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ORGANIC MATERIALS**Beryl and its color varieties.** A. Falster et al., Eds., *extraLapis* English, No. 7, 2005.

This is an English translation of *extraLapis* No. 23, *Aquamarine & Co.* (2002), which has been updated with some new information. It begins with a summary of beryl-group mineralogy and crystallography that includes details on some of the more obscure minerals of the beryl group (i.e., pezzottaite, bazzite, and stoppanite). Emerald is given only passing mention, as it was addressed in a previous *extraLapis* volume, *Emeralds of the World* (see Fall 2002 *Gems & Gemology*, p. 284). Reviews of all major localities follow, and recent information on new finds in Canada and Finland is provided.

Some of the more interesting locality reviews include a detailed analysis of China's future potential as a source of gem beryl, a review of beryl mining in southern California, and a discussion of the "mysterious golden water of Tajikistan" (heliodor reportedly from this locality is thought by the author to be irradiated goshenite from elsewhere).

The issue concludes with a brief review of gem beryl pricing and a history of the discovery, mining, and industrial uses of beryllium. Like all *extraLapis* publications, this one is well illustrated with high-quality gem and mineral photographs as well as detailed maps and line drawings.

TWO

Les corindons à changement de couleur [Color-changing corundum]. L. Massi (laurent.massi@cnrs-imn.fr), *Revue de Gemmologie a.f.g.*, No. 152, 2005, pp. 16–19 [in French with English abstract].

By examining natural and synthetic samples of color-change

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 reviewers, 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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corundum with UV-visible spectroscopy, the author describes four different types of color change, based on trace-element content. Type 1, which changes from blue (daylight) to purple (incandescent and fluorescent light), contains chromium, iron, and titanium. Type 2, which changes from green (daylight) to orange (incandescent/fluorescent), contains only iron and titanium. The color change in type 3 sapphires, which involves green and red (daylight) color is different from that seen with incandescent light, which is different from the color in fluorescent light, is due to vanadium. Type 4, which shows bluish green (daylight) and reddish violet (incandescent/fluorescent), contains chromium, iron, and nickel.

Almost all natural color-change corundum belongs to type 1, although type 2 is also found in natural corundum. Type 3 can be seen in corundum of various origins. Verneuil synthetics show either type 1 or type 3. Type 4 occurs in hydrothermal synthetics.

A natural sapphire from Myanmar studied by the author showed purple, bluish green, and orangy yellow colors. This sapphire also contained nickel, which is unusual in natural corundum.

RT

Gem corals: Classification and spectroscopic features. V. Rolandi, A. Brajkovic [anna.brajkovic@unimib.it], I. Adamo, R. Bocchio, and M. Landonio, *Australian Gemmologist*, Vol. 22, No. 3, 2005, pp. 285–297.

Several gem corals of the classes Hydrozoa and Anthozoa of the phylum Cnidaria were analyzed by FTIR and Raman spectroscopy. Such spectroscopic characterization has proved useful for determining the main features of the mineral phases (calcite or aragonite) and of the organic contents in each sample. Chromophore complexes belonging to the carotenoid family were detected. Coral zoology is also discussed.

RAH

Identification of an imitation of pearl by FTIR, EDXRF and SEM. T. L. Tan, T. S. Tay, S. K. Khairoman, and Y. C. Low, *Journal of Gemmology*, Vol. 29, No. 5/6, 2005, pp. 316–324.

In recent years, there has been an increase in the quality and number of imitation pearls in the marketplace. Many imitation pearls now show strong iridescence and thus are not easily distinguished by visual observation. This article reports on an investigation showing that EDXRF and FTIR spectroscopy, in combination with scanning electron microscopy (SEM), can lead to reliable identification of both imitation and cultured pearls. Reactions to UV radiation were also studied. The objects tested in this investigation were five natural-color freshwater cultured pearls, four dyed freshwater cultured pearls, four imitation pearls, one bead representative of those commonly used in cultured pearls, and one bead used for imitation pearls.

EDXRF spectroscopy showed that both the naturally colored and dyed cultured pearls, as well as the bead used for pearl culturing, contained C, O, and Ca, the compo-

nents of calcium carbonate (CaCO_3). The EDXRF spectra of the imitation pearls showed only C and O, with peaks consistent with the presence of polymers. No Ca was present. EDXRF data for the imitation pearl bead showed the presence of O, Si, Al, and Na, with peaks indicating glass.

FTIR data for the naturally colored and dyed freshwater cultured pearls, as well as the cultured pearl bead, showed typical absorption peaks for CaCO_3 . The FTIR data for the imitation pearls and bead were very different and easily distinguished from that of the cultured pearls. Spectra for the imitation pearls revealed polymeric material but no CaCO_3 peaks. The imitation bead was opaque to infrared below 2500 cm^{-1} and showed a broad band centered at 3510 cm^{-1} , which indicated that it was made from a different material than the imitation pearl coating.

The SEM results also identified obvious differences between the cultured and imitation pearls. Both the naturally colored and dyed cultured pearls showed layered, contoured, flake-like patterns consistent with crystalline layers of CaCO_3 . In contrast, the pearl imitations showed small cubic particles, all of approximately the same size, randomly distributed over the whole surface. The dense suspension of these polymeric cubes created the iridescent effect that mimicked the iridescence of nacre.

WMM

Identification of seawater cultured pearls with dyed nucle-
us. L. Li and M. Yang, *Journal of Gems and Gemmology*, Vol. 7, No. 2, 2005, pp. 7–8 [in Chinese with English abstract].

Recently, saltwater cultured pearls with unusual colors have been seen in the Chinese market. These products were developed in 2002 by a company in Guangxi using dyed nuclei and other techniques. In this article, the authors, including one of China's top pearl researchers (LL), report their preliminary results for the identification of these saltwater cultured pearls.

Three loose cultured pearls ("rosy red," orange, and bluish gray), one bluish gray pearl earring, and one "rosy" red pearl earring were collected for the investigation, and their undyed counterparts were used for comparison. To collect Raman spectra from the nuclei, the nacre was partially peeled off to expose the dyed surfaces. Microscopic observation was also performed.

It was found that clear, parallel color bands from the dyed nucleus could be seen with strong transmitted light. The colored nuclei and colorless nacre layers could also be seen through the drill holes. The "rosy" red and bluish gray samples showed weak bluish white fluorescence to UV radiation. Raman spectra of the cultured pearl surfaces were the same, regardless of whether the nuclei were dyed or untreated. However, Raman spectra of the actual dyed nuclei (even when taken through the drill hole) displayed a strongly fluorescent background and several weak peaks in the $1600\text{--}1400 \text{ cm}^{-1}$ range that are related to the dye materials.

The identification of these saltwater cultured pearls with dyed nuclei can be made using both traditional and advanced gemological techniques. TL

The study of phosphorus in seawater cultured pearls using FTIR. L. Wang, P. Zhou, Y. Liu, and Y. Tang, *Spectroscopy and Spectral Analysis*, Vol. 25, No. 6, 2005, pp. 866–869 [in Chinese with English abstract].

The luster of saltwater cultured pearls is proportional to their phosphorus content. However, due to P's low concentration, it is unclear where and in what state this element exists. In this article, the authors report their investigations of structural variations in saltwater cultured pearls using high-resolution FTIR spectroscopy, powder X-ray diffraction (XRD) analysis, and differential thermal analysis (DTA) techniques.

Cultured pearls of similar color and size were divided by luster into several groups of 50. The nacre layers were collected and crushed into powder; the powdered samples were further subdivided into several groups that were heated to 160°C for varying durations (2 hours, 4 hours, etc.). Analyses by FTIR, XRD, and DTA were conducted before and after heating.

Several new IR absorption peaks (1083, 1049, 630, and 600 cm⁻¹) were seen in the heated samples. These peaks were not related to carbonates, and their intensities increased with heating time. XRD results showed two new diffraction peaks in the heated samples. Analysis of the FTIR and XRD results suggested that the P may be present in a hydroxyl apatite compound (called *pahuite* in the abstract) in the pearls. TL

Study on relationship between luster and surface structure of pearl. L. Cao, S. Guo, and L. Shi, *Journal of Gems and Gemmology*, Vol. 7, No. 3, 2005, pp. 23–25 [in Chinese with English abstract].

The relationship between surface features and luster in pearls has been extensively investigated since the 1950s. Good luster generally results from uniform surface structures; however, investigators are still trying to confirm this relationship. In this article, the authors investigate the surface features of Chinese cultured pearls.

Pink freshwater cultured pearls from Jiangsu and Zhejiang Provinces and white saltwater cultured pearls from Guangdong Province were observed with polarized microscopy and scanning electron microscopy. The samples were divided into three groups (poor, fair, and good) based on their luster.

There was a clear relationship between luster and surface features. SEM images showed spots, voids, and foreign materials on the surface of the freshwater cultured pearls with poor luster; in addition, the aragonite crystals in the nacre were not distributed uniformly and had an average size of about 4 µm. Samples with good luster had aragonite crystals of about 3 µm that were uniformly

arranged in a layered structure. The freshwater cultured pearls with fair luster had characteristics that were intermediate to those described above. There was a similar relationship between luster and surface structure in the saltwater cultured pearls; however, the size of the aragonite crystals was about 2.5 µm for samples showing good luster.

The authors suggest that voids between the aragonite crystals in the cultured pearls showing poor luster could be filled to enhance their luster. TL

DIAMONDS

Diamond formation in metal-carbonate interactions. J. Siebert [julien.siebert@lmcp.jussieu.fr], F. Guyot, and V. Malavergne, *Earth and Planetary Science Letters*, Vol. 229, No. 3–4, 2005, pp. 205–216.

While the earth's inner core could contain the metal-carbon alloy Fe₃C, the carbon within the mantle is predominantly composed of carbonates (and diamond). Thus, a better understanding of carbon alloy and carbonate chemistry would aid the understanding of diamond formation within a young Earth. Reduced silicon alloyed with iron metal reacts chemically with FeCO₃ (siderite) at pressures of 10–25 GPa and temperatures of 1700–1800°C according to: 2FeCO₃ + 3Si_[in metal] = 2Fe_[in metal] + 3SiO₂_[stishovite] + 2C_[diamond]. The only source of C for diamond formation was the carbonate phase. Prior research and modeling suggested carbonate-containing fluids, not metals, were the likely carbon source for diamond.

Thermodynamic modeling of this reaction suggests that under mantle conditions, no Si-bearing metal can coexist with carbonates. Therefore, a high concentration of silicon would encourage diamond formation by reaction with the carbonates under the kinetically favorable conditions of high temperature and pressure. RAH

Kalimantan diamond: Morphology, surface features and some spectroscopic approaches. T. T. Sun [fegemlab@singnet.com.sg], P. Wathanakul, W. Atichat, L. H. Moh, L. K. Kem, and R. Hermanto, *Australian Gemmologist*, Vol. 22, No. 5, 2005, pp. 186–195.

Alluvial diamonds are found around the Landak River in western Kalimantan (the Indonesian portion of Borneo), in the Linhaisai minette in the headwaters of the Barito River in central Kalimantan, and in the Banjarmasin-Martapura area of southeastern Kalimantan. Mining activities date back to 600 AD; fine blue, pink, and canary yellow diamonds have been reported.

A 2002 visit to the Banjarmasin-Martapura area, which produces about 200 carats per month, is described. After a general outline of the mining and trading activities, the authors report the characteristics of 14 rough gem-quality diamonds that ranged from 0.03 to 1.82 ct and were colorless to yellow and brown. The diamonds

showed variable crystal habits (octahedron, tetrahedron, dodecahedron, and macle), and surface features consisted of percussion scars and common black and brown radioactivity stains. They showed predominantly blue and green (and minor yellow) cathodoluminescence. Inclusions identified by Raman spectroscopy consisted of diamond, zircon, perovskite, and diopside. FTIR spectra showed that both type IaA and type IaAB diamonds were present.

RAH

Kimberlites of Zimbabwe: Abundance and composition.

A. D. Khar'kiv, E. F Roman'ko, and B. M. Zubarev, *Russian Geology and Geophysics*, Vol. 46, No. 3, 2005, pp. 318–327.

The authors provide data on several unusual kimberlite pipes in Zimbabwe, at Chingwisi and River Ranch in the south and Quest in the north. The Chingwisi pipe is capped with a hard calcium carbonate horizon known as *calcrete*; it formed within the upper few meters of the pipe and has a much different mineral composition (>90% carbonates) than the underlying unaltered kimberlite. This suggests that such an outcrop of kimberlite could go unrecognized. However, indicator-mineral collection revealed many of the usual kimberlite pathfinders, including pyrope, picroilmenite, Cr-spinel, and clinopyroxene. Detailed chemical analysis of these indicators led the authors to conclude that the Chingwisi pipe has the potential to host diamonds and is mineralogically similar to pipes in the Sakha area of Russia.

The two Quest pipes yielded unique indicator-mineral chemistry. Although both are diamondiferous, only one G10 (high Cr) subcalcic garnet grain was collected, whereas abundant Na-bearing pyrope-almandine garnets were found (up to 40% of the indicators). This unique garnet signature was apparently used by Reunion Mining of Australia to search for more kimberlites in the region. The authors believe the garnets were derived from uppermantle eclogites that were incorporated into the kimberlite magma. Only generic information is provided for the River Ranch pipe, which hosts Zimbabwe's single active diamond mine.

Although Zimbabwe has a large Archean-aged craton (where Clifford's Rule, simplified, suggests diamond-bearing kimberlites may be found), all the diamondiferous pipes studied by the authors are located *outside* of this craton. Thus, the data and conclusions made by the authors will allow scientists and explorers to modify their theories on diamond formation and emplacement.

KAM

Mineral inclusions in diamonds from the Panda kimberlite, Slave Province, Canada. R. Tappert [rtappert@ualberta.ca], T. Stachel, J. W. Harris, N. Shimizu, and G. P. Brey, *European Journal of Mineralogy*, Vol. 17, No. 3, 2005, pp. 423–440.

The mineral inclusions in 90 diamonds from the Panda kimberlite (Ekati mine, Northwest Territories, Canada)

were chemically analyzed using electron microprobe and secondary ion mass spectrometry techniques, and nitrogen aggregation characteristics of the host diamonds were measured by IR spectroscopy. The Panda diamonds are derived principally from peridotitic sources (85%), with a minor content of eclogitic diamonds (10%). Ferropericlase-bearing diamonds (5%) contain combinations of this mineral with olivine, with Mg-Al spinel + olivine, or with a pure silica phase. The chemical characteristics of these inclusions indicate a lithospheric origin from ferropericlase-bearing dunites; however, ferropericlase coexisting with CaSiO_3 (probably originally Ca-perovskite) is regarded as evidence for a lower-mantle origin.

Major-element compositions indicate that the peridotitic diamonds formed in a moderately depleted environment. Inclusion geothermobarometry indicates formation of the peridotitic diamonds in the temperature range 1100–1250°C, following a geothermal gradient of 40–42 mW/m². The nitrogen contents in Panda diamonds vary strongly from below detection (<10 ppm) to 2700 atomic ppm. Taking the early Achaean Re-Os isochron date for sulfide inclusions in Panda diamonds at face value, the low aggregation states of undeformed diamonds may indicate mantle residence at relatively low temperatures (<1100°C); if this is the case, diamond formation beneath the central Slave Province may be restricted to short-lived and localized thermal events. An apparent increase in geothermal gradient with depth in the lithospheric mantle beneath the central Slave Province during the time of kimberlite eruptions (Upper Cretaceous to Eocene) may reflect transient heating of the deep lithosphere during melt infiltration.

RAH

GEM LOCALITIES

Basalt petrology, zircon ages and sapphire genesis from Dak Nong, southern Vietnam. V. Garnier [virginie_garnier@inrs-ete.quebec.ca], D. Ohnenstetter, G. Giuliani, A. E. Fallick, T. Phan Trong, V. Hoáng Quang, L. Pham Van, and D. Schwarz, *Mineralogical Magazine*, Vol. 69, No. 1, 2005, pp. 21–38.

Sapphire deposits associated with basalt can be found throughout the world. Blue, green, yellow, and colorless sapphires are recovered from the Dak Nong mining district in Dak Lak Province, southern Vietnam. The mining targets are Quaternary and Upper Pleistocene eluvial and alluvial placers derived from the several-hundred-meters-thick basalt flows. The 23,000 km² basalt field is made up of a tholeiitic suite without any xenocrysts and an alkaline suite with mantle and lower-crustal xenocrysts. The sapphire xenocrysts contain Fe (0.43–1.26 wt.%), Cr (33–1582 ppm), Ti (35–1080 ppm), Ga (149–308 ppm), and V (28–438 ppm), and are poor in Zn and Mg. Their oxygen isotope ($\delta^{18}\text{O}$) composition ranges from 6.0 to 6.9%, which

is not in equilibrium with the basalt values of 5.0–5.7‰. The chemical composition and O-isotope data from the analyzed sapphires, along with the presence of mantle xenoliths, suggest that the sapphires crystallized deep within the earth and not from the erupting basalt. The $\delta^{18}\text{O}$ data of the corundum show that the crystals were formed in a magma chamber at the crust-mantle boundary and that the magma was contaminated by crustal material. The U-Pb dating of zircons recovered from the sapphire-bearing placers indicates that there were two eruptive events occurring at roughly 6.5 and 1 million years ago. The dates for these basaltic eruptive episodes are in agreement with published data on other regional sapphire-bearing basalt fields.

EAF

Characteristics of cathodoluminescence spectra of jadeite jades from Burma. X. Yuan, L. Qi, and S. Zhang, *Journal of Gems and Gemmology*, Vol. 7, No. 2, 2005, pp. 9–13 [in Chinese with English abstract].

Different types of jadeite jade display different characteristic cathodoluminescence (CL) spectra depending on their composition (e.g., the presence of color-causing impurities such as Cr³⁺, Fe³⁺, and Mn³⁺). In this article, the authors investigated 97 jadeite samples of varying colors using a specially developed CL spectroscope.

The BY-1 cathodoluminescence spectroscope features an interconnected UV-Vis spectrophotometer (Ocean Optics USB-2000) and a digital camera. The jadeite samples were divided into five groups by color (white, purple, green, yellow-brown, and grayish green). Standard gemological properties and IR spectra of all samples were obtained before testing with the BY-1 instrument.

The CL colors and the corresponding spectral peaks varied depending on the jadeite color. White jadeite displayed dark blue, light purple, or greenish yellow CL, with peaks at either 370 or 554 nm. Pinkish purple and purple jadeite showed bright purplish red to reddish purple CL, with peaks located at 370 nm (dominant) and 680 nm (subordinate). Bluish purple jadeite displayed bluish purple CL; the peaks were at 370 nm (subordinate) and 508 nm (dominant). Light green to green jadeite showed bright green to yellowish green CL, with peaks at 554 and 760 nm, while dark green jadeite usually displayed dark red CL and peaks at 693 nm (subordinate) and 760 nm (dominant).

Differences in CL features between natural and treated jadeites were also seen, such as the presence of polymer in B-jade.

TL

Exfiltrative mineralization in the Bukantau ore district (Central Kyzyl Kum region, Uzbekistan). V. G. Pechenkin [pechenkin@urangeo.ru] and I. G. Pechenkin, *Lithology and Mineral Resources*, Vol. 40, No. 5, 2005, pp. 462–471.

The discovery of uranium deposits in the central Kyzyl Kum region of Uzbekistan led researchers to study the ore-bearing potential of young sedimentary sequences. Uplift

roughly 1.6 million years ago exposed Paleozoic basinal structures along rejuvenated faults. This movement allowed for the interaction of various ascending fluids with surface-related processes. The edges of the uplifted blocks were marked by the formation of erosional windows that served as discharge centers for ore-bearing solutions. The formation of manganese ore bodies and gem deposits occurred near these windows at different geochemical barriers. As portions of the Paleozoic fault blocks were uplifted, they underwent extensive fracturing and decompaction. Then, as metalliferous fluids derived from the sedimentary cover layers moved toward the erosional windows, they encountered a newly formed oxygenated barrier which caused the precipitation of manganese oxides. When this same fluid was drawn into the decompressed basement structures, turquoise was deposited on fault surfaces at the reductive (sulfide) geochemical barrier. Thus, turquoise and manganese deposits are vertically separated in cross section although they were formed from the same ore-bearing solutions during a single geologic process. Throughout the section, opal was deposited on fault surfaces within zones of the most intense fracturing and folding. The slightly basic surface fluids had a relatively high Si solubility, so when the fluid encountered deeper acidic fluids the amorphous silica precipitated. Only the most recent tectonically active areas in the north-central portions of the district contain the complete sequence of turquoise, opal, and manganese oxides.

EAF

Gemstone resources of China. C. M. Ou Yang [cmouyang@hkgemlab.com.hk], *Australian Gemmologist*, Vol. 22, No. 4, 2005, pp. 349–359.

The occurrence of gemstones in China is reviewed after brief notes on the geology of this large area. Two diamond-bearing kimberlite pipes in the Wafangdian district of Liaoning Province are yielding 80,000–90,000 carats/year (30–40% gem quality); 12 kimberlite pipes in Mengyin, Shandong Province, produce 50,000 carats/year (10–15% gem quality). Alluvial deposits in Hunan Province yield 20,000–30,000 carats/year (60–65% gem quality, but of small size). Chinese sapphire deposits are found mainly in alkaline basalts and derived alluvium, and are widely distributed over 20 provinces. Ruby (mostly cabochon quality) is found in impure marbles in Yunnan Province. Emeralds are associated with Precambrian pegmatites and greisen in the Wenshan district of southeastern Yunnan Province. Both transparent and chatoyant aquamarine is found mainly in the Altai pegmatite area of Xinjiang Province. Details are also given for gem-quality tourmaline, citrine, and amethyst, mainly from the Altai Mountains; gem-quality pyrope from Cenozoic alkali basalts of eastern China; and peridot from Tertiary alkaline basalts in Zhangjiangkou County, Hebei Province, and in Jiaohe County, Jilin Province. Occurrences of nephrite and bowenite (antigorite serpentine) are also described.

RAH

The Italian island of Elba: A mineralogical jewel in the Tuscan archipelago. F. Pezzotta, *extraLapis English*, No. 8, 2005.

Like the other issues in this series, this volume is an English translation of previously published work from *extraLapis* (in this case, No. 20, *Ensel Elba Die Urlaubsinsel der Mineralogie*, 2002), updated with some new information.

The work begins with a review of the island's mineralogical history. Elba was a source of copper and iron in antiquity. Scientists began studying Elba's mineralogy during the 18th century, and European mineral collectors were soon drawn to the island's many diverse localities. More than 170 minerals have been identified on Elba (it is the type locality for nine of these), and specimens from Elba form an important part of many notable mineral collections. The island is particularly known for specimens of hematite, pyrite, spessartite, and of course, elbaite tourmaline.

A short summary of Elba's geology follows. The volume then reviews in detail all of Elba's major gem and mineral localities, including classic ones such as the Monte Capanne pegmatites and the historic ore deposits, as well as some lesser-known sites. Capsule spotlights of noted collectors are provided, as are high-quality photographs of important specimens.

Also included are sections on visiting Elba for collecting trips, suggestions for prospecting certain localities, a brief review of Elba's snakes (some of which are venomous), and a concluding commentary that offers a tourmaline-related explanation for an element of the Greek myth of Jason and the Argonauts.

TWO

Jazidas minerais: Ametistas [Mineral deposits: Amethysts]. *Diamond News*, Vol. 6, No. 20, 2005, pp. 35–40 [in Portuguese].

This article gives a comprehensive description of amethyst deposits in Brazil's Rio Grande do Sul State. Amethyst and other quartz varieties formed at approximately 50°C within lava deposits covering large areas of this state about 130 million years ago. Amethyst is recovered via open-pit and underground mining, and at present there are 374 mining operations in eight municipalities of Rio Grande do Sul, more than half of which are in Ametista do Sul. Geodes of 200–300 kg are common, and they can attain sizes up to 3,000 kg and 3 m³. Some of the amethyst is heat treated at 450–475°C to produce citrine. Amethyst production in 2000 was 235 tonnes per month; 80% is exported, mainly to the U.S., Japan, and Germany, with 97% of the material exported as rough. Geodes must yield at least 25% cuttable crystals to be worth processing for facet rough, which is approximately 2% of the overall weight of the geode and about 0.5% yield after cutting. Amethyst and citrine represent 12.5% of Brazil's entire export of gem rough and 10.6% of cut gems. The article explains the classification criteria for the geodes and cut stones, and is illustrated

with a geologic map of Rio Grande do Sul and photos of mines and samples.

RT

Musgravites from Sri Lanka. K. Schmetzler [schmetzerkarl@hotmail.com], L. Kiefert, H.-J. Bernhardt, and M. Burford, *Neues Jahrbuch für Mineralogie, Abhandlungen*, Vol. 181, No. 3, 2005, pp. 265–270.

This article presents the physical and chemical properties of four faceted musgravites ($\text{BeMg}_2\text{Al}_6\text{O}_{12}$) that are most probably from Sri Lanka; this represents the first data for this rare species originating from the numerous secondary deposits of this island. The musgravites were identified by Raman spectroscopy and electron-microprobe analysis. Their refractive indices and densities were determined and related to the contents of transition metals, especially Fe and Zn. Mineral and multiphase inclusions indicate the formation of these samples in different geologic environments. A musgravite crystal containing spinel exsolution lamellae was possibly formed in high-grade metamorphic rocks, whereas two samples with graphite and magnesite inclusions may have originated in magnesian skarns.

RAH

"Paraiba-Tourmaline" aus Quintos de Baixo, Rio Grande do Norte, Brasilien. C. C. Milisenda, *Gemmologie: Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 54, No. 2–3, 2005, pp. 73–84 [in German with English abstract].

Paraíba tourmalines were first produced from pegmatites at São José da Batalha near Salgadinho, Paraíba State, Brazil. Today they are also found in the Quintos de Baixo and Boqueirão mines near Parelhas in the neighboring state of Rio Grande do Norte. At all three mines, the pegmatites intruded quartzites of the Ecuador Formation.

The author describes the Quintos de Baixo mine, which began as a beryl mine in 1976. Mechanized underground mining for tourmaline started in 1996. Tourmaline is hand-picked and mostly occurs as crystal fragments averaging approximately 10 g. They are blue, green, bluish green, and red-violet, as well as color-zoned. The largest cut stone to date is "turquoise" blue and weighs 15 ct.

Microprobe analyses of 12 samples showed elbaite composition, with copper and manganese as the most important trace elements (CuO: 0.32–1.96 wt.%; MnO: 0.11–2.53 wt.%). Microscopic examination showed inclusions typical for tourmaline. The author points out that, like tourmaline from other locations, these stones can be color enhanced by gentle heating to approximately 600°C.

RT

The pegmatitic gem deposits of Molo (Momeik) and Sakhan-gyi (Mogok). H. Kyi [macgems@baganmail.net.mm], T. Themelis, and K. Thu, *Australian Gemmologist*, Vol. 23, No. 7, 2005, pp. 303–309.

Molo, about 51 km northeast of Momeik in Myanmar's

Shan State, is a new source of rare gems and minerals, including phenakite, petalite, hambergite, Cs-rich morganite, and pollucite. Botryoidal-type tourmalines of various colors, aquamarine, topaz, and lepidolite also occur. All of these minerals are recovered from alluvial deposits and pegmatitic dikes that intrude the peridotite country rock.

The pegmatite at Sakhan-gyi is about 16 km west of Mogok in the Mandalay Division, and is a source of aquamarine, goshenite, topaz, and quartz. The pegmatite is about 15 million years old and intruded the Kabaing granite (20–16 Ma). Brief details on these pegmatites and their minerals are presented.

RAH

Rubellite and other gemstones from Momeik township, northern Shan State, Myanmar. T. Hlaing and A. K. Win, *Australian Gemmologist*, Vol. 22, No. 5, 2005, pp. 215–218.

Colored tourmalines occur as euhedral gem-quality crystals, mushroom-shaped aggregates, and botryoidal masses in pegmatites near Molo village. Associated minerals with gem potential are aquamarine, trapiche morganite (characterized by the presence of a fixed six-rayed star), and hambergite; other associated minerals are quartz, orthoclase, lepidolite, and petalite. The tourmalines range from black schorl to green and pink fibrous tourmalines. The pink fibrous tourmalines have $n_e = 1.630$, $n_o = 1.650$, S.G. = 2.84–3.06, and are Mn-bearing (average 6.58 wt.% MnO). Hambergite forms as colorless prismatic crystals with $n_a = 1.557$, $n_g = 1.630$, S.G. = 2.33, and hardness = 7½.

RAH

Trapiche of Myanmar. K. K. Win, *Australian Gemmologist*, Vol. 22, No. 7, 2005, pp. 269–270.

Myanmar is the source of a range of gems that display a distinctive spoke-like star, often referred to as a *trapiche*. Representative examples are illustrated, including sapphire, ruby, green tourmaline, aquamarine, morganite, and quartz. Three origins are suggested for the several types of trapiche gems: color-inducing trace elements, inclusions of other minerals, or intergrowths of the same mineral of different color or orientation.

RAH

INSTRUMENTS AND TECHNIQUES

Complementary use of PIXE-alpha and XRF portable systems for the non-destructive and in situ characterization of gemstones in museums. L. Pappalardo [lighea@lns.infn.it], A. G. Karydas, N. Kotzamani, G. Pappalardo, F. P. Romano, and Ch. Zarkadas, *Nuclear Instruments and Methods in Physics Research B*, Vol. 239, 2005, pp. 114–121.

The authors used a combination of two portable, custom-built chemical analysis systems to examine three red gemstones set in Hellenistic (4th century BC to 1st century AD) gold jewelry at the Benaki Museum in Athens,

Greece. The instruments consisted of a PIXE-alpha particle spectrometer with a ^{210}Po source for analyzing light elements (Na to Zn), and an XRF spectrometer with a Rh-anode X-ray tube source for detecting heavier trace elements (Cr and Y). Overall sensitivities were in the 0.2–0.3 wt.% range for each element. Both systems were calibrated against known standards, and the two types of analyses were combined to get overall chemical compositions of the red gems.

The gems were found to be garnets. Two had compositions consistent with almandine from an unknown deposit in India, while the third was an Fe- and Ca-bearing pyrope consistent with a Sri Lankan origin. *Abstracter's note:* The captions "SiK" and "AlK" appear to have been reversed in figure 6 of the article.

Mary L. Johnson

Practical application for measuring gemstone dispersion on the refractometer. T. Linton, *Australian Gemmologist*, Vol. 22, No. 4, 2005, pp. 330–344.

The low-dispersion barium glass hemicylinder refractometer prism of the Eickhorst SR/XS refractometer allows measurement of refractive index in deep blue light (below 500 nm). A summary is given of two relevant papers that were previously published. The combination of these measuring techniques and extrapolation of a wavelength dispersion curve using Sellmeier's linear conversion permits extrapolation of refractive indices at the B (686.7 nm) and G (430.7 nm) Fraunhofer lines. Previous B-to-G lists of the dispersion of gemstones are inaccurate and provide conflicting data. A new list of values is presented for the dispersion of 217 gem materials, measured at the C-F (656.3–486.1 nm) interval. Measurement of dispersion with the gemologist's refractometer produces apparent dispersion, but with the use of a technique for subtracting apparent dispersion from the sum of true + apparent dispersion, this value can be converted to true dispersion.

RAH

Probing diamonds with ions. B. J. Griffin [bjg@cmm.uwa.edu.au] and R. Stern, *Rough Diamond Review*, No. 8, 2005, pp. 42–44.

A new analytical technique called nanoSIMS holds some promise for diamond research. This higher-resolution version of SIMS (secondary ion mass spectrometry) can provide scientists with chemical information on the nanometer level, allowing them to better study internal diamond growth structures.

The basic principle of SIMS is to "sputter" a sample with a beam of ions, and as this primary beam is very finely controlled, it can scan across a sample surface. Charged particles (secondary ions) emitted from the sample are collected by a mass spectrometer, which can detect concentrations of elements down to the ppb (parts per billion) range. NanoSIMS uses oxygen and cesium ion beams at resolutions of up to 100 and 25 nm, respectively. Although minimally destructive, it can ablate successive nanometer

layers of material from sample surfaces, providing depth profiles of elements. The ability of nanoSIMS to provide high-resolution, high-sensitivity chemical data in three spatial dimensions makes this technique quite promising, especially with respect to diamonds.

NanoSIMS analysis of nitrogen in diamond is shown to be well correlated to cathodoluminescence data. Both techniques indicate zoning where nitrogen content differs from one region to another. NanoSIMS may be particularly useful for exploring the chemical and isotopic compositions of these growth structures due to its high resolution, and it reveals finer details than CL imagery. It is hoped that quantifying chemical data on the nanometer level will lead to insights into source classification, thereby allowing individual diamonds to be traced back to their point of geologic origin.

DMK

Quantitative trace-element analysis of diamond by laser ablation inductively coupled plasma mass spectrometry. S. Rege [srege@els.mq.edu.au], S. Jackson, W. L. Griffin, R. M. Davies, N. J. Pearson, and S. Y. O'Reilly, *Journal of Analytical Atomic Spectrometry*, Vol. 20, No. 7, 2005, pp. 601–611.

LA-ICP-MS was used to quantitatively measure 41 trace elements in two fibrous diamonds from Botswana's Jwaneng mine that were previously analyzed by instrumental neutron activation analysis (INAA) and particle-induced X-ray emission (PIXE). A range of instrumental conditions showed that a 266 nm UV laser at 10 Hz provided the best sensitivity, and that synthetic oil and a doped cellulose were the most suitable external standards. Typical detection limits were 5–20 ppb for the rare-earth elements and <500 ppb for the transition elements; Na and Fe had higher detection limits (2–3 ppm). Detailed analytical results are presented. The trace-element patterns obtained by this technique may be used for the characterization of diamonds in genetic studies.

RAH

Use of IR-spectroscopy and diffraction to discriminate between natural, synthetic and treated turquoise, and its imitations. A. Pavese [alessandro.pavese@unimi.it], L. Prosperi, and M. Dapiaggi, *Australian Gemmologist*, Vol. 24, No. 4, 2005, pp. 366–371.

An overview is given on the use of IR spectroscopy, combined in some cases with X-ray diffraction, for determining the nature of turquoise, whether natural, synthetic, treated, or imitation. A total of 94 samples (32 natural, 12 synthetic, 16 treated, and 34 imitations) were analyzed by IR spectroscopy in reflectance mode; some treated turquoise specimens were also examined in transmission mode. Differences in the spectra between natural, treated, and synthetic turquoise were observed. X-ray diffraction was used to resolve ambiguities in identifying some turquoise imitations, and was particularly useful in the precise identification of their constituent phases.

RAH

Use and misuse of optical mineralogy constants in gemmology. D. B. Sturman [darkos@rom.on.ca], *Australian Gemmologist*, Vol. 22, No. 2, 2005, pp. 234–243.

Dangers inherent in the direct transfer of optical data and concepts from mineralogy to gemology are highlighted; these can give rise to confusion and misunderstandings. In particular, the dispersion coefficient is not a reliable indicator of "fire" in faceted gemstones. The author suggests that faceted diamonds show strong "fire" not because of the large dispersion of diamond, but because of other factors not yet well understood. Refractive index plays an equally important role. Factors contributing to doubling are described, and diagrams are presented for the estimation of the doubling effect in gemstones.

RAH

X-ray luminescence, a valuable test in pearl identification. H. A. Hänni [gemlab@ssef.ch], L. Kiefert, and P. Giese, *Journal of Gemmology*, Vol. 29, No. 5/6, 2005, pp. 325–329.

The majority of the world's natural pearls come from saltwater oysters. Today, increasing numbers of beadless freshwater cultured pearls are entering the market. Traces of manganese (Mn) found in the nacre of freshwater cultured pearls and the shells of the mollusks that produce them cause them to luminesce to X-rays. In contrast, the nacre of saltwater-borne samples is inert to X-rays. By use of a sensitive camera, this visible luminescence can be recorded and displayed on a monitor.

A difficulty in using this technique as a means of separation arises because Japanese Akoya cultured pearls and South Sea cultured pearls (both from saltwater) use freshwater bead nuclei, which contain Mn and luminesce to X-rays. The thick nacre common to South Sea cultured pearls obscures the luminescence of the bead nucleus, so it is typically not seen on exposure to X-rays. However, the thinner nacre on Akoya cultured pearls allows the luminescence from the freshwater beads to shine through. Another concern is the presence of dye or natural pigment in the nacre, which may inhibit the luminescence reaction. Therefore, this article suggests that X-ray luminescence only be used as an additional test (after X-radiography) to help separate natural saltwater pearls from beadless freshwater cultured pearls.

WMM

JEWELRY HISTORY

The history of the Ekaterinburg faceting factory. N. Moukhina, *Platinum*, Vol. 1, No. 16, 2005, pp. 62–65 [in Russian].

The Ekaterinburg stone cutting factory was established in 1726, only three years after the founding of the city, which later became the center of the Urals mining and metallurgy industries. Initially, the factory made marble facades for buildings in St. Petersburg. In the mid-18th century, however, it began specializing in faceting gems

and carving decorative stones (e.g., jasper, agate, rhodonite, and quartzite). The craftsmen excelled in "Russian mosaic"—constructing images from small pieces of malachite and jasper. The factory also operated a school for cutting, polishing, faceting, engraving, and making mosaics, and the best pupils were sent to St. Petersburg for additional training.

Most of the artifacts produced in Ekaterinburg were items used to decorate the palaces of the emperors and other nobility. The loveliest materials were made of grayish green Kalkan jasper and serpentine. The article includes photographs of the factory's museum of engraving and jewelry art pieces, such as vases, plates, architectural details, and stone stamps. Notable among these is a mosaic map of France that received the Grand Prize at the 1900 Paris Exhibition. This map was presented to France and exhibited in the Louvre for many years. *BMS*

Ural gemmas. T. Parnyuk, *Platinum*, Vol. 1, No. 16, 2005, pp. 46–49 [in Russian].

Many gem carvings were produced by the Ekaterinburg stone cutting factory between 1796 and 1847, but only at the end of the 20th century was this unique art restored. A special feature of these works is the wide spectrum of materials used: jasper, chalcedony, and agate, among others. Examples of articles made by I. Golubev, I. Nasibulin, G. Ponomarev, and A. Zhukov are described; some are shown in photographs. There are faces of well-known writers and women, fantastic bird figures, landscapes, flower symbols, and folk-tale subjects. The skill of the engravers is apparent through their use of the texture, color, and translucent properties of the stones. Artifacts of Ural masters are very popular at Russian and international expositions. *BMS*

PRECIOUS METALS

Giving gold jewelry and coins as gifts: The interplay of utilitarianism and symbolism. B. Ertimur and O. Sandikei, *Advances in Consumer Research*, Vol. 32, 2005, pp. 322–327.

Turkey is the world's fifth largest market for gold jewelry, and gold jewelry and coins serve a number of cultural functions. They are important for gifts that mark certain rites of passage, as well as a form of women's empowerment and safeguard against misfortune. This article contains interviews with Turkish consumers discussing the reasons they purchased gold coins and jewelry. The authors conclude that gold is a preferred gift for many reasons: investment, adornment, tradition, confidence that it will be well-received, and a statement of a bond between giver and receiver. *RS*

Gold—The emotional metal. J. Cross [jessica@virtualmetals.co.uk], *Applied Earth Science*, Vol. 114, 2005, pp. B101–107.

Gold differs from other commodities in that the vast majority of the metal mined over the centuries remains available in the form of existing bars, coins, and jewelry, and it attracts investors who have an emotional belief in it, beyond economic fundamentals. In addition, gold serves as an unofficial currency in unstable areas.

This article examines how these factors affect three major components of the gold market: official sales, adornment jewelry, and investment. In the first component, governments hold gold as a hedge even though it earns no interest or return. Nevertheless, in 1999 nations of the European Union agreed to sell portions of their official holdings on an orderly basis (approximately 2,000 tonnes from a total of ~16,000 tonnes during 1999–2004). In the jewelry sector, gold adornment items continue to be important in the Middle East and India. In the West, however, it goes through different periods of fashion. In the U.S., yellow gold is losing market share to other consumer items, and in the United Kingdom, it has been equated with crass popular culture. There are difficulties with the investment market as well, because there are no easy ways to invest directly in the metal. *RS*

SYNTHETICS AND SIMULANTS

Characteristics of large-sized ruby crystal grown by temperature gradient technique. C. Song [soocii@mail.siom.ac.cn], Y. Hang, C. Xia, J. Xu, and G. Zhou, *Optical Materials*, Vol. 27, No. 4, 2005, pp. 699–703.

This article describes the use of the temperature gradient technique (TGT) to grow a large ruby crystal. The initial experiment produced a 75 × 45 mm boule. The bulk of the as-grown crystal, 60 × 30 mm, was of good quality with minimal inclusions, showed only Cr³⁺ (no Cr²⁺ or Cr⁴⁺ byproducts), and displayed a high degree of crystalline symmetry.

Based on their previous work and the current study, the authors believe the inclusions are gas bubbles and foreign impurities. Concluding remarks suggest that larger, higher-purity crystals can be achieved with the TGT process by implementing meticulous procedures for preparing the ingredient powders (Al₂O₃ and Cr₂O₃) and improved control of the thermal field during crystal growth. *SW*

Growth of large high-quality type-IIa diamond crystals. X.-C. Wang, H.-A. Ma, C.-Y. Zang, Y. Tian, S.-S. Li, and X.-P. Jia [xjia@mail.jlu.edu.cn], *Chinese Physics Letters*, Vol. 22, No. 7, 2005, pp. 1800–1802.

Colorless high-quality type IIa synthetic diamond crystals up to 4 mm in size have been grown by the temperature-gradient technique at pressures of 5.5 GPa and temperatures of 1200–1300°C. The solvent metal is an Fe-Co-Ni alloy. Ti is added to the solvent metal to reduce the N content in the synthetic diamond, and Cu is added to inhibit

the formation of titanium carbide inclusions. Growth rates are about 1.1–1.6 mg/h. Within the growth chamber, a modified ring-shaped carbon source is used, with the opening in the ring positioned directly above the growing crystal. With this configuration, titanium carbide particles that form in the molten alloy during a growth run are able to float upward and away from the growing crystal, and are thereby less likely to become entrapped within the synthetic diamond as dark metallic inclusions. *JES*

Synthesizing single-crystal diamond by repetition of high rate homoepitaxial growth by microwave plasma CVD. Y. Mokuno [mokuno-y@aist.go.jp], A. Chayahara, Y. Soda, Y. Horino, and N. Fujimori, *Diamond & Related Materials*, Vol. 14, No. 11/12, 2005, pp. 1743–1746.

Many promising technological applications have prompted ongoing research into optimizing the size, quality, and growth rate of single-crystal synthetic diamond produced by the chemical vapor deposition (CVD) method. In this article, three developments are summarized. Use of an “enclosed” substrate holder resulted in the growth of tabular synthetic diamond crystals with smooth and flat surfaces. With this apparatus, a 4.65 ct, 1-cm-thick ($\sim 5 \times 5 \times 10$ mm) single-crystal synthetic diamond was produced by 24 repetitive stages of crystallization over a total growth time of about 150 hours. Some crystals grown in this way were then polished with six cube faces. Further repetitive growth stages on several of these faces resulted in a three-dimensional enlargement of the synthetic diamond.

JES

TREATMENTS

Beryllium-treatment. A. Peretti, D. Günther, and A.-L. Gruber, *Contributions to Gemology*, No. 4, 2005.

The fourth installment of *Contributions to Gemology* compiles previously published research on Be diffusion treatment of corundum from the first two issues, with updates and corrections, and adds new photomicrographs of corundum inclusions.

In the first section, using a variety of advanced methods (SEM, EDXRF, LA-ICP-MS, CL), as well as gemological and spectroscopic testing, the authors examine a wide variety of natural, synthetic, untreated, and treated (before and after) corundum. Although the originally published (2002) version of this report attributed the induced color changes to “internal movement of color centers,” the corrections in this edition clearly establish the role of Be diffusion.

In the second section, the authors use LA-ICP-MS chemical analyses to further examine the mechanisms of the color changes induced by Be diffusion. In contrast to other published reports, they correlate the formation of orange color centers to the $Ti/(Mg+Be)$ ratio; the presence of Si was not found to be related. Orange color was

induced when $Ti/(Mg+Be) > 1$. The role of other trace elements in the formation of color centers was limited or nonexistent.

The new material in the third section of this issue consists of several pages of high-quality inclusion photomicrographs (untreated and treated corundum) with explanatory captions. *TWO*

High-temperature annealing of optical centers in type-I diamond. A. T. Collins [alan.collins@kcl.ac.uk], A. Connor, C.-H. Ly, A. Shareef, and P. M. Spear, *Journal of Applied Physics*, Vol. 97, 2005, pp. 083517-1–083517-10.

The widespread availability of commercial high pressure, high temperature (HPHT) services for changing the color of brown gem diamonds to colorless or other fancy colors has led to the need for a better understanding of the optical defect changes that occur during annealing. Several type Ia natural diamonds and type Ib synthetic diamonds were irradiated with neutrons or 2 MeV electrons, annealed at 800°C, then subsequently either annealed at 1000°C–1750°C and ambient pressure or subjected to HPHT conditions (2300°C, 5 GPa). One type IaA and one type IaB natural diamond, both electron irradiated, were annealed at 33–50°C intervals from 800°C–1600°C to study changes in the H1b and H1c centers. For reference, one natural type Ia brown diamond was annealed at 1600°C–1750°C and several others were subjected to HPHT conditions. FTIR and Vis-NIR absorption spectra (room temperature and 77 K) and cathodoluminescence (77 K) measurements were collected before and after each heating step.

Annealing of type IaA and IaB irradiated diamonds to 1600°C revealed that the H4 defect was destroyed by conversion to H3, confirming that H3 is more stable than H4 and explaining the absence of H4 in most natural diamonds that have undergone long-term annealing in the earth. In addition, carefully controlled interval heating defined the temperature-dependent sequence of creation and destruction of the 594 nm, H1b, H1c, H2, H3, and H4 centers. Annealing of irradiated type Ib synthetic diamonds revealed the creation of both H3 and, surprisingly, N3 centers, as well as the increased development of Ni-N complexes. Annealing of the reference natural brown diamonds resulted in the complete removal of H4 defects and the 491 nm CL line related to plastic deformation, as well as the development of H3 and H2 centers. The ease with which the 491 nm line was annealed out and its distinct presence in natural brown diamonds suggests that plastic deformation occurred very late in their history, most likely during eruption to the surface. Finally, the data indicate that H2 and H3 centers are destroyed by HPHT treatment of dislocation-free diamonds, but their intensities are dramatically increased during HPHT annealing of natural brown diamonds (with abundant dislocations). This suggests a dynamic, competitive process where the final diamond color depends on a combination

of annealing temperature, duration, and the defects present in the diamond before treatment.

CMB

Scale determination of wax and macromolecule polymer-filled jadeite jade. L. Qi, X. Yuan, G. Peng, and G. Yang, *Journal of Gems and Gemmology*, Vol. 7, No. 3, 2005, pp. 1–6 [in Chinese with English abstract].

Jadeite can be enhanced by a variety of processes, such as pure bleaching, corrosion by alkalis/acids, waxing, and polymer filling. Treated jadeite can be identified by microscopic observation and FTIR spectroscopy. However, the relationships among these enhancement processes are unclear, and there has been no detailed investigation of the quantity of wax- and polymer-filling materials in treated jadeite.

Enhancement experiments were mainly performed by one author (GY) at Xiangfa Jade Ltd Co., Foshan, China. A solution of oxalic acid and H₂O₂ with diluted HCl was used at 115°C for the pure bleaching treatment, followed by waxing. In the polymer filling treatment, samples were first placed in a solution of H₃PO₄ and H₂O₂ or HNO₃ and H₂O₂, followed by a NaOH solution to precipitate solid particles into the voids created by the corrosion process, and finally were subjected to polymer filling. Various treated jadeite samples were cut into ~1 cm³ pieces and dried at 210°C for 5 hours before FTIR spectra were obtained.

In the bleached and waxed samples, the intensity of the C-H stretching bands at 2919 and 2850 cm⁻¹ increased with immersion time in the wax. A group of characteristic polymer-related bands in the 3100–2800 cm⁻¹ range (3053, 2967, 2929, and 2874 cm⁻¹) were detected, and slight differences were noted in the fine structures of these bands in other samples reportedly treated by different factories. The absorption of CH₂ and CH₃ related to the amount of wax and polymer in the jadeite, was correlated to two parameters involving the 2919 and 2851 cm⁻¹ bands.

TL

MISCELLANEOUS

Diamonds, foreign aid and the uncertain prospects for post-conflict reconstruction in Sierra Leone. J. A. Grant. *The Round Table*, Vol. 94, No. 381, 2005, pp. 443–457.

In the 1990s, Sierra Leone was racked by a gruesome civil war, which local diamond production played a role in sustaining. Since 2002, with the assistance of international aid organizations, the United Nations, and various governments, the country has been trying to rebuild its shattered economy and infrastructure. Sierra Leone's two chief revenue sources are agricultural products and diamonds.

The country has made significant progress in regaining a degree of control over its production of diamonds from alluvial fields in the interior. Official production rose from \$1.2 million in 1999 to \$126.7 million in 2004. One reason for this dramatic increase is the Kimberley

Process, which requires certification for rough diamonds indicating that they were mined and sold legitimately. However, some industry analysts believe that the majority of Sierra Leone diamonds continue to be exported illegally to avoid the 3% export duty. In addition, entrenched corruption and limited law enforcement resources continue to hinder attempts to regain full control of the country's diamonds and other resources.

RS

Economic feasibility of small-scale black-lipped pearl oyster (*Pinctada margaritifera*) pearl farming in the South Pacific. Q. S. W. Fong, S. Ellis, and M. Haws, *Aquaculture Economics & Management*, Vol. 9, 2005, pp. 347–368.

This article offers a detailed economic analysis of the costs involved in starting and operating a black pearl farm in the South Pacific. A number of island nations in that region have little private industry and remain heavily dependent on aid from foreign governments and development agencies. The authors analyzed the start-up costs—labor, equipment, seeding, land-lease, etc.—factoring in issues such as anticipated oyster mortality and percentage of rejected cultured pearls, to develop an economic model for cultured pearl production over a 20-year period.

The authors project that an initial investment of about \$200,000 would be needed to establish a farm with 25,000 oysters in seed. Because of the time required for the pearl culturing, there would be no income for three years against yearly operating costs ranging from \$160,000 to \$236,000. Years four and five would bring income equaling 40% of expenses, while the operation would turn a small profit (\$44,000) in year six. Profits would begin in earnest in year seven, where returns of \$143,000 would be realized against revenues of \$437,000. These figures, however, are highly dependent on fluctuations in the market price for black cultured pearls (a 1% decrease in price would cause a 5% decrease in profits). In addition, a small farming operation would find it difficult to compete against large, established producers unless a number of farms created cooperatives to realize economies of scale.

RS

Finer points of cutting. D. Knoote [dean.knoote@argylediamond.com.au], *Rough Diamond Review*, No. 8, 2005, pp. 27–28.

This article reviews developments in the history of diamond bruting. Bruting began in the mid-16th century by rubbing the edge of one diamond against another to round the corners and form the face-up shape. Machine-driven bruting was introduced in the 19th century and is still used today.

The bruting process is similar to lathing except the diamond sharp (cutting edge) is clamped to a long holder. By tucking the shaft under the arm and clasping the end holding the sharp, a bruter leverages the stick about a cradle block, and can exercise accurate control of the tool while sensing a feel for the cutting.

Manual bruting requires years of experience. The apprentice bruter first learns to center a diamond, which is critical to maximizing diamond yield. One of the most important skills is being able to shape the rough fast enough to maintain productivity but slowly enough to avoid bearding. Preserving weight versus improving clarity and geometry are also important considerations. Highly skilled and experienced bruters have an advantage over automatic systems, which are not yet as sensitive to subtleties in the process.

Automated bruting was developed in the 1980s. These bench-top machines work by grinding two contra-rotating diamonds against each other. Automated bruting takes longer than manual bruting (~2 hours vs. 15–30 minutes), but this is offset by an operator being able to monitor five or more operations at once. The process also creates very parallel girdles that are particularly suitable for the hold-ers used with automatic polishing machines.

Laser bruting has the advantage of being able to create virtually any shape in about 30–40 minutes; multiple stones can be loaded into special cartridges for unattended operation. When coupled with a computerized scanning and imaging system, laser bruting machines can create shapes with perfect symmetry. One drawback is that once a cutting path is started, the cut is committed, unlike manual bruting where the bruter can monitor and adjust the process.

With the advent of these technologies, the number of manual bruters has declined rapidly. The author predicts that they will soon become redundant, as have manual kerfers.

HJ-G

The history and prehistory of pearlting in the Persian Gulf.

R. Carter [racbahr@hotmail.com], *Journal of the Economic and Social History of the Orient*, Vol. 48, No. 2, 2005, pp. 139–209.

The author examines pearlting activities in this ancient area from three points of view: (1) written accounts about pearls and pearl harvesting in the Persian Gulf, (2) pearls and related archeological artifacts found at various sites in the region, and (3) indirect archeological evidence of possible pearlting activities.

On the first point, the author found that the earliest explicit reference to pearlting dates from the 4th and 3rd centuries BC in what is now Abu Dhabi and Bahrain. Pearlting had become an established enterprise by the time of Alexander the Great. Centuries later, Pliny noted that pearls were the most highly prized valuable in Roman society and praised those from the Persian Gulf. By the 15th century AD, pearlting had become “quite a large industry,” with Bahrain as the primary center. Records of the Dutch East India Company from 1724 estimate that Bahrain pearlers extracted one million pearls annually. The industry continued to grow through the 19th century, with the vast majority of the trade going to India.

On the second point, archeologists discovered pearls

in Late Stone Age (6th and 5th millennia BC) settlements in what is now Kuwait. Most of the pearls were irregularly shaped, and some were incorporated into ornaments. The author argues that these came from deliberate pearl fishing, though this issue is apparently in dispute.

On the third point, the author reviews shifts in human population throughout the area that parallel the development of the pearlting industry.

By the beginning of the 20th century, pearlting was the primary industry of the region, providing the foundation of wealth for many of today's ruling families. The majority of pearls still went to India. Starting in the 1920s, demand for Persian Gulf pearls declined dramatically with the availability of Japanese cultured pearls. The closure of Kuwait's pearl oyster market in 2000 ended 7,000 years of pearlting in the region. RS

Pathology of pearl oyster mortality. M. Hirano, Y. Sugishita, S. M. A. Mobin, K. Kanai, and K. Yoshikoshi (ykazuma@net.nagasaki-u.a.c.jp), *Journal of Aquatic Animal Health*, Vol. 17, No. 4, 2005, pp. 323–337.

Cultured pearl farming of the *Pinctada fucata martensi* oyster has been marked by mass mortality events in some western Japanese farms. First seen in the Kagoshima prefecture in 1993 and progressively identified in the Oita and Ehime prefectures, mass mortality of these cultured oysters was prominent throughout western Japan by 1997. This article presents the results of a case study of healthy and affected oysters.

Based on a single strain of test oysters, mortality events were examined at several farms. Accompanied by water temperature data and growth and mortality rates, most of the information was derived from examinations of affected oysters using optical microscopy and transmission electron microscopy. A histopathological examination of these oysters was comprised of dissection, dehydration, and stabilization of specimens, followed by slicing them thinly. After drying, the structure of the tissue was examined by pathologists using microscopy.

The pathologists found that the tissue of diseased oysters was characterized by blebbing and cell necrosis, spreading from the digestive organ to other regions. No viral, bacterial, mycotic, or parasitic organisms were detected. This is in contrast to earlier suggestions that their mortality was due to an infectious disease. Mass mortality events were demonstrated to be regular annual events, with very similar patterns between farms. Water temperature was found to be only an indirect factor in mass mortality events: It altered the timing and sometimes the severity of the outbreaks, but it is not suspected to be the cause. One suspected environmental factor is the presence of neighboring fish farms, which are known to cause water pollution and deoxygenation resulting from decaying fish waste. This study speculates that at least some farms were probably influenced by organic pollution from these fish farms. DMK