The Journal of

Gemmology

Volume 27 No. 5 January 2001

The Gemmological Association and Gem Testing Laboratory of Great Britain

 ISSN: 1355-4565

Santa Maria aquamarine

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ABSTRACT: A Santa Maria aquamarine is the inspiration for the design of a necklace. Details of the stone are given, as well as descriptions of the design and make-up of the necklace.

The aquamarine

Aquamarine of the highest quality and the finest blue has for many years been called 'Santa Maria' after such material was found at the small locality of Santa Maria in Minas Gerais, Brazil. Since there are so many places called Santa Maria in Brazil, it may have been better to have named the aquamarine after the nearby town, Itabira!

The story is told that in 1925 a mule had fallen down a hole and had broken a leg; the owner of the mule saw blue crystals in the hole and so discovered what came to be the most famous aquamarine locality in the world. For some years blue aquamarines have been mined in several 'lavras' (mines) in the region of Santa Maria, and were of such a good sky-blue colour (like the blue of tropical skies) that after 75 years people still dream today of the super colour of Santa Maria aquamarine. After World War II more aquamarines were found near the original localities, but although similar, they did not quite equal the extraordinary stones of 1925.

In c. 1990 blue beryls were found in a secondary deposit in Mozambique which were similar to the Brazilian 'Santa Maria' aquamarines and these have been called 'Santa Maria Africana'; however, in comparison they appear to have a more steely appearance than the lovely sky-blue of the original Brazilian stones.

Gemmological properties

Santa Maria aquamarines have the following properties: RI n_e 1.578-1.581, n_o 1.585-1.588, birefringence 0.007-8; SG 2.68-2.70.

Spectroscopic investigation of the stone used for the necklace gave absorption lines at 370, 426, 557, 833 and 891 nm. The equipment used was a Perkin Elmer Lambda 12 spectroscope.

The necklet

A Santa Maria aquamarine of 16.75 ct was the inspiration for a necklet designed by one

Figure 1: *Santa Maria aquamarine set in a necklet designed by Elena Villa. Photo by Bob Maurer.*

 ISSN: 1355–4565

author (EV), and made by Hans Dieter Krieger of Idar-Oberstein, Germany (*Figure 1*). Details of the stone's internal features can be seen in *Figure 2*. The inclusions are disc-like and oriented parallel to each other with a rather filmy appearance.

The design

The colour of the aquamarine and the inclusions 'reflecting the shiny waves of the ocean' inspired the creation of this unique piece of jewellery named the 'Light-tree-water-being'. EV writes about the concept and development of the piece as follows:

"Like any other real existing being, the invented being also should have a history. Where does it come from? How has it been called into being? For me nature on earth, under water and in space, offers the richest variety of colours and shapes. Inspired by this natural diversity, the basic idea for this piece of jewellery was born. The coincidence of the strong concentrated forms of energy, light, water and earth, as well as the grace of each of these natural elements, unified in the delicate expressiveness of a jewellery piece, stimulated a new interpretation of nature through jewellery.

"Evolution in its progress is thrilling and cannot be foreseen. The attraction to create new forms of expression, and also new possible forms of living, was more than enough reason to realize an evolutionary association between a gem and an invented being. Under such circumstances the gem can arise to life because it is no more just immobile and beautiful, but part of a living being. The form of living and the gem turn to a symbiosis and reach a stage of subtle living effect.

"The aim was not to have a motionless new piece of jewellery but to compose a new living being with the facilities of jewellery creation design. The result is a decorative independent individual who inspires the fantasy of the wearer as well as the viewer, free and powerful with personal radiation."

Figure 2: *Disc-like inclusions in the aquamarine. Photo by Bob Maurer.*

The light-tree-water-being

In the forests of Canada
where the hugest trees of the world grow
there is a being made out of light and water
living in a remote lake
which has a unique and fascinating under-water world.

At night the being goes on shore
because it feels so lonely.
It gets to know the trees
and has deep conversations with them each night.

One night one tree falls in love with the light-water-being
and from that day on they spend each night together.

From this relationship, protected by trust, tolerance and love,
originates the rarest being in the world
that just can be seen in one single picture:
the light-tree-water-being.

Elena Villa

Manufacture

The piece was cast in platinum, the gold sections being formed by hand and soldered to the platinum. The aquamarine was set and then all pieces were connected by laser; the piece was finally polished with selected areas finished in a satin surface.

Acknowledgements

Thanks to Claudio Milisenda for the spectroscopic investigation.

Identification of a new type of laser treatment (KM treatment) of diamonds

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ABSTRACT: A new technique of clarity enhancement of diamond using a laser (KM treatment) has been identified. Although this treatment is achieved in a similar manner to that of traditional laser drilling, it produces a continuous fracture. This fracture appears more like a feather than a channel. KM treatment may be recognized from remnants of black coloration which sporadically line the surface of the laser-induced continuous fracture. Also by use of differential interference magnification, determination of whether or not the surface-reaching fracture existed prior to polishing can be made. These criteria can enable identification of most KM-treated diamonds.

Keywords: KM treatment, laser drilling treatment, black inclusion, laser-induced continuous fracture, boiling, differential interference microscope.

Introduction

A new technique of clarity enhancement has been identified and its development has been traced to Israel. The treatment is achieved in the same manner as traditional laser drilling treatment, which aims for improvement of the clarity of a diamond by the elimination of black inclusions. Though the new treatment was initially utilized in Israel, the technique may have been employed in Antwerp since early 2000. This treatment method has yet to be officially introduced to the industry and it appears to have been introduced quietly by some diamond dealers, as laser drilling treatment disclosure has become a growing concern worldwide. This technique is called 'KM treatment' which stands for 'Kiduah Meyuhad' meaning 'special drill' in Hebrew.

Materials and methods

KM treatment is used on black inclusions accompanied by internal fractures. One or more pulsed laser beams are focused on the inclusion itself with the resulting heat creating an internal fracture. The point of focus of the beam(s) is then moved towards the closest surface of the diamond at the same time creating a continuous fracture from the inclusion to the surface. This fracture appears more like a feather rather than the traditional laser-induced channel. After this procedure the diamond is immersed in a solution of strong acid and then boiled, and then subjected to pressure to allow the solution to contact the black inclusion via the newly created fracture. This process results in the bleaching of the inclusion.

 ISSN: 1355–4565

Method of investigation: the Nomarski differential interference microscopy technique

In the mid-1950s a French optics theoretician named Georges Nomarski modified the Wollaston prism used for detecting optical gradients in specimens and converting them into intensity differences. Today there are several implementations of this design, which are collectively called differential interference contrast (DIC).

The plane polarized light enters the beam-splitting modified Wollaston prism and is split into two rays, vibrating perpendicular to each other. The rays intersect at the front focal plane of the condenser, where they pass travelling parallel and extremely close together with a slight path difference.

The split beams enter and pass through the specimen where their wave paths are altered in accordance with the specimen's varying thickness, slopes and refractive indices. When the parallel beams enter the objective, they are focused above the rear focal plane where they enter a second modified Wollaston prism that combines the two beams at a defined distance outside the prism itself. As a result of having traversed the specimen, the paths of the parallel beams are not of the same length (optical path difference) for differing areas of the specimen.

The light then proceeds toward the eyepiece where it can be observed as differences in intensity and colour. The design results in one side of a detail appearing bright (or possibly in colour) while the other side appears darker (or another colour). This shadow effect bestows a pseudo three-dimensional appearance to the specimen.

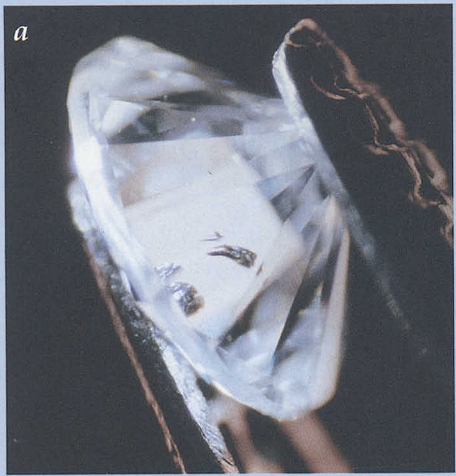
The colour and/or light intensity effects shown in the image are related especially to the rate of change in refractive index, specimen thickness, or both. The three-dimensional appearance is not a representation of the true geometric nature of the specimen, but is an exaggeration based on optical thickness.

The advantages in using DIC microscopy for this work include:

- absence of halos that may be encountered in phase images;
- striking colour (optical staining) or three-dimensional shadow appearance of images.

Figure 1a: *Before KM treatment. Isolated black inclusion is located below the table of a brilliant-cut diamond (at 9 to 10 o'clock).*

Figure 1b: *After KM treatment. Black coloration has been removed from the inclusion. The size of the original inclusion area when viewed from the face-up position does not appear to be changed.*



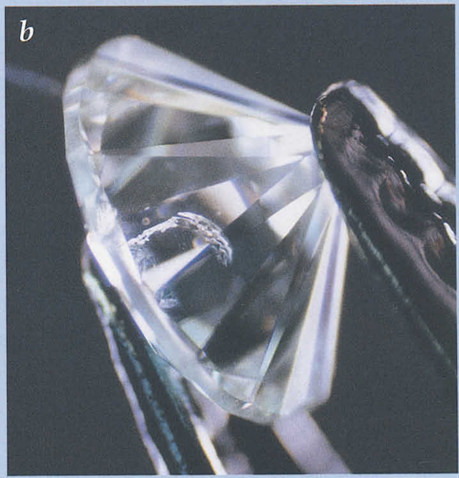


Figure 2a: Before KM treatment. A view of the black inclusion through the pavilion. This shows that the black inclusion is isolated within the diamond and does not reach the surface.

Figure 2b: After KM treatment. The black inclusion has been bleached and the laser-induced continuous fracture is apparent on the left of the inclusion.

Samples

Recently the author observed eight KM-treated diamonds, ranging in weight from 0.30 to 5 carats, and then for this study selected an untreated diamond for treatment in Israel. This diamond is shown in *Figures 1a* and *1b* before and after KM treatment respectively.

Results

Magnification

The author has seen two types of visible characteristics associated with this treatment which may or may not be found together. The first is an unnatural bend at the junction of the induced continuous fracture and the original fracture or cleavage that contained

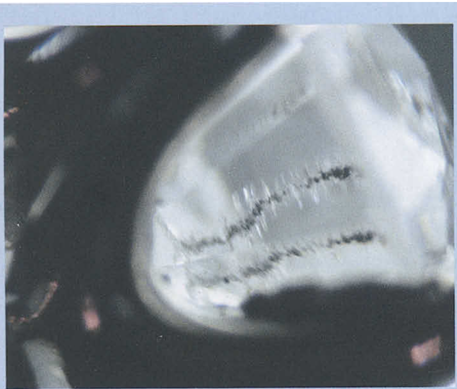


Figure 3: In both of these two KM-treated diamonds, the inclusion (which has the appearance of a centipede) leads to the surface of the table facet and has many smaller cleavages that protrude from its side. Black residue from the inclusion could not be removed completely by the treatment process and can be seen in areas along the laser-induced continuous fracture.

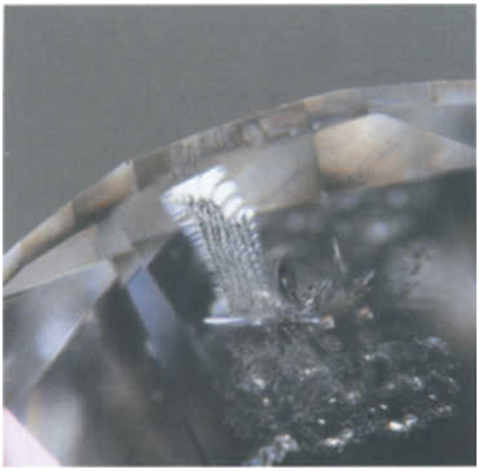


Figure 4: *The remnants of black materials found sporadically lining the surface of the laser-induced continuous fracture are typical of KM-treated diamonds.*

the black coloration (*Figure 2b*). The second type consists of a multitude of smaller cleavages leading out of the laser-induced continuous fracture that are parallel to each other and which create an overall resemblance to a centipede (*Figures 3a* and *3b*). In both types the laser induced continuous fracture retains black spots of coloration that are probably the remnants of the original black inclusions (*Figure 4*).

Nomarski type differential interference microscopy

Examination by differential interference microscopy was employed to judge if the fracture was created before or after the diamond was polished. If the fracture existed before the cutting and polishing of the diamond, depth and thickness of the polishing lines on opposite sides of the cleavage differ and can be visually detected. Where there are polishing drag marks that lead away from the edge of the fracture or where there is rounding of the peripheral edge of the fracture where it meets the surface of the diamond (*Figures 5* and *7*), the fracture was present prior to polishing. For fractures that have been introduced after polishing the diamond, there are no differences in the polishing lines on opposite sides of the fracture and the peripheral edge of the fracture is not rounded (*Figures 6* and *7*). Generally, a surface-reaching laser-induced continuous fracture is too narrow to be observed easily with a 10x loupe. Even at 200x magnification (as in *Figures 6* and *7*) it is still very small. Because of this, it is probable that boiling with acid has to be done under pressure to make it effective in penetrating the fracture and removing any black coloration.

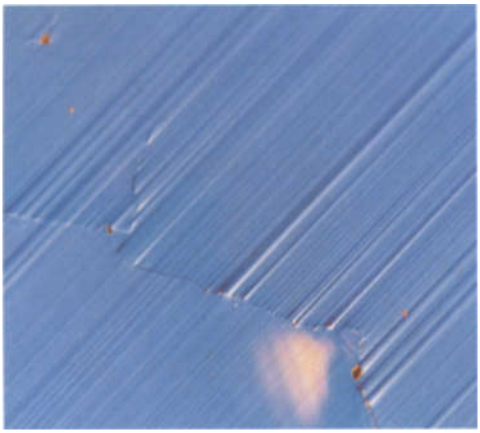


Figure 5: *If the fracture existed before the cutting and polishing of the diamond, depth and thickness of the polishing lines on opposite sides of the fracture would differ (200x magnification).*

Figure 6: *For fractures that have been introduced after the polishing of the diamond, there are no differences between the polishing lines on the opposite sides of the fracture, and the peripheral edge of the fracture is not rounded (200x magnification).*

Figure 7: With observation using the differential interference microscope, it is apparent that the fracture on the right of the photograph existed before the cutting and polishing, and the laser-induced fracture on the left has been introduced after the polishing of the diamond.

Figure 8: This boiled stone displays blue interference colour on the rim of the fracture.

Identification of KM-treated diamonds

The decisive difference between KM-treated diamonds and those with laser drill holes is the presence of a laser-induced continuous fracture, which resembles a feather, and the absence of a narrow straight hole. It may be difficult to distinguish a natural fracture from one generated by KM treatment, but experience should be accumulated from known treated stones. Doubt about the origin of a fracture would in turn lead to problems in reporting or in disclosure of possible treatment.

Although no one distinguishable feature has been present in all of the stones examined to date, one feature, which is unique for stones subjected to the boiling process, has been seen in most of these treated stones. The feature appears similar to the 'flash effect' found in filled diamonds, but it does not show the same colour change when the stone is rotated. Usually, in the experience of the author, boiled stones show interference colour changing from light blue to light brown when the stone is tilted back and forth (see *Figure 8*).

Conclusion

KM treatment is a new method used to remove black coloration from inclusions in order to improve the appearance of diamonds, the same objective for traditional laser drilling methods. Identification of KM treatment may be difficult but two tell-tale signs distinguish it from an untreated stone. The first is the observation (using magnification) of remnant black coloration material sporadically lining the surface of the laser-induced continuous fracture. Secondly, by the use of differential interference magnification, determination of whether or not the surface-reaching fracture existed prior to polishing helps to identify the relative age of the fracture: evidence of KM treatment would lie in the consistency of surface characteristics on opposite sides of the fracture.

Acknowledgements

The author thanks diamond dealers for supplying the samples and for other information. Nobuo Horiuchi of Central Gem Laboratory provided useful suggestions and special thanks go to John Nakama for reviewing this paper. Teramae, Hirata and Soeda, colleagues of mine at Central Gem Laboratory, are thanked for their support.

Further reading

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Notes from the Laboratory

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ABSTRACT: Pearls are reviewed with anecdotal comments on a cultured pearl farm in China, remarks on non-nucleated cultured pearl growth structures, discussion of the comparative sizes of natural and cultured pearls, a button shape in a cultured pearl, the filling of hollow natural pearls and visible features seen in stained pearls. The stories and identification issues behind a number of synthetic and treated stones are considered, and a 'topaz diffusion' treatment applied to corundum is described.

Pearls

Non-nucleated cultured pearls

A visit to a cultured pearl farm in Wuhan, China, was one of the highlights of attending a conference at the Gemmological Institute of the China University of Geosciences. The cultured pearl farm (*Figure 1*) was one of a number in the province belonging to one company. The freshwater mussels used were subsequently identified by staff in the Zoology Department at the Natural History Museum in London as Hyriopsis cumingii (Lea). At the farm, the procedure consists of placing two or three mussels together in plastic mesh nets (*Figure 2*) and tying them to ropes, which are suspended from plastic bottles acting as buoys (*Figure 3*). The spat size of the mussel can be visualized in an eight month

***Figure 1:** The buildings of a cultured pearl farm in Wuhan, China.*

 ISSN: 1355–4565

Figure 2: *The plastic mesh nets used for suspending the mussels in water.*

Figure 3: *Lines of plastic bottle buoys floating in the freshwater lake from which the plastic nets and mussels are suspended.*

old shell (*Figure 4*), where the spat shell has only been extended by one season's growth. The culturing operations are carried out on the mussels when they are between one and three years old. They expect to place about 50 grafts into 50 cm length of shell. Two three-year-old shells were opened up for us. They had been in the water for some two years after the culturing operation. The shell in *Figure 5* shows the cultured pearls in situ on the right-hand side. On the left, some of the cultured pearls had already been removed from the flesh and were returned temporarily for the photograph. The largest shell brought back to London is some five years old (*Figure 6*) and measures 25 x 16 cm.

Figure 4: *An eight-month old shell of Hyriopsis cumingii. The original spat size is evident on the shell surface.*

On the evening after our visit to the farm there was a bring-and-buy sale as part of the annual conference. Several strings of cultured pearls from the company who owned the farm were on display (*Figure 7*). The bags alongside the strings are a health tonic, consisting of a concoction that dissolves powdered cultured pearls. According to the information from the

Figure 5: *An opened shell showing some of the non-nucleated cultured pearls in situ.*

Figure 6: *A five-year old shell of Hyriopsis cumingii.*

Figure 7: *Strings of non-nucleated cultured pearls and bags of 'health tonic' containing ground cultured pearls.*

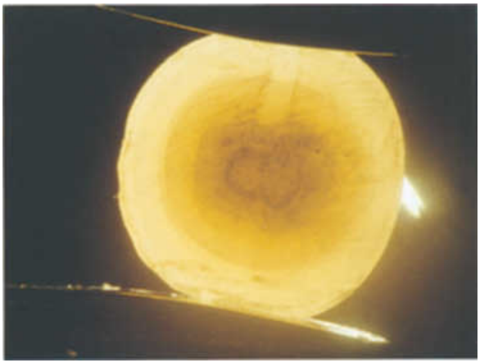


Figure 8: *Cross-section of non-nucleated cultured pearl showing an internal cavity and distinct layers of growth.*

company, about 70 per cent of the pearls recovered are used for cosmetics and health products, leaving the remaining 30 per cent to find their way into jewellery. While we were at the farm, the manageress showed us a 13 x 10 mm perfect drop-shape cultured pearl, which she reported was found with other pearls totally by chance.

There has been a lot of conjecture in the trade press in recent times on larger round non-nucleated cultured pearls being the result of nucleation with other spherically worked non-nucleated cultured pearls. This reminded me that many months before, one of our customers had engaged in a bit of destructive testing on some of his own pearls. He contacted us wondering if the exposed cross section of his non-nucleated cultured pearl (*Figure 8*) indicated that the Chinese culturers were now using small non-nucleated cultured pearls as nucleii in their mussels. Although this interpretation was understandable, what had actually been observed were the strong demarcations between seasonal growth stages.

Natural and cultured pearls

A recent enquirer wondered whether a pearl was more likely to be natural if it was quite large. No such conclusion can be drawn on this basis. However, the enquiry stimulated a review of some of the larger pearls that we have tested in the London laboratory.

The largest nucleated cultured pearl seen at the laboratory in recent years was a hollow cultured pearl, measuring approximately 41 x 34 x 33 mm and weighing 160.50 ct. The radiograph (*Figure 9*) shows a bead of approximately 11.5 mm ensconced in a corner within the enclosed internal cavity of the cultured pearl. In the 1980s Boris Norman of the Australian Pearl Company used to submit some huge natural South Sea pearls. A cursory glance through the records revealed an undrilled iridescent grey natural blister pearl weighing 177.03 ct and an undrilled baroque natural pearl weighing 119.35 ct. The largest South Sea natural pearl that Mr Norman remembers dealing with was over 130 ct (personal communication).

Figure 9: *X-ray radiograph of a 160.50 ct nucleated cultured pearl.*

Figure 10: *The reverse view of the Pearl of Asia (reported weight 600 ct) enclosed in a gem-set foliate mount. In this direction, a pink tourmaline and four jadeite jades surrounding a synthetic ruby are on view. © K. Mikimoto & Co. Ltd., and Al-Tajir of Dubai.*

These pearls were solid all the way through and, even after one to two hours exposure to X-rays, the resulting radiographs often only showed growth arcs around the edges of the pearls. Despite their size, these large pearls, of course, do not compare with historical pearls such as the Hope Pearl (Anon, 1989), claimed to weigh approximately 450 ct, and the Pearl of Asia, which measures approximately 76 x 50 x 28 mm (*Figure 10*).

A collection of seven undrilled pearls, submitted by a wholesaler for identification, weighed 35.62 ct, 27.37 ct, 17.69 ct, 17.23 ct, 15.84 ct, 13.04 ct., and 11.44 ct. The latter six pearls were all determined to be non-nucleated cultured pearls, which was based on the irregular shapes of the cavities revealed by radiographing the pearls in three mutually perpendicular directions. The radiograph of the 35.62 ct pearl revealed the presence of a flattened oval shape within the pearl, which was located off to one side. This has also been interpreted as being the result of the tissue implantation process for producing non-nucleated cultured pearls (Scarratt *et al.*, 2000).

The advent of larger non-nucleated cultured pearls has made the identification problem of differentiating between the cavities present in non-nucleated cultured pearls and the cavities present in hollow natural pearls even more acute. The interpretation of the three-dimensional shape of a cavity in a pearl, and its relationship to the outer contours of the pearl, still form an essential part of origin determination (Kennedy, 1996). Once the cavity is assessed as being within a natural pearl, a further check needs to be made on whether the hollow has been filled with artificial material. The determination is

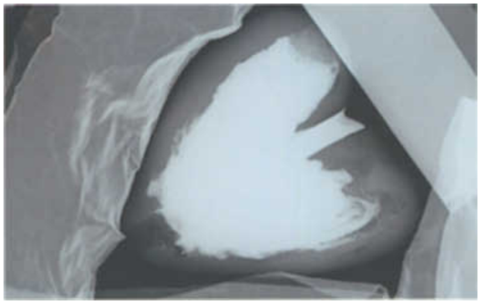


Figure 11: *A plan view radiograph of an artificially filled natural hollow pearl. The filler is metallic in nature and is therefore opaque to X-rays, and is revealed as the white area in the centre of the pearl.*

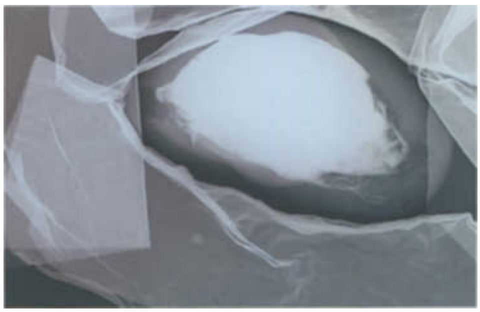


Figure 12: *Side view radiograph of the artificially filled natural hollow pearl in Figure 11.*

Figure 13: *The radiograph of a drop-shaped natural hollow pearl filled with urea formaldehyde resin.*

Figure 14: *A pearl- and gem-set brooch, which was radiographed in order to determine the origin of the pearl. © J. Boghossian.*

based on the evidence from the radiograph and visual examination of the internal cavity via the drill-hole. If the filling material is opaque to X-rays, in general this means it is metallic, then its presence is obvious on the radiograph (*Figures 11* and *12*). If the filler has the same radiolucency as nacre the only clue to its presence is the absence of growth structure within cavity area – the radiograph of a drop pearl (*Figure 13*) reveals an even central area where a urea formaldehyde resin had been used to fill the natural cavity. The interpretation of the radiographs can be complicated by small amounts of cement debris being present within the cavities of hollow pearls. The brooch in *Figure 14* was radiographed (*Figure 15*) and revealed several pins holding the pearl in place. In this case the traces of cement debris associated with the pin drill-holes were not significant enough to be considered as a filling, so it was reported as being a partially hollow natural pearl.

Figure 15: *The radiograph of the brooch in Figure 14 showing the traces of cement around the pins in the drill-holes.*

Grey/black stained pearls

The staining of natural or cultured pearls with silver nitrate can be established by the detection of silver by trace element analysis, or radiographically by the concentration of silver in the thin growth gaps between nacreous layers and/or between the nacre and a cultured pearl nucleus (observed as thin white lines on the radiograph negative).

Figure 16: *Silver concentrated in an imperfection on the surface of a stained cultured pearl.*

Figure 17: *Silver concentrated within the surface interstices of a stained natural pearl.*

On occasions the silver concentrates around surface imperfections (*Figure 16*) can be observed with a 10x lens. Another form of silver concentration was encountered in a stained natural pearl where the stain preferentially entered interstices all over the surface of the pearl, which produced the observed wavy pattern (*Figure 17*).

Both of these 'pearls' displayed the brownish colour revealed by silver stained pearls (*Figure 18*) when illuminated by a fibre optic light (Kennedy, 1996). Please note, however, that lower quality Tahiti cultured pearls and some natural pearls will appear a similar colour.

Figure 18: *Three cultured grey/black pearls illuminated by fibre-optic light. The upper pearl is a naturally-coloured Tahiti cultured pearl and the two lower pearls are stained cultured pearls. The latter two pearls appear a brownish colour in comparison to the naturally-coloured one above.*

Claim and counterclaim

Occasionally the laboratory is contacted from abroad by the owners of gems who have been led to believe that they possess something quite unique. Some while back a gemstone arrived from the Far East with the customer believing he had a painite – unfortunately it was quickly determined to be an orange/red synthetic flame fusion sapphire.

More recently a 536.5 ct stone was delivered to the laboratory, which had reportedly been cut from ruby rough obtained in East Africa. It was an orange/red colour and had a brilliance that belied its claimed origin. The stone had supposedly been subjected to some sort of elemental spectroscopy technique, which showed the stone to consist mainly of aluminium, hence furthering the belief that the stone was a corundum. The RI of the stone was over the 1.79 limit imposed by the RI of the contact fluid. Unfortunately its size made it impossible to fit into the Brewster angle meter. The hydrostatic determination of its SG at 5.99, the fact that it was singly refracting or isotropic in nature (on the polariscope it displayed a wonderful strain pattern) and its RI being greater than 1.79, proved it to be synthetic cubic zirconia. The client was offered an X-ray powder diffraction anaysis if it was deemed necessary to refute the claimed elemental spectroscopy analysis but our conclusion was accepted without any further testing.

Interesting synthetics

Synthetic sapphire

In the absence of bubbles or curved striae in yellow and orange flame-fusion synthetic sapphires it is common to search for Plato lines as proof of synthetic origin. The method requires the stone to be immersed in di-iodomethane and viewed down the optic axis between crossed polars. The Plato lines are seen as intersecting black shadow lines, which have been attributed to glide planes related to the build up and release of stress within the synthetic boule (Hughes, 1997).

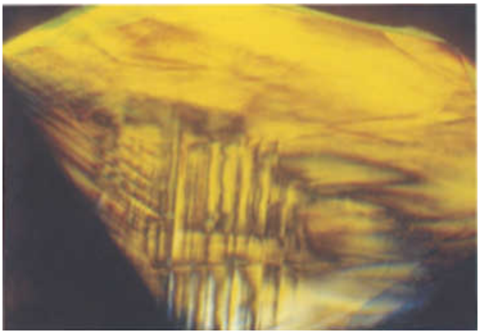


Figure 19: The Plato lines in a synthetic yellow sapphire. The stone was immersed in di-iodomethane and viewed down its optic axis on a microscope between crossed polars.

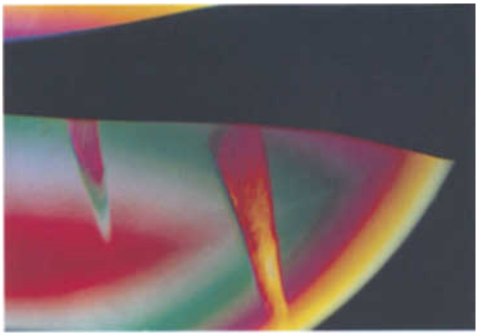


Figure 20: The wedge-shaped twinning seen in a synthetic amethyst observed on a microscope between crossed polars.

Recently, an oval yellow synthetic sapphire revealed the sharpest Plato lines that we can remember seeing (*Figure 19*) and also displayed the 120° or 60° angle between the lines very well.

Synthetic amethyst

A parcel of large amethysts was submitted for testing as the client was suspicious that the stones were synthetic. This was confirmed and one of the stones, interestingly, displayed the typical wedge-shaped twinning (*Figure 20*) seen in synthetic quartz (Koivula and Fritsch, 1989).

Synthetic spinel

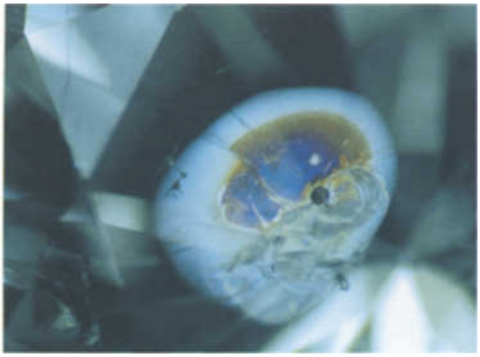
It is generally known that synthetic flame fusion spinels are normally devoid of inclusions, so it was unusual to observe curved growth bands and stringy air bubbles in a green synthetic spinel (*Figure 21*).

Figure 21: Curved growth bands and bubbles observed in a synthetic green spinel.

Diamond treatments and simulants

The presence of glass fracture-filled diamonds on the market has led to an increase in stones submitted by anxious owners who have seen colour flashes in their diamonds. The two stones in *Figures 22* and *23* are typical of untreated diamonds – the open or internal fractures display the sequential rainbow colours expected for iridescence at the thin films that these air-filled fractures generate, which contrast with the more garish monochromatic colours generated by glass-filled fractures (Koivula *et al.*, 1989).

Last year a trading standards officer from one of the UK city councils attended one of our one day courses on the identification of diamond simulants including synthetic moissanite. A few months later he sent what he believed to be two synthetic moissanites to us. He was very pleased with himself to be proved correct. The sad thing about these two stones was the fact that someone had resorted to a hardness test evidenced by the scratches on the tables of both stones (*Figure 24*), caused by a diamond being drawn across them. Unfortunately, due to the differential hardness of diamond, it would be possible for a diamond to be scratched if the 'hard' direction of a diamond is drawn across the 'soft' direction of another diamond (Read, 1999). So the damage caused to the



Figures 22 and 23: *The iridescence seen in air-filled fractures of diamonds.*

two synthetic moissanites cannot even be said to have provided conclusive evidence. How much simpler to look for the doubling of the back facets in a synthetic moissanite to differentiate it from singly refractive diamond.

In the majority of enquiries concerning gem-set jewellery, a customer is happy for diamond simulants to be reported as not being diamond. One customer was importing a range of watch cases with a surround of what were claimed to be Russian diamonds, and sent a sample watch case to us for testing. In their backed setting, we verbally informed the customer that they were not diamonds. However, the customer decided that an exact description for the stones was needed. Our first impressions of the stones led us to believe that they might be artificial glass due to the rounded facet edges and chalky green/blue fluorescence. Once a stone had been unset our first impressions were proved incorrect, since the stone had an RI of more than 1.79. An accurate SG determination was impossible due to the small size of the stone, so a single crystal diffraction pattern from the whole stone was obtained and indicated that the stone was synthetic cubic zirconia. We have subsequently seen more cubic zirconias with these more rounded facet edges.

Figure 24: *Scratches on the table of a synthetic moissanite.*

Diffusion treatment of corundum

Two sapphires, weighing 1.86 ct and 3.02 ct, were found to have inclusions indicating natural origin. The stones were checked under diffused lighting conditions for the tell-tale evidence of diffusion treatment. The evidence for the prevalent diffusion treatment is for the facet edges to show a higher concentration of blue colour in comparison to the centre of the facets (Kane *et al.*, 1990). However, the immediately noticeable feature of these stones was that the reverse situation occurred; the facet edges are picked out as being lighter compared to the rest of the stone (*Figures 25* and *26*). The clue that revealed that this was a known treatment was the observation on the surface of the 'sapphires' of blue blotches, a similar effect to that observed by Johnson and Koivula (1998) in 'diffused' blue/green topaz. This was supported by the presence of the same sort of cobalt spectrum, although in one sapphire with an appreciable chromium content the cobalt peaks were difficult to distinguish due to the underlying chromium aborption spectrum.

Richard Pollak of United Radiant Applications in Del Mar, California, who invented the diffusion process for topaz (Johnson and Koivula, 1998), has confirmed that the same process is being applied to sapphire. A cobalt-doped diffusion treatment was reportedly applied to natural corundum in 1984 (Kane *et al.*, 1990) on an experimental basis. A cobalt-diffused process has been applied to pale blue synthetic sapphires and light pink synthetic sapphires by HRI International Corp. of Middletown, NY (Koivula *et al.*, 1994). However, the nature of the diffusion processes and their effects are not mentioned in either of these references.

In the 'topaz-type diffusion process' the stippling or blotchiness effect is difficult to photograph but relatively easily observed with diffused lighting on a microscope. The same lighting conditions are needed to differentiate the more saturated facet faces from the less saturated facet edges – immersion may also be useful for observing the effect. Two pits below the girdle of the larger stone reveal that the diffusion process also stops short of pit edges, but does diffuse into the bases of the pits themselves. The chromium content of this stone makes it appear red on the microscope although in daylight it is a blue stone and the 'diffused deposit' is also blue. In *Figure 27* the pits appear a grey/blue against the red body colour, and the facet and pit edges stand out as lighter in colour than the rest of the stone – indicating that the diffusion process had stopped short of the pit and facet edges.

Figure 26: *Another view of the same surface-diffused corundum shown in Figure 25.*

Figure 25: *Pavilion view of the smaller surface-diffused corundum. The facet edges stand out as lighter in colour from the rest of the stone (diffused lighting conditions or immersion necessary). The parallel colour zoning is an internal feature related to the growth of the sapphire.*

In the Laboratory Report, the same result was given for these stones as for the better known diffusion process, namely 'Found to be Treated Corundum – the colour has been artificially produced by diffusion treatment'. This form of diffusion treatment of corundum seems to be relatively recent and needs to be added to the checklist of features for identifying corundum.

Figure 27: *The larger surface-diffused corundum, which although being blue in daylight has a red hue on the microscope due to its chromium content. The pits below the girdle reveal that the diffusion process stops short of the pit edges but does diffuse into the bases of the pits themselves.*

Acknowledgements

My thanks to Li Liping of Wuhan University for taking me to see the freshwater cultured pearl farm in China. Thanks also to Jean Boghossian for allowing the photograph of the pearl brooch to be published. Thanks also to Al Tajir of Dubai, the owner of the Pearl of Asia, for permission to use the photograph.

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A glass imitation of blue chalcedony

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ABSTRACT: A new artificial product on the Taiwan gem market, light blue translucent glass, is described and compared to natural blue chalcedony, blue opal and stained chalcedony. The gemmological characteristics of the materials are given and compared. Chemical ED-XFA tests indicate relatively high Na, Ca and low Al values in the glass compared with gemstones of the silica group, and also with such contents in natural glasses. IR spectra of the artificial glass and chalcedony are also quite different. Wollastonite was identified by Raman spectroscopy as a devitrification product forming fine felty fibres or small crystals up to 1 mm thick; they define the degree of translucency of this artificial calcium glass.

Keywords: Taiwan, blue chalcedony, glass imitation, wollastonite, ED-XFA

Introduction

Blue chalcedony is one of the most precious local gemstones in Taiwan. It occurs as irregular small veins in andesitic agglomerate north of Taitung, eastern Taiwan. After having been mined for decades, the deposits are now almost exhausted. Supplies therefore are scarce and many imitations of blue chalcedony are on the market, such as dyed blue chalcedony, dyed blue quartzite and blue opal. In 1998 we found another material resembling blue chalcedony on the market which was declared to originate from China. In the course of our study it turned out to be an artificial blue glass *(Figure 1)*. Natural glasses have been encountered as obsidians, tektites and moldavite (see, for example, Tsai and Wu, 1997).

Figure 1: *A 12.50 ct cabochon-cut glass imitation of blue chalcedony from Taiwan. The 17 mm long sample shows horizontal banding and perpendicular fibrous pattern. Photo by H.A. Hänni, SSEF.*

 ISSN: 1355–4565

The properties of blue chalcedony

Chalcedony is described as a fibrous aggregated form of silica which merges into agate when the banding becomes prominent (Webster, 1983). The microstructure of the sheaf-like fibre array (botryoidal structure) of silica allows some porosity in which natural or artificial pigments can impart colour. The whole structure of this cryptocrystalline material produces, depending on the direction of view, a more or less easily visible banded or polygonal pattern when inspected in transmitted light.

The properties of blue chalcedony from Taiwan have been widely studied by, for example, Huang (1965 and 1982), Chen (1969) and Chen and Zen (1982). So far we have not found any western reference for Taiwan blue chalcedony. The papers conclude that the colour of the Taiwanese blue chalcedony is usually homogeneous sky blue to greenish-blue, the material being semi-transparent to opaque, with a conchoidal fracture. The RI is 1.539, and SG is 2.58. A copper content of 0.01 to 0.02% has been reported, and a small uranium content of 0.002 to 0.0035 %wt gives rise to minor radiation (Huang, 1965).

Imitations

Imitations are substances that may substitute a given gemstone and may be natural gemstones or artificial products. Usually imitations are of lesser value than those that they imitate. The most popular imitations of natural blue chalcedony are dyed blue chalcedony, dyed blue quartzite and blue opal, but the new product described in this paper may also be convincing. Other substances to substitute for blue chalcedony are imaginable such as pectolite (Woodruff and Fritsch, 1989) or hemimorphite (Moses *et al.*, 1998), both of sky-blue colour with a definite structure. The properties of these imitations are listed in *Table I* and some examples in comparison are shown in *Figure 2*.

Figure 2: From left to right: (back) imitation blue chalcedony (glass), dyed blue quartzite, dyed blue chalcedony, (front) natural blue chalcedony (Taiwan), natural blue chalcedony (Taiwan), blue opal (Peru). Photo by H.A. Hänni, SSEF.

Most of the dyed blue chalcedony is free of inclusions and has a homogeneous colour distribution besides a faint 'agate' banding. Such a weak banding structure can be found in most chalcedony (*Figure 3*). Under a Chelsea filter the dyed material appears

Table I: *The properties of blue chalcedony and its imitations.*

Gemstone	*RI (spot reading)*	*SG*	*Hardness*
Blue chalcedony	1.53	2.58	6.5
Dyed blue chalcedony	1.53	2.60	6.5
Dyed blue quartzite	1.54	2.65	7
Blue opal	1.45	2.15	6
Sky-blue glass (chalcedony imitation)	1.54	2.57	5
Pectolite	1.60	2.81	5
Hemimorphite	1.62	3.45	5

reddish-brown. Since RI and SG are the same for the natural and treated blue chalcedony, we cannot distinguish them on the basis of these two properties.

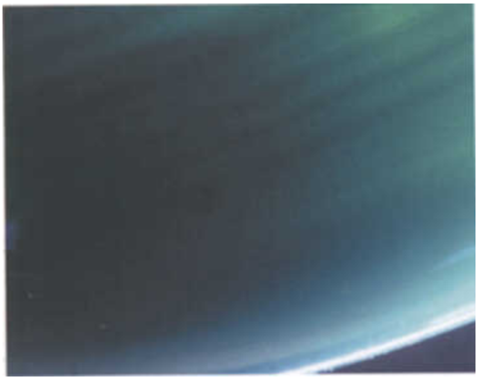

***Figure 3:** Banding structure of dyed blue chalcedony. The banding of chalcedony is usually finer and more homogeneous, whereas bands in the imitation (Figure 1) appear more structured by parallel fibres. Photo by S.T. Wu.*

Dyed blue quartzite possesses a slight porosity which allows the staining to penetrate along grain boundaries. Such material shows concentrations of dye between the quartz grains which are easy to detect when a penlight is used (*Figure 4*). The SG of quartzite is 2.65 which is distinctly higher than that of blue chalcedony (2.58).

***Figure 4:** In dyed blue quartzite the colour is always concentrated on grain boundaries and along fractures. Length of the stone is 8 mm. Photo by S.T. Wu.*

Blue opal usually shows jelly-like inclusions (*Figure 5*) which may look similar to some inclusions in natural blue chalcedony (*Figure 6*), but with its RI of 1.45 and SG of 2.15 it can be distinguished from chalcedony. Blue opal appeared on the market some years ago and has been reported from Chile (Koivula and Kammerling, 1991) and Peru (Milisenda, 1995).

***Figure 5:** Jelly-like inclusions in blue opal from Peru. Length of the stone is 8.6 mm. Photo by S.T. Wu.*

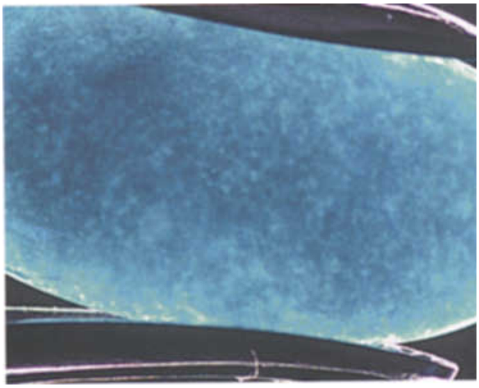

***Figure 6:** Jelly-like inclusions in natural blue chalcedony from Taiwan. Length of the stone is 14 mm. Photo by S.T. Wu.*

Artificial blue glass

Artificial blue glass as an imitation for opaque or semi-transparent stones, such as lapis lazuli (Bosshart, 1983) or blue chalcedony could only be a convincing imitation when it is not transparent but has

***Figure 7:** Raw material of the sky-blue imitation stone, apparently glass slag. Length of piece is approximately 20 cm. Photo by S.T. Wu.*

the same degree of translucency as the substance it is imitating. In order to make a glass translucent rather than transparent, its composition has to include some components that will oversaturate the melt and form crystals when the glass cools down. The process of devitrification may then allow the formation of, for example, devitrite, apatite, wollastonite, or fluorite and cristobalite, in the glassy groundmass (Hammer *et al.*, 1999). Such crystals can render a glass milky through to opaque (Bosshart, 1983; Harding *et al.*, 1989). The range of SG and RI values of artificial glass were shown by Webster (1983) in a diagram modified after Bannister.

***Figure 8:** Three types of sanded samples of blue glass from Taiwan, with decreasing sizes of fibrous inclusions (coarse, medium, fine) correlating with decreasing transparency. A polished cabochon on the left is 17 mm long. Photo by H.A. Hänni, SSEF.*

Macroscopic description

The pieces of rough glass are up to 20 cm across (*Figure 7*); they are inhomogeneous and consist of massive glass with what appears to be a slaggy top zone. Most of the glass is dark or sky blue, but next to the slaggy zone it is green. The degree of transparency is also not uniform. Most of the material is cut into cabochons or bangles. They vary in colour from light sky blue to dark sky blue and range from semi-transparent to semi-translucent (*Figure 8*).

The raw material available for investigation consisted of three different

Glass imitations of blue chalcedony

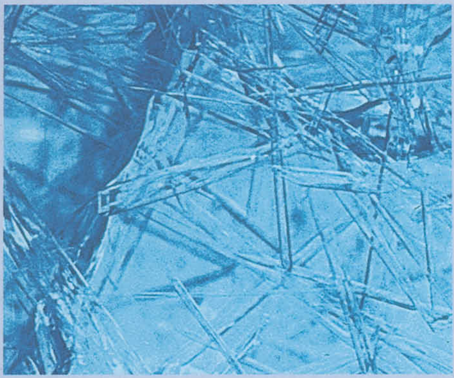

Figure 9: Sample A: Partially devitrified, and containing relatively coarse wollastonite crystals. Magnification approximately 15x. Photo by H.A. Hänni, SSEF.

Figure 10: Sample B: Partially devitrified, with medium sized wollastonite crystals. Magnification approximately 15x. Photo by H.A. Hänni, SSEF.

Figure 11: Sample C: Partially devitrified with very fine wollastonite crystals in a banding pattern. Magnification approximately 15x. Photo by H.A. Hänni, SSEF.

types, varying in their degree of transparency.

Sample A is semi-transparent and of darker blue colour than the other two types. It contains needle-shaped crystals in random orientation, which are clearly visible at 10x magnification (*Figure 9*).

Sample B is lighter in colour and more milky than sample A. Its inclusions cannot be resolved individually at 10x, but a few oddly shaped bubbles may be visible (*Figure 10*).

Sample C is light blue and almost opaque. Patterns of white banding are eye-visible and are confined to sectoral areas (*Figure 11*).

Microscopic description

With a magnification of 10x to 50x the imitation stones display features not expected from their macroscopic appearance. The darker blue and semi-transparent material A contains needle-shaped crystals and inclusions, randomly oriented. They have a four-sided cross-section and may be hollow or filled with glass (*Figure 9*). The medium blue variety of glass B shows similar but finer needles (*Figure 10*); gas bubbles are not common. The light blue variety C is almost opaque and contains dense aggregates of very fine needles. They are arranged as radiating bunches or form a kind of zebra banding (*Figure 11*). Gas bubbles or swirl marks may be hidden by the dense pattern of these inclusions.

Physical data

The RI of 1.54 and SG of 2.57 are values close to those of blue chalcedony. These data are shown in *Table I* with comparable data from other imitations.

The semi-transparent variety A of the glass showed a homogeneous aggregate structure under the polariscope. Under the Chelsea

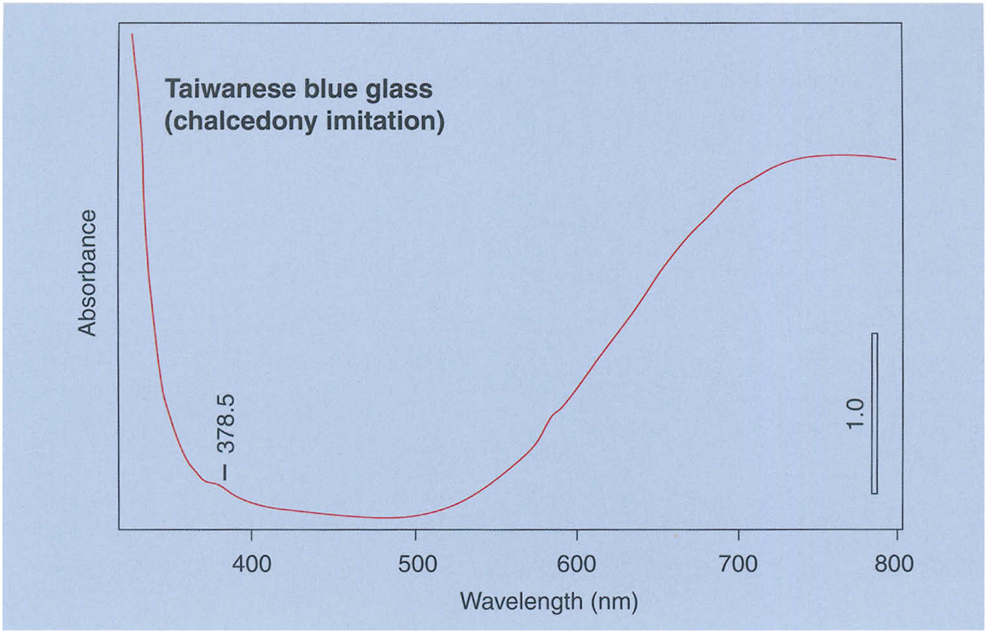

Figure 12: Blue glass chalcedony imitation absorption spectrum from 300-800 nm recorded on a Varian Cary 500 Scan spectrophotometer. The main transparent area is between approximately 400 and 500 nm (blue colours).

filter, the imitation stones appear green. With a hand-held spectroscope no spectral lines were observed. The UV-VIS spectrum recorded with a Varian Cary 500 Scan spectrophotometer is shown in *Figure 12*. It is characterized by general transmission between approximately 350 and 550 nm, and a weak absorption at 378 nm.

UV-reaction

In long-wave UV, the glass imitation stones showed weak bluish-white to

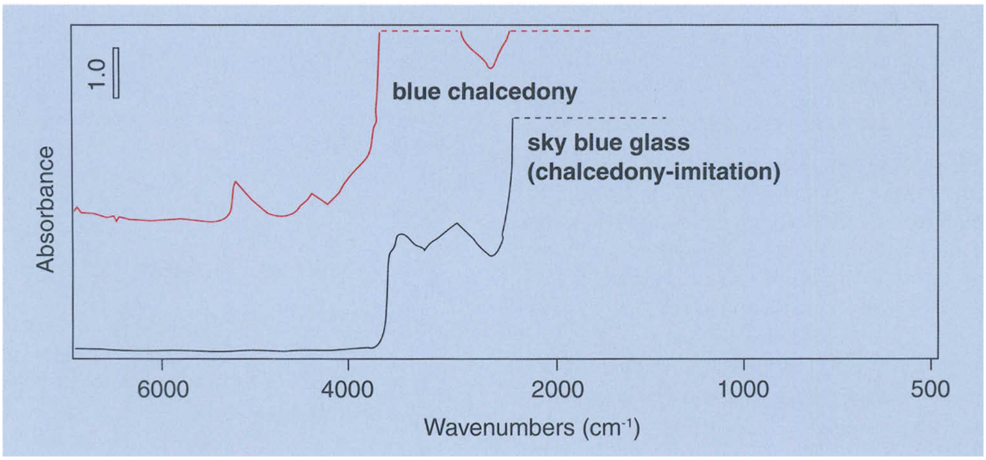

Figure 13: Infrared absorption spectra of blue chalcedony and its glass imitation recorded on solid samples. The spectra show characteristic differences.

yellowish-green luminescence, and moderate to strong yellowish-green luminescence in short-wave UV.

Infrared spectroscopic determinations

The infrared spectrum of natural blue chalcedony is shown in *Figure 13 upper*. The curve indicates complete absorption from 400 cm-1 to 2398 cm^{-1}, and strong absorption between 2689 cm^{-1} and 3758 cm^{-1} with two absorption bands at 4434 cm^{-1} and 5231 cm^{-1}.

The sky-blue glass imitation stones (B and C) have two absorption bands at 2927 cm^{-1} and 3464 cm^{-1} (*Figure 13 lower*) and lack peaks in the 4-5000 cm^{-1} region, a spectrum clearly different from that of blue chalcedony.

With a powder method where imitation glass is ground and mixed with KBr, we also found that the most important features of the infrared spectrum are the same as those of artificial glass (*Figure 14*): both have strong absorption in the 'fingerprint' area at 1053 cm^{-1} and pairs of small absorption bands at 651, 776 cm^{-1}, and 2932, 3450 cm^{-1}.

Chemical analyses

In order to obtain further information about the blue glass imitations, their chemical composition was investigated with a Tracor ED-XFA. The chemical analysis had first a qualitative character and helped to rule out the claim that the blue stones were chalcedony. A standardization for a semi-quantitative major element determination was done with artificial glass reference samples from the glass industry by conventional wavelength dispersive X-ray fluorescence spectrometry WDS-XFA

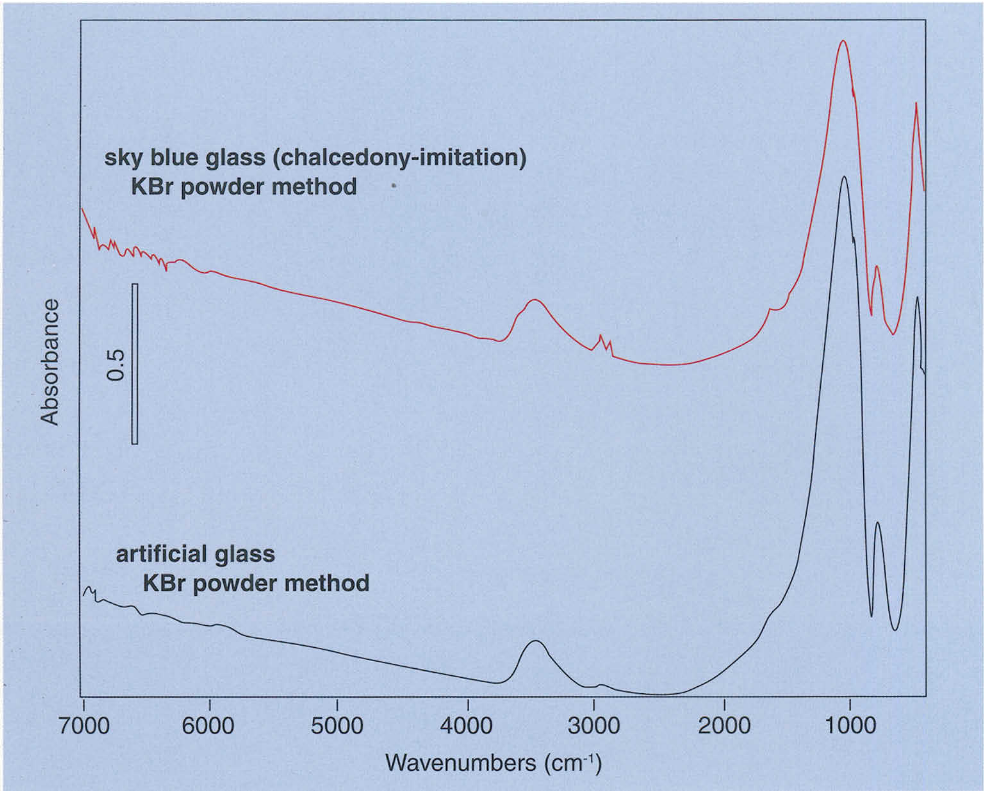

Figure 14: *Infrared absorption spectra of chalcedony imitation and window glass using a powder method with KBr tablets. The spectra show no significant differences.*

Table II: *Chemical composition of natural and artifical glass*

Oxide (%wt)	SiO_2	Al_2O_3	MgO	CaO	K_2O	Na_2O	TiO_2	Fe_2O_3	MnO	Cr_2O_3
Industrial glass references (WD-XRF analyses by J. Cerny)										
Olive standard	71.68	1.96	2.88	10.1	0.51	12.44	0.05	0.10	n.a	0.01
Brown standard	69.65	2.15	3.03	9.73	1.35	13.64	0.05	0.30	n.a	0.03
Green standard	71.57	1.65	2.12	10.29	0.67	12.71	0.06	0.33	n.a	0.22
Dark brown standard	78.02	2.27	2.45	10.43	1.09	12.38	0.06	0.29	n.a	0.03
Natural glass references (EMP analyses by H. Schwander)										
Obsidian Mexico	75.13	12.46	n.d.	0.25	4.75	5.24	0.08	2.01	0.08	n.d.
Obsidian USA	74.61	12.77	n.d.	1.12	5.74	4.50	0.15	1.04	0.08	n.d.
Tektite Thailand	75.13	12.93	0.96	2.32	2.51	0.29	0.61	5.09	0.15	n.d.
Moldavite CS	76.59	9.80	2.07	5.22	4.02	n.d.	0.27	1.75	0.29	n.d.
Taiwanese blue glass (ED-XRF analyses by P. Giese)										
Imitation rough (Sample A)	73.30	0.34	3.85	9.11	0.26	12.98	0.02	0.14	0.01	n.d.
Imitation rough TL (Sample B)	73.01	0.33	3.86	8.54	0.26	13.83	0.02	0.14	0.01	n.d.
Imitation rough TL (Sample C)	72.97	0.45	3.86	9.13	0.31	13.09	0.02	0.17	0.01	n.d.
Natural samples (ED-XRF analyses by P. Giese)										
Dyed quartzite	99.86	n.d.	n.d.	0.09	0.04	n.d.	n.d.	n.d.	n.d.	n.d.
Dyed chalcedony	99.98	n.d.	n.d.	0.02	0.03	n.d.	n.d.	0.01	n.d.	0.06
Blue opal	98.71	0.10	0.03	0.33	0.09	0.73	0.01	n.d.	0.01	n.d.
Taiwanese blue chalcedony	99.62	n.d.	n.d.	0.07	0.03	0.24	0.01	n.d.	0.04	n.d.
Taiwanese blue chalcedony	99.68	n.d.	0.11	0.11	0.05	n.d.	n.d.	0.01	0.04	n.d.

n.a. = not analysed   n.d. = not detected   Chemical data analysed by WD-XRF and ED-XRF are semi-quantitative; EMP data are quantitative.

Raman spectroscopic identifications

The Raman microspectrometer system (Renishaw 1000) is an excellent instrument for the mineralogical distinction of materials of similar appearance such as the blue chalcedony, stained quartzite, pectolite (larimar), blue hemimorphite, opal or glass (see also Hänni *et al.*, 1997). It is also excellent for identifying inclusions, so the method was used to identify the devitrification products in the blue glass (*Figure 15*). The Raman spectrum of a crystal inclusion (*Figure 16*) was matched with that of natural wollastonite in the SSEF Raman Data Search File, and confirmed its identity.

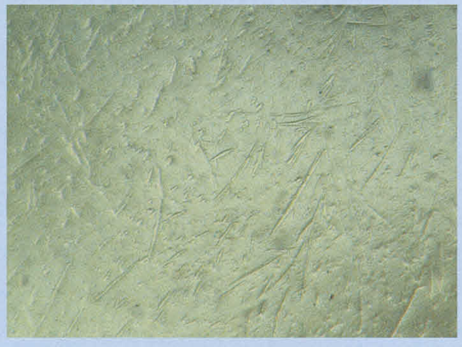

***Figure 15:** Surface of blue glass showing devitrification texture indicated by the wollastonite crystals. Some slender crystals are hollow. Magnification approximately 30x. Photo by H.A. Hänni, SSEF.*

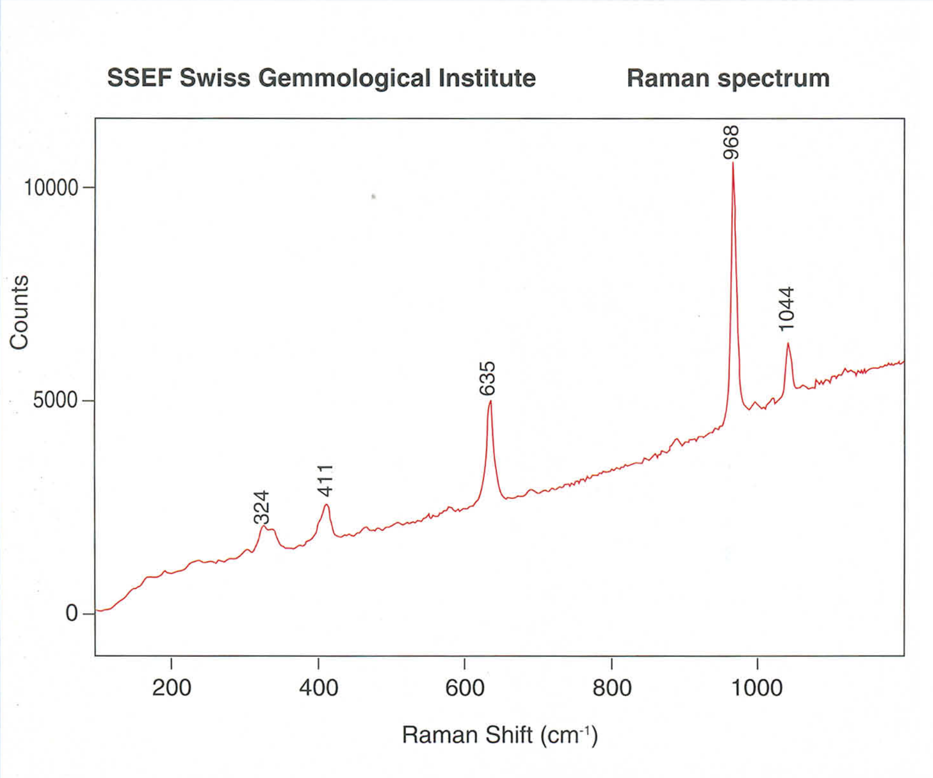

***Figure 16:** Raman spectrum of wollastonite crystal in blue glass.*

(Vetroconsult, Bülach, Switzerland). Natural glass samples of obsidian, tektite and moldavite had earlier been analysed by electron microprobe (Geochemical Laboratory, Basel University). The blue glass samples described in this paper were analysed by energy dispersive spectrometry, X-ray fluorescence analysis (EDS-XFA) at SSEF. The results are presented in *Table II.* Cu, Fe and As were found in trace quantities in the blue chalcedony imitation. The natural glasses are richer in Al, K and sometimes Fe, but poor in Ca. In contrast, the artificial glasses are richer in Ca, occasionally also in Na and relatively poor in Al (Weiner, 1983). This is because in the manufacturing of artificial glass Na, Ca, B or Li may be added in order to bring down the melting point.

The blue imitation glass is richer in Ca and Na and poorer in Al than natural glasses, proving its man-made origin and indicating that it belongs to the group of calcium glasses.

Discussion

The glass imitation of blue chalcedony is in many respects similar to natural chalcedony. A close microscopic inspection may however reveal the bundles of randomly oriented devitrification products, which in the lesser transparent material are in bunches or as radiating aggregates. Needles ordered in bands may give a zebra pattern to the sky blue material. The RI and SG of the glass are close to the values of chalcedony. Additional identification features lie in the infrared spectrum where the peak positions are typical for glass; chalcedony peak positions are quite different.

A chemical characterization of the material is most effective since it shows the compositional difference between chalcedony and natural glasses. The ED-XFA results obtained are typical for a calcium glass. The precipitation of wollastonite as a devitrification product is a result of the high calcium content of the material. Traces of Cu and Fe are responsible for the blue colour, traces of As are recommended in the manufacturing to reduce gas bubbles. It is possible that the blue glass is an industrial waste or slag, as proposed by Johnson *et al.* (1999). The relatively small amount of this product in the market is consistent with such an origin.

Conclusions

The described glass imitation of natural blue chalcedony is a convincing substitute which may intrigue gemmologists because of the similarity of their properties. When mounted, the identification of such stones could create difficulties. However, observation of microscopic features such as radiating fine or irregularly displaced coarser fibres of devitrification products, UV reaction and chemical differences, allow a safe identification. The sky blue stone is richer in Ca, Na and poorer in Al than natural glasses and indicates that it is artificial glass.

Acknowledgements

We thank Mr M.L. Lee for providing the blue chalcedony samples, and Ms S.F. Wang and Mr C.C. Huang for the samples of sky blue imitations. The standardization of ED-XFA glass analyses was carried out by Mrs J. Cerny of Vetroconsult (Bülach, Switzerland) and Professor W.B. Stern (Geochemical Laboratory, University of Basel) whom we thank also for fruitful discussions of the topic. We thank Mr P. Giese for analytical ED-XFA work and Dr M. Krzemnicki for graphic refinement, both of the SSEF Swiss Gemmological Institute in Basel.

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Ornamental granite from Ailsa Craig, Scotland

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ABSTRACT: Ailsa Craig granite, a distinctive arfvedsonite-aegirine-microgranite, has achieved international distinction as the premier raw material used for the world's finest curling stones. The geomechanical attributes of the granite that make for superior curling stones also make it an ideal stone for ornamental pieces and curling jewellery. Carefully selected material is amenable to processing using conventional lapidary equipment, and fine grain size together with uniform texture result in even polished surfaces. Although quarrying operations on the island effectively ceased in 1973, Ailsa Craig granite remains the foremost stone associated with the ice-sport of curling. This traditional reputation has combined with increasing scarcity to provide the basis for development of a niche market for highly prized curling trophies and jewellery items.

Keywords: Ailsa Craig, curling, microgranite, Scotland

Introduction

Granites are well established as construction materials and building stones, but are almost never considered for jewellery applications. However, an unusual microgranite from Ailsa Craig, Scotland (*Figure 1*) has gained international esteem and acceptance for certain special jewellery and ornamental pieces, interest being fostered by its traditional association with the ice-sport of curling.

Curling originated as a winter game in Scotland in the 16th century. Players in teams slide hefty, circular, handle-topped stones across a sheet of ice towards a target zone. The stones each weigh almost 20 kg. The objective is to deliver a greater number of stones closer to the centre of the target zone than the opposing team. Today, curling is played worldwide and the sport gained Olympic status in 1998 (*Figure 2*).

Figure 1: *Ailsa Craig, orientation map.*

 ISSN: 1355–4565

Figure 2: The ice-sport of curling underway at an indoor rink. Great Britain Womens' Team in action at 1998 Olympic Winter Games, Nagano, Japan.

Rock employed for curling stones must possess special geomechanical properties, not only to provide the appropriate running characteristics over the ice-surface, but also to withstand impact damage during collisions with other stones around the target zone. Ailsa Craig granite is one of the original rocks employed in curling stones. More importantly, it is widely acknowledged amongst the curling fraternity as the pre-eminent rock for curling stones.

The production of ornaments using Ailsa Craig granite also has a long history, having been developed by the early manufacturers of curling stones as a means of utilizing residual stone, reject material or otherwise wasted stone. The principal ornamental objects are miniature curling stones of various sizes (*Figure 3*). Not surprisingly, these miniature stone pieces are frequently awarded as trophies at curling competitions. Interestingly, Ailsa Craig microgranite also appears together with agates and other hardstones in 19th-century Scottish brooches and other jewellery material.

Geological setting

Ailsa Craig is a precipitous, rocky island in the Firth of Clyde that forms a prominent landmark some 14 km off the southwest coast of Scotland. It measures approximately 1.2 km in diameter, occupies nearly 105 ha and rises steeply to almost 340 m above sea level (*Figure 4*).

Geologically, the island comprises an igneous boss of fine-grained granite emplaced in Tertiary time (61-62 Ma, Rb/Sr; Harrison *et al.*, 1987) into red sandstone strata (Mauchline Sandstone equivalents) of Permian age. The granite mass varies from a pale grey, dense microcrystalline and even textured leucogranite, to a slightly coarser and less dense rock with prominent dark patches. It is cut by steeply dipping joints and intruded by vertical dykes of dolerite.

The leucomicrogranite is the principal rock exploited for curling stones. However, except for the occasional collection of loose rocks, formal quarrying of stone products at Ailsa Craig effectively ceased in 1973. Since that time, the manufacture of curling stones

Figure 3: *Miniature curling stone made of granite from Ailsa Craig.*

has been sustained partly from diminishing stockpiles, but predominantly from granite deposits elsewhere in the world.

The former quarrying sites for curling stones on Ailsa Craig lie on the northwest coast of the island. Curling stone production was carried out almost entirely by hand-working methods (Anon, 1961). Due to closure of the quarries on the island, worn or broken curling stones made from Ailsa Craig granite are increasingly in demand for recycling, either as inserts for the purpose of refurbishing stones or as raw material for making ornaments and jewellery.

At the present time the island is uninhabited and designated a Special Protection Area in relation to its international importance for breeding seabirds. Its rocky shore and cliff habitats support colonies of gannets, guillemots, razorbills, kittiwakes and myriad other seabirds.

Composition

The granite that forms Ailsa Craig is a rare peralkaline variety with an unusual mineralogy that includes arfvedsonite, aegerine, aenigmatite and glauconite-celadonite (Howie and Walsh, 1981; Harding 1983; Harrison *et al.*, 1987).

The granite consists predominantly of small (c. 1-3 mm) phenocrysts of sodic orthoclase, oligoclase and quartz in a groundmass of sodic orthoclase and interstitial quartz, and with poikilitic patches of riebeckitic arfvedsonite. The feldspar commonly shows much cloudy alteration. Aegirine and aenigmatite are present in small quantities, whereas magnetite, fluorite, glauconite-celadonite, zircon, monazite, rutile, apatite, brookite and pyrite occur spasmodically in trace amounts. Drusy cavities form a conspicuous petrographic feature of the granite and throughout the mass, these vary in size, abundance and mineral filling.

Figure 4: *Ailsa Craig, view looking southwards. The old quarries in leucomicrogranite for curling stones lie in the lower middle foreground. IPR/9-4C British Geological Survey.*

Physical features

Ailsa Craig granite is typically light grey (N7) in colour, although polished surfaces of certain stones may exhibit subtle blue (Ailsa blue-hone), brown, pink or green hues. The green hue predominates throughout much of the granite, whereas the distinctive Ailsa blue-hone, renowned for superior curling stones, appears somewhat restricted in distribution to the leucomicrogranite areas on the upper and northeast parts of the island. Blue hue is attributed to the presence of riebeckitic arfvedsonite. Rare reddened patches are ascribed to hematite staining of granite in proximity to weathered intrusions of dolerite. Rectangular phenocrysts of white (N9) feldspar are prominent in places in the leucomicrogranite.

Granite outcrops of Ailsa Craig appear massive with widely spaced joints. The weathering state of the rock ranges from fresh to slightly decomposed. In addition, the fine grain size, unusual mineralogy and uniform fabric of the stone combine to create a rock of high strength, chemical stability and exceptional toughness.

The geomechanical properties of Ailsa Craig granite appear very uniform. It is an extremely strong rock with compressive strength values between about 350 and 380 MPa. Water absorption ranges up to 0.51%. Bulk density is typically 2.55 Mgm^{-3}, variable by perhaps 1% depending on precise mineral composition. For curling stones, the importance of bulk density relates to the need for stones of standard weights and dimensions. Skid Index measures skid resistance or polishability, and curling stones with low skid indices offer less resistance when sliding on ice. In addition, rebound performance of a stone under collision can be predicted from a qualitative assessment of the coefficient of restitution. Comparative data for some British granites are listed in *Table I*.

Not surprisingly, the physical properties inherent in superior curling stones also apply to various other applications such as sculptural, monumental and architectural stones. Indeed, Ailsa Craig granite has been employed at several prestige sites in Scotland. Prime examples include the National War Memorial within Edinburgh Castle and the floor of the Thistle Chapel within St Giles Cathedral, Edinburgh.

Processing

Ailsa Craig granite can be processed satisfactorily using conventional slabbing, trimming, tumbling and polishing equipment. A wide range of objects has been successfully fashioned, including pendants, earrings, tie pins, cuff links, watch fobs,

***Table I**: Physical properties of some British granites used for curling stones.*

Stone name	Locality	Density (Mgm^{-3})	Compressive strength (MPa)	Skid Index	Rebound property
Ailsa blue-hone	Ailsa Craig, Scotland	2.55	375	1	excellent
Ailsa common	Ailsa Craig, Scotland	2.55	232	1.09	fair
Trevor dark blue	Lleyn, North Wales	2.74	395	1.18	excellent
Trevor coarse-grain	Lleyn, North Wales	2.61	279	1.2	fair
Trevor pink	Lleyn, North Wales	2.67	371	1.15	good
Aberdeen grey granite	Northeast Scotland	2.66	242	1.1	fair
Lennoxtown essexite	Campsie Fells, Scotland	2.99	332	1.2	poor
Bonawe adamellite	West Highlands, Scotland	2.69	202	1.01	fair
Furnace grey granite	West Highlands, Scotland	2.56	302	1.09	good

Figure 5: *Fashioned granite from Ailsa Craig. A selection of curling jewellery pieces.*

brooches, paperweights, bookends, jewellery pieces and giftware items (*Figure 5*).

Careful selection of material is required in order to avoid specimens with minor voids or cavities that may result in pitting on the polished surface. Materials exhibiting patches of large white feldspar phenocrysts are also avoided for aesthetic reasons.

The variable grain composition may affect the polishing characteristics. The softer minerals, such as the feldspars, tend to undercut compared to the harder minerals such as quartz. However, as both are evenly distributed in the phenocrysts and groundmass of the rock and fine grainsizes predominate throughout, few irregularities on polished surfaces are discernible.

Conclusions

Ailsa Craig granite is a rare arfvedsonite-aegirine-microgranite, typically pale grey in colour and uniform in fabric. The granite is very dense and strong with a bulk density of 2.55 Mgm^{-3} and a compressive strength of 375 MPa.

Ailsa Craig granite has achieved international fame due to its association with the sport of curling and its reputation as the premier raw material for the worlds finest curling stones. Although the extraction of granite from quarries on Ailsa Craig effectively ceased in 1973, the reputation of the stone remains paramount. Traditional esteem together with increasing scarcity of supply has stimulated modern developments in the jewellery sector.

Due to increasing demand for curling trophies and items of jewellery that incorporate Ailsa Craig granite, broken or worn out curling stones will increasingly provide a valuable source of raw material.

An extensive range of ornaments, giftware and jewellery items is produced from Ailsa Craig granite using conventional lapidary equipment.

Acknowledegments

Thanks are extended to Kay Bonspiel for supplying various samples of Ailsa Craig granite used in this study. The World Curling Federation, the British Geological Survey and the Jewellery Division of Beam & Co supplied the photographs for *Figures 2, 4 & 5* respectively. Amco Robertson Mineral Services Ltd and the Royal Caledonian Curling Club kindly provided the author with access to information sources.

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The fashioning of rock crystal for spectacles in Sri Lanka

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ABSTRACT: Rock crystal has been a major component in the spectacle industry of Sri Lanka from ancient times. The remnants of the industry can still be seen today and this article describes the ancient spectacle industry, based on transparent quartz as the raw material. All stages of the manufacturing process and the primitive methods and instruments used in the industry are described in detail.

Keywords: Glass, lens, quartz, rock crystal, spectacles

Introduction

Spectacles are worn as a remedy for long- or short-sighted vision and for some other eye disorders. Sometimes spectacles are worn purely for style and today are made out of glass, plastic or polycarbonate. However, there are old spectacles found in Sri Lanka whose lenses are made from common rock crystal. The spectacle lenses described here are solely fashioned from rock crystal using the most primitive methods and are quite popular among those elders of Sri Lanka who suffer from eye ailments.

The history of the lens industry goes back many centuries. It is believed that the Chinese were the first to produce lenses, long before the trade was introduced to the West. The original lenses would probably have been made from rock crystal which was used in ancient times to kindle fire - thus it was known as fire glass. The Chinese made spectacles from rock crystal but the lenses were planar, lacking any curative effect, and the inference is that they were used for style rather than to correct astigmatism (Jones, 1995).

A unique reference to the use of spectacles during the Roman era was made by Pliny the Elder (23-79 AD), who wrote the following:

"Emeralds are usually concave so that they may concentrate the visual rays. The Emperor Nero used to watch in an emerald the gladiatorial combats."

This quotation appears to be the earliest publication mentioning the use of a monocle as a remedy for short sighted vision. Even though this would have been a success at the time and very many people could have witnessed the incident or read through the passage later on, there is no evidence to establish the fact that spectacles were in use during the next twelve centuries.

According to available data, the revival of a spectacle industry in the west occurred around 1280-1285 in Florence, Italy. Their popularity soon spread among people with defective vision, and some people gave the credit for their invention to a nobleman named Amati who died in 1317 (Jones, 1995).

Most people believe that the spectacle industry started in Asia before Europe. In Sri Lanka the industry is believed to have

 ISSN: 1355–4565

Figure 1: Raw material used in the spectacle industry to make lenses (smoky quartz).

started in 1346, in the famous Kandyan kingdom, and is preserved even to this day.

Today the trade is practised by a Mr Gunasoma who lives in Kahamba, a small hamlet which is situated about 9 km WSW of Kandy and 1 km from the Gadaladeniya temple in Sri Lanka. This temple is famous for its intricate wood carvings. Kahamba was once home to many craftsmen who were engaged in the spectacle trade for generations, but easier more lucrative careers that did not demand such intricate knowledge and craftsmanship induced most of them to quit the industry.

According to the folk-tales narrated among the present generation of craftsmen, they are the descendants of those ancient craftsmen who were the king's spectacle makers at the time of King Bhuvanekabahu IV (1346-1353), ruler of Sri Lanka during the Gampola period. At that time clear beryl was used to produce spectacle lenses, but now they use clear quartz. Even today they adopt the most primitive methods to make the spectacles and only the frame is modern. There is evidence that ancient spectacle frames were made of ivory and tortoiseshell. Some ivory and tortoiseshell spectacle frames which date back to the Kandyan era (during the 18th and 19th centuries) can be seen at the National Museum of Sri Lanka (document reference numbers 06-212-213 and 30-121-445). There is a belief in Sri Lanka that spectacles with natural rock crystal lenses can control a cataract if worn at the initial stages of the disease. Because of this belief, whether it is true or not, the traditional spectacle industry is still popular in Sri Lanka.

Figure 2: Industrial quality corundum crystals (abrasive material).

Materials and methods

Earlier clear beryl, called *tharippu* in Sinhalese, had been used as the raw material for lens making and this gave the name *Diya tharippu* to the spectacles, which is still in use today. Nowadays, due to the scarcity of clear beryl, clear quartz (some of it smoky) is used

Figure 3: *Grinding the quartz slice with a bow driven grinding wheel.*

Figure 5: *Bifocal lens (bifocal part constructed at the top owing to the limited capability of grinding implements used).*

as the raw material (*Figure 1*). Quartz is uniaxial positive, so in order to manufacture lenses as close to isotropic as possible, the quartz is cut perpendicular to the c-axis. Cutting is done by a manually operated circular blade of steel fed with corundum slurry and it takes about five to six hours to cut one quartz slice.

Abrasive powder

For cutting, grinding and polishing, home-made abrasive of varying fineness is used. In order to prepare this abrasive, industrial quality (not gem quality) corundum crystals (*Figure 2*) are first burned, then ground using a grinding stone and finally mixed with water to make a slurry. The slurry is passed through different sieves to separate the abrasives appropriate for the different purposes of cutting, grinding and polishing. A quartz slice is first ground to an initial shape using a manually operated (bow driven) grinding wheel, fed with corundum slurry as the abrasive (*Figure 3*). This is a time consuming task and needs much patience.

Figure 4: *Grinding the lenses to get the right curvature in a special grinding stone selected from a series of such grinding stones with different curvatures.*

After being ground to the initial shape, the lens is fixed to a wooden handle using a home-made adhesive consisting of a compound of paraffin wax (earlier beeswax), shellac and lamp soot. Then it is ground in a grinding stone with a particular curvature selected from a set of grinding stones with different curvatures (*Figure 4*); at this stage fine corundum slurry is used for lubrication. Differently powered lenses can be produced from the grinding stones of different curvatures. There is also a special grinding stone with a variable outward curvature for production of bifocal lenses. Because of the limited grinding facilities available to make bifocal lenses, the lower portion, which is ground and polished to assist reading cannot be made circular or oval as modern lenses are. The traditional lens is one single unit ground and polished to cater for two specifications (*Figure 5*).

The lenses are finally polished in a long piece of wood (wooden lap) using a very fine corundum slurry. The lap is made from carefully selected 'Katu Erabadu', a tree grown in most parts of the country principally for the soft wood industry (*Figure 6*).

Figure 6: *Wooden lap used for final polishing (made from Katu Erabadu).*

Figure 7: *A pair of spectacles produced for short-sighted vision.*

Finally the lenses made to the doctor's prescription are fitted to a frame of the customer's choice (*Figure 7*). Mostly the spectacles are to correct short-sighted vision, but sometimes orders are taken to cater for special eye problems, such as a squint, which requires spectacles fitted with different lenses on either side.

Spectacles made from rock crystals, fashioned from primitive instruments and methods, are still produced to meet the requirements of many among the elderly who have defective vision.

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Abstracts

Diamonds | Synthetics and Simulants
Gems and Minerals | Instruments and Techniques

Diamonds

Zur Bestimmung von GE POL Diamanten: erste Erkenntnisse.

J.P. Chalain, E. Fritsch and H.A. Hänni. *Gemmologie. Z.Dt.Gemmol.Ges*, **49**(1), 2000, 19-30, 2 photographs, 1 table, 3 diagrams, bibl.

In March 1999 Lazare Kaplan (LKI) and General Electric (GE) announced that for the next ten years their colour-improving process would be marketed by POL (Pegasus Overseas Ltd.), this being a daughter company of LKI, a sight holder of De Beers. All diamonds treated by this process are marked 'GE POL' on the girdle. A two-step identification method for these diamonds is proposed. Almost all GE POL diamonds are type IIa near colourless diamonds; they can be separated from other diamonds of similar colour using the SSEF IIa Diamond Spotter in conjunction with a short wave UV light (254 nm). The results can be checked by FTIR spectrometry. Secondly, a Raman spectrum of these IIa stones is obtained using the 514 nm laser line of the Raman spectrometer. If a luminescence pattern at 3760 cm^{-1} is observed, this proves the presence of a small number of NV centres in the stones. This is believed to be characteristic of the material used for the GE process as all GE POL diamonds exhibit this emission. The non-treated colourless IIa diamonds tested did not show the NV feature. Further research is necessary to confirm preliminary findings. E.S.

Extreme chemical variation in complex diamonds from George Creek, Colorado: a SIMS study of carbon isotope composition and nitrogen abundance.

I.C.W. Fitzsimons, B. Harte, I.L. Chinn, J.J. Gurney and W.R. Taylor. *Mineralogical Magazine*, **63**(6), 1999, 857-78.

Diamonds from a George Creek kimberlite dyke preserve complex intergrowths between two major growth generations: homogeneous diamond with yellow-buff, and diamond with blue-green CL and local growth zonation. Secondary ion MS has revealed large variations both in N concentration and C isotope composition within these diamonds: even within single stones. N contents and $\delta^{13}C$ values can vary from 0 to 750 ppm and 0 to -20 ‰, respectively. The CL characteristics correlate directly with N: diamond with yellow-buff CL has a uniform N content, whereas the zoned diamond has bright blue CL bands with high N (50-70 ppm) and dark blue or green CL bands with low N (0-20 ppm). The $\delta^{13}C$ values also vary between the two growth generations in any one diamond, but show no consistent correlation with either CL or N. R.A.H.

Cr-pyrope garnets in the lithospheric mantle. I. Compositional systematics and relations to tectonic setting.

W.L Griffin, N.I. Fisher, J. Friedman, C.G. Ryan and S.Y. O'Reilly. *Journal of Petrology*, **40**(5), 1999, 679-704.

This is a major study of mantle garnets. Over 12,600 samples of Cr-pyrope garnets with $Cr_2O_3 > 1$ wt.% and $Mg/(Mg+Fe) > 0.65$, derived mainly from kimberlites and lamproites (plus some alluvial samples) mostly from southern Africa, Siberia, Canada and Australia have been analysed for major and trace elements as part of diamond exploration studies. Relative depths of crystallization for each sample have been estimated using Ni-derived temperatures. Mn, Ni and Zn are related to *T*-dependent partitioning between garnet and olivine. Cr content indicates degree of depletion of the host rock; Fe, Y and Ga have been removed by primary depletion. High-*T* re-fertilization metasomatism yields positive correlations between Fe, Zr, Ti, Y and Ga. *P/T* controls Ca/Cr in lherzolite garnets. There are systematic changes with age from > 2500 through 2500-1000 to < 1000 m.y. garnets. Data are shown mainly in scatter diagrams. B.E.L.

Mit High-tech ins nächste Jahrtausend.

V.M.F. Hammer and J. Stefan. *Gemmologie. Z.Dt.Gemmol.Ges*, **49**(1), 2000, 7-17, 1 photograph, 1 table, 1 diagram, bibl.

The authors warn about difficulties in distinguishing new high-tech developments from natural stones. The

Abstractors

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R.K. Harrison	R.K.H.	M. O'Donoghue	M.O'D.	I. Sunagawa	I.S.
R.A. Howie	R.A.H.	P.G. Read	P.G.R		

For further information on many of the topics referred to, consult *Mineralogical Abstracts*

 ISSN: 1355-4565

two examples given and discussed are the GE POL diamonds and the Nova Diamonds. The GE POL diamonds are sold with a laser inscription on their girdle, they are usually fairly clean, sometimes a little foggy, colour generally D to G, mainly type IIa, sometimes type I, fluorescence 80%. Since December 1999 the firm Novatek Inc. in Utah has been using a high pressure /high temperature process to improve mainly brown stones, producing lively yellows, yellow-greens and greens; these diamonds are also to be sold with a suitable girdle inscription. The authors discuss whether a stone which cannot definitely be shown to be treated should have to be declared as treated. E.S.

Gem news.

M.L. Johnson, J.I. Koivula, S.F. McClure and D. DeGhionno (eds). *Gems & Gemology*, **36**(2), 2000, 160-73.

Brief descriptions are given of a new 'Tycoon' diamond cut (a rectangular or square mixed cut with step-cut facets on the pavilion and a centred rhombus on the table), designed to provide more brilliance than a standard emerald-cut. R.A.H.

[Accessory minerals from eclogites and diamond-bearing rocks of Kumdykul deposit.]

F.A. Letnikov, N.G. Zvonkova, N.V. Sizykh and B.S. Danilov. *Proceedings of the Russian Mineralogical Society*, **128**(6), 1999, 16-27. (Russian with English abstract.)

The accessory minerals (ilmenite, magnetite, rutile, apatite, zircon, chalcopyrite, pyrite, pyrrhotite and garnet) from eclogites and from diamond-bearing rocks of the Kumdykul deposit were studied by EPMA and the data compared with results for the same minerals from kimberlites. In no cases (except for pyrrhotite) was there any similarity between the compositions of the respective minerals, supporting the hypothesis of a crustal source for the minerals and diamonds of the Kumdykul deposit. The minerals from diamond-bearing tectonites and eclogites are quite different, implying a different genesis. In general, the results confirm the concept that the thinly dispersed diamonds of the Kumdykul deposit were formed within narrow shear zones at points of local superpressure under the effect of reduced fluids from a deep origin. R.A.H.

A new lasering technique for diamond.

S.F. McClure, J.M. King, J.I. Koivula and T.M. Moses. *Gems & Gemology*, **36**(2), 2000, 138-46.

A new laser treatment to remove near-surface dark inclusions in diamonds without leaving a surface-reaching drill hole has recently entered the trade. Observations are here reported on several round brilliant-cut diamonds before and after such treatment. This method causes small cleavages to develop or expand around an inclusion; once the cleavage reaches the surface, it serves as a conduit for the solution that is used to bleach the dark inclusion. Irregular, wormhole-like channels are used to widen the cleavage to facilitate entry of the bleaching solution. The resulting feather has a more natural appearance than the traditional laser drill channel. R.A.H.

Gem Trade Lab notes.

T.M. Moses, I. Reinitz and S.F. McClure. *Gems & Gemology*, **36**(2), 2000, 155-9.

Notes are given on a blue, strongly zoned, irregularly shaped, 3.43 ct rough diamond and the 1.33 ct round brilliant cut from it; IR absorption spectra show the characteristic boron peaks at 1300, 2455, 2800 and 2930 cm^{-1} in the blue portion of the rough stone. R.A.H.

Geology, petrology and geochemistry of Narayanpet kimberlites in Andhra Pradesh and Karnataka.

K.R.P. Rao, T.A.K. Reddy, K.V.S. Rao, K.S.B. Rao and N.V. Rao. *Journal of the Geological Society of India*, **52**(6), 1998, 663-76.

Kimberlites have been found in S India at Wajrakarurand and also around Maddur and Narayanpet, Mahabubnagar district; Landsat imagery and photo-interpretation studies, geological traverses and stream sediment surveys indicate their presence also in W Mahabubnagar and in the adjoining Gulbarga district, Karnataka. Kimberlites of the Narayanpet kimberlite field (NKF) are emplaced along E–W and NW–SE-trending major faults and associated NE–SW tear faults in the peninsular gneissic complex, which contains enclaves of Dharwar greenstones from the Gadwal schist belt. These kimberlites occur as small bodies a few m across and as dykes with a strike length of ~ 2 km, their mineral assemblage (olivine, chrome diopside, magnesian ilmenite, chrome spinel and rare pyrope garnet) and textures indicate they correspond with hypabyssal-facies or root zone kimberlites. Mantle xenoliths are rare; however, spinel lherzolite is abundant in two kimberlites. NKF kimberlites are depleted in SiO_2 (~ 35 wt.%), are potassic ($K_2O > Na_2O$) and Mg-rich ($MgO > 20$ wt.%), and their *REE* abundances are consistent with derivation by partial melting of mantle and subsequent fractional crystallization. Their similar petrology and geochemistry implies derivation from a similar upper mantle source. Whilst processing and testing of some of the kimberlites have not yielded any diamonds, finds in the Krishna and Bhima River gravels suggest diamondiferous kimberlites may occur to the S and SW. J.F.

Contrasting isotopic mantle sources for Proterozoic lamproites and kimberlites from the Cuddapah basin and eastern Dharwar craton: implication for Proterozoic mantle heterogeneity beneath southern India.

N.V.C. Rao, S.A. Gibson, D.M. Pyle and A.P. Dickin. *Journal of the Geological Society of India*. **52**(6), 1998, 683-94.

Kimberlites intruding Precambrian basement at Anantapur (1090 m.y.) and Mahbubnagar (1360 m.y.) near the W margin of the Cuddapah basin, have initial $^{87}Sr/^{86}Sr$ ratios of 0.70205-0.70734 and εNd of +0.5 to +4.68. Mesoproterozoic lamproites (1380 m.y.) from the Cuddapah basin and from its NE margin have initial $^{87}Sr/^{86}Sr$ ratios of 0.70520-0.7390 and εNd of -6.43 to -8.29, suggesting they were derived from enriched sources with time-averaged higher Rb/Sr and lower Sm/Nd values than bulk earth, whereas the kimberlites were derived from depleted sources with lower Rb/Sr and higher Sm/Nd values. T_{DM} ages suggest lamproite source enrichment (~ 2000 m.y.) preceded that of kimberlites (~ 1370 m.y.). Results show the existence of isotopically contrasting upper mantle sources for S India kimberlites and lamproites, and provide evidence for a lateral, isotopically heterogeneous mantle beneath the Cuddapah basin and E Dharwar craton. How these results might affect diamond exploration is also discussed. J.F.

Identification of HPHT-treated yellow to green diamonds.

I.M. Reinitz, P.R. Buerki, J.E. Shigley, S.F. McClure and T.M. Moses. *Gems & Gemology*, **36**(2), 2000, 128-37.

Examination of recently introduced greenish-yellow to yellowish-green diamonds treated with high-*P* and high-*T* by three companies has revealed several identifying characteristics. These include a highly saturated body colour, well-defined brown to yellow octahedral graining, moderate to strong green 'transmission' luminescence and visible evidence of heating. A strong line at 503 nm, a dark band from ~480-500 nm and green emission lines at 505 and 515 nm are visible in a hand-held spectroscope. Near-IR spectra show a peak at 985 nm, an indicator of high-*T* exposure.
R.A.H.

New filling material for diamonds from Oved Diamond Company: a preliminary study.

J.E. Shigley, S.F. McClure, J.I. Koivula and T.M. Moses. *Gems & Gemology*, **36**(2), 2000, 147-53.

Diamonds marketed by the Oved Diamond Co., New York, which have been filled with a new glass formulation (XL-21), are readily identifiable as treated by the intense flash-effect colours seen with magnification (binocular microscope or loupe). Durability testing showed that this filler material is more stable to conditions of normal jewellery repair, such as direct heating with a torch, than the filler produced by this company a decade ago. However, some damage to the filler was seen in half of the Oved diamonds that were subjected to a standard prong retipping. R.A.H.

Gems and Minerals

Photoluminescent properties of defect spinels.

D. Ajó, S. Carbonin, I. Rizzo and G. Pozza. *Neues Jahrbuch für Mineralogie, Monatshefte*, **2000**(2), 91-6.

The photoluminescent behaviour of Cr^{3+} in a series of synthetic gemstones and some smaller gemstones mounted in an old brooch were investigated. In addition to their examination optically, XRD and XRF techniques were used where size allowed. Two of the synthetic stones were found to be corundum, but others were cubic with *a* 7.97 Å, *n* 1.73, and microanalysis indicated a formula of $Mg_{0.39}Al_{2.41}O_4$. The photoluminescence spectra showed the λ_{cr} values of 693.7 and 694.5 nm for the two corundums, but the values for the defect spinels were in the range 690.7-691.5 nm. The use of photoluminescent spectroscopy is recommended for the non-destructive testing of Cr^{3+}-bearing samples of unusual geometry.
R.A.H.

Gemmological notes.

H. Bank, U. Henn and C.C. Milisenda. *Gemmologie. Z.Dt.Gemmol.Ges*, **49**(1), 2000, 1-6, 8 photographs.

Four collectors' stones from Sri Lanka are discussed; they are an orangy-purple cassiterite, an oval hessonite, a taaffeite and a grey-green faceted pyrope-spessartine. Recently an increasing number of 'natural' Russian emeralds were submitted to the laboratory and were found to be hydrothermally grown synthetics; they ranged from 2 mm squares to stones weighing 15 ct. Also a 'natural' ruby from Russia was found to be flux-grown; it had very strong red fluorescence. Flux-grown synthetic rubies from Douros in Greece showed minute birefringent solid inclusions under an immersion microscope. A number of dyed quartzes are on the market from the USA; these are rock crystals with various dyes filled into their fractures; they are easy to recognize with a loupe. Opals are often impregnated with resin to improve durability and clarity. The resin should have similar or identical RI to that of the stone. A variety of the mineral pectolite which is found in the Dominican Republic is offered under the trade name larimar. This translucent to opaque blue aggregate is cut as cabochons or used for small objects and sculptures; it may be impregnated with the resin Opticon.
E.S.

Lazulithvorkommen in Österreich.

R. Berl. *Mineralien Welt*, **11**(3), 2000, 39-54, 6 maps, illustrated in colour.

Several lazulite-bearing deposits in Austria are described with notes on their geology and on accompanying mineral species. Some of the lazulite is used ornamentally though most material appears to be opaque. M.O'D.

Ruby and sapphire from Jegdalek, Afghanistan.

G.W. Bowersox, E.E. Foord, B.M. Laurs, J.E. Shigley and C.P. Smith. *Gems & Gemology*, **36**(2), 2000, 110-26.

The Jegdalek area some 60 km ESE of Kabul hosts about 20 mines in proterozoic marble interstratified with gneisses. The gem corundum occurs in irregular lenses < 2-3 cm wide within individual beds of coarse-grained marble; pink sapphire forms ~ 75% of the production, with 5% ruby, 5% mixed blue and red-to-pink corundum and 5% sapphire. Most of the material is semi-transparent and is fashioned with cabochons; only ~ 3% of the corundum is facetable with top-quality ruby rarely exceeding 5 ct. These gem corundums have ε 1.760-1.762, ω 1.76-1.770, *D* 3.97-3.99; rubies had Cr_2O_3 0.250-1.971, TiO_2 0.002-0.078, Fe_2O_3 0.016-0.174 wt.%, the corresponding values for sapphires being 0.037-0.445, 0.008-0.145 and 0.068-0.431 wt.%. Common internal features are partially healed fracture planes, lamellar twin planes, colour zoning and inclusions of calcite, apatite, zircon, iron sulphides, etc. R.A.H.

Gemmological miscellany.

G. Brown. *Australian Gemmologist*, **20**(10), 2000, 441-4, 7 illus. in colour, 1 in black-and-white.

The interesting gemstones covered in this miscellany include a faceted colourless tourmalinated quartz, several Sri Lankan pyrope-spessartine garnets with a colour change similar to vanadium-doped synthetic sapphire, a Russian ornamental clinochlore marketed as the healing stone 'Seraphinite', cloudy amber beads from the Baltic region which display a wood-like texture, and a group of 'reconstructed' materials that imitate ornamental materials such as turquoise, lapis lazuli, azurite-malachite, coral, charoite and sugilite. A useful teaching aid consists of four simple two-dimensional clear acrylic models which can be used to demonstrate how light is transmitted through round brilliants with various proportions and finish. P.G.R.

The Slocan Valley sapphire deposit, Nelson, British Columbia, Canada.

R.R. Coenraads and J.W. Laird. *Australian Gemmologist*, **20**(10), 2000, 410-15, 5 illus. in black-and-white, 2 maps.

The main areas of corundum mineralization are confined to two outcrops known as Blu Starr and Blu Moon. These lie at the junction of the Slocan and Little Slocan rivers some 30 km east of the town of Nelson in southern British Columbia. Blu Starr corundum, discovered in 1991, occurs as hexagonal barrel-shaped crystals typical of corundum found in metamorphic environments. Crystals are mainly in the 5-8 mm range, although stones exceeding 250 ct are occasionally found. Blu Moon corundum, discovered in 1993, occurs as hexagonal barrel-shaped crystals, plates and bipyramidal crystals up to 3-4 cm long. Initial heat treatment experiments are currently in progress to optimize the colour range and clarity of the gemstones, which have been turned various shades of blue including the preferred cornflower blue. Commercial viability of the deposits has yet to be proved. P.G.R.

Geologia, mineralogia e storia della Himalaya Mine.

J. Fisher, E.E. Foord and G.A. Bricker. *Rivista mineralogica italiana*, **24**(1), 2000, 16-35, illus. in colour.

Detailed geological and mineralogical account of the Himalaya mine, celebrated for gem-quality tourmaline. The mine is situated within the Mesa Grande pegmatite district of California and was discovered about 100 years ago. An estimated 100 metric tons of tourmaline are believed to have been recovered during the life of the mine. The Mesa Grande pegmatite district is one of about 20 pegmatite districts in the Peninsula Range batholith: the Himalaya dyke system has intruded rocks of Cretaceous age and the event may have taken place around 93 Ma. The fine tourmaline crystals occur with quartz, plagioclase, muscovite, lepidolite and cookeite, with some fluorapatite, beryl and other minerals. The tourmaline is elbaite and occurs as doubly terminated crystals often showing bright green at one end and rose pink to burgundy at the other. M.O'D.

A travers la nomenclature des émeraudes; émeraudes de Puerto Vejo, émeraudes vieilles, émeraudes de vieille roche, émeraudes de vieille mine.

F.H. Forestier. *Revue de gemmologie*, 140, 2000, 26-31.

A survey of the history of emerald with emphasis on nomenclature and on specimens found in Peru. M.O'D.

Schweizer Rubine von Hand geschliffen.

A. Frey. *Schweizer Strahler*, **12**(1), 2000, 20-1.

Brief details of the hand polishing of ruby from Switzerland are given. Material is found at the Val Traversagna. M.O'D.

La mission française AFG en Colombie.

D. Giard. *Revue de gemmologie*, 140, 2000, 7-13, 2 maps.

Account of the visit made by an AFG party to some of the emerald mines of Colombia with notes on the perceived state of the emerald trade. M.O'D.

Historique des gisements d'émeraude et identification des émeraudes anciennes. 2nd part.

G. Giuliani, M. Chaussidon, H.-J. Schubnel, D.H. Piat, C. Rollion-Bard, C. France-Lanord, D. Giard, D. de Narvaez and B. Rondeau. *Revue de gemmologie*, 140, 2000, 32-5.

A survey of the origins of emerald in classical and later times with particular reference in this part to trade routes between South America, India, Afghanistan and Pakistan on the one hand, and European centres on the other. M.O'D.

Zum Stabilisieren von Edelsteinen.

H. Heldner. *Schweizer Strahler*, **12**(1), 2000, 7-9.

Short review of the colour enhancement of some of the major gem species. M.O'D.

Gem news.

M.L. Johnson, J.I. Koivula, S.F. McClure and D. DeGhionno (eds). *Gems & Gemology*, **36**(2), 2000, 160-73.

Mention is made of a bi-coloured cat's-eye beryl from Pakistan, sphene deposits in N Madagascar, and the 'Aurora Borealis', a 131 ct Oregon opal carved to depict the N slope of the Brooks mountain range, Alaska. R.A.H.

Maissau: Amethyst aus Niederösterreich.

G. Knobloch. *Lapis*, **25**(5), 2000, 35-8.

The amethyst deposit at Maissau, Lower Austria, has been worked for at least 150 years. Recently a number of fresh occurrences of gem-quality material have been found: the colour and transparency appear excellent. M.O'D.

[A study on mineralogic and physicochemical characteristics of beryls and aquamarines in pegmatites of different origin.]

W. Li, Z. Li and Y. Mao. *Kuangwu Yanshi (Journal of

Mineralogy & Petrology), **18**(4), 1999, 423-8. (Chinese with English abstract.)

Beryls and aquamarines from the Mufushan pegmatite, which resulted from magmatic differentiation, and from the Ailaoshan pegmatite, which originated by metamorphic anatexis, have different compositional and fluid inclusion characteristics. Their optical and physical properties, molecular formulae, and the physical and chemical nature of their solid and liquid inclusions are tabulated. R.A.H.

[Study on the mechanism of colour variation for iron-containing beryl.]

X. LI AND K. YUAN. *Kuangwu Yanshi (Journal of Mineralogy & Petrology)*, **18**(4), 1999, 1-4. (Chinese with English abstract.)

The colour of Fe-bearing beryl can be altered by exposure to γ-irradiation or heat. The polarized absorption and electron spin resonance spectra, before and after colour enhancement, showed that the γ-irradiation caused the oxidation of channel Fe^{2+} to Fe^{3+} and the reduction of octahedral Fe^{3+} to Fe^{2+}. The Fe^{3+} at octahedral and channel sites was reduced to Fe^{2+} by heating. These changes in the valency of iron ions controlled the colour variation of the beryl. R.A.H.

Edelsteine aus Sambia – Teil 2: Turmalin uns Aquamarin.

C.C. MILISENDA, V. MALANGO AND K.C. TAUPITZ. *Gemmologie. Z.Dt.Gemmol.Ges*, **49**(1), 2000, 31-43, 6 photographs, 6 maps, 3 diagrams, bibl.

Gem-quality tourmalines and aquamarines rarely occur in the same deposit although both are found in core zones of pegmatites enriched with alkalis and rare elements and formed at lowish temperatures. Also minor amounts of red garnets, topaz, moonstone, morganite, amethyst, and smoky and rose quartz, occur occasionally. At present there are about 150 gemstone pegmatites known in Zambia, but relatively few are exploited to their potential. This paper described the recently explored Jagoda mine area with mainly pink, red and green tourmalines and some aquamarines. Also described are the Hofmeyer tourmaline mine, the aquamarine mine at Kapirinkesa and the Lundazi-Chama mine with both tourmalines and aquamarines. Mining and processing are mechanised and well organized in the larger mines. The annual production is estimated at US$10 million, but with much illegal mining and marketing it could be $20-30 million. Capillaries and growth tubes form a typical inclusion pattern in the pink, yellow and green tourmalines examined. Minute fluid inclusions were observed in the aquamarines. E.S.

Gem Trade Lab notes.

T.M. MOSES, I. REINITZ AND S.F. MCCLURE. *Gems & Gemology*, **36**(2), 2000, 155-9.

Pink and yellow bi-coloured unheated zoisite from Tanzania is described. R.A.H.

Über Achate und vergleichbare Hohlraumfüllungen in Sedimentgesteinen.

G. NIEDERMAYR. *Mineralien Welt*, **11**(3), 2000, 55-60, illustrated in colour.

Agate and other concretions of ornamental quality are reported from a number of different locations, including Madagascar, Iraq, Oman, Austria and California. Some specimens are completely filled with barite and calcite, while others contain discernible individual crystals.

M.O'D.

L'euclase bleu-verte de Colombie.

F. NOTARI AND P.-Y. BOILLAT. *Revue de gemmologie*, 140, 2000, 18-20.

Blue transparent euclase of good colour and suitable for ornamental use is described from Quebrada Negra, Chivor, Colombia. Three-phase inclusions containing liquid, gas and fluorite have been identified: both chromium and iron have previously been identified as the cause of the blue colour in euclase, and both have been identified in the Colombian specimens, but in this instance as Fe^{2+} is involved (Fe^{3+} not being present), iron would appear to have no influence on coloration. Several Cr features are identified in the absorption spectrum.

M.O'D.

Nouvelles découvertes d'émeraudes et pierres de Colombie.

C.E. OSORIO AND J.-C. MICHELOU. *Revue de gemmologie*, 140, 2000, 14-17.

Among new gem discoveries in Colombia are rubies, sapphires and good quality amethyst from the Mercaderes region of Cauca department. Most sapphire specimens are fancy coloured and need heat treatment before being offered for sale. Some alluvial diamonds have been reported from Guiania department. Pale blue euclase and fluorite are reported in papers by Notary and Vuillet respectively (q.v.), conch pearls of good quality are also noted from locations on the Caribbean coast.

M.O'D.

Les inclusions de pyrite dans l'émeraude de Colombie.

P.J. ROTLEWICZ. *Revue de gemmologie*, 140, 2000, 16-17.

Pyrite inclusions in emerald are briefly described and illustrated with reference to specimens from Colombia.

M.O'D.

Okorusu: Fundstelle attraktiver Fluorite in Namibia.

P. RUSTEMEYER. *Lapis*, **25**(2), 2000, 24-9, illus. in colour.

Fine large ornamental-quality crystals of green and purple fluorite are described from the Okorusu mine situated approximately 300 km north of Windhoek and 48 km north of Otjavarongo, Namibia. Some crystals are green with purple edges or cores: a strong blue fluorescence is displayed by some crystals. Size range up to 15 cm cubes. M.O'D.

Characteristics of nuclei in Chinese freshwater cultured pearls.

K. SCARRATT, T.M. MOSES AND S. AKAMATSU. *Gems & Gemology*, **36**(2), 2000, 98-109.

Field research indicates that many Chinese growers of freshwater cultured pearls (FWCPs) are using larger mussels *(Hyriopsis cumingi)*, combined with new tissue-insertion techniques, to grow a larger, better-shaped product. X-radiographs of ~ 41,000 Chinese FWCPs from dozens of farms are examined, and 10 samples were sectioned. All showed evidence of mantle tissue nucleation only. The presence of a bead, whether shell or tissue-nucleated FWCP, would be identified by distinctive features in the X-radiograph. R.A.H.

Ein Besuch beim grössten Opal Australiens.

W. Schiebel. *Mineralien Welt*, **11**(2), 2000, 63.

Describes a sandstone block 2 x 1 x 1 m in size containing precious opal classed as light crystal opal. The source is the Olympic Dam mine, near Andamooka, South Australia. The specimen has been named Atlas. M.O'D.

Proterozoic melting in the northern peridotite massif, Zabargad Island: Os isotopic evidence.

J.E. Snow and G. Schmidt. *Terra Nova*, **11**(1), 1999, 45-50.

The two very different hypotheses for the geodynamic history of the three Zabargad peridotite bodies have important implications for the origin and age of the whole peridotite complex. In one, Zabargad peridotite bodies are young asthenospheric mantle that was juxtaposed with ancient crustal gneisses during the opening of the Red Sea; whilst in the other, the complex may be a single package of residual mantle and lower crust of pan-African age uplifted during the Miocene. To decide between these two models, five samples of Zabargad peridotite and two pyroxenites were analysed for Os isotopes. $^{187}Os/^{188}Os$ ratios are 0.1198-0.1320, and correlate with Al_2O_3, giving an age for the N body, based on the Os isotope evolution curve for bulk earth, at 1400 ± 300 m.y. This agrees with previous suggestions that the N and central peridotite bodies are probably ancient continental lithospheric mantle, whilst the S body is recent asthenospheric mantle. These results from both central and S bodies are consistent with either crustal age hypothesis. J.F.

Steckbrief: Chrysoberyll.

Lapis, **25**(4), 2000, 8-1, illustrated in colour.

Full properties, modes of occurrence and major chrysoberyl localities accompany five colour photographs of characteristic crystal forms. M.O'D.

[The infrared spectra of Mingxi sapphires, Fujian.]

D. Tang. *Kuang Yanshi (Bulletin of Mineralogy. Petrology and Geochemistry)*, **18**(4), 1999, 385-8. (Chinese with English abstract)

The IR absorption bands at 1090, 795, 776, 642, 606 and 456 cm^{-1} have been recorded in Mingxi sapphires. In comparison to the sapphires from Shangdong, the 790 cm^{-1} band is split into 776 and 795 cm^{-1} bands and there is also a band at 1161 cm^{-1} in the Mingxi sapphires. The absorption bands at 3310, 3234, and 3188 cm^{-1} are related to OH in the sapphires; the H content is estimated on the basis of the absorption of the 3310 cm^{-1} band. The H content is higher in blue sapphires than in yellow sapphires. The IR bands and their relation to the colour are attributed to the presence of defect clusters (Moon and Phillips, *J. Amer. V. Ceram. Soc.*, **77**, 1994, 356). R.A.H.

La fluorite verte de Peñas Blancas.

P. Vuillet À Ciles. *Revue de gemmologie*, 140, 2000, 21-5.

Green fluorite of fine quality is described from Peñas Blancas in the Muzo-Coscuez mining district of Boyaca state, Colombia. Three-phase inclusions have been observed and a number of crystals have been faceted and carved. M.O'D.

Neue Überraschungen aus dem Pamir, dem Karakorum und dem Himalaya.

A. Weerth, V.M.F. Hammer. *Lapis*, **25**(5), 2000, 22-9.

New minerals of gem quality recently described from the Pamirs, Karakoram and Himalayas include elbaite (rubellite), violet sodalite, purple fluorapatite, and green andradite from Afghanistan; rutile, red zircon and green transparent clinoenstatite from Pakistan. Details of the occurrences are given. M.O'D.

What's new in minerals.

Mineralogical Record, **31**, 2000, 193-6.

Specimens of gem interest at the Munich and Pasadena shows, noted by different correspondents, include: emerald with calcite from the La Pita mine, Boyacá, Colombia; pale green beryl from the Erongo Mountains, Namibia; golden beryl from Dos Barras, Minas Gerais, Brazil; brownish-pink topaz from the Wah Tu Wah mine, Yunnan, China; and yellow fluorapatite from Cedar City, Iron County, Utah, USA. M.O'D.

The Joseph A. Freilich collection.

W.E. Wilson. *Mineralogical Record*, **31**, 2000, 4-79, illustrated in colour.

The Freilich collection is described and its major items illustrated: a history of its formation and curation and a short biography of the owner are also given. The collection includes a number of top-quality gem species crystals. M.O'D.

Instruments and Techniques

Nelson M17 gemstone cooling unit.

T. Linton and B. Bretherton. *Australian Gemmologist*, **20**(10), 2000, 421-4, 4 illus. (3 in colour), 1 table.

The Nelson M17 cooling unit consists of a modified vacuum flask in which a 13 mm diameter copper rod has been inserted through its screw-on lid, and a test base that holds both a McCrone spectroscope and a transformer-driven light source. When the vacuum flask has been filled with a suitable freezing mixture the exposed top of the metal rod acts as a 'cold finger' to reduce the temperature of a gemstone from 0°C (using crushed ice and water) to the region of minus 200°C (using liquid nitrogen). At these temperatures the VIS fine line absorption spectrum of many gemstones is enhanced, making it possible to identify irradiated and annealed diamond, and to discriminate between synthetic yellow sapphire and natural yellow sapphire (via the reddish fluorescence of the UV irradiated synthetic stone which is masked at room temperatures). The GAA Instrument Evaluation Committee recommend the use of this low-cost cooling unit for resolving carefully selected problem identifications. P.G.R.

The Hanneman refractometer.

T.LINTON, K. HUNTER AND A. CUMMING. *Australian Gemmologist*, **20**(10), 2000, 432-5.

The original Hanneman-Hodgkinson refractometer was large and difficult to set up, and for these reasons never became widely used. In this new more compact version, two standard distances can be set between the gemstone under test and the scale, the greater distance giving improved accuracy. Two scales are provided to cover gemstones having pavilion angles between 41 and 43 degrees. The range of the scales can be extended by use of a built-in immersion cell to cover high refractive index gems such as diamond and synthetic moissanite. The low cost of the refractometer kit, and the fact that with care it can provide readings almost equivalent to those obtainable with a critical angle refractometer, make this instrument suitable both for gemmological students and for those who wish to measure the refractive indices of high RI gemstones. P.G.R.

The Brewster-angle meter.

T.LINTON, K. HUNTER AND A. CUMMING. *Australian Gemmologist*, **20**(10), 2000, 428-31, 2 illus., 1 table.

The GAGTL Brewster-angle meter uses a 5mW, 670 nm laser to measure the polarisation angle of faceted gemstones and (by means of tables and a graph) determine their refractive indices. The GAA Instrument Evaluation Committee found there was a calibration error of 0.2 of a degree over the instrument's range and some decrease in accuracy at the high end of the scale (both possibly due to transit damage). However, repeatable readings were obtained by four evaluators over a range of eight test stones from quartz to synthetic rutile. [Abstractor's note – although not included in the range of test stones, synthetic moissanite is also well within the instrument's range of 1.43 to 3.3, and can be readily identified.] P.G.R.

Synthetics and Simulants

Garnet dissolution and the emplacement of kimberlites.

D. CANIL AND Y. FEDORTCHOUK. *Earth & Planetary Science Letters*, **167**(3-4), 1999, 227-37.

Dissolution of mantle-derived garnet in H_2O-bearing kimberlite melt was investigated experimentally to provide data on the survival of garnet xenocrysts commonly found in kimberlites. Garnet dissolution was determined by measuring the rate of radius change of garnet spheres, in synthetic kimberlite melt above its liquidus, as a function of *T* and *P*, and the results were applied to 80 garnet xenocrysts in an hypabyssal-facies macrocrystic kimberlite of the Slave Province, Canada. The time-scale required to preserve these garnets during kimberlite ascent depends on the magma's *T* path during ascent. Dissolution data require kimberlite magmas to exist only for minutes near their liquidus *T* in the mantle, and in conjunction with the existence of newly-formed fritted dissolution rims on cracked garnet xenocrysts, possibly from explosive emplacement, it is likely that the final stage of kimberlite ascent in the crust to the root zone of the diatreme possibly took only seconds/minutes. J.F.

Synthetic fresnoite – a new gemstone simulant.

U. HENN. *Australian Gemmologist*, **20**(10), 2000, 426-7, 2 illus. in colour, 1 table.

The natural mineral fresnoite ($Ba_2Ti(Si_2O_8)$) crystallizes in the tetragonal system with H = 3-4, RI 1.765-1.770. The yellow crystals were first discovered in Fresno County, California, USA. Faceted orange synthetic fresnoite grown by the Czochralski method is being offered on the market as a gemstone simulant under the trade name 'Terbium' (an inappropriate name as terbium is the rare earth element Tb). P.G.R.

Synthetische Alexandritdrillinge.

U. HENN. *Gemmologie. Z.Dt.Gemmol.Ges*, **49**(1), 2000, 51-3, 6 photographs, bibl.

By using the flux method synthetic alexandrites can be produced as twinned crystals. Synthetics of a Russian production have a macroscopical appearance like natural alexandrite triplets. However, the stones can be identified by flux feathers and residues. E.S.

Short gemmological notes.

Gemmologie. Z.Dt.Gemmol.Ges, **49**(1), 2000, 49-50.

A letter by K. Nassau questions the reliability of reflectivity for distinguishing moissanite from diamonds. He points out that the reflectivity of synthetic moissanite can be changed from 116/119 down to 100 (the value for diamonds) or even down to zero. The manufacturers do not intend to use this process and no one else is known to use it at the present time. In an answering letter, J.P. Chalain and M.S. Krzemnicki acknowledge Dr Nassau's argument, but think for the time being reflectivity is a good tool for distinguishing moissanite, but add that the strong double refraction and typical inclusions, such as fine tubes parallel to the optic axis, would be sufficient to make the identification. E.S.

BOOK REVIEWS

Achat: der Edelstein, aus dem Idar-Oberstein entstanden ist

Christian Weise Verlag, München, 2000. pp 96, illus. in colour, softcover. ISBN 3 921656 54 0 (main journal *Lapis* has ISSN 0945 8492). DM 34.80.

Obtainable separately from the subscription to the excellent journal *Lapis*, this beautiful celebration of the agates of Idar-Oberstein (mostly) is a worthy companion to the previous study of rock crystal (*Bergkristall*) in the same series. As usual the text continues without too obvious divisions and covers the agates of the Steinkaulenberg and other areas well-known to British (and German) gemmologists. Some details of agate occurrence, recovery and fashioning are given, but pride of place goes to the superb photographs of some of the innumerable patterns which agate can display. Some account of colour and patterning is given, but we are spared a long list of varietal names (though some of them may well be useful addenda to two, at least, of the recent nomenclature surveys). There are notes on local museums, on a collection of 'eye' agate and on an agate used as a cameo by Ptolemy II. Idar-Oberstein does not have it all its own way as there are descriptions and photographs of remarkable specimens from countries worldwide. Some, but not all, chapters include lists of references but there is no overall bibliography – for obvious reasons. Readers may well contemplate building up a set of *extraLapis*, issues of which, I am told, go out-of-print alarmingly fast. M.O'D.

Handbook of mineralogy. Vol. IV. Arsenates, phosphates, vanadates

J.W. Anthony, R.A. Bideaux, K.W. Bladh and M.C. Nichols, 2000. Mineral Data Publishing, Tucson (PO Box 37072, Tucson, AZ 85740). pp ix, 680, hardcover. ISBN 0 9622097 0 8. US$108.00 plus $6.00 postage and packing.

This is the penultimate volume in this first-rate and essential series in which the format of one species, one page, has been found to work very well. Previous volumes have already been reviewed: they cover elements, sulphides, sulphosalts (Vol. 1), silica and the silicates (Vol. 2, in two parts), halides, hydroxides and oxides (Vol. 3). Confident (with some reason) of the accuracy of the text, the publishers offer $5 reward for any error spotted. While the more avid collectors may regret the necessarily short accounts of localities, the data comes in so convenient and rigorously edited a form that the majority of users will find everything they need: in any case references are given for each species. The text is backed up by the SEARCH software, available from the publishers: this allows searching by chemical constituents as well as by names. Gemmologists will find entries for turquoise, variscite and some rarer ornamental species. M.O'D.

Rediscover opals in Australia

S. Aracic and M. Aracic, 2000. The authors, Lightning Ridge (PO Box 143, Lightning Ridge, NSW 2834). pp 415, illus. in colour, hardcover. ISBN 0 9595830 2 5. A$150 for boxed hardcover special edition for collectors, A$75 for general hardcover, A$45 for softcover.

This magnificently illustrated book updates and revises the authors' previous work, *Discover opals before and beyond 2000*, published in 1996. The collectors' hardcover edition includes a bookmark complete with an opal cabochon – the one in my copy is a very pleasant stone. This is the only occurrence of book + stone that I have seen since the publication of *Let's hunt for Herkimer diamonds* (1950), in which a small rock crystal is attached to the back cover in such a way that it can be seen via a pierced hole from the front.

This reviewer found the previous version of the book (*J.Gemm.*, 1998, **26**(2), 132) well able to rank with seminal works by Wollaston and Murphy and the revision, whose history can be found on page 413-4, has added a number of photographs and commentary on opal fields Australia-wide. Of special interest is an updated reprint of *A prospector's guide to opal in Western Queensland*, first published in *Queensland Government Mining Journal* in 1996: the commentary fits comfortably into the main text. Maps of some of the opal fields also reproduce well but naturally the opals themselves take pride of place. It is interesting to read about the rise of some areas and the working-out of others: Queensland, for example, produces superb opal as well as the attractive but less spectacular boulder opal with which the state is more often associated. Lightning Ridge, too, has seen the closure of some famous deposits and there is a list of new fields discovered since 1996. The mines and their products are not the only topics – claims and counterclaims are recounted, as well as efforts by large mining companies to take over large opal-producing areas and the possible social and economic effects of this kind of action.

Everything you could want to know about opal is here and readers are strongly advised to get this book, whose print-run will not last long if sales overtake stock as quickly as they did the last time out. M.O'D.

Famous diamonds (4th edn.)

I. Balfour, 2000. Christie's, London. pp 320, illus. in colour, hardcover. ISBN 0 903432 65 X. £65.00.

The revised and updated edition of what has now become a classic includes a description and photograph of the Millennium Star, originally 777 ct and the sixth largest rough diamond ever to be found – the polished stone, displayed during 2000 at the Millennium Dome in London, weighs 203.04 ct. The stone is graded D colour and both internally and externally flawless and forms part

 ISSN: 1355–4565

of the De Beers' Millennium Jewels, its companions being 11 variously-shaped blue diamonds with a total weight of 118 ct.

This timely entry is a pattern for all the others, 77 in all, some of which were in the first edition published in 1987. The diamond world is in the news probably as never before and the text has been revised in a number of places to take recent developments into account. These include the much greater prominence of coloured diamonds, which are described from the scientific point of view by Eric Emms, and some of the names carefully chosen for the colours (champagne, cognac) have brought to prominence diamonds which 50 years ago might very well have been classed as industrial goods. The text describes the exciting finds of diamond sources in Canada and Australia as well as the more traditional ones.

More details of well-known diamonds have come to light since the last edition, published in 1997, and one stone, previously believed to have been lost, has surfaced (read the book for details!). The text is equally remarkable for its comments on changing trade conditions and the personalities of celebrated buyers over the years. The pictures are as good as ever and my sole mild complaint is that the bibliography should have been brought up-to-date, as there is no mention, for example, of the recent comprehensive coverage of the Crown Jewels. M.O'D.

Forever brilliant. The Aurora Collection of colored diamonds

A. Bronstein and S.C. Hofer, 2000. Ashland Press/Aurora Gems, New York. pp xiv, 89, illus. in colour, hardcover. ISBN 0 9659410 2 7. £29.00.

The Aurora Collection of coloured diamonds featured in *The Nature of Diamonds*, an exhibition established in the American Museum of Natural History, New York City, in 1997. The collection also formed the basis for a large, important and beautifully-produced book by the second author, *Collecting and classifying colored diamonds*, published in 1998 (reviewed in *J. Gemm.*, 1998, **26**(4), 273). The present venue of the exhibition is Tokyo's National Science Museum.

The book consists almost solely of a catalogue of the Aurora Collection, which comprises 260 coloured and faceted diamonds. Each entry is accompanied by a colour photograph and gives particulars of the stone's weight, colour, measurements, shape, style of cutting, common name for the colour, hue, lightness and saturation. More extensive notes on colour in general are given in a preliminary section. The pictures are good, while those on the dust-jacket are magnificent! Readers with a serious interest in diamond should really try to obtain both books though the present one is easier to carry. M.O'D.

Diamanten

München Mineralientage, Oberhaching (Postfach 1361, D-82034 Oberhaching, Germany), 2000. pp 240, illus. in colour, softcover. DM 50.00.

Diamond is the theme of this year's München Mineralientage, and this well-illustrated catalogue contains a number of short papers including accounts of mining and of exceptional specimens of diamond as a vehicle for feng-shui. Among the illustrations of polished stones and crystals are reproductions of crystal drawings from texts by Fersman and Goldschmidt. Photographs of diamond polishing and of diamond mining, of diamond depicted on postage stamps and of characteristic inclusions occupy a number of pages, and in the remainder of the catalogue are the usual colourful and useful advertisements, book reviews, papers on fossils and details of the show itself. M.O'D.

Edel Steine aus Holz. Katalog zur Austellung im Deutschen Edelsteinmuseum Idar-Oberstein vom 3.9 bis 15.11.1999

Deutsches Edelsteinmuseum, Idar-Oberstein, 1999. pp 79, illus. in colour, softcover. ISBN 3 932515 21 8. Price on application.

This is a multi-author account of the formation, discovery and working of fossil (silicified) wood in different areas of the world, especially in Germany, and was published to accompany an exhibition held in 1999. Particular attention is paid to deposits in Saxony and Thuringia, and there are many useful references to paleobotany and other studies not regularly encountered by gemmologists. The pictures are first-rate, as always from the museum, and altogether the book fills what might easily have become a serious gap in the study of ornamental materials. M.O'D.

La mine de fluorine de Valzergues, Aveyron

E. Guillou-Gotkovsky, 2000. The author, Le Perray-en-Yvelines (46 Petite Rue Verte, F-78610). pp 228, illus. in colour, hardcover. ISBN 2 9514462 0 9. FF290 plus FF80 postage and packing.

Yellow crystals, many of gem quality, distinguish fluorite from the Valzergues mine, Aveyron, France. The present work, whose print run is stated to be 2000 copies with an additional 60 special issues, describes the geology and mineralogy of the mine and gives a detailed account of its mining history, the latter topic producing a number of interesting photographs as well as many mine diagrams. The pictures of the fluorite crystals will, however, be the first stop for the reader: since fluorite on the whole furnishes relatively large specimens, it has been possible to illustrate forms, especially twinning, in such a way that the specimen's appearance is easily understood. Minerals accompanying fluorite are also described and many of them illustrated. There is a useful bibliography. Readers who have an interest in mineral specimens should try to see a copy of this book. M.O'D.

Deutsche Steinschneidekunst aus dem Grünen Gewolbe zu Dresden (Sonderausstellung im Deutschen Edelsteinmuseum Idar-Oberstein 1 Oktober bis 6 Dezember 1998)

J. Kappel, 1998. Deutsches Edelsteinmuseum, Idar-Oberstein. pp 195, illus. in colour, softcover. ISBN

3 932264 09 6. Price on application.

This scholarly survey describes and illustrates major examples of German ornamental hardstone fashioning to be seen in artefacts held in the Green Vaults at Dresden. The book is loosely but usefully arranged by date, place and type of material. The first chapter describes the search for 'precious stones' in Saxony during the 16th to the 18th centuries (mostly agates, but also the fine yellow topaz from Schneckenstein). This is followed by an account of the agate and jasper workings in the upper Nahe area and of the rise of Idar-Oberstein as a gemstone centre. The same area is also described in the following chapter, which pays particular attention to the techniques of agate-cutting used there in 1800. The scene now shifts to Dresden, where the manufacture of hardstone ornaments and the establishment of the Green Vaults are illustrated in the final chapters. There is a most useful bibliography and the many illustrations are very well reproduced. The book will be invaluable for the student of hardstone recovery, working and fashioning, as well as for the connoisseur of the decorative arts. M.O'D.

Dictionary of gems and gemology

M. Manutchehr-Danai, 2000. Springer, Berlin. pp 532 (pagination ends before conclusion of text), hardcover. ISBN 3 540 67482 9. £103.00.

Yet another gemmological dictionary, and from the depths of the reviewer's memory came an adaptation of part of an Irish song: '*They wrote it again/Over and over and over again*'. In general, while some may be worthy, few if any add to science, but the reviewer has still to search wearisomely among the near-pathologically tedious old and never-used names for the odd unexpected nugget that might be worth knowing. I am surprised that so generally adept a publishing house should produce so uneven a book at so high a price. For the gemmologist there is nothing new, the mineralogist is unlikely to bother with it, and the beginner, worst of all – and this is truly regrettable – is led from the start into paths already well-trodden by the tediously prolix, along which he will find many tempting, uncertain and occasionally dangerous fruits. Though described as a Professor of Mineralogy (institution not stated), the author or compiler surely could have, and certainly should have, sought the advice of perhaps more experienced colleagues.

So that the reader will get what I mean, try these out: p 3, *Abbreviations and symbols*, optic sign of uniaxial crystals reversed and, so that the reader won't miss the point, the author in pursuit of consistency gets the biaxial wrong too! Noting that the author had quoted formula units per unit cell, immediately reminiscent of *Hey*, I checked *formula units* but in vain. The entry for *unit cell* does not make the connection. Spessartine (correct formula then given) "may contain Mn" (good to get that learnt); alumina, "an important constituent of aluminium oxide"; allanite, "...radioactive, making it interesting to gem collectors" (!); no mention of the cleavage of kunzite under kunzite but an entry *kunzite – see spodumene*, but not emphasized in that entry where the heat-sensitivity of kunzite is omitted; painite "is prized by collectors".

Probably there are two reasons for this sorry state of affairs: one seems to be a language/translation/printing problem (the original language was Persian) over which the author has been wretchedly served by his proof-reader, whose name unwisely appears in the preface; the other being the difficulty of distinguishing between a dictionary and an encyclopedia – all dictionaries of gemmology, and probably every other subject, suffer from this and it is hard to see how it could be avoided. To be sure, the author has put a great deal into the book, but if a fairly quick read-through turns up so many examples of ignorance or carelessness, how can you trust the remainder of the text?

At so high a price (and the production is nothing to write home about – the paginator nodded off with the tedium of the text?) the publishers should have ensured that the author was at least served by people who knew what they were doing. Possible purchasers beware! M.O'D.

Gem and jewelry pocket guide

R. Newman, 2001. International Jewelry Publications, Los Angeles. pp 156, illus. in colour, softcover. ISBN 0 929975 30 8. US$11.95.

The book measures 18 x 11 cm and will fit into a bag or pocket. It is subtitled *A travelers guide to buying diamonds, colored gems, pearls, gold and platinum jewelry* and the text accurately fulfils this stated aim. As always with this author, the presentation is immaculate and each opening displays high-class pictures of gemstones and jewellery. The book opens with a succinct account of how items are priced, this including a note on how to make best use of the lighting conditions prevailing when a stone is examined. Treatments, synthetic and imitation stones are described next, before the book's largest section in which the major gemstones and organic materials are discussed, followed by consideration of gold and platinum jewellery.

An excellent chapter lists and comments on marketing terms and euphemisms: I was interested to see the adjective *faux* used with pearls to denote imitation pearls – I have seen it used with inorganic materials too and would be interested to know the significance. The reader can learn how to buy, how to choose an appraiser, scrutinize laboratory reports, deal with customs, consult a list of useful web sites and find out who will supply jewellery for photographs – and much more. There is still room for a useful bibliography and for short identification tables. Short guides don't come better than this. M.O'D.

Treatments

B. Sechos, 2000. National Council of Jewellery Valuers, Sydney (PO Box Q605, QVB Post Shop, Sydney NSW 1230, Australia). pp 10, illus. in colour, softcover. Price on application.

An attractively illustrated and concise booklet on the various gemstone treatments likely to be encountered by the jewellery valuer today, and forming the printed accompaniment to a series of lectures given in each of the Australian capital cities. Though not intended as a stand-alone publication, it none the less fulfils that task very well and would form an excellent and topical background to most courses likely to be held today. M.O'D.

Diamond clarity grading

B. Sechos, 2000. National Council of Jewellery Valuers, Sydney (PO Box Q605, QVB Post Shop, Sydney NSW 1230, Australia). pp 24, illus. in colour, softcover. Price on application.

Useful and well-illustrated lecture notes designed to accompany a lecture tour held in Australian capital cities, but standing alone perfectly adequately as a simple introduction to diamond clarity grading. The photographs show what is needed and the text gives many useful hints on practice which would serve the grader very well. Examples of certificates are given. A separate sheet, '*SPEED*', outlines five steps involved in clarity grading – Squares of the table (symmetrically aligned?), Point of the culet (open or chipped: are facet edges offset?), Eye (does the specimen show a fish-eye?), Edge and girdle (is the stone round or the girdle too thin, etc?), Depth percentage (how to work out total depth %). M.O'D.

The star and cross polyhedra (forms part 4 of The complete? polyhedra)

P. Taylor, 2000. Nattygrafix, Ipswich. pp 78, softcover. ISBN 0 9516701 5 8. £6.00.

Readers with an interest in shapes and forms will welcome the continuation of architect Patrick Taylor's study of the complete? polyhedra. The diagrams and text are very well produced, star and cross forms being the chief topic this time. M.O'D.

Turmalin 2000. Katalog zur Ausstellung im Deutschen Edelsteinmuseum Idar-Oberstein vom 19.2 bis 27.8.2000

Deutsches Edelsteinmuseum, Idar-Oberstein, 2000. (*Editions des Deutschen Edelsteinmuseum Idar-Oberstein, Bd 3.*) pp 96, illus. in colour, hardcover. ISBN 3 932515 22 6. Price on application.

One of a series of small-scale multi-author guides issued by the German Gemstone Museum at Idar-Oberstein, this book would serve many different interests as an introductory guide to the tourmaline group of minerals and the ornamental potential some of the individual species possess. The illustrations are especially good and well worth buying the book for on their own. In addition there are discussions of crystal structure, composition, properties and of the major locations of gem-quality material. The account of the causes of colour is particularly interesting. Each chapter has its own list of references. The book was published to accompany an exhibition held in 2000: I should like to have visited it! M.O'D.

Structure of crystals (3rd revised edn.). Modern crystallography 2

B.K. Vainshtein, V.M. Fridkin and V.L. Indenbom, 2000. Springer, Heidelberg. pp xx, 520, hardcover. ISBN 3 540 67474 8. £68.50.

The excellent series *Modern Crystallography*, with four titles, is now passing into its third edition with the virtually evergreen major text by Professor Boris K. Vainshtein and his co-authors: sadly Professors Vainshtein and Indenbom have died, but have left a fine work behind them and in good hands. This second volume of the four-volume series deals with crystal structure, the first with crystal symmetry. The bibliography has been brought up-to-date and there has been some addition to the text, notably in the timely revision of some of Vainshtein and Indenbom's chapters. M.O'D.

Proceedings of the Gemmological Association and Gem Testing Laboratory of Great Britain and Notices

OBITUARY

Eric Moore Bruton
President 1994-1996

Eric Bruton of Great Bentley, near Colchester, died on 8 December 2000 at the age of 85. He was well-known for having 'cracked' the secret code of the international Diamond Bourses and Clubs for pricing polished diamonds. He set up courses to teach grading and pricing at the Sir John Cass College in London. The international diamond industry knew him through his textbook *Diamonds*, and he was also recognized as one of the primary writers of books for clock and watch collectors.

Eric was born in 1915 in London. He began his writing career with Iliffe & Sons on a weekly newspaper devoted to transport, before joining a small group of specialists at George Newnes Ltd. producing *Practical Mechanics, Practical Motorist, Practical Wireless*, etc.

During the Second World War he held a commission in the engineering branch of the RAF in charge of technical training, spending some of the time in India. After the war he returned to writing, the most significant event in his life at this time being an offer in 1947 to edit four specialist publications and specialized books after the owner and publisher had succumbed to a severe heart attack. These were the *Industrial Diamond Review, Horological Journal, The Gemmologist and Goldsmiths' Journal*, which were outside his range of knowledge. Immediately he threw himself into as many courses as possible, from silversmithing at the famous Central School of Art and Crafts to horology by correspondence course and gemmology at Chelsea Polytechnic, qualifying for his FGA in 1950.

During this time he married Anne Britton, a fiction editor and author, and started writing books more seriously, the first of these being a crime book set in an old printing works. Thirty-two more books followed over the years, the first eleven crime fiction and the rest serious books mainly on gemmology and antique clocks and watches. One book on automation was chosen by

Eric Bruton in 1997 presenting the Bruton Medal to the first medallist, Rita Tsang Wai Yi of Hong Kong. © Peter Dyer Photographs Ltd.

 ISSN: 1355–4565

the government to be distributed to developing countries along with others on fundamental modern issues.

In 1960 he became a director of a subsidiary publishing company of Thomson International and saw an opportunity to start a colour newspaper, *Retail Jeweller*, in 1962. It was the first publication originated in the Thomson Organization (the rest had been bought) and, having eliminated the competition, remains today the only UK trade publication in the jewellery industry. The experience encouraged him to join the jewellery trade itself in 1967 by founding the Diamond Boutique in Maidenhead, designing, making and selling precious jewellery.

Eric began to devote most of his time to diamonds, some of it visiting diamond and gem mines in all parts of the world, many in almost inaccessible places, where it was noted that the prospectors and miners, and elsewhere the geologists, engineers, crystallographers, sorters and graders, cutters and polishers, brokers and dealers, wholesalers and retailers, knew little of each other's activities although they depended so much upon each other. With this in mind, he carried out a systematic study of all aspects of diamond, especially gem quality, getting to know all the key people in the industry at the time. Then he wrote the comprehensive book *Diamonds*, which remained the international standard work from 1970 to recent times, despite various attempts to supersede it.

In 1997 the GAGTL introduced the Bruton Medal; this is awarded to the candidate who submits the best paper in the Gem Diamond Examination which, in the opinion of the Examiners, is of sufficiently high standard to merit the award.

Over the years Eric Bruton was active on the executives of the British Horological Institute, the Gemmological Association, and the Crime Writers Association, as well as in two City Livery Companies, also becoming President of the National Association of Goldsmiths and later of the GAGTL. He received various awards including one from the Worshipful Company of Goldsmiths and two from America for outstanding contributions to scientific horology and gemmological literature respectively.

* * *

Norman V. Clarke (D.1983, DGA 1996) of Cockburnspath, Berwickshire, died suddenly on 1 September 2000. Norman's interest in all things gemmological stemmed from knowledge of electronic instrumentation and a fascination for geology, and was a 'mature' student when he started his studies.

Sigurd G. Olsen (D.1954 with Distinction), Bergen, Norway, died recently.

John Lewis Toole (D.1965) of South Delta, BC, Canada, died on 19 October 2000.

PHOTO COMPETITION 2001

Born yesterday

Gemstones are mined, cut and refashioned every day, with many more stones being 'created' in laboratories around the world. To celebrate the new Millennium, submit your picture of a gemstone 'born' (or even 'reborn'), loose or set in jewellery, during 2000.

All entries will be judged for originality, beauty and gemmological interest.

The following prizes, sponsored by Harley Advertising Ltd., Bristol, will be awarded:

First Prize £100

Second Prize £75

Third Prize £50

The closing date for the Competition is *30 April.*

MEMBERS' MEETINGS

GAGTL Conference 2000

The Annual Conference was held on Sunday 29 October at the Barbican Centre, London. A full report was published in the December 2000 issue of *Gem & Jewellery News*.

London

On 17 November at the Gem Tutorial Centre, 27 Greville Street, London EC1N 8TN, Greg Sherman and Branko Deljanin gave an illustrated lecture entitled *A new process to modify colour of natural (and synthetic) diamonds.*

On 23 November at the Gem Tutorial Centre Helen Fraquet gave a talk entitled *Amber – has the bubble burst*? Those present were able to examine a number of samples of natural and treated amber.

Midlands Branch

On 29 September at the Earth Sciences Building, University of Birmingham, Edgbaston, a *Gemmology and Gem Testing Quiz* was held.

GIFTS TO THE ASSOCIATION

The Association is most grateful to the following for their gifts for research and teaching purposes:

Professor Hermann Bank, Kirschweiler, Germany, for an alexandrite crystal.

Richard Burton for two botryoidal tourmalines.

Dennis Durham, Kingston upon Hull, East Yorkshire, for a collection of gemstones including tourmaline, garnet, andradite, scapolite, onyx and chalcedony.

Eddie Fan, Hong Kong, for seven samples of jadeite from a new locality in Myanmar.

John R. Fuhrbach, Amarillo, Texas, for a large parcel of Zambian amethyst cobbled rough.

Hassan Hamza, Kotugodella, Sri Lanka, for one blue and two pink sapphires.

Janice Kalischer, Finchley, London, for a selection of stone-set jewellery.

Ioanna Lalaounis Tsoukopoulou, Athens, Greece, for a copy of *Artists' jewellery in contemporary Europe. A female perspective?*

Ing. Romario, Monza, Italy, for a copy of his book *The Iron Crown and Imperial Europe.*

Dr John Saul, Paris, France, for four pieces of Libyan desert glass.

Shen Feng, Director of the National Laboratory of China, Beijing, for a silver, gold, quartz and gem-set pendant.

A.E. Ward & Sons Ltd., London, for synthetic amethysts and colour-change corundums.

Professor Grazia Zini, Ferrara, Italy, for a collection of cut and rough stones and a Ferrara guide book.

On 27 October at the Earth Sciences Building, Stephen Dale, Director of Tessier, gave an illustrated talk on the works of Peter Carl Fabergé.

On 24 November at the Earth Sciences Building, Michael O'Donoghue gave a talk entitled *Minerals of Pakistan.* There was a display of specimens, plans of mines, mine reports and prospects, and published and unpublished literature.

The Branch's 48th Annual Dinner was held on Saturday 2 December at Barnt Green.

North West Branch

On 18 October at Church House, Hanover Street, Liverpool 1, David Lancaster gave a talk entitled *Minerals and gems at the Great Exhibition of 1851.*

The Branch AGM was held on 15 November at Church House, at which Irene Knight, Deanna Brady and Dr John Franks were re-elected Chairman, Secretary and Treasurer respectively. The AGM was followed by a talk by John Pyke Snr entitled *Gem collection and anecdotes.*

Scottish Branch

On 31 October at the British Geological Survey, Murchison House, West Mains Road, Edinburgh, Brian Jackson gave a talk on *Pegmatite minerals.*

On 20 November at the British Geological Survey, Greg Sherman and Branko Deljanin gave an illustrated lecture entitled *A new process to modify colour of natural (and synthetic) diamonds.*

PRESENTATION OF AWARDS

The Presentation of Awards gained in the 2000 Examination was held at Goldsmiths' Hall, Foster Lane, London EC2, on Monday 30 October, despite the storms and flooding which affected many parts of the UK.

Jeffery Monnickendam, a member of the GAGTL Council of Management, presided and welcomed those present, particularly those students who had travelled from as far away as Hong Kong, India, Japan, Kenya and the USA, and those from many European countries. He announced that in January and June 2000 a total of 744 students entered the Gemmology Preliminary and Diploma, and the Gem Diamond Examinations. A total of 100 students qualified in the Diploma examination and 85 students passed the Gem Diamond Examinations.

Jeffrey Monnickendam introduced Alan Collins, Professor of Physics at King's College London and President of the GAGTL, who presented the awards before he delivered his

Neil Rose receiving the Bruton Medal awarded to the best candidate in the Gem Diamond Examination. Neil was the Tully Medallist in 1994. © Peter Dyer Photographs Ltd.

address (see below). A vote of thanks was given by Ian Thomson, who concluded the proceedings by thanking the Goldsmiths' Company for kindly permitting the GAGTL to hold the ceremony at the Hall.

Address by Professor Alan Collins

Tonight's presentation of awards ceremony is the second of the official functions in which I have been involved since being elected as President of the Gemmological Association; both within little more than 24 hours. Yesterday I was delighted to chair the morning session at the Annual Conference.

As you know, I am not myself a gemmologist; my subject is physics. But for many years I have studied the physics of colour centres in diamond. During that time some of my work has been of relevance to the gem trade, and I have had a very fruitful interaction with the Gemmological Association. As a result, I have certainly learned many things about diamond that I would not have known if I had just stuck to physics. Even so, I had not expected to be asked to serve a term as President of the Association, but I am very pleased to have been asked, and I look forward to following in the footsteps of the distinguished presidents who have preceded me.

I am sure that many of you, like me, have sometimes found yourselves at a social function talking to someone that you don't know, and usually one of the questions that comes up is "What sort of work do you do?" I used to reply, "I am a physicist," but I found from experience that that was an excellent conversation-stopper; many people are not very sure what physics actually is, and simply don't know what to say next; others respond, often with a sense of pride, saying that they failed physics at school; and I had one dear lady who asked me to have a look at a rash on her arm. And so, nowadays, if someone asks me what sort of work I do, I tell them that I carry out research on diamond. I think here I may be following the example set by my younger daughter; many years ago when she was in junior school she had to write down what her parents did. She was not really very sure what my work entailed, and, in any case, it sounds jolly boring to say that your father is a university lecturer, and so she wrote "My daddy is a diamond merchant."

Diamond is exciting

But you see, everyone has heard of diamond; everyone thinks they know something about diamond. Diamond is exciting, diamond is glamorous; diamond is Shirley Bassey singing 'Diamonds are forever' in the James Bond film of the same name. Diamond is Marilyn Monroe singing 'Diamonds are a girl's best friend' in the film 'Gentlemen prefer blondes.' Most of you who have received your awards this evening are too young to have seen that film, but those of you who have will, I am sure, agree with me that Marilyn looked a lot better than she sang. And that's why, almost 40 years after her very sad death, pictures of Marilyn Monroe are still used to illustrate articles written about diamonds.

Dr Louise Joyner receiving the Anderson-Bank Prize from Professor Alan Collins. © Peter Dyer Photographs Ltd.

Research

One of the next questions that people often ask is "How long have you been doing research on diamond?" and when I reply "37 years" many of them simply cannot believe it. They will say "How on earth can you spend 37 years doing research on diamond?" Now, of course, as a member of staff in a university, I spend only part of my time on research, but even so, to many people – particularly those who are not scientists – it sounds incredible that someone could be interested in the same material for such a long time. However, those of you who have collected your certificates this evening, particularly those of you who are starting out in your careers, will find that, in the field of gemmology, there is always something new. There may be a new location where a particular gemstone is found; there may be a new way of making the gem material synthetically; there may be new simulants that look more like the real thing; there may be different types of treatment to enhance the appearance of the gemstone; there will be new types of instrumentation which will enable research workers to learn more about the material and better able to detect if it has been treated. And so, whether you are involved in production, in sales, in research, or whatever, what you have learned in your gemmology courses is just the beginning.

In my research, I began by looking at what is called 'Type IIb' diamond. Those of you who have done the Gem Diamond Diploma will know that natural type IIb diamonds are very rare, and can have a beautiful blue colour, like the Hope Diamond and the Eugenie Blue, which are both in the Smithsonian Museum. Unlike all other diamonds, type IIb diamonds conduct electricity, and it was the electrical properties that we were interested in, although it was also necessary to study the diamonds by optical spectroscopy.

Artificially coloured

At about the same time, diamonds that had been artificially coloured using radiation damage were coming onto the market, and one afternoon – I suppose it would have been in the late 1960s – the head of our research group brought a gentleman into the laboratory who had a large pear-shaped blue diamond, and wanted to know whether it was naturally or artificially coloured. The gentleman was Basil Anderson, who was then Director of the London Gem Testing Laboratory and regarded as one of the world's most distinguished gemmologists. He was a graduate of King's College London, and knew that there was a diamond research group in the Physics Department. And so he brought the stone down to the Strand to see if we could do anything with it. Anderson hovered around anxiously while we stuck his diamond into a lump of plasticene and lashed it in front of the spectrometer; then, after half an hour or so, we were able to tell him that the stone was artificially coloured. I don't remember his reaction, and in those days I was certainly not aware of the huge difference in the value of a natural blue diamond and a treated blue diamond.

Preliminary Trade Prize and Anderson Medal winner Helen Dimmick receiving her awards. As Helen was unable to attend the Presentation of Awards because of the severe weather conditions, Professor Alan Collins presented the Medal and Prize to her at the meeting held at the Gem Tutorial Centre on 17 November.

Diamond synthesis

It was also in the 1960s that the first synthetic diamonds became available for study by research groups. These were not the sort of specimens that nowadays worry the gem trade; most of them were less than 1 mm across. Nevertheless, they were large enough to make measurements on, and it soon became clear that, while many of the properties of synthetic diamond were the same as those of natural diamond, there were important differences. Much of this early work is still relevant to the gem trade today. Although the first synthetic diamonds were very small, in 1970 General Electric described a method for manufacturing large gem-quality synthetic diamonds. Initially this caused some anxiety in the gem trade, but it soon became clear that it was cheaper to dig gem-quality diamonds out of the ground than to synthesise them in the laboratory.

NEW PRIZES FOR STUDENTS

The Christie's Prize for Gemmology

The Council of Management is pleased to announce that Christie's have agreed to sponsor the prize awarded to the student who achieves the best marks in the Gemmology Diploma Examination and whose main source of income is in the jewellery trade. It will be called the Christie's Prize for Gemmology. The GAGTL is most grateful to Christie's for this expression of support for excellence in gemmological studies and it underlines a continuing positive attitude towards the value of education.

The Deeks Diamond Prize

The Council is also most grateful to Noel Deeks, for many years a Council member, for the funding of a prize to the student who gains the highest marks in the Gem Diamond Diploma Examination, to be named the Deeks Diamond Prize. Some years ago, Noel taught the diamond course when it was only available to FGAs, but latterly he has been developing instruments to make identification of diamonds and other gems easier.

It is a pleasure to acknowledge this support and the prizes will be added incentives to our many students.

I've already mentioned the artificial coloration of diamond. Research in the 1950s had shown that radiation damage will colour a diamond blue or green, and the diamond that Anderson had brought down to King's had been treated in that way. If such a diamond is then heated to around 800°C the absorption band that produces the blue/green colour disappears and, in most cases, a new absorption band is produced which gives the diamond a yellow colour. For producing fancy-coloured diamonds for the gem trade this is all that it was necessary to know, but in the 1970s physicists began to ask: "What happens if irradiated diamonds are heated to higher temperatures?" and "What happens if synthetic diamonds are heated to very high temperatures (up to 2000°C, or higher)?". This was just curiosity-driven research, but it led to important revisions in the criteria for recognizing diamonds that had been artificially coloured and also to a much better understanding of the differences between natural diamonds and synthetic diamonds.

There isn't time to dwell on all the significant developments in diamond research, but if we move forward to the 1980s, two important announcements from Japan initiated a huge increase in the amount of research carried out world-wide on diamond. One was the claim by Sumitomo that they were able to grow large synthetic diamonds at a cost that was competitive with that of natural diamonds; the other was the revelation that large-area diamond films could be produced by chemical vapour deposition – a process in which a gas containing carbon is decomposed to form diamond. It is the Sumitomo work that has had most impact on the gem trade, and there have been numerous articles comparing the properties of synthetic gem-quality diamonds and natural diamonds.

HPHT treated diamonds

There are now several laboratories and commercial organizations which have the high-pressure high-temperature (HPHT) equipment needed to manufacture large synthetic diamonds. The reason why this is very significant follows from the extraordinary developments announced in the final year of the twentieth century. First General Electric and Lazare Kaplan International showed that they could take natural brown diamonds (which are relatively inexpensive) and convert them to near-colourless or possibly pink or blue specimens. Then, less than a year ago, a company called NovaDiamond showed that some low-quality brown natural diamonds could be converted into fancy yellow and fancy green colours. How is it done? They use the same HPHT equipment that is used to produce synthetic diamonds, but the process is very much quicker than growing a gem-quality stone, and so is much more profitable. I don't remember any topic in diamond research generating so many publications in such a short space of time, and most of these are in the gemmological literature. For me, one of the most satisfying things has been that much of the curiosity-driven research carried out over the last twenty years or so is now allowing us to understand why the HPHT treatment changes the colour of the diamonds, and to devise methods to check whether diamonds have had their properties changed in this way.

I've described just a few examples from the field of diamond research to illustrate the way that interesting and challenging new developments continually occur. I am sure that all of you who are newly qualified in gemmology, or some specialised aspect of gemmology, will have many interesting and challenging years ahead of you, and I wish you all every success.

FORTHCOMING EVENTS

1 February	**London**. *Psst! Wanna buy a diamond, guv? STEPHEN WHITTAKER*
21 February	**Scottish Branch**. *The quest for Scottish diamonds. JOHN FAITHFULL*
23 February	**Midlands Branch**. *The garnet group – understanding solid solution. PROFESSOR DR HENRY HÄNNI*
1 March	**London**. *Gemstones from the Hindu Kush. GUY CLUTTERBUCK.*
21 March	**North West Branch**. *Jewellery of the Art Nouveau era coupled with the art of René Lalique. DAVID CALLAGHAN*
22 and 23 March	**London**. *Visits to De Beers.*
30 March	**Midlands Branch**. *The Toyshop of Europe. SHENA MASON*
27 April	**Midlands Branch**. *A new combination gemstone finger-printer and high RI refractometer. DR JAMIE NELSON. This meeting will include the Branch AGM.*
3 May	**London**. *My 40 years with gems. DR KURT NASSAU*
4-7 May	**Scottish Branch Conference**. Queen's Hotel, Perth. The programme will include:
	ULRIKA AL KHAMIS. Averting the Evil Eye: Semi-precious stones in Islamic culture
	RICHARD DRUCKER: Coloured stone guide. Gemstone values: sources of reference
	ERIC EMMS and ANA CASTRO. D is for Gemmology
	CALLY OLDERSHAW. Gem collections of the Natural History Museum: tales behind the gems
	The Conference will also include a workshop session and a field trip.

For further information on the above events contact:

London	Mary Burland on 020 7404 3334
Midlands Branch:	Gwyn Green on 0121 445 5359
North West Branch:	Deanna Brady on 0151 648 4266
Scottish Branch:	Catriona McInnes on 0131 667 2199

GAGTL WEB SITE

For up-to-the-minute information on GAGTL events visit our web site on www.gagtl.com

MEMBERSHIP

The following have been elected to membership during September, October and November:

Fellowship and Diamond Membership (FGA DGA)

Cubbins, Graham, Marton, Blackpool. 1999/2000
Kampiotis, George, Athens, Greece. 1996/1997

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Ascot, Leon, Ruschlikon, Switzerland. 2000
Berner, Peter, Gelterkinden, Switzerland. 2000
Berry, Shoshana, Salisbury, Wiltshire. 2000
Blomquist, Eva, Jönköping, Sweden. 2000
Canty, Jess, London. 1987
Chokshi, Shivang Rajnikant, Gujarat, India. 2000
Chow, Suet Lai, Shatin, Hong Kong. 2000
de Landmeter, Edward, Soesterberg, The Netherlands. 2000
Dowling, Siobhan Loyola, Canary Wharf, London. 2000
Droesser, Niklas Bernd, Leverkusen, Germany. 2000
Fok Ki Yu, Lantau Island, Hong Kong. 2000
Gemin, Nadine, St Julien-en-Genevois, France. 1994
Ho, Anna, NT, Hong Kong. 2000

Ho Sau Lan, Hong Kong. 2000
Ho Sau Wa, Ma On Shan, Hong Kong. 2000
Hung Tin Man, NT, Hong Kong. 2000
Kim, Jungshin, Seoul, South Korea. 2000
Ladak, Nelina, London. 2000
Lamarre, Claude, Lasalle, Quebec, Canada. 2000
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Matheson, Eric Ross, Vancouver, B.C., Canada. 2000
Mohideen, Mohamed Fazal, Colombo, Sri Lanka. 1989
Ng, Bianca Suen Lam, Hong Kong. 2000
Oksanen, Tarja Kaarina, Helsinki, Finland. 2000
Pagel-Theisen, Verena, Kronberg, Germany. 1966
Pajor, Matthias Valentin, Gelterkinden, Switzerland. 2000
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Punchihewa, Leslie Joseph, Colombo, Sri Lanka. 1983
Rathwell, Eden L, California, U.S.A. 2000
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To, Flora L.H., Kowloon, Hong Kong. 2000
Tock, Bryon, Ilkley, Yorkshire. 1990
Tolmie, Nigel Lester, Stratford-on-Avon, Warwickshire. 1975
Tuckwell, Alice Elizabeth, Untersiggenthal, Switzerland. 2000
Verhoeven, Pia M.C., Nijmegen, The Netherlands. 2000
Wang Yiren, Shanxi Province, P.R. China. 2000
Willis, Kathryn, Palmers Green, London. 1996
Wong, Rebecca Lai King, Ontario. 2000
Ziemelis, Ojars, Akersberga, Sweden. 1988

Diamond Membership (DGA)

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Why use the SSEF IIa Diamond Spotter™ with the new SSEF IIa Diamond Illuminator™

Type IIa diamonds are found as colourless, pink or brown stones. Colourless stones may be naturally colourless or the result of high pressure, high temperature (HPHT) treatment (GE-POL, Bellataire diamonds etc). Type IIa (and rare type IaB) transmit short-wave ultraviolet (SWUV) light. Most diamonds are type Ia and do not transmit SWUV. Commercial short-wave UV-lamps such as the new SSEF IIa Diamond illuminator™ produce monochromatic SW radiation of 254 nm. These lamps can be used with the SSEF IIa Diamond Spotter™. Its screen is made of a substance that fluoresces when exposed to such a light source. When a colourless IIa diamond is identified by its transmission of SWUV, resulting in a green spot on the screen, the diamond should be further analysed in a specialised gem laboratory (e.g., SSEF, AGTA, Gübelin) where the HPHT treatment can be identified by Raman luminescence spectrometry. If a colourless diamond does NOT transmit SWUV it is not type IIa hence not a HPHT treated diamond.

The SSEF IIa Diamond Illuminator™ is an ideal light source for the detection of type IIa diamonds.

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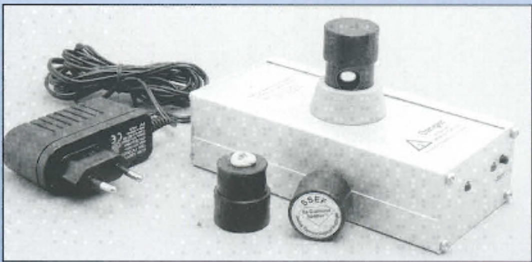

The SSEF IIa Diamond Illuminator™ has been designed for use with the SSEF IIa Diamond Spotter™.

A brilliant cut diamond should be placed with the girdle into the small hole of the SSEF IIa Diamond Spotter™ to ensure optimum light transmission. BlueTack or plasticine must be used to close any space around the diamond, to block stray light from passing aound the stone. Then place the SSEF IIa Diamond Spotter™ with the diamond at the bottom into the holder of the SSEF IIa Diamond Illuminator™ and switch on the SWUV source. Two reactions of the screen in the SSEF IIa Diamond Spotter™ are possible: fluorescence or no fluorescence. In the case of a green fluorescent light spot on the screen, the diamond transmits SWUV and is thus of type IIa (or rare type IaB) and may have been "decolourised" by HPHT treatment. If no reaction, the colourless diamond is not a IIa diamond, thus not HPHT treated. If there is no stone placed on the hole of the spotter, a bright green fluorescence spot can be seen when SWUV is switched on.

The testing of diamonds with SSEF IIa Diamond Spotter™ should be made in a dark (or at least darkened) room.

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Warning: *SWUV radiation is hazardous for the eyes, be sure to protect your eyes from the SWUV when working with the SSEF Type IIa Diamond Illuminator™.*

For further information, see the news section at www.ssef.ch or e-mail gemlab@ssef.ch

The **SSEF IIa Diamond Illuminator™** is sold with adapter and voltage converter by SSEF for US$500 or US$650 together with an SSEF IIa Diamond Spotter™ (plus shipment). The Spotter alone is US$150 (plus shipment).

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Guide to the preparation of typescripts for publication in *The Journal of Gemmology*

The Editor is glad to consider original articles shedding new light on subjects of gemmological interest for publication in *The Journal*. Articles are not normally accepted which have already been published elsewhere in English, and an article is accepted only on the understanding that (1) full information as to any previous publication (whether in English or another language) has been given, (2) it is not under consideration for publication elsewhere and (3) it will not be published elsewhere without the consent of the Editor.

Typescripts Two copies of all papers should be submitted on A4 paper (or USA equivalent) to the Editor. Typescripts should be double spaced with margins of at least 25 mm. They should be set out in the manner of recent issues of *The Journal* and in conformity with the information set out below. Papers may be of any length, but long papers of more than 10 000 words (unless capable of division into parts or of exceptional importance) are unlikely to be acceptable, whereas a short paper of 400–500 words may achieve early publication.

The abstract, references, notes, captions and tables should be typed double spaced on separate sheets.

On matters of style and rendering, please consult *The Oxford dictionary for writers and editors* (Oxford University Press, 1981).

Title page The title should be as brief as is consistent with clear indication of the content of the paper. It should be followed by the names (with initials) of the authors and by their addresses.

Abstract A short abstract of 50-100 words is required.

Key Words Up to six key words indicating the subject matter of the article should be supplied.

Headings In all headings only the first letter and proper names are capitalized.

A **This is a first level heading**

First level headings are in bold and are flush left on a separate line. The first text line following is flush left.

B *This is a second level heading*

Second level headings are in italics and are flush left on a separate line. The first text line following is flush left.

Illustrations Either transparencies or photographs of good quality can be submitted for both coloured and black-and-white illustrations. It is recommended that authors retain copies of all illustrations because of the risk of loss or damage either during the printing process or in transit.

Diagrams must be of a professional quality and prepared in dense black ink on a good quality surface. Original illustrations will not be returned unless specifically requested.

All illustrations (maps, diagrams and pictures) are numbered consecutively with Arabic numerals and labelled Figure 1, Figure 2, etc. All illustrations are referred to as 'Figures'.

Tables Must be typed double spaced, using few horizontal rules and no vertical rules. They are numbered consecutively with Roman numerals (Table IV, etc.). Titles should be concise, but as independently informative as possible. The approximate position of the Table in the text should be marked in the margin of the typescript.

Notes and References Authors may choose one of two systems:

(1) The Harvard system in which authors' names (no initials) and dates (and specific pages, only in the case of quotations) are given in the main body of the text, e.g. (Gübelin and Koivula, 1986, 29). References are listed alphabetically at the end of the paper under the heading References.

(2) The system in which superscript numbers are inserted in the text (e.g. ... to which Gübelin refers.[3]) and referred to in numerical order at the end of the paper under the heading Notes. Informational notes must be restricted to the minimum; usually the material can be incorporated in the text. If absolutely necessary both systems may be used.

References in both systems should be set out as follows, with *double spacing* for all lines.

Papers Hurwit, K., 1991. Gem Trade Lab notes. *Gems & Gemology*, **27**, 2, 110–11

Books Hughes, R.W., 1990. *Corundum*. Butterworth-Heinemann, London. p. 162

Abbreviations for titles of periodicals are those sanctioned by the *World List of scientific periodicals* 4th edn. The place of publication should always be given when books are referred to.

Volume 27 No. 5 January 2001

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Cover Picture - Insert

The 'Light-tree-water-being'

The colour and inclusions of the aquamarine inspired the creation of this piece of jewellery by Elena Villa. See Santa Maria aquamarine p. 257. Photo by Bob Maurer.

ISSN: 1355–4565

Designed & Produced by Harley UK