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GEMOLOGICAL
ABSTRACTS

COLORED STONES AND ORGANIC MATERIALS

Crystallization of biogenic Ca-carbonate within organo-mineral micro-domains. Structure of the calcite prisms of the pelecypod *Pinctada margaritifera* (Mollusca) at the submicron to nanometre ranges. A. Baronnet, J. P. Cuif [jean-pierre.cuif@u-psud.fr], Y. Dauphin, B. Farre, and J. Nouet, *Mineralogical Magazine*, Vol. 72, No. 2, 2008, pp. 617–626.

Atomic force microscopy (AFM) and transmission electron microscopy (TEM) were used to investigate the fine structure of calcite prisms in *Pinctada margaritifera* shell. AFM showed that the prisms were made of closely packed circular micro-domains (in the 0.1 μm range) surrounded by a dense cortex. TEM images and diffraction patterns revealed the internal structure of the micro-domains, each of which was enriched in calcium carbonate. Hosted in distinct regions of each prism, some of these domains were fully amorphous while others were fully crystallized as subunits of a larger calcite crystal. At the border separating the two regions, the micro-domains displayed a crystallized core and an amorphous rim, probably representing an arrested crystallization front. Compared to recent data concerning the stepping mode of growth of the calcite prisms and the resulting layered organization at the micron scale, these results offer unexpected insight into the modalities of biocrystallization. *RAH*

Emerald deposits and occurrences: A review. L. A. Groat [lgroat@eos.ubc.ca], G. Giuliani, D. D. Marshall, and D. Turner, *Ore Geology Reviews*, Vol. 34, No. 1/2, 2008, pp. 87–112.

This section is designed to provide as complete a record as practical of the recent literature on gems and gemology. Articles are selected for abstracting solely at the discretion of the section editors and their abstractors, and space limitations may require that we include only those articles that we feel will be of greatest interest to our readership.

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Emerald is rare because unusual geologic and geochemical conditions are required to bring together sufficient amounts of Be (to make beryl) with Cr and/or V (the coloring agents). This article reviews the major emerald deposits of the world and presents chemical composition data for samples from each deposit.

In the classic model, Be-bearing pegmatites interact with Cr-bearing ultramafic or mafic rocks to form emeralds. In Colombian and certain other deposits, however, emeralds result from regional or tectonothermal metamorphic processes without magmatic activity. Various schemes have been proposed to classify emerald deposits, but not all have been useful in clarifying the actual conditions of emerald formation. Recent studies have demonstrated that emeralds crystallized under conditions where a combination of geologic mechanisms (magmatic, hydrothermal, and metamorphic) brought Be in contact with Cr and/or V in the right geologic setting.

In the field, emerald can be recognized by its color, hardness, and form, but it will not concentrate in heavy mineral fractions because of its relatively low SG. Exploration for emerald deposits is typically based on structural geology considerations and geochemical studies of soils and stream sediments in a target area. *JES*

The formation of precious opal: Clues from the opalization of bone. B. Pewkliang, A. Pring [pring.allan@saugov.sa.gov.au], and J. Brugger, *Canadian Mineralogist*, Vol. 46, No. 1, 2008, pp. 139–149.

The composition and microstructure of opalized saurian (Plesiosaur) bones from Andamooka, South Australia, were compared to saurian bones that were partially replaced by magnesian calcite from the same geologic formation, north of Coober Pedy, South Australia. The opalized bones were essentially pure SiO_2 (88.59–92.69 wt.%), with minor Al_2O_3 (2.02–4.04 wt.%) and H_2O (3.36–4.23 wt.%). No traces of biogenic apatite remained after opalization. During the formation of the opal, the coarser details of the bone microstructure were preserved down to the level of the individual osteons (~100 μm), but the central canals and boundary area were enlarged and filled with chalcedony, which postdates opal formation. The chemical and microstructural features are consistent with opalization occurring as a secondary replacement after partial replacement of the bone by magnesian calcite, and also with the opal forming first as a gel in the small cavities left by the osteons, with individual opal spheres growing as they settled within the gel. Changes in the viscosity of the gel provide a ready explanation for the occurrence of color and potch banding in opals. The indication that opalization is a secondary process after calcification in the Australian opal fields is consistent with a Tertiary age of formation. *RAH*

Nouvelles des travaux sur le béryllium et les saphirs bleus [News on beryllium and blue sapphire research]. V. Pardieu and L. Klemm, *Revue de Gemmologie*, No. 163, 2008, pp. 7–9 [in French].

The authors first give a brief history of the beryllium diffusion treatment of corundum. The presence of Be in *untreated* sapphire was first reported by P. Wathanakul and colleagues at the 2004 International Gemmological Conference, in a trapiche sapphire from Houay Xai in Laos. In mid-2006, F. Claverie and coauthors detected Be in untreated blue sapphires from Ilakaka, Madagascar. Twenty-eight blue sapphires obtained at the Ilakaka mines by one of the present authors were analyzed at the Gübelin Gem Lab, and 12 contained Be in local concentrations of 1–20 ppm. Complementary analyses at other labs (in Bangkok, Berne, and Lucerne) confirmed the findings.

Beryllium in untreated blue sapphires seems to be concentrated in comet-tail inclusions. These cloud-like inclusions also contained some Nb, W, Sn, and Ta. A correlation between these elements and Be could be useful for separating Be-diffused blue sapphire from untreated blue sapphire containing beryllium. The data might also serve as a chemical fingerprint for origin determination. *Guy Lalous*

Perlenzucht mit *Pinctada maxima* in Südost-Asien—ein Beispiel [Pearl culturing with *Pinctada maxima* in Southeast Asia—An example]. H. A. Hänni [gemlab@ssef.ch], *Gemmologie: Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 56, No. 3–4, 2007, pp. 83–95 [in German].

This article describes modern pearl farming with *Pinctada maxima* oysters in Southeast Asia, using as examples two pearl farms in Bali and Irian Jaya. The oysters are cultured from fertilized eggs derived from carefully selected donor oysters. Hygienic standards are closely controlled during the entire growth process. These and other measures resulted in a good yield of high-quality pearls. After harvest, the oysters are not re-seeded; the meat is used for seafood and the shells for their nacre. The cultured pearls are processed, quality graded, and marketed in Australia. *RT*

Thortveitite: A new gemstone. R. Chapman [ross@gemsofaus.com.au], I. F. Mercer, A. H. Rankin, and J. Spratt, *Journal of Gemmology*, Vol. 31, No. 1/2, 2008, pp. 1–6.

A purple waterworn pebble of unknown origin was acquired in Bangkok in 2004, and it was cut into a strongly pleochroic, biaxial gemstone weighing 10.01 ct. It was identified as thortveitite (confirmed by Raman analysis), a scandium yttrium silicate that was previously unknown in gem quality.

Electron microprobe analysis revealed significantly higher concentrations of Sc and lower concentrations of Y than were reported in the literature for nongem thortveitite, which is normally opaque to translucent and found only as very small crystals. The unusual chemical composition suggested a possible synthetic origin, though the presence of three-phase inclusions in a planar array indicated otherwise. Unlike quenched flux or melt inclusions, these features were composed of a gas bubble, brine, and cubic daughter crystal suspected to be halite; this suggested formation in a hydrothermal environment. The inclusions showed signs of exposure to heat, either in nature or in the laboratory. *ES*

Vaterit in Süßwasser-Zuchtperlen aus China und Japan [Vaterite in freshwater cultured pearls from China and Japan]. U. Wehrmeister [wehrmeis@uni-mainz.de], D. E. Jacobi, A. L. Soldati, T. Häger, and W. Hofmeister, *Gemmologie: Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 56, No. 3–4, 2007, pp. 97–116 [in German].

Chinese and Japanese freshwater cultured pearls (beaded and non-beaded) were analyzed by Raman spectroscopy and LA-ICP-MS. The results showed that they consisted only of aragonite and vaterite, with no calcite. For the most part, the vaterite was concentrated near the center of the cultured pearls; less commonly, it occurred in small blemishes on the surface. Continuous growth structures transected both the aragonite and the vaterite areas. Low concentrations of Na and Sr were found in the vaterite, as well as relatively enriched Mg values, which allowed its distinction from aragonite by LA-ICP-MS.

The authors concluded that vaterite is a common phase in freshwater cultured pearls from China and Japan, and that it tends to concentrate near their centers. It was found in cultured pearls of high quality, as well as in lackluster samples. *RT*

DIAMONDS

Kimberlite-hosted diamond deposits of southern Africa: A review. M. Field [matthew-field@btconnect.com], J. Stiefenhofer, J. Robey, and S. Kurszlaukis, *Ore Geology Reviews*, Vol. 34, No. 1/2, 2008, pp. 33–75.

This article reviews a century of scientific study of kimberlites in southern Africa and the diamonds and mantle-derived rocks they contain, which has increased our understanding of geologic processes and the conditions of diamond crystallization in the subcontinental lithosphere. The formation of kimberlite-hosted diamond deposits involves a lengthy and complex series of events, beginning with the growth of the diamonds in the mantle, followed by their removal and transport to the surface by kimberlite magmas. Age dating of mineral inclusions indicates diamond growth occurred several times during the earth's geologic history. Older diamonds—of Archean age—are mainly peridotitic, whereas younger diamonds originated from eclogitic, websteritic, or lherzolitic rocks, and their formation periods correspond in age with major tectonothermal events in southern Africa.

Only about 1% of the kimberlite bodies discovered in southern Africa have been commercially exploited for diamonds, but among them are some of the world's richest mineral deposits. The bulk of this article is a review of 34 diamond mines in the region, including summaries of their geology and characteristics of their diamonds and mantle-derived rocks. The mines vary greatly in size, diamond grade, and value, as well as in their mantle-derived mineral suites. All the deposits are hosted by the Kalahari Craton, indicating that it provided the right environment for diamond growth and subsequent transport to the surface by kimberlite magmas. *JES*

Magnetic inclusions in diamonds. B. M. Clement [clementb@fiu.edu], S. Haggerty, and J. Harris, *Earth and Planetary Science Letters*, Vol. 267, No. 1/2, 2008, pp. 333–340.

Natural diamonds sometimes contain dark inclusions that are often described as being graphite or a sulfide mineral. In this study, the authors examined 11 near-colorless, slightly rounded octahedral diamond crystals (2–4 mm) with dark eye-visible inclusions (believed to be a sulfide) for possible remnant magnetism. All the samples were from the Orapa mine in Botswana. The dark inclusions were found to be single or multiple metallic black and opaque fracture systems, each of which contained a tiny grain (20–50 μm) of pyrrhotite. When released by crushing of the diamond, these tiny grains appeared "dirty-yellow." Pyrrhotite has a greater differential expansion than diamond, and its presence caused the localized fracturing of the host crystal. The black material within the fractures had the same chemical composition as the associated inclusion. The shape and orientation of the pyrrhotite inclusions indicate that they formed at the same time as the host diamond. They were found to be capable of carrying strong and stable remnant magnetization.

These results suggest that with the availability of suitable samples, it may be possible to obtain information about the earth's geomagnetic field during key intervals of geologic time. Furthermore, specific details of the remnant magnetism would allow individual diamonds with pyrrhotite inclusions to be uniquely identified, even in cases where the inclusions are quite small (i.e., only a few microns in diameter). *JES*

Nanometre-sized mineral and fluid inclusions in cloudy Siberian diamonds: New insights on diamond formation. A. M. Logvinova [logv@niggm.nsc.ru], R. Wirth, E. N. Fedorova, and N. V. Sobolev, *European Journal of Mineralogy*, Vol. 20, No. 3, 2008, pp. 317–331.

Nanometer-size isolated inclusions were studied in four cloudy octahedral diamonds from the Internationalaya pipe and one from the Jubileynaya mine, both in Yakutia. TEM, AEM, EELS, and HREM analyses of the samples were conducted, as well as line-scan and elemental mapping. All the crystals exhibited an octahedral habit with opaque central cuboid cores that contained numerous nano-inclusions (30–800 nm). They were composed of multiphase assemblages that included silicates, oxides, carbonates, brines (KCl), and fluid bubbles. Distinguishable crystalline phases included a high-Mg silicate, dolomite, Ba-Sr carbonate, phlogopite, ilmenite, ferropericlase, apatite, magnetite, K-Fe sulfide (possibly djerfisherite), and kyanite. Carbonates identified by TEM from all the diamonds studied showed a general enrichment in incompatible elements such as Sr and Ba. Some elemental variations in the crystalline phases may be explained by fractional crystallization of the fluid/melt or the mixing of fluids with different compositions.

RAH

Using phosphorescence as a fingerprint for the Hope and other blue diamonds. S. Eaton-Magaña [sally.magana@gia.edu], J. E. Post, P. J. Heaney, J. Freitas, P. Klein, R. Walters, and J. E. Butler, *Geology*, Vol. 36, No. 1, 2008, pp. 83–86.

Little quantitative research exists on the phosphorescence properties of natural blue diamonds. This study used broadband UV radiation and a novel spectrometer system to examine the luminescence of 67 natural blue diamonds, including stones from the Aurora Butterfly and Aurora Heart collections, as well as the 45.52 ct Hope and the 30.62 ct Blue Heart.

The red phosphorescence of the Hope Diamond was once believed to be quite rare. This study showed that virtually all natural blue diamonds have red phosphorescence; however, the color is often masked by a concomitant luminescence in the green-blue region of the spectrum. Sixty-two of the 67 samples exhibited two phosphorescence peaks—at orange-red (~660 nm) and green-blue (~500 nm wavelengths). Significantly, the study demonstrated that because these two bands are nearly always present, the relative intensity of emissions and their decay kinetics (i.e., the ratio of peak intensities plotted against the half-life of the 660 nm peak) yields a unique "fingerprint" for each specimen. Phosphorescence analysis therefore provides a robust method to discriminate among individual blue diamonds using a relatively inexpensive, portable desktop spectrometer.

The authors also examined three blue synthetic diamonds and an HPHT-annealed gray-turned-blue natural diamond. All four exhibited the phosphorescence band at 500 nm but not the one at 660 nm, which suggests that phosphorescence spectroscopy might be an effective tool for discerning synthetic and HPHT-treated diamonds from natural blues.

Although the authors acknowledge there is insufficient evidence to completely describe the defect states, impurities, or energy-transfer mechanisms of phosphorescence, their findings suggest that the same donor-acceptor pair recombination mechanism is active in both natural and synthetic blue diamonds. *ERB*

GEM LOCALITIES

Advances in our understanding of the gem corundum deposits of the West Pacific continental margins intraplate basaltic fields. I. Graham [i.graham@unsw.edu.au], L. Sutherland, K. Zaw, V. Nechaev, and A. Khanchuk, *Ore Geology Reviews*, Vol. 34, No. 1/2, 2008, pp. 200–215.

The continental margins of the western Pacific contain the world's largest and richest deposits of gem ruby and sapphire. These deposits are genetically related to Late Mesozoic to Late Cenozoic basaltic volcanism, and today they are spread over a distance of more than 12,000 km, extending from Russia (Siberia) to Australia (Tasmania). The gem corundum consists of xenocrysts of magmatic and/or metamorphic origin trapped in the host basalt. The corundum is mined from placer deposits formed by weathering of the basalt.

Corundum suites from each origin type have distinctive trace-element geochemistry, mineral inclusions, crystallization ages, and formation conditions. Magmatic corundum appears to have crystallized under upper-mantle to mid-crustal pressure-temperature conditions (~700–1200°C), from melts of syenitic to nepheline syenitic composition. In contrast, the metamorphic corundum appears to have formed at slightly higher temperatures (~800–1300°C) and at depths ranging from the mantle to the lower crust. The conditions of corundum formation at the major deposits within the western Pacific continental margins are discussed.

JES

Afghan beryl varieties. L. Natkaniec-Nowak [natkan@uci.agh.edu.pl], *Journal of Gemmology*, Vol. 31, No. 1/2, 2008, pp. 31–39.

The author presents an in-depth characterization of three specimens of Afghan beryl from pegmatites at Ghursalak in Konar Province (aquamarine and morganite) and from the Panjshir Valley (emerald). INAA, XRD, ICP-AES, ICP-MS, and IR spectroscopic techniques were used to examine the beryls, and the results are summarized in accompanying tables. IR spectroscopy of the aquamarine and emerald indicated the presence of organic matter, probably bituminous material within structural channels. The author notes that while Afghanistan has not been a major gem producer for the world market, many important gems have been known from the region since Egyptian, Greek, and Roman times. Production is growing, and examples of fine material have appeared in markets worldwide.

ES

Age and origin of gem corundum and zircon megacrysts from the Mercaderes–Rio Mayo area, south-west Colombia, South America. F. L. Sutherland [lin.sutherland@austmus.gov.au], J. M. Duroc-Danner, and S. Meffre, *Ore Geology Reviews*, Vol. 34, No. 1/2, 2008, pp. 155–168.

Alluvial gem corundum has been known for several centuries from the Rio Mayo area of southwestern Colombia. Samples recovered from this area (some near colorless but most multicolored, 99% of them sapphire) exhibit features such as color zoning, polysynthetic twinning, and healed fractures, as well as various mineral inclusions (rutile, apatite, zircon, some plagioclase, and occasional allanite, which appears to be an inclusion unique to this locality). U-Pb dating of the zircon, allanite, and apatite inclusions suggested the corundum crystallized approximately 10 million years ago, placing the formation in the Miocene epoch. Corundum formation appears to be related to geologic events associated with the uplift of the northern portion of the Andes Mountains and accompanying volcanism. The article provides chemical composition data for both the corundum and the important mineral inclusions. *JES*

Black opaque gem minerals associated with corundum in the alluvial deposits of Thailand. S. Saminpanya [seriwat@hotmail.com] and F. L. Sutherland, *Australian Gemmologist*, Vol. 23, No. 2, 2008, pp. 242–253.

Black opaque spinel, pyroxene, and magnetite occur in gravels associated with corundum in the alluvial deposits of Denchai and Bo Phloi, Thailand. Raman spectra and XRD patterns have been used to unravel some of the misnomers surrounding these materials in the gem markets. The black spinel lies in the spinel-hercynite series, the black pyroxene is mostly augite, and the magnetite lies in the magnetite-ulvöspinel series. The details of their chemical composition suggest that these minerals did not originate in the same environment as the corundum or the basaltic host rocks. *RAH*

Gem corundum deposits of Madagascar: A review. A. F. M. Rakotondrazafy, G. Giuliani [giuliani@crpg.cnrs-nancy.fr], D. Ohnenstetter, A. E. Fallick, S. Rakotosamizanany, A. Andriamamonjy, T. Ralantoarison, M. Razanatseheno, Y. Offant, V. Garnier, H. Maluski, C. Dunaigre, D. Schwarz, and V. Ratrimo, *Ore Geology Reviews*, Vol. 34, No. 1/2, 2008, pp. 134–154.

Gem corundum is found at a number of localities in Madagascar, primarily in the central and eastern portions of this island nation. Ruby and sapphire formed at different stages and in distinct environments. The authors describe four main geologic settings:

1. primary deposits in magmatic rocks such as syenites, granites, and alkali basalts
2. primary deposits in metamorphic rocks such as granulites
3. primary deposits that resulted from alkaline metasomatism due to fluid circulation occurring along discontinuities in gneisses and granulites
4. secondary deposits derived from the erosion of surrounding rocks

The article provides an excellent review of the major ruby and sapphire deposits of Madagascar, including their geologic setting and age, host rocks, typical mineral assemblages, and inferred conditions of formation. *JES*

Greenish quartz from the Thunder Bay Amethyst Mine Panorama, Thunder Bay, Ontario, Canada. L. B. Hebert [labaker@gps.caltech.edu] and G. R. Rossman, *Canadian Mineralogist*, Vol. 46, No. 1, 2008, pp. 111–124.

The Thunder Bay Amethyst Mine Panorama is a major amethyst deposit on the western shore of Lake Superior in southern Ontario. Although most of the quartz is amethystine, loose pieces of yellowish green and green quartz have been found, and greenish gray quartz occurs *in situ* as part of a color-gradation sequence that includes colorless and smoky quartz along with chalcedony. Analysis of samples of all these colors show corresponding trends in the salinity and temperature of the quartz-forming hydrothermal solutions. The greenish material exhibits greater turbidity and more numerous fluid inclusions than the amethyst. Furthermore, differences in crystal growth rates also appear to have influenced the color of the quartz.

The authors conclude that the greenish gray coloration is not from the secondary heating of preexisting amethyst, but rather is another distinct radiation-induced color variety of quartz. This color resulted from specific chemical constituents in the hydrothermal solutions, the conditions of natural radiation exposure, and the incorporation of molecular water in the quartz, both as nano-scale and micro- to macro-scale fluid inclusions. The greenish gray material appears to have formed during the initial stages of mineralization, and these solutions underwent a decrease in salinity and quartz growth rate during quartz precipitation. *JES*

Opal-C, opal-CT, & opal-T from Acari, Peru. F. Caucia [caucia@crystal.uniipv.it], C. Ghisoli, I. Adamo, and M. Boiocchi, *Australian Gemmologist*, Vol. 23, No. 2, 2008, pp. 266–271.

Optical features, SG and XRD data, and IR spectroscopic features are described for 25 translucent-to-opaque volcanic opals from the Acari region of Peru. The XRD and IR results correspond with opal-C and opal-CT, with some samples being pure tridymite (i.e., opal-T). Opals displaying various colors and transparencies were classified according to their luster, and the relationship between luster and the presence of phyllosilicate phases within the opals was assessed. Andean opals with a vitreous but dull porcelain-like luster were opal-C and opal-CT that were free of phyllosilicates. *RAH*

Les pegmatites à béryl de la région d'Ambazac, Haute-Vienne [Beryl-bearing pegmatites from Ambazac, Haute-Vienne]. J. Patureau, *Revue de Gemmologie*, No. 164, 2008, pp. 12–16 [in French].

The massif of Haute-Vienne (north of Limoges, in the French Massif Central) consists of three types of leucogranite. The Saint Sylvestre leucogranite is the youngest (320 million years) and forms the Ambazac Mountains. This unit hosts numerous potassic pegmatites along with some sodalithic pegmatites. The potassic pegmatites are typically lenticular and are composed of K-feldspar, biotite, muscovite, and quartz, with apatite and beryl as accessory minerals. In the 19th and early 20th centuries, the pegmatites were actively exploited for K-feldspar (used in the porcelain industry of Limoges), piezoelectric smoky quartz crystals, and—most recently—uranium. Some gem-quality beryl was recovered, including goshenite, aquamarine, and heliodor. Of these, golden yellow to green-yellow heliodor has been the most abundant in recent decades. A few gemstones, including a 6.65 ct golden beryl, have been faceted from these finds. *FP*

INSTRUMENTS AND TECHNIQUES

Accelerating refractive rendering of transparent objects. K. C. Hui [kchui@acae.cuhk.edu.hk], A. H. C. Lee, and Y. H. Lai, *Computer Graphics Forum*, Vol. 26, 2007, No. 1, pp. 24–33.

Ray tracing may be used to create photorealistic computer images of transparent gemstones and other objects. However, this technique requires a great deal of computation and is inherently slow. The authors propose a technique for the interactive rendering of transparent objects using a refractive rendering algorithm. There are two stages in the algorithm: pre-computation and shading. In the pre-computation stage, a ray-tracing process tailored to gemstone rendering is performed. A database is constructed for the storage of information such as the ray directions and the positions of the corresponding image points. In the next stage, these data are retrieved from the database for the shading of the transparent object, taking illumination into consideration. The time required for the pre-computation process is proportional to the number of polygons (p) composing the model, the image size (number of pixels, s), and the number of internal reflections (r). The performance of the shading process is determined by the light obstruction test and the illumination calculation, with a time complexity of p^2 and sr, respectively. Experimental results show that refractive rendering is significantly faster than ordinary ray-tracing techniques. *Dennis Zwigart*

Clarification of measurement of the RIs of biaxial gemstones on the refractometer. B. D. Sturman [darkos@rogers.com], *Journal of Gemmology*, Vol. 30, No. 7/8, 2007, pp. 434–442.

The author describes three rules for refractometer observations of biaxial gemstones that, if followed correctly, allow one to determine optic character and sign by simply recognizing observed patterns (without the need to construct graphs of RI measurements). All four possible biaxial patterns are discussed, and diagrams illustrate the behavior of gem materials on the refractometer based on calculated movements of shadow edges for different orientations of the optical elements and the facet being measured. The author notes that although one biaxial pattern is quite common and requires use of a polarizing filter to determine true beta, the other three are rare and may only show up at all because gem cutters sometimes use a large crystal face for the gemstone's table. *ES*

Determination of the optic axial angle in biaxial gemstones and its use in gemmology. B. D. Sturman [darkos@rogers.com], *Journal of Gemmology*, Vol. 30, No. 7/8, 2007, pp. 443–452.

Of the many concepts from optical mineralogy that have been applied to gemology, one that is little known is the use of optic axis angle to identify biaxial gemstones. This is especially helpful for differentiating between biaxial gemstones with similar or overlapping RIs (e.g., peridot vs. sinhalite). It can also distinguish between a uniaxial gem and a biaxial gem that has one optic axis oriented perpendicular to the table, which produces one variable and one constant shadow edge during rotation on a refractometer (e.g., tourmaline vs. actinolite). Along with background explanation, the author gives detailed examples and diagrams. Determination of the optic axis angle requires the same data needed to determine the optic sign, but the optic axis angle is a much more discriminatory constant for use in the identification of biaxial gemstones. *ES*

SYNTHETICS AND SIMULANTS

Gemmologische Kurzinformationen: Imitation für Feuerachat [Gemmological brief notes: Imitation of fire agate]. U. Henn [ulihenn@dgemg.com], *Gemmologie: Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 56, No. 3–4, 2007, pp. 127–129 [in German].

Attractive beads sold as fire agate were proved to be heat-treated chalcedony (agate). The heating causes surface cracking that is somewhat reminiscent of fire agate, but the beads showed none of the surface iridescence or botryoidal structure that are typical of true fire agate. *RT*

Innovative composites 'Fusion.' G. Choudhary, *Gems & Jewellery*, Vol. 17, No. 2, 2008, pp. 20–22.

The author reports on some interesting gem assemblages, eye-catching composites marketed as "Fusion." The gems have concave pavilion facets, which improves their brilliance and overall appearance. Combinations include citrine and amethyst imitating ametrine, and topaz and amethyst resembling tanzanite. The composites vary from three to five pieces, giving an impression of multicolored stones.

Identification of these composites is straightforward. The presence of junction planes, which appear as sharp separations between the layers, is diagnostic. Spherical or flattened gas bubbles, dendritic flow patterns, and iridescence may all be present along the junction planes. In addition, the glues may fluoresce chalky blue to white under short-wave UV. *Guy Lalous*

'Paraíba' tourmaline and similar looking materials. G. Choudhary and C. Golecha, *Gems & Jewellery*, Vol. 17, No. 1, 2008, pp. 16–18.

Paraíba tourmaline simulants are becoming more common in the marketplace. Materials such as apatite and glass have been joined by cubic zirconia and hydrothermal synthetic beryl; production of the latter two has reached a commercial scale. Short descriptions of these four simulants are presented, and their gemological properties are compared in a table. The authors describe a glass simulant with swirled color zoning, which at first glance displayed pleochroism reminiscent of that seen in tourmaline. All four simulants are easily separated from tourmaline through standard gemological testing. *ES*

Single-crystal polarised-light FTIR study of an historical synthetic water-poor emerald. F. Bellatreccia, G. Della Ventura [dellaven@uniroma3.it], M. Piccinini, and O. Grubessi, *Neues Jahrbuch für Mineralogie Abhandlungen*, Vol. 185, No. 1, 2008, pp. 11–16.

Reexamination of a synthetic emerald grown in the late 19th century using a flux method showed its composition to be nearly stoichiometric and homogeneous except for significant variations in chromium (1.45–2.59 wt.% Cr_2O_3). Trace amounts of Ti, Mg, Fe, Zn, Na, K, and F were also noted. Despite the flux growth method, FTIR spectra in the OH-stretching region showed the presence of weak but significant H_2O vibrations. The polarized FTIR spectra collected with $E \perp c$ consisted of a sharp, intense band at 3463 cm^{-1}, whereas the $E \parallel c$ spectra consisted of two minor bands at 3643 and 3587 cm^{-1}. These bands were assigned to the υ_3 antisymmetric stretching and υ_1 symmetric stretching modes of type II water in the structural channels. These water molecules were probably associated with Li impurities in the mineral from the flux used for the synthesis. Using the molar absorption coefficient, the authors derived a water content of ~30 ppm. *RAH*

TREATMENTS

Copper diffusion treatment of andesine and new mine of Tibet. *Gem Information*, Japan Germany Gemmological Laboratory, Vol. 37–38, 2008, pp. 1–8 [in Japanese, abstracted from English translation].

Chinese andesine has attracted considerable attention due to rumors that an unknown treatment can reproduce the red color seen in some natural material. EDXRF data were collected for samples of pale yellow rough andesine before and after three stages of an unspecified treatment process performed in Thailand. These samples showed increasing CuO levels and deeper diffusion of red color with each stage of treatment. After the third stage, copper levels reached those recorded for andesine from the market.

Two pieces of pale yellow Mongolian rough underwent treatment (also unspecified) in China. Viewed in immersion, they showed less color at their surface and more color internally than the Thai-treated stones. The red color, when magnified, consisted of tiny reddish orange spots. Copper concentrations measured in these samples were also similar to those of andesine available in the market.

A new andesine deposit in a rugged mountainous area of Tibet was also described. Hand mining by locals during the summer has yielded stones with natural red and green hues, most of them <1 ct when cut. More information is needed to distinguish untreated Tibetan andesine from the treated stones. *ERB*

Pearl treatments: How pearls, natural and cultured, are treated to enhance them, and how to detect the treatments. S. Kennedy, *Organic Gems*, No. 7, 2008, www.maggiecp.co.uk/subs/OG7%20Jan%2008/Pearl_Treatments.htm.

The article gives an overview of the primary pearl treatments encountered in the market. Most involve color enhancement, such as the use of silver nitrate staining to darken a pearl's appearance. The author also describes the filling of internal hollows in large pearls to enhance their weight. Both filling and silver nitrate staining are detectable by X-radiography. The author notes that some enhancements are still difficult to detect, such as yellow treated South Sea cultured pearls. Some practical knowledge of certain characteristics indicating treatment is provided. Two examples are the high likelihood of treatment in a matched string of brown Tahitian cultured pearls, and the fact that black is not a natural color for cultured pearls from freshwater mussels. *Annette Buckley*

Surface treatment of gemstones, especially topaz: An update of recent patent literature. K. Schmetzer [schmetzerkarl@hotmail.com], *Journal of Gemmology*, Vol. 31, No. 1/2, 2008, pp. 7–13.

Following up on his 2006 *Journal of Gemmology* paper (covering the period 1996–2005), the author updates a list of patents pertaining to the surface treatment of gem materials. Although it is not known if any of the reported technologies have already been implemented, the author warns that that at least some will probably be applied in the future. Two types of surface treatment are identified and discussed: (1) processes not involving heat treatment (i.e., coatings of wear-resistant material, coatings that cause an optical phenomenon, and coatings that form a diffractive optical element), and (2) processes involving heat treatment (i.e., heat treatment while in contact with a plate containing transition metals, and heat treatment following deposition of a coating). *ES*

MISCELLANEOUS

Development of an object-oriented classification model using very high resolution satellite imagery for monitoring diamond mining activity. E. Pagot [elodie.pagot@jrc.it], M. Pesaresi, D. Buda, and D. Ehrlich, *International Journal of Remote Sensing*, Vol. 29, No. 2, 2008, pp. 499–512.

Satellite imagery has become a valuable tool in diamond exploration. This article details the development of a methodology for monitoring diamond mining activity from very high resolution satellite images using a multi-criteria "fuzzy" classification system. Previous investigations were based on medium-resolution sensors (e.g., Landsat TM data). In this study, two sets of satellite remote-sensing data were acquired four months apart and then processed using a "fuzzy sets" procedure. ("Fuzzy sets" are those in which elements have *degrees* of membership, rather than either belonging or not belonging to the set.) The authors discuss in detail the data-processing flow–image preprocessing methodology (geometric and radiometric corrections); image processing using multi-resolution segmentation and supervised fuzzy logic classification software; and the classification scheme that would eventually provide the object maps and statistics to assess the status of mining activity in the imaged areas (e.g., increasing, decreasing, or stable mining activity).

Of interest in one African diamond-producing zone was a large mechanized mine and small artisanal "hand-dug" sites that only required light manpower and equipment. The identification parameters for the mines (e.g., average size, aerial geometric shape, distance from rivers, water-clarity status, and excavation materials) were operationalized and became part of multi-temporal data sets.

The multi-criteria method showed an overall accuracy of 91% based on comparison with image datasets from standard manual photo interpretation. The authors conclude that the object-oriented interpretation model developed in the study proved successful in monitoring the level of diamond mining activity.

The advantages of using such image analysis include the wealth of additional information that can be derived from image objects, its robustness, its success in monitoring the level of diamond mining activity in inaccessible areas, and the complementing of maps with qualitative and quantitative information on mining activity for both small artisanal and large mechanized mines. *ERB*

Making diamonds work for development: An overview of initiatives. K. Hund, July 2008, www.madisondialogue.org/Hund_SRK_MadisonDialogue_v6_dblsided.pdf.

There has been a proliferation of initiatives aimed at producing truly "clean," "fair," or "ethical" gold, diamonds, and other minerals, so that these resources can better contribute to sustainable development in the local communities where they are mined. These initiatives have been instigated and/or sustained by various stakeholders in the diamond business, as well as by governments, donors, NGOs, and other organizations. This paper analyzes nine initiatives designed to improve the lives of artisanal diamond miners and small-scale diamond cutters in various parts of Africa. Some have had better results than others, and the successes and failures are identified to provide lessons for the future.

Two initiatives in the Democratic Republic of the Congo are briefly described, though the report acknowledges that much more is happening there (e.g., diamond-oriented efforts by Congolese civil society organizations working on the social and environmental impacts of mining and forestry). The report also examines two company-led diamond fair trade initiatives: one by Finesse Diamonds, a U.S.-based De Beers sightholder, and the other by Target Resources, a London-based gold and diamond miner. Many other fair trade initiatives focusing on gems and gold offer lessons to be learned, but are beyond the scope of this paper.

A brief overview is provided of attempts by individual retailers worldwide to sell only diamonds that are ethically sourced. Many choose the safe option of Canadian stones, or even synthetic diamonds, yet these do not contribute to the development of diamond-producing countries in Africa.

Setting goals for standards and establishing guidelines is critical to establishing trust in fair trade principles. Seven organizations that are attempting to do so are analyzed. An overview of charity initiatives is given, many of which are using diamond industry profits to fund African development projects. As such, there is a difference between "diamond charity" and "development diamonds." The report concludes with eight issues for discussion: the lack of clarity as to what constitutes an "ethical diamond," the urgent need for monitoring, the difficulty of achieving overall aims, the ongoing lack of information exchange, the inability of many charities to address root problems, the need to collaborate, the fact that too many initiatives are top-down rather than bottom-up, and the failure to recognize existing internal structures that might be most effective.

The author provides a list of socially responsible diamond retailers and designers, as well as references and websites. An overview matrix of the different initiatives and what they aim to achieve is also included. *EJ*