michael.huegi@gemmologie.ch)
Swiss Gemmological Society
Bern, Switzerland

Dr Michael S. Krzemnicki FGA
Swiss Gemmological Institute SSEF
Basel, Switzerland

Gem-A Notices

Gifts to the Association

Gem-A is most grateful to the following for their generous donations that will support continued research and teaching:

John Bradshaw, for examples of faceted apatite, nephrite, aventurine quartz, jadeite, sodalite and Montana sapphire, along with a selection of rough stones including willemite, tourmaline, scapolite, halite, natrolite, fluorite and danburite.

P.J. Watson, UK, for a collection of 24 books.

Dennis Ho, Hong Kong, for a collection of 20 crystals including diopside from South African, apatite and sphene from Madagascar, and topaz and sphene from Myanmar.

Harry Thomson, for a collection of assorted loose gemstones from a student collection.

Barbara Kolator, UK, for examples of faceted labradorite, azurite 'suns', three 'thunder eggs', boulder opal slabs, 'fairy' opal and a selection of sapphire 'wash' from Queensland, Australia.

Gem-A Open Evening

16 July 2019
Tour Gem-A's headquarters and meet our tutors. https://gem-a.com/event/rsevents/event/50-gem-a-open-evening

Gem-A USA

In February 2019 Gem-A announced the establishment of Gem-A USA, an independent, non-profit entity, which will provide Gem-A's signature Gemmology and Diamond Diploma courses to the next generation of gemmologists in the United States.

Gem-A USA are delighted that Jewelry Television (JTV) will be the first to offer its Gemmology Foundation, Gemmology Diploma and Diamond Diploma courses in Knoxville, Tennessee, as an Accredited Teaching Centre (ATC).

Gem-A CEO, Alan Hart FGA DGA, commented: 'With fantastic partnerships across Asia and Europe, we believe now is the perfect time for Gem-A to expand its reach with Gem-A USA. As our affiliate in the U.S. market, both institutions share the same commitment to gemmological education, quality courses and teaching excellence that has shaped Gem-A since its inception in London in 1908. We are also thrilled to welcome JTV as the first ATC for Gem-A USA. In the coming months, we look forward to welcoming more institutions, schools and colleges who share our passion for gemmology and nurturing the next generation of gemstone and jewellery professionals.'

Gem-A USA classes will commence with JTV in September 2019.

Gem-A presents...

FREE GEMMOLOGY WEBINARS

Are you based outside of the UK? Do you find it difficult to get to Gem-A HQ in London for our workshops? For the first time, Gem-A is pleased to offer a series of one-hour webinars, designed to boost your gemmological knowledge no matter where you are in the world. Our convenient webinars are targeted at beginners who want to get a grasp of the basics, fast. Each of our webinars is entirely free – just book your place by searching 'Gem-A' on Eventbrite and join us from the comfort of your own home or office.

Understanding Gemstones

18 Jul 2019

Start your gemmology journey with this accessible beginner's guide to gemstones. This tutor-guided webinar will explain the physical characteristics of popular gems such as sapphire, emerald and ruby, while explaining their origins, history and vital care techniques. At the end of this webinar, you will have a better grasp of basic gemmology and the terminology that makes it an exciting and varied field of study.

Understanding Diamonds

10 Oct 2019

Are you passionate about diamonds but want to know more? This tutor-guided webinar will explain how diamonds are formed, what makes them special and how to assess their value and qualities using the 4Cs: cut, colour, clarity and carat weight. You will learn the basics of diamond certification and begin to discover the broader issues of diamond synthetics and simulants. At the end of the webinar, participants will be one step closer to understanding the uniqueness of diamond.

Learning Opportunities

CONFERENCES AND SEMINARS

Mineralogical Society of America Centennial Symposium
20–21 June 2019
Washington DC, USA
www.minsocam.org/MSA/Centennial/MSA_Centennial_Symposium.html
Sessions of interest: Scientific Characterization of High-Value Gemstones; Mineral Inclusions in Diamonds from the Deep Earth; Museum Mineral Collections in the Next 100 Years

Sainte-Marie-Aux-Mines 56th Mineral & Gem International Show
27–30 June 2019
Sainte-Marie-aux-Mines, France
www.sainte-marie-mineral.com
Note: Includes a seminar programme

19th International Meeting on Crystal Chemistry, X-ray Diffraction and Spectroscopy of Minerals
2–5 July 2019
Apatity, Russia
www.ksc.ru/en/xrd2019
Note: Will include several presentations on diamond

Goldsmiths' Company Jewellery Materials Congress 2019
8–9 July 2019
London
www.assayofficelondon.co.uk/events/the-goldsmiths-company-jewellery-materials-congress

2019 Antique Jewelry & Art Conference
26–27 July 2019
Newark, New Jersey, USA
www.jewelrycamp.org
Note: Includes a seminar programme

Asia Oceania Geosciences Society 16th Annual Meeting
28 July–2 August 2019
Singapore
www.asiaoceania.org/aogs2019/public.asp?page=home.htm
Session of interest: Tectonics, Minerals, Metals and Gems Resources of Asia Oceania Region

52nd NAJA Mid-Year ACE© It Conference
3–6 August 2019
Dallas, Texas, USA
www.najaappraisers.com/html/conferences.html

Northwest Jewelry Conference
9–11 August 2019
Seattle, Washington, USA
http://northwestjewelryconference.com

Dallas Mineral Collecting Symposium
22–25 August 2019
Dallas, Texas, USA
www.dallassymposium.org

15th Biennial Meeting of the Society for Geology Applied to Mineral Deposits
27–30 August 2019
Glasgow, Scotland
www.sga2019glasgow.com
Session of interest: Supergenes, Gems and Non-Metallic Ores

36th International Gemmological Conference
27–30 August 2019
Nantes, France
www.igc-gemmology.org

Japan Jewellery Fair 2019
28–30 August 2019
Tokyo, Japan
www.japanjewelleryfair.com/en
Note: Includes a seminar programme

42nd Joint Mineralogical Societies of Australasia Seminar
31 August–1 September 2019
Perth, Western Australia
www.minsocwa.org.au/gallery.html

International Jewellery London (IJL)
1–3 September 2019
London
www.jewellerylondon.com
Note: Includes a seminar programme

10th International Congress on the Application of Raman Spectroscopy in Art and Archaeology (RAA2019)
3–7 September 2019
Potsdam, Germany
www.raa2019.de

30th International Conference on Diamond and Carbon Materials
8–12 September 2019
Seville, Spain
www.elsevier.com/events/conferences/international-conference-on-diamond-and-carbon-materials

XVIIIème Rendez-Vous Gemmologiques de Paris
9 September 2019
Paris, France
www.afgems-paris.com/rdv-gemmologique

9th European Conference on Mineralogy and Spectroscopy (ECMS 2019)
11–14 September 2019
Prague, Czech Republic
http://ecms2019.eu
Workshop of interest: Gemstone Deposits

Denver Gem & Mineral Show
13–15 September 2019
Denver, Colorado, USA
www.denvermineralshow.com
Note: Includes a seminar programme

Geological Society of America (GSA) Annual Meeting
22–25 September 2019
Phoenix, Arizona, USA
www.geosociety.org/GSA/events/GSA2019
Session of interest: Gemological Research in the Twenty-First Century—Characterization, Exploration, and Geological Significance of Diamonds and Other Gem Minerals

14th International Congress for Applied Mineralogy (ICAM 2019)
23–27 September 2019
Belgorod, Russia
www.geo.komisc.ru/icam2019/en
Themes of interest: Precious Stones; Cultural Heritage

International Colored Gemstone Association (ICA) Congress
12–15 October 2019
Bangkok, Thailand
www.gemstone.org/events/2019-congress

Chicago Responsible Jewelry Conference
25–26 October 2019
Chicago, Illinois, USA
www.chiresponsiblejewelryconference.com

Munich Show/Mineralientage München
25–27 October 2019
Munich, Germany
https://munichshow.de/?lang=en
Note: Includes a seminar programme

Gem-A Conference 2019
2–3 November 2019
London
https://gem-a.com/event/conference-2019

2019 CIBJO Congress
18–20 November 2019
Manama, Bahrain
www.cibjo.org/congress2019

MAESA 2019: Earth Sciences and Sustainable Development
29 November–1 December 2019
Yangon, Myanmar
www.maesa.org
Sessions of interest: Mineralogy and Origin of Gem Deposits; Geographic Typing of Gemstones and Advances in Instrumentation

Jewelry History Series
4–8 January 2020
Miami, Florida, USA
www.originalmiamibeachantiqueshow.com/show/special-events

52nd NAJA ACE© It Annual Winter Conference
2–3 February 2020
Tucson, Arizona, USA
www.najaappraisers.com/html/conferences.html

AGTA Gemfair Tucson
4–9 February 2020
Tucson, Arizona, USA
https://agta.org/seminars
Note: Includes a seminar programme

Tucson Gem and Mineral Show
13–16 February 2020
Tucson, Arizona, USA
www.tgms.org/show
Note: Includes a seminar programme

Inhorgenta Munich
14–17 February 2020
Munich, Germany
www.inhorgenta.com/index.html
Note: Includes a seminar programme

47th Rochester Mineralogical Symposium
23–26 April 2020
Rochester, New York, USA
www.rasny.org/minsymp

American Gem Society Conclave
27–29 April 2020
Denver, Colorado, USA
www.americangemsociety.org/mpage/conclave2020-home

Diamonds – Source to Use 2020
9–11 June 2020
Johannesburg, South Africa
www.saimm.co.za/saimm-events/upcoming-events/diamonds-source-to-use-2020

OTHER EDUCATIONAL OPPORTUNITIES

Gem-A Workshops and Courses
Gem-A, London
https://gem-a.com/education

Lectures with Gem-A's Midlands Branch
Fellows Auctioneers, Augusta House, Birmingham
Email louiseludlam@hotmail.com

- Miranda Wells—The Changing Face of Tourmaline
  27 September
- Shirley Mitchell—Valuations
  25 October
- Richard Maymon—Pearls
  29 November

Lectures with The Society of Jewellery Historians
Society of Antiquaries of London,
Burlington House, London
www.societyofjewelleryhistorians.ac.uk/current_lectures

- Beth Wees—Jewelry for America
  25 June
- Maria MacLennan—Forensic Jewellery
  24 September
- Calling all Potential Lecturers! [three speakers TBA]
  22 October
- Rachel Church—Brooches, Badges and Pins at the Victoria and Albert Museum
  26 November
- Thomas Holman—A Box Full of Buttons: The Life and Work of Frederick James Partridge (1877–1945)
  28 January 2020
- Stephen Whittaker—TBA
  25 February 2020
- Carol Michaelson—Chinese Jade Jewellery and Ornaments from the Neolithic to the Present
  24 March 2020
- Ute Decker—TBA
  26 May 2020
- Kirsten Kennedy—TBA
  23 June 2020

New Media

Burma Gems/Sri Lanka Gems

By Vladyslav Y. Yavorskyy, 2018. Yavorskyy Co. Ltd, New York, New York, USA, www.gemstonesbook.com, 232 pages (Burma) and 236 pages (Sri Lanka), illus., ISBN 978-0692919682 (Burma) and ISBN 978-0692121412 (Sri Lanka). USD188.00 hardcover with slipcase for the two-volume set.

Yavorskyy's two companion volumes—*Burma Gems* and *Sri Lanka Gems*—are photographic adventures that engage anyone who wants a visual treat. They can make you feel as if you are on location with the author.

Burma Gems

Early in this book (p. 5) the author states, 'the selection of topics and ratio of gemstones covered in this book is strictly subjective and defined by the author's personal taste'. Every following page is filled with colourful photographs taken by the author between 1996 and 2018; in only one instance (p. 11) is the page not in full colour. He further states:

> There is no coloured gemstone more highly valued than ruby nor is there any land in any civilization that produces more beautiful rubies than Burma. Rubies throughout history were mined in Mogok. These deposits together with jade, blue sapphire, spinel, chrysoberyl, zircon, amber, moonstone and other coloured stones make Burma the most prominent source of gems ever to have existed. But to me the more precious gems of Burma are its people, nature, culture, history, and its mysterious spirit which inspired me to create this book.

And from here to the end of the book, Yavorskyy has produced page after colourful page filled with either gemstones or a combination of stones with other 'precious gems' alluded to above—most often the Burmese people. Various stones are highlighted using dramatic images accompanied by labels such as 'Red Spinel', 'Red Ruby', 'Blue Sapphire', or 'Not All Sapphires are Blue'. Often the same gems are shown in multiple photos from different angles. Sidebars provide simple explanations where Yavorskyy thought necessary, but they are kept brief so as not to distract from the photographic beauty. For many two-page spreads, no words are necessary at all.

The reader soon realises that this book, like *Sri Lanka Gems* covered below, is a labour of love. It documents Yavorskyy's extraordinary travels into what he calls 'the land of adventure'. Towards the end of the book, in a few brief paragraphs on pp. 229–230, Yavorskyy gives more background about his interests in 'My Story': '… this country has always had a special place in my heart, and will always remain my sacred haven, my precious home away from home.'

Having been to Burma myself numerous times, this reviewer can confirm that Yavorskyy has captured what many of us know who have been there: Burma is a unique place for anyone who loves life, history, beauty and romance, and has a passion for gems.

Sri Lanka Gems

Yavorskyy's *Sri Lanka Gems* is an extraordinary photographic journey of this island paradise which includes history, gem-mining areas, wildlife, and various topics pertaining to other aspects of Sri Lankan life, cities and people. While there are no written chapters as such, near the front of the book are brief contributions titled 'About the Book' by Rachel J. Beard and 'Sri Lanka: Island of Gems' by Jack Ogden (covering Sri Lanka's history). Several two-page spreads consist of illustrations taken from Robert Knox's *An Historical Relation of the Island Ceylon in the East Indies* (1681), which is probably the first book written in English on Ceylon.

Sri Lanka Gems focuses on people and beautiful places, both in the wild and in mining areas and towns. Interspersed throughout are many full-page or double-page photos of dazzling gemstones from historic jewellery pieces, private collections and dealer friends. Actually, every page seems to have a few small inserts of fine gems—mostly sapphires of all colours, but also spinels, chrysoberyls, garnets and various other local gems. Most of the stones in the book have been in

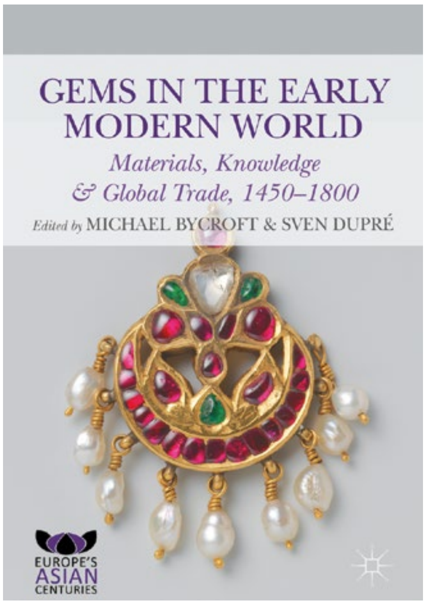
Yavorskyy's hands over his years in the gem trade.

I find this quotation from p. 60 emblematic of this fine book:

> Despite the relatively small scale of the island itself, Sri Lanka boasts a fabulously diverse landscape and wildlife population. From coast to coast, the undulating topography creates an array of microclimates and, consequently, a host of biodiversity and animal species not found anywhere else. Rich in rivers, waterfalls, mountain ranges, plains, and pristine coastlines, the vistas of the Sri Lankan landscape are truly unique.

Both *Burma Gems* and *Sri Lanka Gems* are books that can be appreciated by novices, advanced gem collectors and the general public. They are written to accompany Yavorskyy's other three books: *Terra Spinel*, *Terra Garnet* and *Gemstones: Terra Connoisseur*. Anyone who has been to Burma or Sri Lanka, desires to go there or just wants to learn more about them should consider these books for their library.

Bill Larson FGA
Pala International
Fallbrook, California, USA



Gems in the Early Modern World: Materials, Knowledge and Global Trade, 1450–1800

Ed. by Michael Bycroft and Sven Dupré, 2019. Palgrave Macmillan, London, www.palgrave.com/us/book/9783319963785, 359 pages, illus., ISBN 978-3319963785 (hardcover) or 978-3319963792 (eBook). USD119.99 hardcover or USD89.00 eBook.

Recent years have shown an upsurge in research into the origins, trade and use of gemstones in the past, with the results published in a wide range of journals, from gemmological to historical and archaeological. The present volume reflects this interest by presenting 11 essays, plus an introductory chapter by the editors, which are grouped under three headings: 'Motion', 'Value' and 'Skills'. The authors are all specialists in their fields, and the net result is a volume which sheds a broad light on gem history and summarises the state of present knowledge.

The introductory chapter by the editors sets the scene by discussing, briefly, how studies of the interrelationship among materials, technology, economics and art can shed light on such subjects as the early exploitation of Brazilian diamonds and Colombian emeralds. This introductory chapter is an erudite contribution in its own right.

The first chapter, by Hugo Miguel Crespo on 'The Plundering of the Ceylonese Royal Treasury, 1551–1553: Its Character, Cost, and Dispersal', leaps straight in to show how the global movement of gems was by no means always a consensual process. One only has to wander around the museums in Colombo, Kandy and elsewhere in Sri Lanka to see how very little old jewellery survives in what was for more than two millennia the 'Island of Gems'. An inventory of the Ceylonese royal treasury drawn up by the Portuguese in the 1550s listed vast amounts of jewels as well as gold and silver coinage and objects, most of which were put up for sale. Crespo shows how a few equivalent pieces that survive in European museums provide insight into the types of gems and jewellery mentioned in the inventory.

Next, Christina Anderson focuses on one Antwerp family—the Hellemans—which made several gem-trading expeditions via the overland route to India in the years between around 1550 and 1610. The information was gleaned from archives in Antwerp and Venice. Anderson's chapter is primarily concerned with just one generation of the family, and how they spread out to important trading centres such as Venice, Seville (from which they could also trade with the New World) and Constantinople. As the documents show, the gems they dealt with included not only diamonds and pearls but also emeralds from South America (which were already being traded in India by that time) and opals. The author does not mention if the documents note the origin of the opals, but Mexico is a possibility.

Robert Boyle's 1672 *Essay About the Origins and Virtues of Gems* is well known to gemmologists who have an interest in history. The third chapter of *Gems in the Early Modern World* takes a fascinating new look at this work in 'The Impact of European Trade with Southeast Asia on the Mineralogical Studies of Robert Boyle', by Claire Sabel. Boyle lived at a time when science was supplanting superstition in the consideration of gems, and when the global gem trade (and the London diamond trade in particular) was in full spate. Boyle's enquiring mind sought factual information about gems from Southeast Asia. As the author notes, Boyle wanted to show how a gem's composition and formation might explain its physical characteristics.

The next chapter crosses the world to draw on textual and pictorial sources to consider coral in China during the Ming dynasty. In 'Branches and Bones: The Transformative Matter of Coral in Ming Dynasty China', Anna Grasskamp explains how this gem material was an important export from the Mediterranean region to China, a route that went in the opposite direction to most of the trade in gem materials. This long predated direct European sea trade with the East and had established coral as a rare material with Buddhist connotations—and also reinforced the monopoly of the Ming emperor in theory if not in practice. The author suggests that coral was seen as a 'transformative material' between sea and land. Add in the tree-like (and perhaps bone-like) appearance of branched coral and its blood-like colour, and symbolic importance is inevitable. In Renaissance Europe coral could relate to the resurrection of Christ; in Buddhist China coral could similarly represent transformation. This essay, to the present reviewer anyway, covers the least familiar subject in the book, and could well be expanded into a whole book by itself. The popularity of coral in Tibetan Buddhist ornaments (about as far away from the sea as you can get) has always intrigued, but this reviewer's knowledge of coral in China has been limited to Berthold Laufer's succinct discussion in his 1919 *Sino-Iranica; Chinese Contributions to the History of Civilization in Ancient Iran, with Special Reference to the History of Cultivated Plants and Products* (incidentally not mentioned in Grasskamp's detailed bibliography, which probably means that this century-old work is outdated).

The next chapter takes us back to Europe, in which Michael Bycroft looks at 'Boethius de Boodt and the Emergence of the Oriental/Occidental Distinction in European Mineralogy'. The belief that gems from the East were better than those from nearer lands can be traced back to classical writers and continued through medieval times (e.g. the heat of the sun in the Orient was more favourable to gem growth). As geographical knowledge grew, so did knowledge of gem sources, but still Oriental gems were deemed the best. It would have been useful had the author pointed out more clearly that in many cases the Oriental/Occidental distinction might have derived from gems being long identified by colour rather than species. 'Oriental amethyst' was purple sapphire and far harder, of course, than the purple variety of quartz we know as amethyst; similarly, 'Oriental topaz' was yellow sapphire and not the softer yellow topaz (or citrine); and so on. These terms were used in the trade into the 20th century.

Marcia Pointon follows this with the best-known 'Oriental' gem in the 17th century: diamond. In 'Good and Bad Diamonds in Seventeenth-Century Europe' Pointon mainly focuses on what were termed *laskes*—Indian-cut diamonds, typically thin cleavage slices—which were considered too unattractive for use in Europe. Although an object of trade, they were almost invariably seen as material for recutting. A detailed discussion of this often-forgotten style of diamond is useful, but there seems a lack of understanding of diamonds here. For example, Pointon describes a cleaved diamond as 'cut across the natural grain of the stone', and also she is seemingly unaware that the 'violet' diamond illustrated by Tavernier was what later became the French Blue and then the Hope. It was never a 'rose cut' as she describes. This reviewer also questions whether gems such as the Koh-i-Noor should be, or ever have been, described as *laskes*. At the time the Koh-i-Noor arrived in Britain it was described as a 'rose'.

The medicinal use of gems in ancient times and through to the Renaissance is well known, but it is interesting to see the extent to which such traditions survived after that. In 'The Repudiation and Persistence of Lapidary Medicine in Eighteenth-Century Dutch Medicine and Pharmacy', Marieke Hendriksen argues that the use of gem materials in medicine might have lingered because of conservative guilds and possibly even wealthy patrons. Belief in the medicinal properties of some gems survives to some extent to this day, but was largely rejected due to a wider understanding of chemistry from the early 18th century onwards. Perhaps the author could have pointed out that behind some of the apparent mumbo-jumbo there might be some truth. For example, the Roman author Pliny said the copper mineral and gem material malachite had medicinal properties, and it was used in medieval times to fight infection. It works. Soldiers, for example in the jungles of Vietnam, have been advised to put copper compounds in their socks to prevent fungal infections. There are many more examples.

A contribution to our understanding of the history of gem cutting comes in Marjolijn Bol's *Polito et Claro*: The Art and Knowledge of Polishing, 1100–1500'. Bol discusses in detail the various texts describing gem cutting, in particular the *Doctrina Poliendi* of ca. 1300. However, it is not clear what the author adds to Geoffroy Grassin's original publication of this text, and, if anything, might confuse the issue. For example, Bol seems to imply that the engraving of diamond is mentioned, and that what this reviewer takes to be a description of the polishing of the engraved designs (i.e. the hollows) on gems is instead a reference to rotary polishing the gems' flat surfaces. What the author calls 'a landmark treatise' on gem cutting—an anonymous work of which an early 16th-century copy by Peder Månsson survives—illustrates a crank-operated rotary gem-polishing machine. As Bol points out, the date of the original manuscript is unknown, and thus the date of the equipment shown is uncertain. Her suggestion of late 15th to early 16th century seems correct. Certainly, having the flywheel mounted with a vertical axis seems to be an advance on the gem-polishing machines in the 15th-century drawings by (probably) Henri Arnaut de Zwolle and in the *Codex Latinus Monacensis 197*. (*Editor's note*: See the article by K. Schmetzer on pp. 544–550 of this issue for more on this subject.)

Gems in the Mughal world are considered by Taylor Viens in 'Mughal Lapidaries and the Inherited Modes of Production'. Viens starts by discussing an (unfortunately undated) gem-set and enamelled falcon from the collections of the Qatar Islamic Museum. The essay then looks at the historical background to the Mughal artistic tradition, the nature of the workshops in which such objects were made and patronage. The author notes that the authenticity of the falcon has been doubted, although not formally in a publication. Perhaps the author's seemingly strange choice of this undated object as the point of departure for his essay was because it allowed him to air his brief but astute questioning of certain aspects of the falcon in a long endnote. This interesting essay is let down slightly by a seeming lack of familiarity with gems and lapidary work. For example, the statement that rubies and sapphires can only be cut with other rubies or sapphires (and diamond) ignores emery, the mainstay of Indian lapidary work. Also, he says 'as the Mohs scale of mineral hardness was not developed until 1812, it is not possible that the Mughals were operating under an identical perception of mineral hardness'. Since the Mohs scale is purely relative, the Indian lapidary would have had an identical understanding of hardness, as did the Medieval Islamic gem cutters.

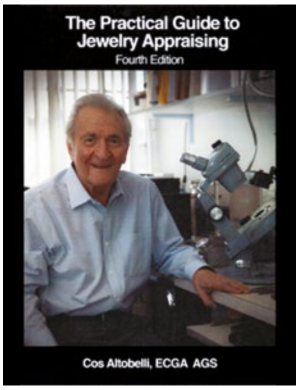
We come back to Europe with Karin Hofmeester's 'Knowledge, Technique, and Taste in Transit: Diamond Polishing in Europe, 1500–1800'. Hofmeester describes the migration of diamond cutting centres—from Venice to Flanders—first in Bruges and later Antwerp. By the mid-1580s Antwerp had 31 diamond cutters and 21 diamond polishers; some 60 years later there were 160 polishers. Then cutting moved to Amsterdam. Against this background the essay traces the development of diamond cuts: point cuts, tables, roses and eventually brilliants. The author then considers the ways in which skills and ideas of new cuts were transferred—via books as well as apprenticeships—and also how diamond merchants obtained their knowledge about where best to buy, how to judge quality and, of course, where best to sell. The popularity of books on gems, including information on diamonds and diamond cutting, starting with Cellini's 1569 *Trattato*, might well have been as much for the personal standing of the author (and his business) as for the education of the public.

Wherever there are gems, there are imitations of them. This has been true throughout history. In 'Gems and Counterfeited Gems in Early Modern Antwerp: From Workshops to Collections', Marlise Rijks starts with a 16th-century manuscript in the Museum Plantin Moretus in Antwerp. It includes recipes for making counterfeit pearls and instructions for how to detect fake gems. Rijks then uses a variety of sources, including archives and paintings, to look at gems in society, from the trade and guilds to patrons. Considering gems in society brings the author back to the final section of her essay: counterfeit gems and recipes for them. Rijks notes the problem of inventories that seldom explicitly mention fake gems but discusses the few cases where they do. There is also discussion of who was the target audience for such recipes, along with the suggestion that they might have been for the educated public, as well as those in the trade and those who actually wanted to learn the 'profitable arts'. Wider public accessibility of such information, of course, came in the wake of printing.

Bearing in mind the number of essays and the obvious size constraints of a single volume, it is perhaps unfair to point out where additional essays might have provided a more rounded picture of the subject. Nevertheless, one important aspect that is absent is the gemmological side: the research carried out on gems set in surviving medieval and Renaissance objects over the last few decades. Overall the volume provides a useful contribution to the subject and, following on from 2017's *Gemstones in the First Millennium AD: Mines, Trade, Workshops and Symbolism* (Römisch-Germanisches Zentralmuseum; reviewed in *The Journal*, Vol. 35, No. 7, 2017, pp. 680–681), shows a growing interest in gem and lapidary history. Input from a gemmologist in the editing stage would have made this a more authoritative book, and it seems fair to suggest that more gem and jewellery historians could benefit from a working knowledge of gemmology.

Dr Jack M. Ogden FGA
London

The Practical Guide to Jewelry Appraising, 4th edn.



By Cos Altobelli, 2018. Self-published, http://altobelli.com/order, 285 pages, illus., ISBN 978-1513636603. USD99.99 (AGS members) or US$129.99 (non-members) softcover.

True to its title, the fourth edition of *The Practical Guide to Jewelry Appraising* is a useful resource to those beginning their career as fine jewellery appraisers. This book also offers, for gemmologists considering the profession, a glimpse into the ups and downs of appraisal practice. As in past editions, this version covers a wide variety of jewellery appraisal issues, providing tips and guidance based largely on Altobelli's decades of experience in the field. The author delivers insight and information through case histories and real-life experiences, helping to drive the concepts home. Sample templates and forms included in the final chapter are invaluable tools for the new appraiser.

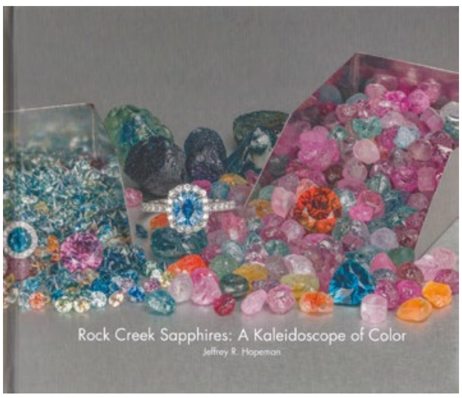
New to the fourth edition are sub-chapters on color-vision testing and chipped diamonds, as well as suggested text to assist the appraiser in dealing with the difficulty of detecting synthetic and HPHT-treated diamonds. The profession of personal property appraisal has developed and changed dramatically over the past 35 years, due in no small part to pioneers and visionaries such as Altobelli. However, some of the information provided in this book is outdated and not in keeping with current personal property appraisal standards. The author states that personal property appraisers have been given guidelines in the form of USPAP (Uniform Standards of Professional Appraisal Practice) but are not governed by or held to these standards. Most professional jewellery appraisal organisations consider USPAP the 'standard of care' in the profession and require adherence by their members.

Throughout the text the author reiterates the necessity for appraisers to complete formal appraisal education and to be cognisant of their level of competency when accepting and completing an appraisal assignment. Altobelli also stresses the importance of continuing education for practising appraisers. *The Practical Guide to Jewelry Appraising* is written from the perspective of an American Gem Society Emeritus Certified Gemologist Appraiser (AGS ECGA) and an AGS retail jewellery store owner, and is therefore most appropriate for those working in the USA.

Theresa (Teri) L. Newman Brossmer
Gem Appraisals Unlimited LLC
Glendora, California, USA

Rock Creek Sapphires: A Kaleidoscope of Color

By Jeffrey R. Hapeman, 2019. Self-published, www.earthstreasury.com/product/rock-creek-sapphires-a-kaleidoscope-of-color, 84 pages, illus., ISBN 978-0464752288. USD79.00 hardcover.



Rock Creek Sapphires is a relatively small book, at just 84 pages. As the name suggests, it focuses on sapphires originating from just one location: Rock Creek, Montana, USA. This deposit was discovered in the early 1890s, and between 1930 and 1936 the sapphires were sold mostly to the Swiss watch trade for use as jewel bearings. Before heat treatment, more than 90% of the rough material typically yields light- to medium-toned greyish blue to greyish green cut gems that are less than 4 mm in diameter.

As the name also suggests, *Rock Creek Sapphire: A Kaleidoscope of Color* is primarily a picture book. What makes it interesting and of value to gemmologists is that it showcases some of the finest heat-treated and untreated gems that have been produced from this deposit. Although comprising only 10% of the current production, fancy-colour sapphires occur across the entire spectrum of sapphire colours. The author, a skilled lapidary as well as an excellent photographer, treats the reader to a beautiful panorama of these paradigm gems.

Of particular use to gemmologists is a small but useful section of photomicrographs illustrating inclusions that are typical of untreated sapphires from this deposit. Photomicrographs showing inclusions in treated stones also would have been useful. There is an image of one characteristic inclusion (p. 33) that resembles a bird's-eye view of a hexagonal spider's web. Similar inclusions occur in the majority of heat-treated gems from this locale.

Other sections illustrate modern mining and sorting methods practised at the Rock Creek deposit, along with images of typical mine-run production from the current operations.

Well written and intelligently organised, this book provides an excellent addition to both the jeweller's and gemmologist's library. It is also an excellent reference for gem collectors.

Richard W. Wise
Author of *Secrets of the Gem Trade, The Connoisseur's Guide to Precious Gemstones* and *The French Blue*
Charlottesville, Virginia, USA

Sixteenth Annual Sinkankas Symposium—Pearl

Ed. by Stuart Overlin, 2019. (No publisher listed) 108 pages, illus., ISBN 978-0991532049. Print on demand; price available upon request (promotional@dpidirect.com).

The 16th Annual Sinkankas Symposium, focusing on natural and cultured pearls, was held in April 2019 at the Gemological Institute of America in Carlsbad, California, and was co-hosted by the Gemological Society of San Diego (for a report on this event, see the Conferences section of this issue of *The Journal*, pp. 557–558). Attendees received an attractive proceedings volume that contains contributions from each of the speakers and also some supplementary information on natural and cultured pearls.

The volume begins with a listing of the symposium programme, speaker biographies and abstracts of the presentations. These are followed by speaker contributions covering a wide range of topics: a historical overview of pearls from Mexico's Sea of Cortez and information on cultured pearls from the author's farm in Guaymas (Douglas McLaurin-Moreno), a brief history of pearls and the use of natural and cultured pearls in jewellery (Blaire Beavers), an autobiographical journey of a pearl dealer (Betty Sue King), a review of the varieties and sources of freshwater and saltwater natural/cultured pearls (Elisabeth Strack), information on collecting natural pearls from Mexico's Baja California and elsewhere (Bill Larson), a review of pearl publications in *Gems & Gemology* (Chunhui Zhou), an overview of cultured pearls in the gem/jewellery market and pricing trends (Stuart Robertson), and reinventing pearl jewellery design (Hisano Shepherd). The volume closes with sections on pearl history and a bibliography that are reprinted from the 2013 book titled *Splendour & Science of Pearls* by Dona Dirlam and Robert Weldon.

The book features many beautiful photos of natural and cultured pearls, jewellery and interesting historical subject matter. It is produced on heavy paper stock and the quality of the printing is excellent. A limited number of advertisements are placed on the inside covers and opening/closing pages so they do not interrupt the flow of the articles. This reviewer would have appreciated having the sizes of the natural/cultured pearls indicated in several of the photo captions, but this is a minor quibble. Gemmologists, enthusiasts, collectors and anyone interested in natural and cultured pearls will benefit from having this attractive and informative book in their library.

Brendan M. Laurs FGA

Other Book Titles

COLOURED STONES

Banded Agates, a Genetic Approach
By Marco Campos Venuti, 2018. Edizioni AccorpaMente, Italy, 200 pages, ISBN 978-8894038040. USD35.00 softcover.

GEM LOCALITIES

Derbyshire Blue John, 3rd edn.
By Trevor Ford, 2019. East Midlands Geological Society, Nottingham, 80 pages, ISBN 978-0951971796. GBP6.50 softcover.

JEWELLERY HISTORY

The Steppe and the Sea: Pearls in the Mongol Empire
By Thomas T. Allsen, 2019. University of Pennsylvania Press, Philadelphia, Pennsylvania, USA, 240 pages, ISBN 978-0812251173. USD45.00 hardcover.

JEWELLERY AND *OBJETS D'ART*

Anna Hu: Symphony of Jewels, Opus II
By Janet Zapata with Sarah Davis, 2019. Vendome Press, New York, New York, USA, 192 pages, ISBN 978-0865653412. USD75.00 hardcover.

The Art of the Jeweler: Excellence and Craftmanship
By Guillaume Glorieux, 2019. Gallimard Publishing House, Paris, France, 76 pages, ISBN 978-2072822605. EUR14.50 softcover.

Carnet by Michelle Ong
By Vivienne Becker and Joel Rosenthal, 2019. Thames & Hudson, New York, New York, USA, 272 pages, ISBN 978-0500021637. USD95.00 hardcover.

Farah Khan: A Bejewelled Life
Ed. by Paola De Luca, 2019. Rizzoli, New York, New York, USA, 304 pages, ISBN 978-8891818904. USD125.00 hardcover.

Gioielli del Potere: Corene e Tiare (Jewellery of Power: Crowns and Tiaras)
Ed. by Alba Cappellieri, 2018. Silvana Editoriale, Milan, Italy, 96 pages, ISBN 978-8836641529 (in English and Italian). EUR18.00 softcover.

Jean Schlumberger: The Rachel Lambert Mellon Collection from the Virginia Museum of Fine Arts
By Kristie Couser, 2018. Virginia Museum of Fine Arts, Richmond, Virginia, USA, 120 pages, ISBN 978-0300238747. USD30.00 hardcover.

Jewellery Illustration and Design, Vol. 1
By Manuella Brambatti and Vinci Cosimo, 2018. Promopress, Barcelona, Spain, 160 pages, ISBN 978-8416851577. EUR35.00 softcover.

Jewels & Jewelry
By Clare Phillips, 2019. Thames & Hudson, New York, New York, USA, 224 pages, ISBN 978-0500480342. USD40.00 softcover.

Looking at Jewelry: A Guide to Terms, Styles, and Techniques
By Susanne Gänsicke and Yvonne J. Markowitz, 2019. Getty Publications, Los Angeles, California, USA, 132 pages, ISBN 978-1606065990. USD19.95 softcover.

Medieval Art in Motion: The Inventory and Gift Giving of Queen Clémence de Hongrie
By Mariah Proctor-Tiffany, 2019. Penn State University Press, University Park, Pennsylvania, USA, 232 pages, ISBN 978-0271081120. USD89.95 hardcover or USD39.99 Kindle edn.

Literature of Interest

COLOURED STONES

The 9th Annual National Opal Symposium. R. Benjamin-Thomas, *InColor*, No. 41, 2019, 18–23, www.gemstone.org/incolor/41.*

The art & science of reading rough jadeite jade: 2 parts science, 1 part art, and a lot of luck. R.S.K. Lee, *Journal of the Gemmological Association of Hong Kong*, **39**, 2018, 48–59, www.gahk.org/journal/2018/a12.pdf.*

Behind the silk screen: A surprise in a star ruby. E.B. Hughes, *Journal of the Gemmological Association of Hong Kong*, **39**, 2018, 37–38, www.gahk.org/journal/2018/a10.pdf.*

A combinative technique to recognise and discriminate turquoise stone. H. Sabbaghi, *Vibrational Spectroscopy*, **99**, 2018, 93–99, http://doi.org/10.1016/j.vibspec.2018.09.002.

The ecological impact of mining rose quartz with needle-like inclusions. Z. Hu and Y. Guo, *Ekoloji*, **27**(106), 2018, 1533–1541, http://ekolojidergisi.com/article/the-ecological-impact-of-mining-rose-quartz-with-needle-like-inclusions-5505.*

Femtosecond laser ablation-ICP-mass spectrometry and CHNS elemental analyzer reveal trace element characteristics of danburite from Mexico, Tanzania, and Vietnam. L.T.-T. Huong, L.M. Otter, M.W. Förster, C.A. Hauzenberger, K. Krenn, O. Alard, D.S. Macholdt, U. Weis, B. Stoll and K.P. Jochum, *Minerals*, **8**(6), 2018, article 234 (15 pp.), http://doi.org/10.3390/min8060234.*

Fluid inclusions study of trapiche and non-trapiche rubies from the Mong Hsu deposit, Myanmar. G. Giuliani, J. Dubessy, I. Pignatelli and D. Schwarz, *Canadian Mineralogist*, **56**(5), 2018, 691–703, http://dx.doi.org/10.3749/canmin.1800013.

Gem-quality tourmaline from LCT pegmatite in Adamello massif, central southern Alps, Italy: An investigation of its mineralogy, crystallography and 3D inclusions. V. Diella, F. Pezzotta, R. Bocchio, N. Marinoni, F. Cámara, A. Langone, I. Adamo and G. Lanzafame, *Minerals*, **8**(12), 2018, article 593 (21 pp.), http://doi.org/10.3390/min8120593.*

Gemmological characteristic of Pakistan emerald. H. Guo, X. Yu and H. Han, *Journal of Gems & Gemmology*, **20**(Supp.), 2018, 1–10 (in Chinese with English abstract).

Identification of the host lithology of tourmaline using laser-induced breakdown spectroscopy for application in sediment provenance and mineral exploration. N.J. McMillan, J. Curry, B.L. Dutrow and D.J. Henry. *Canadian Mineralogist*, **56**(4), 2018, 393–410, http://dx.doi.org/10.3749/canmin.1800004.

Inclusion of [*sic*] ruby from Yen Bai, Vietnam. Q. Wang and J. Di, *Journal of Gems & Gemmology*, **20**(Supp.), 2018, 11–15 (in Chinese with English abstract).

Interpretation of national standard turquoise grading. C. He, F. Cao, J. Di, M. Yang, R. Liu and L. Liu, *Journal of Gems & Gemmology*, **20**(6), 2018, 7–17 (in Chinese with English abstract).

Intricate tunnels in garnets from soils and river sediments in Thailand – Possible endolithic microborings. M. Ivarsson, H. Skogby, B. Phichaikamjornwut, S. Bengtson, S. Siljeström, P. Ounchanum, A. Boonsoong, M. Kruachanta, F. Marone, V. Belivanova and S. Holmström, *PLoS ONE*, **13**(8), 2018, article e0200351 (20 pp.), http://doi.org/10.1371/journal.pone.0200351.*

Mineralogical characteristics and genesis of green nephrite from the world. X. Liu, H. Zhang, Y. Liu, Y. Zhang, Z. Li, J. Zhang and F. Zheng, *Rock and Mineral Analysis*, **37**(5), 2018, 479–489 (in Chinese with English abstract).

Mineralogical and spectral characteristics of tanzanite. M. Lai, Z. Liao, R. Yang, Z. Zhou and Q. Zhong, *Spectroscopy and Spectral Analysis*, **38**(9), 2018, 2872–2876 (in Chinese with English abstract).

On the greenish-yellow color of natural Brazilian titanite. E.L. Tolentino, C.H. Dias, M.L.S.C. Chaves, K. Krambrock and M.V.B. Pinheiro, *Physics and Chemistry of Minerals*, 2018 (11 pp.), http://doi.org/10.1007/s00269-018-0998-2.

Origin characteristic and identification of nephrite from Luodian, Guizhou Province. Z. Liao, Q. Zhong, Y. Zhi and H. Wang, *Journal of Gems & Gemmology*, **20** (Supp.), 2018, 54–64 (in Chinese with English abstract).

Pleochroism and color change in faceted alexandrite: Influence of cut and sample orientation. K. Schmetzer, *Gems & Gemology*, **55**(1), 2019, 61–71, http://doi.org/10.5741/gems.55.1.61.*

A study of minerals associated with turquoise using infrared spectrometer & the significance of their identification (1). X. Liu, Q. Chen and W. Jin, *Journal of the Gemmological Association of Hong Kong*, **39**, 2018, 62–72, www.gahk.org/journal/2018/a13.pdf (in Chinese with English abstract).*

Your friends the inclusions. The detective at the party of inclusions. Fifth episode. L. Costantini and C. Russo, *Rivista Italiana di Gemmologia/Italian Gemological Review*, No. 6, 2019, 7–13.

CULTURAL HERITAGE

Preventing art and antiquities crimes using forensic geology. R.M. Di Maggio, in P.M. Barone and W.J.M. Groen, Eds., *Multidisciplinary Approaches to Forensic Archaeology*, Springer, Cham, Switzerland, 2018, 239–249, http://doi.org/10.1007/978-3-319-94397-8_18.

Regulation and intellectual change at the Paris goldsmiths' guild, 1660–1740. M. Bycroft, *Journal of Early Modern History*, **22**(6), 2018, 500–527.

The Talisman of Charlemagne: New historical and gemological discoveries. G. Panczer, G. Riondet, L. Forest, M.S. Krzemnicki, D. Carole and F. Faure, *Gems & Gemology*, **55**(1), 2019, 30–46, http://doi.org/10.5741/gems.55.1.30.*

DIAMONDS

Brilliance of round brilliant diamond under different simulative light sources. R. Li, X. Yuan and Q. Wu, *Journal of Gems & Gemmology*, **20**(6), 2018, 43–51 (in Chinese with English abstract).

Diamonds from the Deep: How old are diamonds? *Are* they forever? K.V. Smit and S.B. Shirey, *Gems & Gemology*, **55**(1), 2019, 102–109, www.gia.edu/gg-issue-search?ggissueid=1495280241814&articlesubtype=diamondsfromthedeep.*

The many facets of diamond crystals. Y. Palyanov, *Crystals*, **8**(2), 2018, article 72 (9 pp.), http://doi.org/10.3390/cryst8020072.*

Morphological characterization of diamonds from Royal Mineralogical Museum of Naples. M. Rossi and M.R. Ghiara, *Rivista Italiana di Gemmologia/Italian Gemological Review*, No. 6, 2019, 53–57.

Peculiarities of diamonds in eclogitic xenoliths from the Komsomolskaya kimberlite pipe, Yakutia. Z.V. Spetsius and N. Bogush, *Doklady Earth Sciences*, **480**, 2018, 666–670, http://doi.org/10.1134/S1028334X18050306.

FAIR TRADE

The emergence of conflict-free, ethical, and fair trade mineral supply chain certification systems: A brief introduction. S. Van Bockstael, *Extractive Industries and Society*, **5**(1), 2018, 52–55, http://doi.org/10.1016/j.exis.2017.12.014.

"It can lift someone from poverty": Imagined futures in the Sierra Leonean diamond market. N. Engwicht, *Extractive Industries and Society*, **5**(2), 2018, 260–266, http://doi.org/10.1016/j.exis.2018.02.010.

GEM LOCALITIES

Devonshire marbles: History of the industry and the geology of these classic British ornamental stones. G. Walkden, *Geology Today*, **33**(6), 2018, 224–232, http://doi.org/10.1111/gto.12212.

Ethiopian emeralds, a stunning discovery. J. Bergman, *Rivista Italiana di Gemmologia/Italian Gemological Review*, No. 6, 2019, 37–40.

Gems of Italy [hyalophane to 'Pietra Paesina']. E. Amore, R. Appiani, V. Bordoni, M. Campos Venuti, G. Cattaneo, F. Caucia, G. Conti-Vecchi, E. Costa, C. Ghisoli, A. Guizzardi, D. Leoni, M. Macrì, A. Maras, L. Marinoni, M. Mauri, L.M. Pich, A. Mottana, P. Stara, S. Tegani and F. Troilo, *Rivista Italiana di Gemmologia/Italian Gemological Review*, No. 6, 2019, 24–31.

Green andradite from Bor open pit, Dalnegorsk, Russia. B.Z. Kantor, *Mineralogical Almanac*, **24**(1), 2019, 6–7.

Land of origins: A gemological expedition to Ethiopia. W. Vertriest, D. Girma, P. Wongrawang, U. Atikarnsakul and K. Schumacher, *Gems & Gemology*, **55**(1), 2019, 72–88, http://doi.org/10.5741/gems.55.1.72.*

Mineralogy and geochemistry of the Erongo sub-volcanic granite-miarolitic-pegmatite complex, Erongo, Namibia. A.U. Falster, W.B. Simmons, K.L. Webber and A.P. Boudreaux, *Canadian Mineralogist*, **56**(4), 2018, 425–449, http://doi.org/10.3749/canmin.1700090.

On the color and genesis of prase (green quartz) and amethyst from the island of Serifos, Cyclades, Greece. S. Klemme, J. Berndt, C. Mavrogonatos, S. Flemetakis, I. Baziotis, P. Voudouris and S. Xydous, *Minerals*, **8**(11), 2018, article 487 (13 pp.), http://doi.org/10.3390/min8110487.*

Petrogenesis of the cogenetic Stewart pegmatite-aplite, Pala, California: Regional implications. D.M. Morton, J.B. Sheppard, F.K. Miller and C.-T.A. Lee, *Lithosphere*, **11**(1), 2018, 91–128, http://doi.org/10.1130/l1026.1.*

Tourmaline production in the Erongo region of Namibia. J. Saltzman, *Journal of the Gemmological Association of Hong Kong*, **39**, 2018, 75–76, www.gahk.org/journal/2018/a14.pdf.*

Trace elements and U-Pb ages of zircons from Myanmar jadeite-jade by LA-ICP-MS: Constraints for its genesis. S. Cai and E. Zhang, *Spectroscopy and Spectral Analysis*, **38**(6), 2018, 1896–1903 (in Chinese with English abstract).

U-Pb ages of zircon inclusions in sapphires from Ratnapura and Balangoda (Sri Lanka) and implications for geographic origin. E. Elmaleh, S.T. Schmidt, S. Karampelas, K. Link, L. Kiefert, A. Sussenberger and A. Paul, *Gems & Gemology*, **55**(1), 2019, 18–28, http://doi.org/10.5741/gems.55.1.18.*

Zircon xenocrysts from Cenozoic alkaline basalts of the Ratanakiri volcanic province (Cambodia), Southeast Asia—Trace element geochemistry, O-Hf isotopic composition, U-Pb and (U-Th)/He geochronology—Revelations into the underlying lithospheric mantle. P. Piilonen, F. Sutherland, M. Danišík, G. Poirier, J. Valley and R. Rowe, *Minerals*, **8**(12), 2018, article 556 (33 pp.), http://doi.org/10.3390/min8120556.*

INSTRUMENTATION

Light pollution effects of illuminance on yellowish green forsterite color under CIE standard light source D 65. J. Tang, G. Ying and C. Xu, *Ekoloji*, **27**(106), 2018, 1181–1190, http://ekolojidergisi.com/article/light-pollution-effects-of-illuminance-on-yellowish-green-forsterite-color-under-cie-standard-light-5427.*

Miniaturized Raman spectrometers applied to gemstone analyses on works of art. J. Jehlicka and A. Culka, in P. Vandenabeele and H. Edwards, Eds., *Raman Spectroscopy in Archaeology and Art History: Volume 2*. Royal Society of Chemistry, London, Chapter 16, 2018, 234–253, http://doi.org/10.1039/9781788013475-00234.

A new method for determining gem tourmaline species by LA-ICP-MS. Z. Sun, A.C. Palke, C.M. Breeding and B.L. Dutrow, *Gems & Gemology*, **55**(1), 2019, 2–17, http://doi.org/10.5741/gems.55.1.2.*

MISCELLANEOUS

Gems and placers—A genetic relationship par excellence. H.G. Dill, *Minerals*, **8**(10), 2018, article 470 (43 pp.), http://doi.org/10.3390/min8100470.*

Lapidary art in Thailand. R. Borger, *InColor*, No. 42, 2019, 28–30, www.gemstone.org/incolor/42/28.*

Limits to artisanal and small-scale mining: Evidence from the first kimberlite mines. W.P. Nel, *Journal of the Southern African Institute of Mining and Metallurgy*, **118**(8), 2018, 845–852, http://doi.org/10.17159/2411-9717/2018/v118n8a6.*

New case studies: Diamonds, jades, corundum and spinel. L. Kiefert, P. Hardy, K. Schollenbruch and W. Xu, in P. Vandenabeele and H. Edwards, Eds., *Raman Spectroscopy in Archaeology and Art History: Volume 2*. Royal Society of Chemistry, London, Chapter 17, 2018, 254–270, http://doi.org/10.1039/9781788013475-00254.

Precision gem faceting in Thailand. R. Innue, *InColor*, No. 42, 2019, 32–33, www.gemstone.org/incolor/42/32.*

Thailand: The undisputed ruby trading kingdom – A brief history. V. Pardieu, *InColor*, No. 42, 2019, 14–22, www.gemstone.org/incolor/42/14.*

NEWS PRESS

Colombia moves to put emeralds on a par with Roquefort. G. Long, *Financial Times*, 9 November 2018, www.ft.com/content/65ed98e4-c340-11e8-84cd-9e601db069b8.

Farming Japan's precious akoya pearls. M. Liu, CNN, 1 January 2019, https://edition.cnn.com/style/article/tasaki-japan-akoya-pearls/index.html.*

How the sapphire trade is driving lemurs toward extinction [Madagascar]. P. Tullis, *National Geographic*, 6 March 2019, www.nationalgeographic.com/animals/2019/03/sapphire-mining-fuels-lemur-deaths-in-madagascar.*

Queen Victoria's small coronet has a big story. R. Garrahan, *New York Times*, 22 March 2019, www.nytimes.com/2019/03/22/fashion/jewelry-victoria-and-albert-museum-london.html.*

You know your diamond's cut and carat. But does it have ethical origins? T. Hsu, *New York Times*, 8 January 2019, www.nytimes.com/2019/01/08/business/diamonds-origin-tiffany-consumers.html.*

ORGANIC/BIOGENIC GEMS

Growth kinetics and distribution of trace elements in precious corals. D. Vielzeuf, A.C. Gagnon, A. Ricolleau, J.-L. Devidal, C. Balme-Heuze, N. Yahiaoui, C. Fonquernie, J. Perrin, J. Garrabou, J.-M. Montel and N. Floquet, *Frontiers in Earth Science*, **6**, 2018, article 167 (18 pp.), http://doi.org/10.3389/feart.2018.00167.*

Identification of horny [*sic*] coral. S. Wen, X. Liu and J. Liu, *Superhard Material Engineering*, **30**(5), 2018, 63–68 (in Chinese with English abstract).

Microsctructure characteristic of amber from Myanmar. X. Jiang, Y. Wang and F. Kong, *Journal of Gems & Gemmology*, **20**(6), 2018, 18–30 (in Chinese with English abstract).

Mining blue amber for jewellery & crafts in Dominica. A. Shih, *Journal of the Gemmological Association of Hong Kong*, **39**, 2018, 78–79, www.gahk.org/journal/GAHK_Journal_2018_v5.pdf (in Chinese with English abstract).*

PEARLS

Akoya cultured pearls with Corallium species bead nuclei. E.-A. Jeong, J. Moon and K. Hiroshi, *Journal of the Gemmological Association of Hong Kong*, **39**, 2018, 40–44, www.gahk.org/journal/2018/a11.pdf.*

On the deep origin of the depressed rings on pearl surface illustrated from Polynesian *Pinctada margaritifera* (Linnaeus 1758). J.-P. Cuif, A. Perez-Huerta, C. Lo, O. Belhadj and Y. Dauphin, *Aquaculture Research*, **49**(5), 2018, 1834–1847, http://doi.org/10.1111/are.13638.

Pearl industry in the UAE region in 1869–1938: Its construction, reproduction, and decline. K. Aqil, *RUDN Journal of Sociology*, **18**(3), 2018, 452–469, http://doi.org/10.22363/2313-2272-2018-18-3-452-469.*

Production of pearls. C. Zhu, P.C. Southgate and T. Li, in A.C. Smaal, J.G. Ferreira, J. Grant, J.K. Petersen and Ø. Strand, Eds., *Goods and Services of Marine Bivalves*, Springer, Cham, Switzerland, 2018, 73–93, http://doi.org/10.1007/978-3-319-96776-9_5.*

Provenance discrimination of freshwater pearls by LA-ICP-MS and linear discriminant analysis (LDA). A. Homkrajae, Z. Sun, T. Blodgett and C. Zhou, *Gems & Gemology*, **55**(1), 2019, 47–60, http://doi.org/10.5741/gems.55.1.47.*

SYNTHETICS

How Lightbox reversed the communication strategy of synthetic diamonds. D. Angelino, *Rivista Italiana di Gemmologia/Italian Gemological Review*, No. 6, 2019, 48–51.

Luminescence and EPR properties of high quality ruby crystals prepared by the optical floating zone method. F. Liu, B.A. Goodman, X. Tan, X. Wang, D. Chen and W. Deng, *Optical Materials*, **91**, 2019, 183–188, http://doi.org/10.1016/j.optmat.2019.03.018.

The sixth element: A close look at De Beers pink synthetic diamond. A. Malossi, *Rivista Italiana di Gemmologia/Italian Gemological Review*, No. 6, 2019, 43–46.

Spectral characteristics and application of synthetic hydrothermal red beryl. X. Dong, L. Qi, Z. Zhou and D. Sun, *Spectroscopy and Spectral Analysis*, **39**(2), 2019, 517–521 (in Chinese with English abstract).

TREATMENTS

A brief history of gem corundum heat treatment in Thailand. *InColor*, No. 42, 2019, 68–74, www.gemstone.org/incolor/42/68.*

Colour discussion on turquoise optimized by electrochemical method. C. Shen, X. Lin and Z. Lin, *Journal of Gems & Gemmology*, **20**(4), 2018, 16–22 (in Chinese with English abstract).

Gemological identification of natural turquoise and treatment turquoise in Hubei. Y. Xu and J. Di, *Acta Mineralogica Sinica*, **38**(4), 2018, 646–654 (in Chinese with English abstract).

The heat treatment of corundum at moderate temperature. F. Notari, T. Hainschwang, C. Caplan and K. Ho, *InColor*, No. 42, 2019, 76–85, www.gemstone.org/incolor/42/76.*

Identification of "insignificant-filled" turquoise. Y. Qu, *Journal of Gems & Gemmology*, **20**(5), 2018, 44–50 (in Chinese with English abstract).

A method of determining heated ancient nephrite jades in China. Y. Bao, *Journal of Gems & Gemmology*, **20**(Supp.), 2018, 110–115 (in Chinese with English abstract).

Quantitative characterization appreciation of golden citrine golden by the irradiation of $[FeO_4]^{4-}$. G. Ying, Z. Xinyan, L. Xiang and Z. Ye, *Arabian Journal of Chemistry*, **11**(6), 2018, 918–923, http://doi.org/10.1016/j.arabjc.2018.02.003.*

Research on the identification characteristics of organic silicon filling in turquoise. J. Su, T. Lu, H. Dai, Q. Deng and J. Zhang, *Journal of the Gemmological Association of Hong Kong*, **39**, 2018, 81–84, www.gahk.org/journal/2018/a15.pdf (in Chinese with English abstract).*

Sapphires heated with *pressure* – A research update. M.S. Krzemnicki, L. Cartier, R.W. Hughes, T. Leelawatanasuk, L. Kiefert, G. Choudhary, S. McClure, C. Milisenda, E. Gambini, S. Kim, D. Schwarz, C. Dunaigre and Y. Horikawa, *InColor*, No. 42, 2019, 86–90, www.gemstone.org/incolor/42/86.*

Sri Lankan sapphire enhanced by heat with pressure. H. Choi, S. Kim, Y. Kim, T. Leelawatanasuk, T. Lhuaumporn, N. Atsawatanapirom and P. Ounorn, *Journal of the Gemmological Association of Hong Kong*, **39**, 2018, 16–25, www.gahk.org/journal/2018/a06.pdf.*

COMPILATIONS

***G&G* Micro-World.** Structure of Condor agate from Argentina • Multiphase inclusion in beryl • Native copper inclusions in Indonesian purple chalcedony • Grandidierite inclusions in sapphires • Lazurite inclusion in spinel • Fossil insect in opal • Trapiche-like ruby from Batakundi, Pakistan • Sapphire inclusion with rutile 'silk' in Burmese star sapphire • Star-like growth in yellow sapphire • Orpiment inclusion in barite. *Gems & Gemology*, **55**(1), 2019, 110–117, www.gia.edu/gg-issue-search?ggissueid=1495280241814&articlesubtype=microworld.*

Gem News International. Tucson 2019 report • Boulder opal mining in Australia • Brazilian alexandrite • Cat's-eye nephrite from Washington, USA • Color-change pyrope • Colombian emerald and Mozambican ruby from Fura Gems • Colored stone trends • Granada Gallery display • Gray spinel • Greenland ruby • Hand-carved cameos from Italy • Moonstone jewellery • Oregon sunstone • Montana sapphire mining • 'Rainbow lattice' feldspar • Responsibly sourced gemstones • Chinese and Japanese gem markets • Unusual faceted stones • Jeff Hapeman on gem cutting • 283.74 ct tsavorite • Gem cutting in Idar-Oberstein, Germany • Designs by Derek Katzenbach, Jeffrey Bilgore and Paula Crevoshay • Responsible and sustainable practices • Buccellati Award • Orange sapphire with golden sheen • Sapphires and trapiche emerald from Colombia • CIBJO responsible sourcing book • Conference reports • E. Alan Jobbins obituary. *Gems & Gemology*, **55**(1), 2019, 118–160, www.gia.edu/gg-issue-search?ggissueid=1495280241814&articlesubtype=gni.*

Lab Notes. 552.7 ct yellow diamond from Diavik, Canada • Chatoyant quartz/tourmaline doublet • 11.34 ct dark blue gahnospinel • Glass bangles resembling jade • Faceted parisite • Interesting freshwater bead-cultured pearls • Color-change Burmese sapphire • CVD layer grown on natural diamond • Faint green HPHT-grown synthetic diamonds • Paraíba-like synthetic sapphires. *Gems & Gemology*, **55**(1), 2019, 91–101, www.gia.edu/gg-issue-search?ggissueid=1495280241814&articlesubtype=labnotes.*

**Article freely available for download, as of press time*

SAVE THE DATE!

Gem-A Conference 2019

November 2-3

etc.venues
County Hall
London, UK


Pala International
PalaGems.com / PalaMinerals.com
+1 800 854 1598 / +1 760 728 9121
Spessartine garnet set • Total weight 37.83 ct
Blooms from Pala International Grounds • Photo: Mia Dixon