

# 09 Abstracts

## GEMOLOGICAL

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### COLORED STONES AND ORGANIC MATERIALS

**Cultured freshwater pearls from the Yangtze River (China); characterisation by optical microscopy, scanning electron microscopy, cathodoluminescence, electron microprobe analysis, and Raman spectroscopy.** M. Dumańska-Słowik [dumanska@uci.agh.edu.pl], W. Heflik, L. Natkaniec-Nowak, M. Sikorska, and A. Wesełucha-Birczyńska, *Australian Gemmologist*, Vol. 23, No. 4, 2008, pp. 290–299.

Unbeaded Chinese freshwater cultured pearls imitate natural pearls very closely. Their cores were found to contain polymorphic  $\text{CaCO}_3$  minerals (aragonite or a mixture of aragonite, calcite, and vaterite), and their exteriors were composed of aragonite with dark to light green “oscillatory” concentric layers of mother-of-pearl. The presence of these mineral phases was confirmed by their Raman spectra. The 1526 and 1133  $\text{cm}^{-1}$  bands characteristic of natural pearls were not recorded in the spectra of the Chinese freshwater cultured pearls, and may afford a means of distinguishing the two. RAH

**Grüne Quarze—Farbursachen und Behandlung [Green quartz—Causes of colour and treatment].** R. Schultze-Güttler [rainersg@usp.br], U. Henn, and C. C. Milisenda, *Gemmologie: Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 57, No. 1–2, 2008, pp. 61–73 [in German].

Large quantities of faceted green quartz have recently been observed in the trade. Four types are described: (1) natural green, heated in nature; (2) amethyst laboratory-heated to 400–500°C, known as *prasiolite*; (3) laboratory-irradiated quartz, the color of

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which tends to fade at low temperatures (150°–200°C) or when exposed to strong sunlight; and (4) synthetic green quartz. The absorption spectrum for each is characteristic. Natural green quartz shows bands in the near-IR region at 725, 930, and 1040 nm, with a window at ~550 nm. Prasiolite has a wide absorption band with a maximum at 720 nm, while irradiated quartz has a broad absorption maximum at 592–620 nm. Synthetic green quartz shows a transmission maximum at ~510 nm and broad absorption bands with maxima at ~740 and 930 nm.

GL

**Hackmanite, tugtupite and afghanite—Tenebrescence and fluorescence of some sodalite related minerals.** J. Tunzi and G. Pearson [grantpearson@optusnet.com.au], *Australian Gemmologist*, Vol. 23, No. 4, 2008, pp. 349–355.

The tenebrescence of hackmanite from Afghanistan and Myanmar was compared with that of tugtupite from Greenland. The hackmanite displayed variable tenebrescence, but the tugtupite was largely inactive. Afghanite, a rare mineral from Afghanistan that is chemically related to hackmanite, was not observably tenebrescent.

RAH

**Jarina, o marfim da Amazônia [Jarina, the ivory of Amazonia].** M. Lima da Costa, S. F. Santos Rodrigues, and H. Hohn, *Diamond News*, Vol. 9, No. 29, 2008, pp. 38–44 [in Portuguese].

The seed of the *Jarina* palm, known in English as ivory nut, resembles ivory. Until it was replaced by plastic in the 20th century, this seed supplied the material for nearly all shirt buttons worldwide. Recently, ivory nut has regained popularity as a material for jewelry and carvings. The authors describe the palm and its occurrence and growth conditions, the properties of the nut, color treatments, and jewelry uses.

RT

**Marble-hosted ruby deposits from Central and Southeast Asia: Towards a new genetic model.** V. Garnier, G. Giuliani [giuliani@crpg.cnrs-nancy.fr], D. Ohnenstetter, A. E. Fallick, J. Dubessy, D. Banks, H. Q. Vinh, T. Lhomme, H. Maluski, A. Pêcher, K. A. Bakhsh, P. V. Long, P. T. Trinh, and D. Schwarz, *Ore Geology Reviews*, Vol. 34, 2008, pp. 169–191.

Marble-hosted ruby deposits from Afghanistan, Pakistan, Kashmir, Tajikistan, Nepal, Myanmar, northern Vietnam, and southern China share many structural, mineralogical, and radiometric features. These deposits are located in metamorphic blocks that experienced major tectonic events during the Cenozoic India-Asia collision. In many of the deposits, rubies were formed as scattered crystals along veins or certain horizons within marbles. Host marbles from all the deposits studied were rich in calcite and low in dolomite. Whole-rock chemical analyses of the marbles indicate that their Al, Cr, and V contents were

sufficient to produce rubies. The rubies are commonly associated with micas, chlorite, feldspar, graphite, pyrite, rutile, titanite, humite, and forsterite; occasionally with spinel, tourmaline, and amphibole; and rarely with sapphirine and zoisite.

Petrographic analyses show that the ruby-bearing marbles formed at a temperature of 610°–790°C and pressure of ~6 kbar. Fluid inclusions in the ruby samples were either single phase or, more commonly, two phase. They contained native sulfur, COS complexes, H<sub>2</sub>O, CO<sub>2</sub>, H<sub>2</sub>S, and several solid inclusions (typically diaspore, rutile, and dolomite). Fluid inclusion studies bracket ruby formation conditions at 620–670°C and 2.6–3.3 kbar, indicating that the rubies crystallized during retrograde metamorphism of the marbles.

Stable isotope geochemical data for the (C,O,H)-isotopic compositions of minerals associated with the rubies are also presented. The (C,O)-isotopic compositions of carbonates suggest that the marbles acted as a metamorphic closed-fluid system, meaning that the fluids circulating in the marbles during metamorphism were released by the devolatilization of carbonates. Furthermore, the carbon isotopic signatures of graphite in the carbonates indicate that it had an organic source and that it exchanged C-isotopes with the carbonates during metamorphism.

The authors propose a new genetic model for the formation of these ruby deposits. First, sedimentary protoliths, including carbonates enriched with clay minerals and organic matter, were deposited on the Paleo-Tethys platform during the Precambrian to Permo-Triassic. During the India-Asia collision, these sediments were metamorphosed, transforming the carbonates into amphibolite-grade marbles. Ruby crystallized during the retrograde metamorphic path, mainly by destabilization of muscovite or spinel. The metamorphic fluids were rich in CO<sub>2</sub> released by carbonate devolatilization and in F, Cl, and B released by salts derived from evaporites in the protolith. These evaporites were key to the formation of the ruby deposits, as the salts mobilized typically immobile Al and transition metals in the marbles, leading to ruby crystallization.

The authors suggest taking the following guidelines into account when prospecting for new deposits: (1) the lithologic control of mineralization, and (2) the presence of indicator minerals (e.g., Na-rich phlogopite, pargasite, edenite, Mg-tourmaline, Cr-rich titanite, spinel, and anhydrite) in marbles or in alluvials.

KSM

**Morfologia di perle naturali e coltivate al microscopio elettronico a scansione (SEM) [The morphology of natural and cultured pearls under the scanning electron microscope (SEM)].** A. Maras, E. Amore, S. Mazziotti-Tagliani, M. Macri, and A. Mancini, *Rivista Gemmologica Italiana*, Vol. 3, No. 3, 2008, pp. 201–213 [in Italian].

The nacreous surface of pearls can display surface struc-

tures that are step-like, labyrinthine (i.e., resembling fingerprints), or spiral. The aim of this investigation was to find out whether these structures are due to the pearl oysters, varying growth conditions, or both, and whether they are characteristic for certain types of pearls. The authors used visible light and scanning electron microscopy (SEM) to analyze the surface of two freshwater cultured pearls (one of them "chocolate"), a Red Sea saltwater pearl, an Akoya saltwater cultured pearl, and three additional saltwater cultured pearls (South Sea, Tahitian, and "golden"). The analysis revealed differences and similarities in samples from different sources. The results are illustrated with SEM micrographs.

RT

**Nucleated cultured pearls: What is there inside?** M. Superchi [superchi@mi.camcom.it], E. Castaman, A. Donini, E. Gambini, and A. Marzola, *Gemmologie: Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 57, No. 1–2, 2008, pp. 33–40.

Standards established by the Japan Pearl Promotion Society state that the nuclei of beaded cultured pearls should have a layered nacreous structure of the same material, density, and hardness as the cultured pearls themselves. However, the cost of the traditional Mississippi Basin freshwater mussel shell—and the demand for larger beads in recent years—have led to the use of other materials and the need to identify these nuclei, given the different costs and qualities they represent. Consideration has been given to mother-of-pearl from different freshwater and saltwater mollusks, shells from Tridacnidae clams, and the artificial composite "bironite." Freshwater mother-of-pearl can be separated from saltwater *Tridacnidae* and other nuclei by LA-ICP-MS analysis based on the presence (or absence) of Mn. This article illustrates how Laue diagrams may also be useful in separating the different materials, especially those in which Mn is absent, such as the saltwater beads and "bironite."

*Abstractor's note:* Since 2004, the *Tridacna* species have been listed as vulnerable according to the Red List of the International Union of Conservation of Nature. This gives added environmental importance to the development of a method to identify the use of nuclei made from the shells of these clams.

JEC

**The oxygen isotopic composition as an indicator of the genesis of "basaltic" corundum.** S. V. Vysotsky, V. V. Yakovenko, A. V. Ignat'ev, and A. A. Karabtsov, *Russian Journal of Pacific Geology*, Vol. 3, No. 1, 2009, pp. 64–68.

Gem corundum can form in a range of geologic environments, but the material derived from alkali basalts (and similar mafic igneous rocks) are among the most important economically. Within alkali basalts, the corundum may occur as xenocrysts (foreign material) or as megacrysts (direct crystallization). For some deposits (e.g., Yogo Gulch,

Montana), the type of crystallization has been debated for years. Measuring the oxygen isotope composition of corundum is one method to help resolve these questions.

The authors of this study measured and compared oxygen isotope values for corundum and associated minerals from three sapphire deposits previously linked with basaltic rocks: (1) the Yogo lamprophyre dike, (2) the Khabok River, Tunkin Depression, Russia; and (3) alluvium derived from the Podgelbanochnyi volcano in Primorye, Russia. A total of six samples were tested. Interestingly, sapphire and phlogopite (a key constituent of the lamprophyre host rock) from Yogo shared very similar oxygen isotope values (5.6 and 6.0‰, respectively), implying that the sapphire formed directly from the lamprophyre; this contradicts previous conclusions that the sapphires are xenocrysts derived from underlying metamorphic basement rocks (see, e.g., K. A. Mychaluk, "The Yogo Sapphire Deposit," Spring 1995 *G&G*, pp. 28–41). Conversely, a plagioclase-corundum inclusion in basalt from the Tunkin Depression clearly had a xenocrystic origin. The oxygen isotope values for the corundum (9.1‰) and host basalt (6.1‰) varied by 3‰, with the value for the corundum falling outside the accepted range for "basaltic" corundum (4.5–7.0‰). Microscopic study of the same inclusion supported a xenocrystic origin (probably from a metamorphic protolith). Alluvial sapphires from Primorye showed oxygen isotopic values within the normal range for basaltic sapphire and are likely derived from alkali basalt.

This technique could evolve into a method to help determine the provenance of faceted sapphires.

KAM

**Structural, mineralogical, and biochemical diversity in the lower part of the pearl layer of cultivated seawater pearls from Polynesia.** J.-P. Cuif [jean-pierre.cuif@u-psud.fr], A. D. Ball, Y. Dauphin, B. Farre, J. Nouet, A. Perez-Huerta, M. Salomé, and C. T. Williams, *Microscopy and Microanalysis*, Vol. 14, No. 5, 2008, pp. 405–417.

This study of 30 cultured pearls from *Pinctada margaritifera* mollusks of various Polynesian islands was undertaken to investigate the structural and compositional patterns of the early developmental stages of the pearl layer. The initial steps in cultured pearl formation display evidence of metabolic changes that occur during formation of the pearl sac and vary from one cultured pearl to another. In contact with the bead, the lower parts of the cultured pearl layer exhibit mineralization that differs from the regular concentric layered nacreous material produced later by the graft. An unusual association of organic and mineral materials is deposited during this early period, leading to the formation of various structures that in general have a radial orientation perpendicular to the nucleus surface. These structures are thought to result from the formation of subparallel prisms (either aragonitic or calcitic) pro-

duced simultaneously in adjacent areas of the pearl sac. Grafting and the subsequent pearl-sac formation processes appear to lead to a disturbance in the genomic activity of the grafted epithelium cells, and to unusual molecular associations in the early period of uncontrolled mineralization during pearl-sac formation. *JES*

## DIAMONDS

**Diamonds of Russia.** G. F. Anastasenko and M. B. Leybov [m\_leybov@mail.ru], *Rocks and Minerals*, Vol. 83, No. 6, 2008, pp. 508–517.

This article surveys Russia's centuries-old involvement with diamonds, from the czars' acquisitions of fine Indian and Brazilian stones to the first (noncommercial) discovery of diamonds in 1829 and the vast, state-supported geologic expeditions that discovered major commercial deposits over a century later. Several million square kilometers of dense, gnat-infested Siberian forests and swamps, with no roads and severe climate, were of intense interest. What remained unsolved, beyond a few placer deposits scattered across the Siberian craton, was the bedrock source of the diamonds. This changed in 1953–1954 when two female geologists discovered that pyrope concentrates from the Markha Basin resembled those from South African kimberlite. They traced the pyrope upriver to locate the diamondiferous kimberlite pipes in the D'yaka Valley, and in so doing developed the method of indicator mineral prospecting still in use today.

East Siberia has hundreds of kimberlite pipes, and the few diamondiferous ones were enough to position Russia among world leaders in diamond production. The giant Udachnaya pit yields about half of all Russian diamonds. The Siberian craton has produced about 200 large—50+ ct—diamonds (up to 342.5 ct). The great success in East Siberia also stimulated exploration of European Russia, especially its northern and central parts. The Arkhangelsk field, discovered in the 1980s, now accounts for 20% of Russian diamond production. About 50% of those diamonds are gem quality, and a significant number are nitrogen-free (colorless) stones used for high-tech applications. Airborne geophysical surveys have revealed about 130 “pipe-type” anomalies in the south of European Russia, an area considered promising because of its well-developed infrastructure and mild climate. *ERB*

**New frosty frontiers: The challenges of mining in Canada's territories.** D. Zlotnikov, *CIM Magazine*, Vol. 3, No. 7, 2008, pp. 20–24.

Extreme climate poses many problems for mining in Canada's Northwest Territories. Winter is the only time to effectively survey much of the area, since drilling can only be accomplished when all the swamps and lakes are frozen. Temperatures can reach lows of  $-40^{\circ}\text{C}$ , and workers forced to stay indoors during these conditions can be

struck with “cabin fever.” At this temperature, steel becomes brittle, and steel containers can crack and allow noxious chemicals to escape. During the summer months, helicopters and planes are often grounded due to fog and freezing rain, delaying or preventing the delivery of equipment, food, and workers. Barges are the least expensive form of transportation, but they are not a feasible option unless the mine is located next to a body of water. The primary mode of transportation is trucking via the Tibbit to Contwoyto Winter Road. Although the road is only open from February to April, it allows delivery of most of the year's fuel and equipment. If temperatures become too mild during these months, the road closes early, increasing the probability that replacement equipment or necessary supplies will have to be delivered the following year. *JS*

**Three centuries of diamonds: Preserving a tradition in Brazil.** B. Farrar, *Rock & Gem*, Vol. 39, No. 3, 2009, pp. 37–40.

All significant diamond production in Brazil is from alluvial deposits or conglomerates formed from them. The *garimpeiros*, or prospectors, have an intimate knowledge of the area's formations and utilize different mining techniques at different times of the year. They work in the river during the dry season and on the sides of the valley during the rainy season. Besides their important role in world mining heritage, traditional Brazilian mining practices have less impact on the environment. When the *garimpeiros* are gone, their knowledge will go with them. One organization, Garimpo Real, seeks to preserve their methods. *MK*

**What a gem! Ontario's first diamond mine.** M. Scales, *Canadian Mining Journal*, Vol. 130, No. 1, January 2009, pp. 16–21.

The Victor mine is the first diamond mine in the Canadian province of Ontario. It took 37 years to research, plan, and construct, but the mine produces diamonds that are higher in per-carat value (\$400/ct) than anywhere else.

Surrounding First Nation communities contributed to the project with their environmental knowledge, and they negotiated over \$110 million in supporting business agreements with De Beers. The Victor mine is composed of two textural types of kimberlite, with the central part of the north pipe containing the most valuable grade of ore. This area is being mined first, and the process of separating diamonds from the ore is highly automated to promote employee safety and company profitability. *AB*

## GEM LOCALITIES

**Gem corundum from the St. Arnaud district, Western Victoria, Australia.** W. D. Birch, *Australian Journal of Mineralogy*, Vol. 14, No. 2, 2008, pp. 73–78.

Waterworn sapphire crystals ( $\leq 7$  mm) showing a wide range of colors (green, dull blue, pale yellow, pink, purple, and pale brown) are found in concentrates from an alluvial gold mine in ferruginous gravel at Carapooee, near St. Arnaud in southeastern Australia. Chemical analysis by LA-ICP-MS suggests that these sapphires were derived from mainly metamorphic and metasomatic source rocks, with a smaller magmatic component, similar to the gem corundums from basalt-related Cenozoic goldfields in eastern Australia. RAH

**The 100-year history of the Benitoite Gem mine, San Benito County, California.** W. E. Wilson [minrec@earthlink.net], *Mineralogical Record*, Vol. 39, No. 1, 2008, pp. 13–42.

This article surveys the history of the Benitoite Gem mine, the original source of California's state gemstone, beginning with a prospector's discovery of this occurrence in the New Idria district of San Benito County in 1907. Here, crystals of benitoite were found as both facetable gem material and mineral specimens (often together with black neptunite and yellow-brown joaquinite) within natrolite veins in an altered blueschist host rock. Since then, benitoite has been found at a few nearby claims in the same area, at four other places in California, and at several other world locations, but none of this material matches the quality and beauty of the original find.

This chronological report, prepared in honor of the 100th anniversary of the discovery, is based on both published information and important historical documents that include mine records from the early years of production. It highlights a number of interesting individuals, including miners, mineral and gem dealers, and professional geologists who were involved with the discovery and mining of benitoite over the past century. Following an initial period of mining activity, the operation was mostly inactive from about 1914 to 1952 except for some unauthorized mineral collecting. Since then, there has been intermittent mining of both the primary deposit and the eluvial and colluvial material that lay at the base of deposit. Most mining activity ended in 2005. Attractive mineral specimens of benitoite can today be found in a number of museums and in private collections. The largest faceted benitoite weighs 15.42 ct. JES

**Ion microprobe zircon U-Pb age and geochemistry of the Myanmar jadeitite.** G. Shi [shiguanghai@263.et.cn], W. Cui, S. Cao, N. Jiang, P. Jian, D. Liu, L. Miao and B. Chu, *Journal of the Geological Society, London*, Vol. 165, 2008, pp. 221–234.

Of the few jadeite locations worldwide, the Hpakan-Tawmaw deposit in the northern Myanmar state of Kachin is the largest and most important. This deposit is located in the western part of the Sagaing fault zone belonging to the Indo-Burman Range, which was formed by the subduction of the Indian plate beneath the Burmese

platelet. Primary jadeitites were formed as veins (1.5–5 m wide and 5–100 m long) crosscutting serpentinized peridotite. An amphibolite boundary zone 1–50 cm wide is found between jadeite veins and serpentinized peridotite bodies.

The geochemistry of eight jadeitite samples was determined using XRF (for major oxides) and ICP-MS (for trace-element abundances) to understand their petrogenesis and tectonic relationship to subduction zones. Bulk-rock trace-element compositions showed U-shaped rare-earth element (REE) patterns with positive Eu anomalies. Overall, REE abundances were low, with moderate enrichment of high-field-strength elements and some large ion lithophile elements. These observations are all consistent with a metasomatic origin for the jadeitite.

One white to pale gray jadeitite sample was crushed to extract ~200 zircon grains for electron microprobe and sensitive high-resolution ion microprobe (SHRIMP) analyses. Three groups of zircons were identified, based on their internal textures, luminescence, mineral inclusions, and chemical compositions. Group I zircons were typically zoned and contained Na-free, Mg-rich silicate mineral inclusions and also the highest U and Th contents and Th/U ratios. They were inferred to have crystallized during an igneous (e.g., formation of oceanic crust) or hydrothermal (e.g., serpentinization) event. The weighted mean age of Group I zircons from U-Pb dating was  $163.2 \pm 3.3$  Ma, suggesting that serpentinization of the oceanic crust of the Indian plate occurred during the Middle Jurassic. Group II zircons, which occurred as rims on Group I zircon cores, did not show zoning features and had lower Th/U ratios. They contained jadeite and jadeite-rich pyroxene inclusions, suggesting Group II zircons were syngenetic with the jadeitite samples. The formation age of Group II zircons was determined to be  $146.5 \pm 3.4$  Ma, indicating that the formation of the Myanmar jadeitites, and the subduction of the eastern Indian oceanic plate, occurred during the Late Jurassic. The low U and Th contents and Th/U ratios (lowest of the three), growth habits, and age of Group III zircons suggested that a thermal event occurred after jadeitite formation, around  $122.2 \pm 4.8$  Ma (Early Cretaceous), resulting in localized recrystallization. The presence of Middle Jurassic Group I zircons of hydrothermal origin in jadeitite samples provides an important geochronological constraint on the evolution of the Indo-Burman Range, indicating that it may have started earlier than previous models that placed it at Late Cretaceous-Eocene age. KSM

**Modes of occurrence and origin of precious gemstone deposits of the Mogok Stone Tract.** M. Thein, *Journal of the Myanmar Geosciences Society*, Vol. 1, No. 1, 2008, pp. 75–84.

The Mogok area of Myanmar has been famous for more than a century as one of the world's most important gem sources. This article briefly reviews Mogok's regional geol-

ogy and categorizes the gem deposits into eight primary and secondary occurrences. The former include gem-bearing bands in marbles, skarns along the contact zones between marbles and nepheline syenites or syenites, segregations of gems (particularly sapphire) in the same two rock types as well as syenite pegmatites, and hydrothermal veins extending from the same pegmatites. The secondary occurrences include alluvial and eluvial placers, and what the author refers to as “fissure-filled” and “sink-hole- or cavern-filled” deposits. The marbles and the alluvial deposits are the two most economically important producers.

The author concludes by listing some special geologic conditions that may account for the abundance of gems (particularly ruby and sapphire) in Mogok: the presence of aluminous clays as bands in the original limestones, which then metamorphosed to marbles; additional alumina supplied by igneous intrusions in the region; a calcite-rich marble composition; and high-grade regional metamorphism (amphibolite to granulite facies) and contact metamorphism (pyroxene hornfels facies). JEC

**Winza, ein neues Rubinvorkommen in Tansania [Winza, a new ruby deposit in Tanzania].** K. Schmetzer, W. Radl, and D. Schwarz, *Lapis*, Vol. 34, No. 5, 2009, pp. 41–46 [in German].

This article supplements previous work by D. Schwarz et al. (“Rubies and Sapphires from Winza, Central Tanzania,” Winter 2008 *G&G*, pp. 322–347). Along with a short description of the deposit and mining, it provides a detailed description of the crystal morphology. Based on their habits, the crystals could be divided into two groups: prismatic-tabular-rhombohedral and dipyrnidal. In both groups, some unusual combinations of crystal faces occurred, such as pseudo-octahedral crystals (strongly resembling spinels) with negative rhombohedral faces as dominant forms. RT

## INSTRUMENTS AND TECHNIQUES

**A place for CZ masters in diamond colour grading.** M. D. Cowing [michael@acagemlab.com], *Journal of Gemmology*, Vol. 31, No. 3/4, 2008, pp. 77–83.

The use of cubic zirconia master stones for diamond color grading has been controversial since their introduction more than 20 years ago. This article is a detailed discussion of how CZ master stones can be used in conjunction with diamond master stones to enhance and confirm diamond color grade calls. Traditional objections to the use of CZ master stones include the different yellow hue of CZ vs. diamond, variations in the dispersion and luster, plus concerns about the color stability of CZ. The appeal of CZ master sets is initially one of economy, but many industry professionals who trade in diamonds (and thus suffer financially if a color grade is off when buying) use CZ mas-

ter stones as a supplement to their diamond masters. The author notes, however, that it takes practice to adjust to the higher dispersion of CZ. Although nitrogen-rich type Ia diamonds may have a different shade of yellow, it is easier to grade yellow against yellow than to grade brown or gray against yellow.

The author compared two sets of CZ master stones from two different producers under five different lighting conditions (daylight fluorescent, daylight fluorescent through a Lexan plastic filter to remove UV, cool white fluorescent, a full-spectrum fluorescent, and a white LED lamp). Results from grading CZ master sets by three experienced color graders illustrated the differences in the two products, with one being decidedly superior. The differences in absorption spectra and amounts of fluorescence were not enough to materially affect the results. JEC

**Practicality of Colibri™, a diamond colour-grading product by Sarin.** J. Kawano and K. Saikyo, *Gemmology*, Vol. 40, No. 476, 2009, pp. 23–27.

Color grading D-to-Z diamonds involves an element of subjective visual observation, but a completely objective method has been sought for some time. Sarin Technologies is working to fill this need through its automatic color-grading instrument, the Colibri colorimeter, which is intended for faceted type Ia diamonds with yellow (cape) color. The device is suitable for laboratory and retail use, requiring only a small desk space and weighing 1.2 kg (about 2.6 lbs.). It uses a 100-volt electric power supply or a rechargeable battery with 10 hours of continuous operation. Color grading takes about 5 seconds. According to Sarin, samples can range from 0.2 to 270 ct and can be mounted or unmounted. The machine measures the sample’s color and compares it with the measurement of the empty test chamber to derive a numeric value that corresponds to standard color grades issued by GIA, AGS, and HRD.

The authors tested the Colibri at the GAAJ-Zenhokyo Laboratory by measuring some 14,000 diamonds, and they concluded that when properly used, the machine is fairly useful for objective color grading of most cape-series stones. The Colibri provided consistent measurements, especially for stones <1 ct; round brilliants with a cut grade of Good or better and fluorescence from none to medium blue; and cape diamonds. Correct color estimates for stones with brown or gray hues could be achieved by adding 1.5 to 2.0 to the numeric result; however, no correction could be made for strong blue fluorescence. Karen G. Fenech

**Visualization of the internal structures of cultured pearls by computerized X-ray microtomography.** U. Wehrmeister [wehrmeis@uni-mainz.de], H. Goetz, D. E. Jacob, A. Soldati, W. Xu, H. Duschner, and W. Hofmeister, *Journal of Gemmology*, Vol. 31, No. 1/2, 2008, pp. 15–21.

While there are usually observable differences between natural pearls and beadless cultured pearls, these differences are not always sufficient for conventional X-radiography to distinguish. Through computerized X-ray microtomography, CaCO<sub>3</sub> polymorphs within a sample can be revealed at a resolution one or two orders of magnitude higher than is possible with conventional radiograms. Combined with micro-Raman spectroscopy, it is also possible to detect vaterite, a metastable polymorph associated with the remnants of graft tissue in cultured pearls. Using sample tomograms depicting two-dimensional cross-sections and three-dimensional visualizations, along with Raman intensity maps, the authors describe the structures seen in four types of cultured pearls: beadless Chinese freshwater, beadless Japanese freshwater from Lake Biwa, beaded freshwater from Lake Biwa, and beaded South Sea. The article notes that while vaterite areas are suggested by certain features in the tomograms (probably caused by higher concentrations of organic molecules), these must still be verified using micro-Raman spectroscopy. This combined technique lends itself to scientific research and the nondestructive testing of high-value pearls.

ES

## SYNTHETICS AND SIMULANTS

**Effects of Al and Ti/Cu on synthesis of type-IIa diamond crystals in Ni<sub>70</sub>Mn<sub>25</sub>Co<sub>5</sub>-C system at HPHT.** S.-S. Li, X.-P. Jia, C.-Y. Zang, Y. Tian, Y.-F. Zhang, H.-Y. Xiao, G.-F. Huang, L.-Q. Ma, Y. Li, X.-L. Li, and H.-A. Ma [maha@jlu.edu.cn], *Chinese Physics Letters*, Vol. 25, No. 10, 2008, pp. 3801–3804.

This study used the temperature-gradient method under high pressure and high temperature to grow low-nitrogen type IIa synthetic diamonds. They were grown in a cubic anvil high-pressure apparatus at 5.5 GPa and 1560 K using high-purity graphite as the carbon source and a Ni<sub>70</sub>Mn<sub>25</sub>Co<sub>5</sub> alloy as the catalyst/solvent. Al and Ti/Cu were tested as nitrogen getters to produce low nitrogen concentrations. The authors found that using Al as the nitrogen getter resulted in crystals with a yellow coloration and obvious inclusions. Using Ti/Cu as the nitrogen getter, the authors produced a colorless, inclusion-free 2 mm synthetic diamond with a nitrogen concentration <1 ppm. Decreasing the temperature gradient in the experimental assembly slowed the growth rate, which improved the clarity of the crystal.

The article explains these results in terms of reversible versus irreversible reactions. The authors describe Al reacting with N: Al + N ⇌ AlN. The reversibility of this reaction is given as the reason measurable amounts of N are still present in diamonds grown with Al as the nitrogen getter. Ti was found to be a more efficient nitrogen getter than Al, with the irreversible reaction Ti + N ⇒ TiN (as long as enough Ti is added to compensate for all

the N). A similar reaction occurs between Ti and C, so Cu is added to decompose TiC by the irreversible reaction TiC + Cu ⇒ Ti<sup>-</sup> + Cu<sup>+</sup> + C. The best results were achieved using a 1.8 wt.% Ti/C additive with a growth rate of 1.03 mg/hr for 20 hours. The seed crystal was 0.6 mm, and the (100) face was used as the growth surface. JS-S

## TREATMENTS

**Diamants de couleur traités à haute température et à haute pression [High temperature and high pressure treated colored diamonds].** E. Erel [e.ere1@gubelingemlab.ch], *Revue de Gemmologie*, No. 167, 2009, pp. 10–17 [in French].

HPHT treatment has been performed on type I, type IIa, and type IIb rough and faceted diamonds; the resulting colors depend on the chemical properties of the starting material. After treatment, type Ia diamonds with a natural weak yellow to brown color exhibit a fluorescent yellow or yellow-green intense “fancy” color, or an intense yellow or orange color without the green fluorescence. Treated pink-to-red diamonds are produced in two steps: After HPHT treatment is used to add a type Ib component to type Ia starting material, irradiation and heating at low temperature is used to obtain the desired color. Treated diamonds occasionally display characteristic visual features such as surface etching and internal graphitization. When these indicators are not present, conclusive identification requires advanced testing such as UV-Vis-NIR and infrared spectroscopy. FP

**Diamants de couleur traités par irradiation puis chauffage à “basse” température [Colored diamonds irradiated and heated at low temperature].** E. Erel [e.ere1@gubelingemlab.ch], *Revue de Gemmologie*, No. 164, 2008, pp. 6–10 [in French].

Radiation-induced color is the result of damage caused when carbon atoms are knocked out of their normal position, creating vacancies in the atomic lattice. The result is a sharp peak at 741 nm in the diamond’s spectrum, known as the GR1 (General Radiation) band. Irradiation alone produces a blue-to-green or black coloration; the GR1 color center disappears when the stone is heated to 600°C. During the heating process, radiation-induced vacancies migrate through the lattice and pair with nitrogen to create new color centers. One of the first to develop is the 595 nm absorption at 275°C; maximum absorption at 595 nm is reached at 800°C, and an associated peak is often observed at 425 nm. H3 (503 nm) and H4 (496 nm) centers appear at 500°C, as do H1b and H1c (at 5170 and 4940 cm<sup>-1</sup> in the infrared spectrum). A combination of irradiation and heating at low temperature produces yellow, orange, pink, or red color, depending on the diamond type. The presence of the H1b and H1c centers is evidence that a stone has been most likely been irradiated and annealed. GL

**Pérolas tratadas [Treated pearls].** *Diamond News*, Vol. 9, No. 29, 2008, pp. 17–24 [in Portuguese].

With the exception of most Tahitian and South Sea products, cultured pearls sold in the market today are treated to improve their surface quality and color, and sometimes to produce colors not found in nature. The treatments can be classified into three groups: (1) bleaching and polishing, which removes undesired hues and improves luster; (2) irradiation, which induces greenish, bluish, and even black colors; and (3) dyeing, which produces all kinds of colors with both natural and artificial coloring agents.

RT

**Study of black diamond made by nitrogen ion-implantation and irradiated green diamond.** H. M. Choi, Y. C. Kim, S. K. Kim, J. W. Park, and A. Abduriyim [laboratory@gaaj-zenhokyo.co.jp], *Gemmology*, Vol. 40, No. 473, 2009, pp. 2–6 [in Japanese with English supplement].

Part one of this study discusses how deep, evenly colored black diamonds can be produced by nitrogen ion implantation and annealing. Nitrogen ion implantation typically has a shallow penetration depth and yields a weak black or green color. The facet surfaces of 10 transparent and light brown diamonds (most of them less than 0.12 ct) were subjected to three treatment conditions: (1) N<sup>+</sup> ion irradiation and no heating, (2) post-N<sup>+</sup> irradiation heat treatment at 600°C for two hours in a vacuum, and (3) triple the radiation dose and annealing time of treatment 2. N<sup>+</sup> ions were implanted to a depth of 40 nm, with their mass decreasing gradually from 18 to 40 nm depth. X-ray photoelectron spectroscopy indicated that diamond was converted to a 40-nm-thick layer of graphite by N<sup>+</sup> ion implantation; subsequent annealing led to crystallization of the graphite layer, producing a more uniform and vivid black diamond. Although the English translation is unclear on whether treatment condition 2 or 3 was responsible for these results, it appears to favor higher ion dose and longer annealing time.

In part two of the study, a 7.69 ct step-cut Fancy bluish green, type IIa diamond was examined. The color appeared uniform, but concentrations were faintly visible along facet junctions when the stone was viewed in immersion. The authors discuss the significance of the diamond's 1077.9 nm band in the near-infrared region and conclude that the green color was caused by artificial irradiation.

ERB

**XPS and ToF-SIMS analysis of natural rubies and sapphires heat-treated in a reducing (5 mol% H<sub>2</sub>/Ar) atmosphere.** S. Achiwawanich, B. D. James, and J. Liesegang [j.liesegang@latrobe.edu.au], *Applied Surface Science*, Vol. 255, 2008, pp. 2388–2399.

The authors studied the effects of heat treatment in a reducing atmosphere on surface features of Mong Hsu

rubies and Kanchanaburi sapphires using X-ray photoelectron spectroscopy (XPS) and time-of-flight secondary ion mass spectrometry (ToF-SIMS). Samples were heat treated in a high-temperature electric furnace with a 5 mol.% H<sub>2</sub>/Ar atmosphere for one hour at 1000–1600°C. Visual examination and spectroscopic analyses were performed between each heating stage. The blue cores of Mong Hsu rubies were removed by heating above 1300°C, and the overall red hue was enhanced during treatment. Above 1400°C, whitish particles developed in the samples. The blue component in dark greenish gray and pale blue Kanchanaburi sapphires was diminished by heating above 1200°C. At the same time, the dark greenish gray color was intensified with increasing concentration of the associated precipitate inclusions. For both rubies and sapphires, XPS and ToF-SIMS analyses showed that surface concentrations of various trace elements (Fe, Ti, Ca, V, Mn, Cu, and Cr) had relative maxima around 1300–1400°C, indicating that bulk diffusion into the stones occurred with progressive heat-treatment stages at higher temperature. ToF-SIMS spatial images of Ti, Cr, and Fe indicated that with progressive heat treatment, Ti ions in rubies and sapphires distribute fairly uniformly on the surface, whereas Fe and Cr ions tend to cluster and then form particles on the surface.

The authors conclude that heat treatment of the corundum samples in a reducing atmosphere affected the oxidation state of Fe but not Ti. They also suggest that dissociation of Fe-Ti interaction may occur during heat treatment in a reducing atmosphere, which they attribute to differences in diffusion rates of defect clusters associated with Fe and Ti.

EVD

## MISCELLANEOUS

**Accessible and total lead in low-cost jewelry items.** J. L. Yost and J. D. Weidenhamer [jweiden@ashland.edu], *Integrated Environmental Assessment and Management*, Vol. 4, No. 3, 2008, pp. 358–361.

Recent legislation in the U.S. has banned products intended for children that contain >0.06 wt.% lead. Previous studies by the second author have shown that much costume jewelry sold in the U.S. contains nonpermissible levels of lead; however, critics of the new rules have argued that plated lead jewelry does not contain dangerously high levels of *accessible* lead (that is, lead that could be absorbed by the human body if the object were ingested). The authors tested 64 low-cost jewelry items (all with >0.06 wt.% lead) and subjected them to the lead-accessibility test recommended by the U.S. Consumer Product Safety Commission (rinsing in dilute hydrochloric acid). Fifty of the items were found to exceed the limit for accessible lead (175 µg); 30 of these had accessible lead >1000 µg. The authors conclude that plating is generally ineffective in limiting lead exposure.

TWO

**Gems. Elements**, Vol. 5, No. 3, 2009, pp. 137–200.

This special issue contains a review of current developments in gemology. It opens with an introduction to the “developing science” of gemology by guest editors E. Fritsch and B. Rondeau. L. Groat and B. Laurs then review gem formation, production, and exploration. G. R. Rossman describes the geochemistry of gems, while B. Devouard and F. Notari review gem identification. R. E. Kane, and J. E. Shigley and S. F. McClure, describe current developments in synthetic and treated gems, respectively. The articles conclude with a review of current research on pearls and coral by J.-P. Gauthier and S. Karampelas.

TWO

**Green bench practices reduce environmental impact.** C. Dhein, *JCK*, Vol. 179, No. 11, 2008, pp. 68–73.

Awareness of the environmental impact of jewelry making has grown recently, and the author offers tips to help jewelers develop sustainable business practices. Jewelers are encouraged to review their supply chain and request copies of their suppliers’ environmental policies. If none exist, they should encourage their suppliers to develop and abide by sustainable practices. Jewelers should buy from companies that are trying to make a difference and choose local suppliers to minimize costs and carbon footprint. Tracing the supply chain is more difficult for gems than for metals.

Other suggestions: Collect anything used in precious-metal manufacturing and turn it in for refining. Encourage customers to recycle their precious metals. Consider switching to less toxic alternatives to traditional studio practices, such as a citric pickling solution, which is greener (if slower). Reduce the size of packaging, choose recycled versions, and encourage suppliers to do the same. A list of additional reading and organizations and resources promoting responsible and ethical materials is included.

EJ

**Model for responsibility.** B. Moss, *Modern Jeweler*, Vol. 107, No. 8, 2008, pp. 42–47.

Because of recent consumer preferences for dealing with socially and environmentally responsible corporations, the jewelry industry is taking steps to ensure that its product, often an expression of love, is not tarnished by ethical concerns. In 2003, global diamond producer Rio Tinto established a Business Excellence Model (BEM) for Indian diamantaires and jewelry manufacturers. BEM factories and sites must comply with the Kimberley process and adhere to standards of sourcing/quality control, environmental protection, health and safety, and social responsibility. Indian diamond manufacturers, the world’s principal source of diamond jewelry, are keen to adhere to global production standards. So far, manufacturers who have adopted the BEM model have given enthusiastic feedback. Positive outcomes include greater productivity and reduced product turnaround time, goodwill gained in the industry, improved worker health with lower absenteeism, and new local sponsorship of social institutions and educational systems. Ultimately, the consumer can feel confident that jewelry purchased through retailers who work with BEM suppliers has been manufactured with the highest global standards.

AB

**Why China manufacturers are optimistic despite global slowdown.** *Jewellery News Asia*, No. 290, October 2008, pp. 81–84.

In the wake of the global financial crisis, Chinese diamond jewelry manufacturers have turned their attention from exporting to the U.S. to creating branded jewelry lines for their domestic market. Several polished diamond wholesalers observed that Chinese consumers are broadening their preferences to include diamonds >0.50 ct and SI-clarity goods, both of which had been a difficult sell there. They are also establishing closer ties to local retailers in promoting their branded diamond jewelry pieces, noting that manufacturers must pay more attention to changing fashion trends and changes in the retail environment.

RS

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