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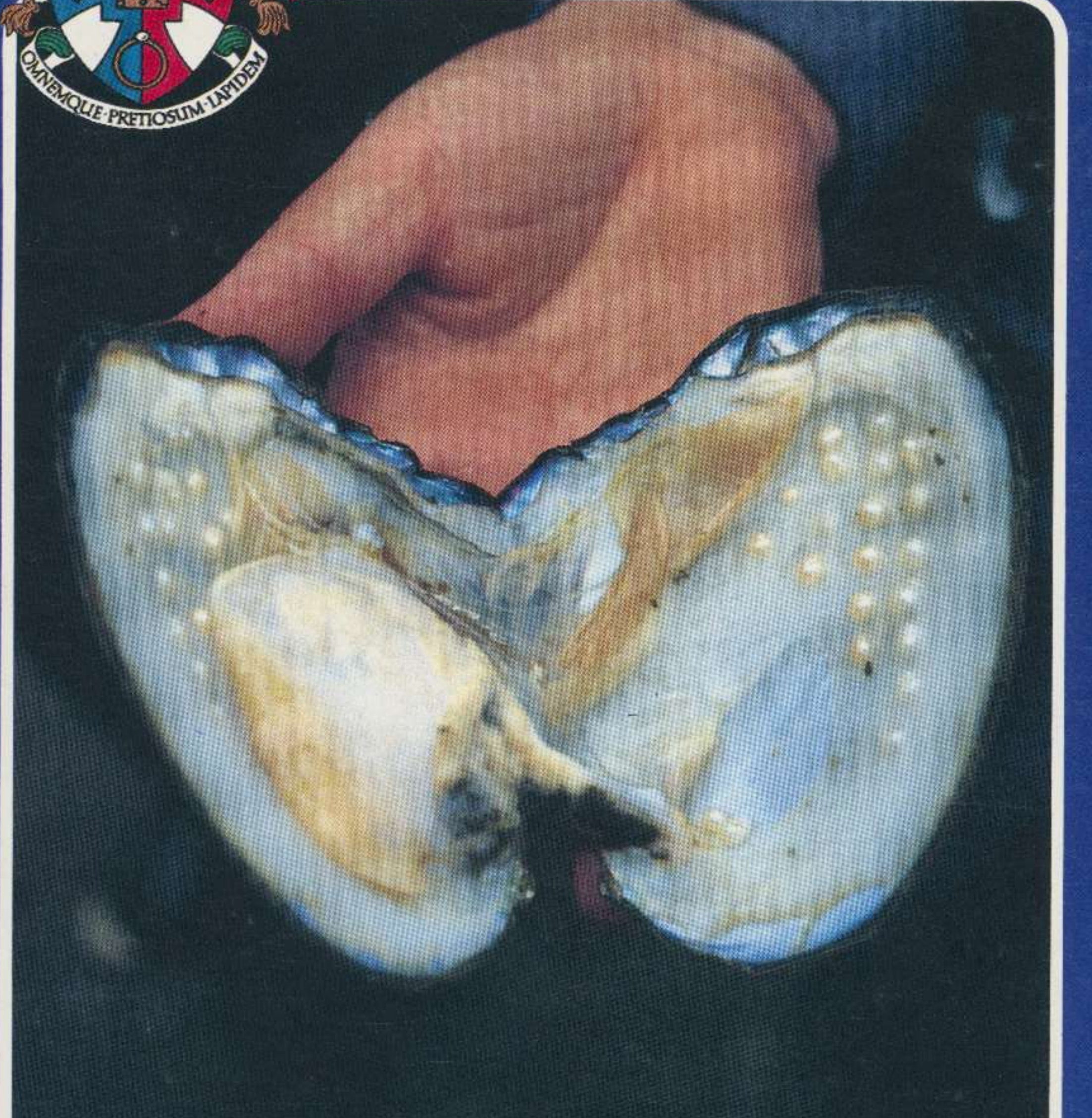

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Cover Picture

Opened valves of the pearl mussel *Cristaria plicata*, showing the translucent mantle covering the pearls, Yangxin, China (see Jobbins and Scarratt, p.3). *Photograph by K. Scarratt.*

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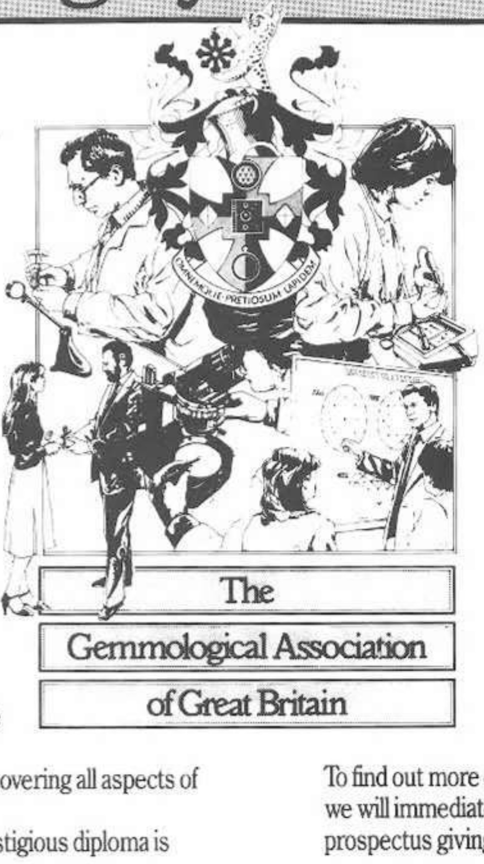

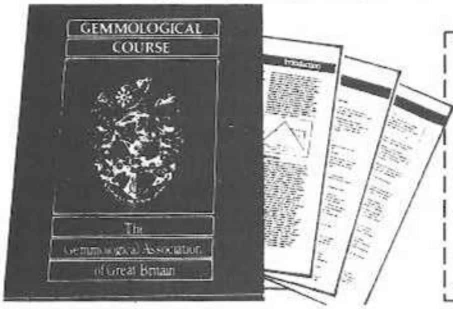
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Some aspects of pearl production with particular reference to cultivation at Yangxin, China

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Fig. 1. The pearl mussel, *Cristaria plicata*, used in Yangxin, China, showing the growth stages of the mussel with a series of cultured pearls.

Abstract

The whole and beaded cultured pearl has been with us since the 1920s and has formed the major part of the pearl market for several decades. The non-nucleated cultured pearl, produced in Lake Biwa in Japan, came to the market in the late 1950s and at the time caused some difficulties in terms of identification. In recent years freshwater cultured pearls, such as those from Lake Biwa, have been referred to simply as 'freshwater pearls'. As natural freshwater pearls can be and are recovered from various rivers around the world, it is essential in the case of the freshwater cultured pearl to include such a qualifying term within any description.

During the last decade an enormous number of freshwater cultured pearls have been brought on to the market by the Chinese. Mostly these in the main have been the lower quality material which are said to resemble 'rice crispies'. So many of these were brought to the market that the price per row became extremely low. Freshwater cultured pearls of a higher quality are now produced in addition to the very popular 'rice crispy' type.

During May 1989 the authors were allowed to visit a pearl farm located in Yangxin, China. Here they discovered an arrangement of small man-made lakes, resembling a 'trout farm', that housed the various stages of

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mussel and pearl production. Their questions regarding the production techniques were answered readily and a number of specimens of the mussel (*Cristaria plicata*) and the good and poorer quality cultured pearls were purchased for future investigation. (See Figure 1.) Forty cultured pearls are produced from each mussel in a time span which may be as little as nine months.

Introduction

Pearl is unique amongst gem materials in that, apart from being drilled, it is mostly worn as it is found; whereas, with the exception of the rare well-formed crystal, diamonds, rubies, sapphires and emeralds all require cutting and polishing before they are seen at their best. Pearl is also unusual as a gem material in that it is growing 'at the present time' in many different parts of the world.

When one speaks or writes of a *pearl*, without qualification, then the material which is being described should be *natural* pearl. *Cultured* pearls should be so described, whether they are of salt-water or fresh-water origin. It has been argued by some, particularly in advertising standards disputes, that as the cultured pearl is growing in its *natural* environment, distinction between it and the natural pearl is less important. The argument against such a statement is quite compelling. Firstly, the natural pearl is one of the rarest of gems whereas the cultured pearl can hardly be considered in such a light, and secondly, whilst it may appear to be growing in its 'natural environment' in fact, the mollusc in which the cultured pearl grows is a product of man's nurturing.

The Gulf

It was not so long ago that *natural* pearl trading formed a significant, if not the major, part of the total trade for a number of States. In about 1915, just a short time before the whole cultured pearl first made its impact upon Europe, Qatar in the Gulf had 350 pearling boats (see Figure 2) based in its main town Doha. In order to understand the significance of this number one has to understand that the population of Doha at that time was just 12,000. There were only 50 shops in the suq, 60 sea going trading boats running to Oman and less than 100 fishing boats (Scarratt, 1987).

Fig. 2. Typical pearl fishing boat at Doha, Qatar.

Countries such as Qatar and Bahrain would sell their pearls (see Figure 3) to Indian merchants who in turn would drill them and make them up into 'Bombay Bunches' for sale to European merchants. Whilst these and other Gulf nations may still, in some small way, fish for pearls in their waters, the vast majority of natural sea water pearls on the market today are 'old pearls'. That is pearls that have been strung and re-strung, sold and re-sold, over the last 50 years and more.

There are a number of reasons for the lack of present-day sea-water pearl fishing. There is the economic situation in the Gulf, the previous pearling nations no longer have to rely upon the pearl as a source of income since they now have oil and gas production. There is also plenty of safer and more profitable work that potential divers can do on dry land rather than risking their lives in the Gulf waters. There is the pollution factor, and finally the large production of cultured pearls in several areas of the world which give the natural product increased competition. It is obvious then that today new natural pearls, marine or freshwater, are difficult to obtain and the reasons for this are not simply, as is often recorded in the literature, that the beds are 'fished out' or have been killed off by pollution.

The introduction of the whole and beaded cultured pearl in the 1920s undoubtedly gave the natural pearl producing nations a few short-term problems, nevertheless without its introduction today's enormous 'pearl' market would not exist. The discovery of oil and gas in The Gulf made it inevitable that fewer natural pearls would have been available in any event. However, these same Gulf nations have far from lost their interest in the natural pearl and the population of states such as Bahrain still regard the pearl, if not quite with reverence, then as having a special place not only in history but also in modern life.

There is still a small production of natural freshwater pearls around the world, notably in Bangladesh, North and South America and Scotland. Some of the North American freshwater pearls are particularly beautiful and come in an attractive range of colours.

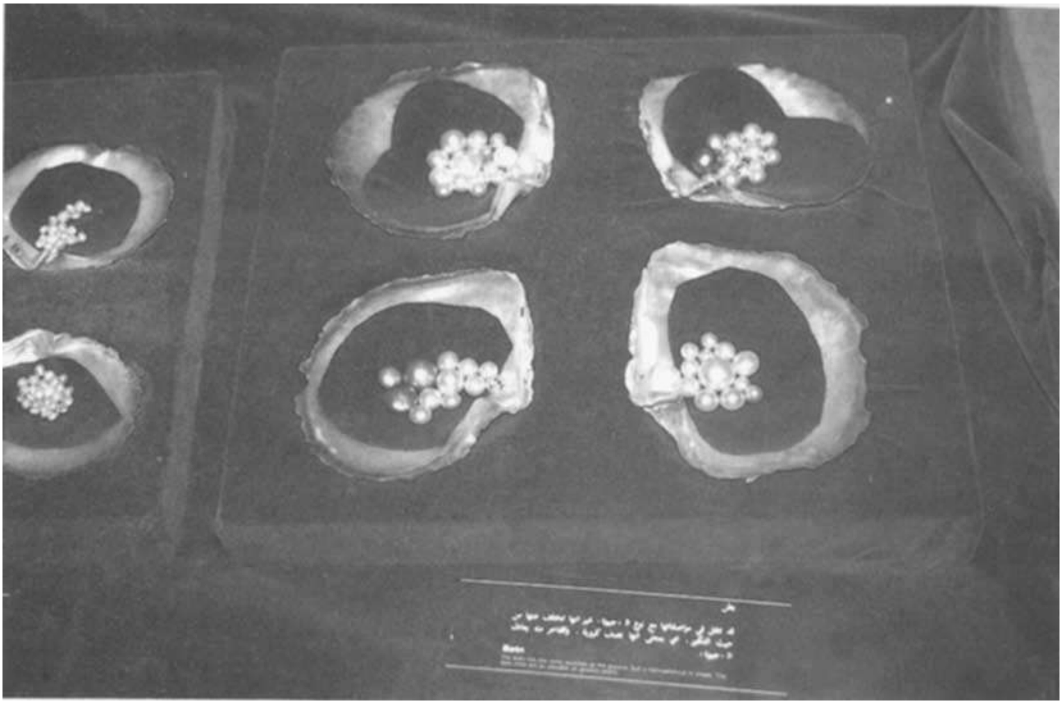

Fig. 3. Natural pearls at Doha, Qatar.

Scotland

The pearls fished from the rivers of Scotland can have a particularly attractive lustre which is quite characteristic (see Figure 4). There are very few pearl fishers in this part of the world and only one real specialist; his methods of operation have been handed down through his family. It is a lonely, back-breaking task, but occasionally there is an ample reward. Bill Abernethy wades into the fast-flowing rivers of Scotland with a split-ended pole, a home made glass bottomed jug and a large sack hanging from his shoulder (see Figures 5 and

Fig. 4. Scottish river pearls; the Abernethy pearl (11.5mm in diameter), the Cairncross necklace and valves of *Margaritifera margaritifera*, the parent mussel.

Fig. 5. Bill Abernethy and Ken Scarratt fishing for pearls in Scotland.

Fig. 6. The 'tools of the trade'; including home-made glass-bottomed jug, waders, cleft stick and bag for holding shells.

6). He knows exactly when and where to fish each river. Whilst bent over and looking through the glass bottom of his jug, which he holds in his teeth, he searches the rocky bottom until he locates a group of mussels, upright and mostly covered in gravel. The split end of the pole is then very skilfully pushed over each mussel and it is lifted from the water and placed into the sack. Once the sack is full he returns to the river bank and from the external appearance of each shell he predicts the possibility of a pearl being present. The mussels that he suspects might yield a prize he opens and searches through the fleshy interior for the pearl or pearls. Those mussels which he feels have no chance of containing a pearl are put back into the river unopened and still alive.

Japan

The whole and beaded cultured pearl which has held and expanded upon its place in the jewellery market since the 1920s, consists of a beaded core of mother-of-pearl, around which the pearl producing mollusc has deposited a nacreous layer. This layer may be relatively thick, as is often the case for those pearls cultured in the South Seas or Burma (see Figure 7), it may be reasonably thick, as is the case for the better quality Japanese pearls, or it may be so thin as to allow the observer to see the banded nature of the mother-of-pearl bead through the nacre. Indeed some layers are so thin that the phrase often used to describe them is that they have barely 'had a lick' from the mollusc (see Figure 8).

To produce this type of cultured pearl, a mother-of-pearl bead is inserted into the mollusc along with a small square of mantle tissue. The mollusc is then returned to the water. Providing that the bead is not rejected, a 'pearl sac' then forms around it and a gradual built-up of nacre is secreted over its surface.

The beautiful part of Japan south of Osaka known as Kashikojima, an area of tranquil inlets and islands, is home for many of the Japanese beaded cultured pearl producers. Here the pearl producing oysters hang quietly from hundreds of rafts (see Figure 9), but this quiet and apparently leisurely spot hides a hive of typically efficient Japanese industry.

The spat houses and 'operation rooms' have a clinical appearance (see Figure 10) for what is a production line activity. The young oysters are nursed through their early lives, with the water

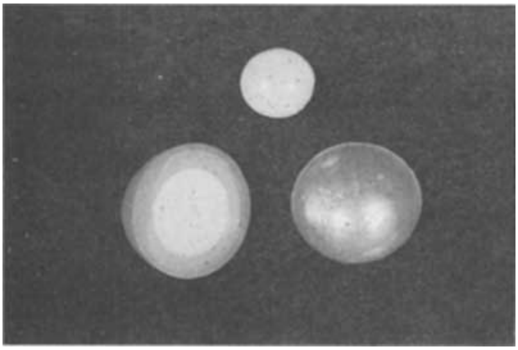

Fig. 7. Sectioned cultured pearl from Mergui, Burma; diameter of pearl 12mm, bead nucleus 7mm.

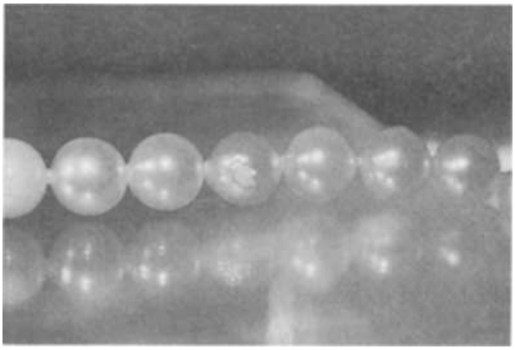

Fig. 8. Poor quality cultured pearl with thin outer nacreous layer.

temperature at given depths being checked at regular intervals. Once the operation to insert the bead has taken place the nursing continues, even to the extent of regular cleaning by a specially designed machine.

There is another type of cultured pearl which is known either as a 'non-nucleated' or 'tissue graft' cultured pearl. As the name implies, no bead nucleus is used to obtain these pearls – a small piece of 'tissue' is used instead. The other and main difference between these and the beaded variety is that the mollusc used is in the main a freshwater mussel rather than a marine oyster.

In the late 1950s this new form of freshwater cultured pearl began to appear on the London market. This was being produced in Lake Biwa, the largest lake in Japan.

By 1981, the spat were being reared in clean concrete tanks and supported in special nets. On maturity, mantle tissue was inserted and the mussel returned to the lake. The pearl cultivating areas were inlets from the main lake, often lined with

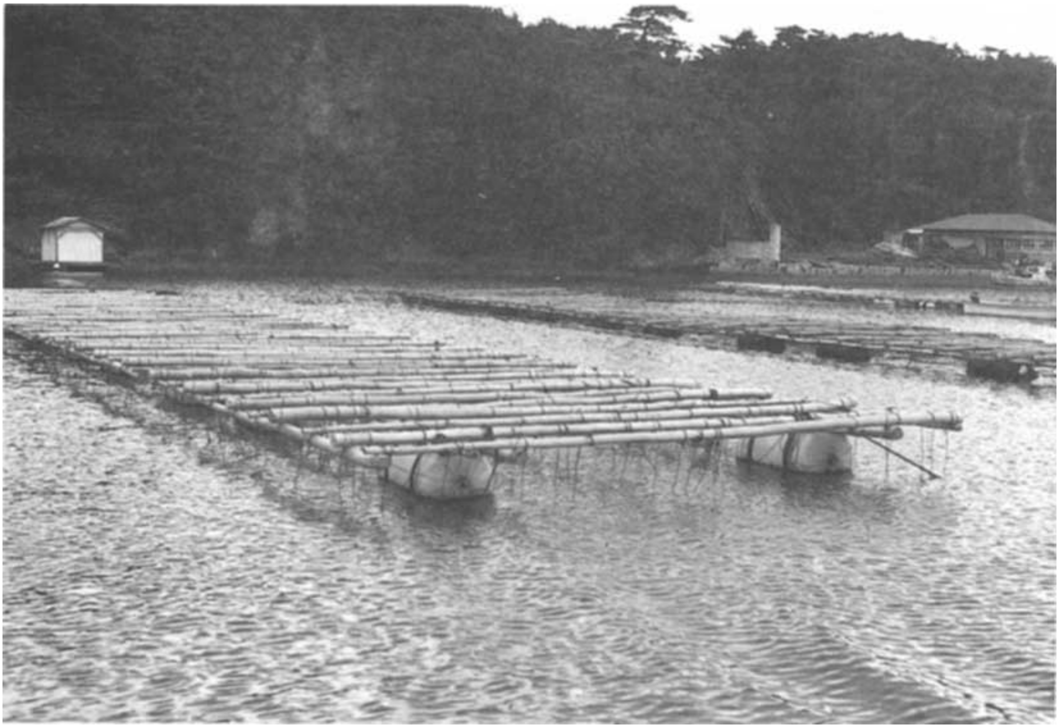

Fig. 9. Rafts supporting nets with marine oysters, Ago Bay, Japan.

Fig. 10. The 'clinical appearance' of the pearl 'operation room' at Ago Bay, Japan.

Fig. 11. Rafts surrounded by bamboo fences in the Lake Biwa area, Japan.

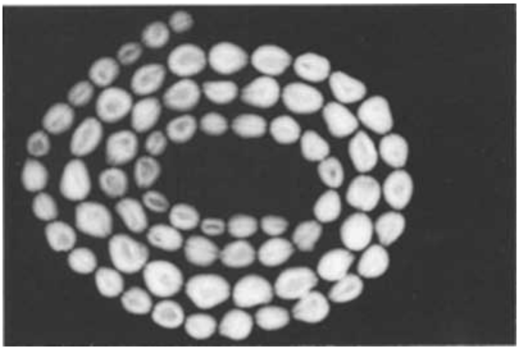

Fig. 12. X-radiograph of non-nucleated cultured pearls from Lake Biwa.

rushes at the sides. In the cleared areas were large pens bounded by closely spaced bamboo poles (see Figure 11). The pearl mussels were kept in nets suspended from long wires which in turn were supported by bamboo poles. The mussel used is *Hyriopsis schlegeli* and squares of mantle tissue cut from a sacrificial mussel are inserted into the mantle tissue of a living individual. Up to twenty inserts were placed into each valve of a mussel. Pearls of various colours and sizes were reported and quite bizarre shapes were routinely produced.

Having no 'normal' nucleus these pearls created new identification problems in terms of the results gained from X-radiography. They also virtually put the 'endoscope' into redundancy. The endoscope relied upon the behaviour of a beam of intense light within the 'pearl's' interior. A pinpoint beam of light directed into a natural pearl's concentric (onion like) structure from inside its drill hole merely followed the structure and emerged as a flash of light still within the drill hole. As the bead used in the 'normal' culturing process has a layered rather than concentric structure, the pinpoint beam did not emerge as with the natural pearl but most of it was directed along the 'layered structure' towards the outside of the 'pearl'. As the non-nucleated cultured pearl does not have a bead nucleus it is obvious that the endoscope would produce similar results for these as it would for the natural pearl. However it was not long before experienced testers learned to recognize the particular whitish appearance of the 'Biwa pearls', and their characteristic structure on an X-radiograph (see Figure 12).

In the early '80s the market began to see large numbers of 'freshwater cultured pearls'. These were produced by the old practitioners of the art, the Chinese. At one stage the market was so flooded with these low quality, 'rice crispy', cultured pearls that even in London one could obtain a row for a few pounds.

Fig. 13. Drilling small non-nucleated baroque cultured pearls with a double-ended drilling machine, Yangxin, China.

Despite some assertations to the contrary, in the authors' experience quite good quality Chinese freshwater cultured pearls have been available for a number of years, and this was confirmed during a recent visit by the authors to a pearl farm in China.

Pearl Farming in Yangxin, Hubei Province, China

During May 1989 the authors visited China following an invitation from the China University of Geosciences to instruct a group of lecturers in gemmology. During their stay in Wuhan (a large university town on the Yangtze river), they asked if it would be possible to visit a pearl farm.

The farm chosen was in Yangxin, which is situated south east of Wuhan, a distance of approximately 170km. The authors were accompanied by Professor Yan Weixuan and other members of the gemmology class, approximately twenty people in all. The countryside around Wuhan and all the way to Yangxin is extremely wet with hundreds of lakes and is ideally suited for rice growing. After having to change route and use some extremely rough roads the party arrived at about 1300 hrs. They were met by the mayor of the area and a number of other dignitaries including the foreign affairs representative. A large and special lunch was provided at the local hotel.

From the hotel they were taken to the offices and work rooms of the pearl farming company – The Yangxin Integrated Company of Pearl. The Company employs about 40 people with Mr Lu Chun Ming as engineer and Chairman of the Board. Here they observed the drilling at great speed of the small baroque non-nucleated cultured pearls (see Figure 13) and a display case showing the Company's products. The most striking exhibit was an open (preserved) mussel which, when closed, would be approximately 19-20cm in length and 12cm in width. This contained a large number of cultured pearls located in the upper portion of the mantle. Fifty loose, coloured pearls and two long strings of baroques (see Figure 14) were purchased for later investigation.

They then proceeded to the pearl farm itself (see Figure 15a), visiting the nursery ponds, the spat sheds, the pearl producing ponds and the culturing shed, in that order. The processes involved for the culturing of pearls at this farm are listed below.

1. The parent mussel, *Cristaria plicata* (specimen identified by Solene Morris of the British Museum (Natural History)) when about to spawn is placed into the nursery pond (see Figure 15b).

2. The parent spawns and is returned to the mature ponds.

Fig. 14. Inspecting long rows of small baroque non-nucleated pearls at Yangxin, China.

3. The spat attaches itself to a specially introduced fish (described as having two barbs – no species given) and after a short time the fish is taken from the nursery pond and placed in the concrete 'spat trays' in the spat house (see Figure 16), where the water in the trays is always flowing.

4. When suitably grown, the spat fall off, and before the fish can eat them, the fish are removed.

5. At approximately 2cm the spat are placed in the nursery pond and left there until they reach 8cm in length.

6. At 8cm they are taken to a small shed where the culturing process takes place.

7. One mussel is sacrificed at this point for its almost transparent whitish mantle tissue – a strip approximately 1.5 to 2cm wide is taken from the outer edge of the mantle (see Figure 17), sliced once or twice lengthways and then crossways to make numerous squares of tissue.

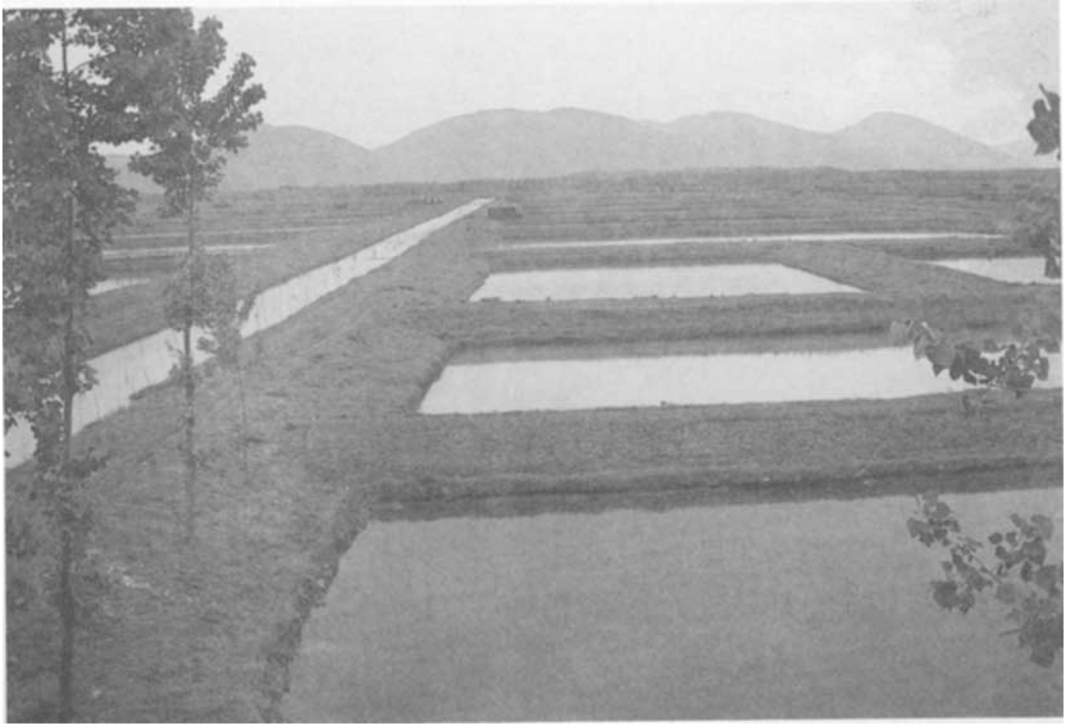

Fig. 15a. General view of the pearl farm at Yangxin, China.

Fig. 15b. The nursery pond at the pearl farm, Yangxin, China.

Fig. 16. Concrete 'spat trays' at the pearl farm, Yangxin, China.

Fig. 17. Removing the outer edge of the almost transparent mantle from the sacrificial mussel.

Fig. 18. Inserting the small squares of mantle tissue into the mussel.

Fig. 20. Mussel nets supported from wires – the non-floating type.

8. Forty squares of tissue are then inserted into another mussel (see Figure 18) and this is then placed into one of the two types of maturing pond with [a] floating and [b] non-floating support poles.

   The floating type consists of a minimum of four intersecting bamboo poles, which, whilst being secured to the banks to keep them in position relative to the sides of the ponds, are not anchored to the bottom (see Figure 19). Therefore as the water rises or falls the mussels remain at the same depth – this method produces the better quality pearls. The non-floating type consists of a number of vertical bamboo poles placed in a line across the pond. A wire stretches from one side of the pond to the other and is supported at approximately equal distances by the upright bamboo poles (see Figure 20). From the wire the mussels are hung in nets in a similar manner to that used for the floating type. The nets contain from two to four mussels, and are of two basic types [a] resembling a net shopping bag without any support, in which the mussels are not separated and [b] a wide, supported, net in which the mussels are separated (see Figure 21).

Fig. 19. Recovering a net containing a pearl mussel from the floating type of raft.

Fig. 21. Opened pearl-bearing mussels and the different types of net in which they are grown.

With some forty pearls, 'rice crispy' quality or top quality, being produced from each mussel after a growth period of as little as nine months (see Cover Picture), one can imagine the enormous output possible from these farms. In fact one does not even have to 'imagine' this output, just look in any jeweller's window, anywhere in the world or go to any trade show and many examples of this product will be seen.

The pearls the authors brought back with them were examined by X-radiography. The structures seen on the resulting radiograph were found to be typical of non-nucleated cultured pearls.

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Star rhodolite garnet from Tanzania

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Abstract

This article describes the first reported asteriated rhodolite garnet from Tanzania and details the specimen's gemmological properties.

Acicular rutile crystals are a well-known inclusion in almandine garnets (Webster, 1983; Gübelin and Koivula, 1986; Liddicoat, 1987). When fashioned en cabochon, stones containing a relatively dense, even concentration of these fine needle-like inclusions may exhibit asterism in the form of a four-rayed or six-rayed star. Both India (Webster, 1983; Rohrbach, 1986) and the Emerald Creek area of Idaho, USA (Zeitner, 1986; Rohrbach, 1986) are reported as sources of star almandine garnet.

Rhodolite, a reddish-purple to purple mixture of almandine and pyrope garnets, was originally described from an occurrence in North Carolina, USA (Hidden and Pratt, 1898). Rhodolite garnet is also found in Sri Lanka (Webster, 1983), which has been a major commercial source (Federman, 1984). In the past few decades a number of rhodolite sources have also been described from (or off the coast of) Africa, including Zimbabwe (Campbell, 1972), Malagasy (Campbell, 1973) and Tanzania (Phillips, 1962; Sinkankas, 1968; Sarofim, 1970; Pough, 1973). The latter is now an important commercial source (Federman, 1984). Like almandine, rhodolite from a number of localities also contains acicular rutile crystals (Campbell, 1972; Webster, 1983). Little mention has been made, however, to these inclusions giving rise to asterism in rhodolite garnet (Rohrbach, 1986).

Recently the authors had the opportunity to examine a rhodolite garnet cabochon which exhibited a four- or six-rayed star, depending on the direction of observation. The stone, which had been purchased as rough and fashioned by Mr Barton Curren of Glyptic Illusions, Topanga, California, USA, came from a parcel of Tanzanian material reportedly from the Kangala mine. According to Mr Curren, the rough was relatively inexpensive as it was more highly included than most of the uncut Tanzanian rhodolite he had purchased in the past.

Gemmological properties

Visual appearance

The stone examined was a slightly off-round double cabochon weighing 15.60 carats and measuring 13.53mm × 13.13mm × 9.62mm (Figure 1). It exhibited a vitreous surface lustre and a very high degree of diaphaneity for an asteriated stone, being almost transparent. The asterism was in the form of a distinct four- or six-rayed star (Figure 2). Using the Gemological Institute of America's coloured stone grading nomenclature, the body colour would be described as a dark, slightly brownish purplish red.

Microscopic features

The most noticeable feature seen through the microscope were elongated, very fine acicular crystals of rutile showing typical 110/70 degree epitaxial orientation along the edges of rhombic dodecahedral faces (Figure 3). This rutile 'silk' in most cases runs the entire length or width of the stone.

Also noted under magnification were thin, flat, semi-transparent plates of ilmenite (Figure 4) and one small, dark subhedral crystal inclusion, surrounded by tension fractures, which appeared to be a zircon.

Refractive index and optic character

Using a GIA GEM Instruments Duplex II refractometer and employing the distant vision method, the spot refractive index was determined to be 1.75.

When examined in the polariscope the cabochon exhibited an anomalous doubly refractive reaction, as is typical of many red garnets (Webster, 1983). The true singly refractive nature of the gem was determined by the absence of any spot birefringence on the refractometer, the lack of doubling when viewed through the microscope, and the absence of pleochroism when examined through a calcite dichroscope. When viewed under crossed polars through the microscope, however, the doubly refractive nature of the rutile needles was confirmed.

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Fig. 1. When viewed from the side at a steep angle this star rhodolite garnet exhibits 6-rayed asterism, but when looking down on the dome of the cabochon a 4-rayed star is seen. *Photograph by Barton Curren.*

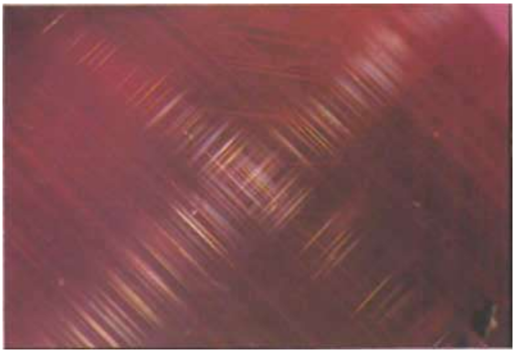

Fig. 2. The 'star effect' and its relation to the rutile inclusions can be seen here. 40x.

Fig. 3. Very fine acicular crystals of rutile pictured here are the cause of the asterism in this Tanzanian star rhodolite. 40x.

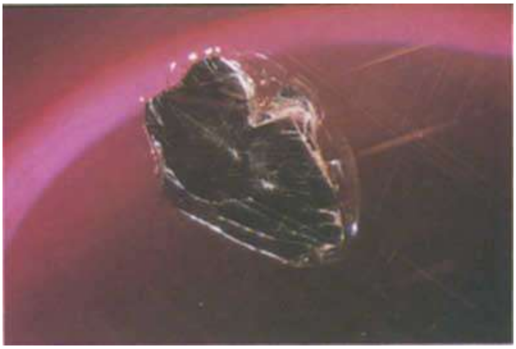

Fig. 4. Ilmenite plates, like the one pictured here, were also detected in the star rhodolite. 30x.

Spectrum, colour filter reaction and UV fluorescence

The visible-light absorption spectrum of the specimen was examined using a GIA GEM Instruments DISCAN digital scanning diffraction grating spectroscope. When viewed in direct transmitted light the stone exhibited the following absorption features: general absorption (i.e., a 'cutoff') from 400-440nm; a weak band at 465nm, a somewhat stronger band at 507-510nm, another weak band at 521-531nm, a strong band at 562-581nm; and general, very vague absorption in the blue-green to yellow regions, and in the far red. These features are generally consistent with those reported for rhodolite garnet (Webster, 1983; Stockton and Manson, 1985; Liddicoat, 1987).

When viewed through a Chelsea colour filter in direct transmitted light the star rhodolite garnet appeared brownish orange. It was inert to both long-wave and short-wave ultraviolet light, and exhibited no phosphorescence, as is to be expected from iron-containing garnets (Webster, 1983).

Specific gravity

The relative density of the rhodolite was determined using the hydrostatic weighing method on a Voland chain balance. Six separate weighings/calculations yielded a value of 3.80 plus or minus .01.

The gemmological properties of the East African star rhodolite garnet are summarised below in

Conclusion

The Tanzanian star rhodolite examined by the authors adds a new occurrence for such asteriated garnets. The gemmological properties determined for this specimen are in general consistent with those previously reported in the literature for the almandine-pyrope mixture known as rhodolite. In view of the relative common occurrence of acicular rutile as inclusions in the rhodolites from this region it is very likely that more of these asteriated garnets will be seen.

Table 1 – gemmological properties

Surface lustre:	Vitreous
Diaphaneity:	Nearly transparent
Star:	Distinct, 4- or 6-rayed star, depending on direction of observation
Colour:	Dark, slightly brownish purplish red
Magnification:	Fine, acicular rutile 'silk;' ilmenite plates; zircon (?) crystal
Spot RI.:	1.75
Polariscope reaction:	Anomalous doubly refractive
Spectrum:	440nm cutoff; 465, 507-510, 521-531, and 562-581nm bands; vague general absorption in blue-green to yellow regions and in far red
Chelsea filter reaction:	Brownish orange
UV Fluorescence:	LW – inert, no phosphorescence SW – inert, no phosphorescence
Specific gravity:	3.80 + .01

Acknowledgements

The authors would like to thank Mr Bartonon Curren of Glyptic Illusions, Topanga, California, for providing them with the specimen for this investigation.

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[*Manuscript received 2 March 1989.*]

Rewarding 'howlers'

David Kent, FGA

London

Whilst the late Basil W. Anderson was marking the Gemmological Association's examination papers, he used to keep notes about mistakes or 'howlers' made by the candidates which amused him and which he called his examiner's 'rewards'. He published a selection of them in the *Journal* in 1970, 12, 3.

Three of his particular favourites at that time were:

'The removal of bubbles clinging to the surface of a stone during a hydrostatic density determination was by means of a camel's hair brush.'
'Imitation lapis is produced by dying agates and other poor cherts' (a pathetic thought!)
A test for radium treated diamond: 'it should be raped in black paper with photographic film'.

During the last nine years of marking papers, this examiner has followed B.W.A.'s example and collected similar slips, etc., made by students; very often they are caused by the appallingly poor standard of spelling which seems to exist these days.

It must be stressed that, of course, the students' names are unknown to the examiner – they are numbers only.

The behaviour of specimens in heavy liquids during a density test cause some of the lighter moments:

It sank like a stone!
It floated happily.
It sank sedately (a comforting thought).
It floated defiantly.
The stone remained suspended in all liquids!?
It sings in 3.06.
It plummets in 3.32.
It flouts in 3.06.
It bobbed back to the surface.

Amongst the description of crystals:

Topaz has a slippaly feel.
The crystal was doomed.
It had a chizzle end.
It was shaped like the Ace of Diamonds.
The stone suffers from basal cleavage (poor thing!).
It had every other corner knocked off.
'Chevrons' were seen on a diamond crystal.
The other end of the crystal is not present.
Crystal is a glass.

During the spectrum tests:

Zircon spectrum described by a candidate as 'like fence posts' and by another as 'a jailhouse'.
Almandine was like cricket stumps (a sports enthusiast?)
It has a pipe organ appearance.
Abortion lines in the blue.
Spectrum seen in the blue with the aid of 'a balloon of cobalt water'.

Optical effects, etc.:

It blinks in the polariscope.
Long distance RI.
Complete distinction.
Double refraction is single.
Stone is badly floored.
Amorous birefringence.
It had square bubbles.
Tiger stripped.
The zircon had been fried.
Boubles and stray.

In the unlikely event of our *Journal* being found in a dentist's waiting room, readers would not appreciate the 'rewards', but qualified gemmologists will, of course, know what the candidate intended to say.

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Two remarkable Lechleitner synthetic emeralds

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Abstract

Two samples of Lechleitner hydrothermally-grown fully synthetic emeralds were characterized microscopically as well as by modern analytical and spectroscopical methods. Two types of colour zoning corresponding to subsequent growth layers parallel to the table facets, as well as corresponding to neighbouring sub-individuals with sub-grain boundaries perpendicular to the table facets were observed. The distribution of colour-causing trace elements (chromium, iron, nickel and copper) in different layers and sub-layers of the synthetic emeralds clearly reflects the results of microscopic examinations and reveals details of growth histories as well as seeding and other growth techniques applied by J. Lechleitner for the production of the two samples. Colour and pleochroism of the stones as well as spectroscopic properties in the visible and infrared range are understandable as a function of chemical composition (traces of the transition metal elements chromium, iron, nickel and copper as well as minor amounts of alkali oxides, i.e. Li_2O and Na_2O). A general survey on various types of hydrothermally- and flux-grown Lechleitner synthetic emeralds is also given.

Introduction

Lechleitner synthetic emeralds have been commercially produced since the end of the fifties by Johann Lechleitner of Innsbruck, Austria. Different types of samples with distinctly varying properties were grown under variable growth conditions and seeding techniques. In gemmological literature, only part of these types of Lechleitner synthetic emeralds have been comprehensively described, and at present no adequate subdivision of growth types according to physical and chemical properties has been published.

The first type of Lechleitner's products, which was sold under the trade names 'Emerita' or 'Symerald', is composed of natural faceted or pre-shaped beryl cores which are overgrown hydrothermally by a thin layer of synthetic emerald (Holmes & Crowningshield, 1960; Schlossmacher, 1960; Gübelin, 1961a, b, c). Later on, continuing his experimental work, Lechleitner developed a product which was described as wafer- or sandwich-type hydrothermally-grown beryl-emerald-beryl composite and consists of a colourless natural beryl seed plate with dark green emerald layers on each side, which are fading into colourless beryl layers towards the table and base of the stones (Liddicoat, 1964; Flanigen *et al.*, 1965, 1967; Theisen, 1966; Lechleitner, 1988). In the next step of experimental work, using seed plates of synthetic emerald (Lechleitner, 1988), several fully synthetic emerald varieties were grown. One sample of this production which was examined by Eppler (1968), is described to consist of a hydrothermally-grown seed plate of synthetic emerald, which is almost symmetrically covered on both sides by four different layers of hydrothermally-grown synthetic emerald. Obviously, this specimen was placed several times in the autoclave in order to avoid growth of colourless chromium-free beryl layers.

The two samples to be described comprehensively in the present paper are hydrothermally-grown Lechleitner synthetic emeralds which are similar or almost identical with this multi-layered composite type examined by Eppler (1968). Due to the lack of adequate data of physical and chemical properties of Lechleitner fully synthetic emeralds, the present author took the opportunity to examine two samples of this type using modern gemmological and mineralogical methods. The results obtained are – according to his knowledge – unique for synthetic emeralds and, in addition, these data may be useful to demonstrate the relationship between different methods of investigation in order to determine adequate and representative properties of a sample.

Subsequently, in order to avoid further confusion in gemmological literature (c.f. Gunawardene, 1985), a general survey of Lechleitner synthetic emeralds is given, which is, however, partly incomplete due to the lack of adequate experimental data of all types of Lechleitner synthetic emeralds and, thus, needs further revision and supplementary work. This general survey was worked out by the present author and was submitted to J. Lechleitner in 1988 in order to eliminate mistakes and misunderstandings. Therefore, this general survey has to be regarded as an authorized summary of Johann

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Fig. 1. Faceted hydrothermally-grown Lechleitner fully synthetic emerald (sample 2). Size of the stone approx. 6.4 × 4.3mm. (*Photo by O. Medenbach, Bochum, West Germany*)

Lechleitner's work on growth of synthetic emeralds of various types.

Experimental details

The two samples to be described in the present paper were made available to the author by a private collector, who bought them in the late sixties or early seventies. Both samples were faceted gemstones, weighing and measuring 0.57 ct and 6.3 × 4.4 × 2.8mm (sample 1) as well as 0.55 ct and 6.4 × 4.3 × 2.7mm (sample 2, Figure 1), respectively.

The samples were investigated by ordinary gemmological techniques, and absorption spectroscopy of both stones in the visible and ultraviolet range was used to clarify the possible influence of different trace elements on the colour of these two Lechleitner synthetic emeralds. Colour-causing trace element contents were examined non-destructively by electron microprobe and X-ray fluorescence analysis. In addition, one faceted stone (sample 1) was sawn in a direction perpendicular to the table facet and part of the stone was examined by electron microprobe in order to determine the variation of chemical composition in different growth zones quantitatively. Another part of sample 1 was powdered and small amounts of emerald powder (2mg) were used to prove hydrothermal growth of the stone by infrared spectroscopy. The remaining powder was taken for wet chemical analysis in order to determine an average chemical composition of the sample.

Results

Microscopic examination in immersion liquid revealed both samples to consist of several layers the boundaries of which are orientated parallel to the tables of the faceted stones (Figures 2, 3). The angles between optical axes of the synthetic emeralds and the tables of the stones (i.e. the oblique angles between optical axes and boundaries of different growth zones) were determined as indicated in Table 1 using an especially developed sample holder (Schmetzer, 1985, 1986).

Two types of boundaries between different layers parallel to the table facet were observed in both samples: on one hand, these boundaries consisted of plane surfaces which separate differently coloured zones within the synthetic emeralds. On the other hand, part of the boundaries between layers parallel to the table facets of the stones revealed a distinct step-like microstructure. Pronounced colour zoning arranged perpendicular to the table facets is observed between different layers separated by both types of boundaries.

A somewhat more irregular and less distinct colour zoning is found within single layers, i.e. more or less intensely coloured areas are also found within single growth zones parallel to the table facets

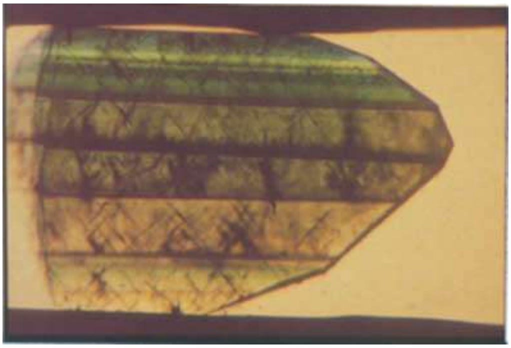

Fig. 2. Hydrothermally-grown Lechleitner fully synthetic emerald (sample 1); colour zoning and layered structure parallel to the table facet with a central seed (layer I) and two symmetrically arranged layers above and below (layers II and III), each of them consisting of several sub-layers. 25x.

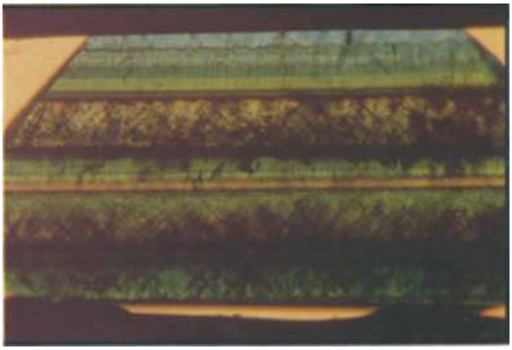

Fig. 3. Hydrothermally-grown Lechleitner fully synthetic emerald (sample 2); colour zoning and layered structure parallel to the table facet consisting of several layers and sub-layers, which are not symmetrically arranged above and below a central seed. 25x.

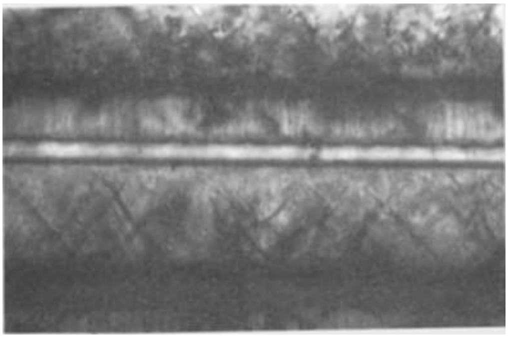

Fig. 4. Hydrothermally-grown Lechleitner fully synthetic emerald (sample 2); dominant layered structure parallel to the table facet consisting of step-like growth lines and colour zoning, subordinate irregularly changing sub-grain boundaries between sub-individuals connected with colour zoning almost perpendicular to the dominant layered structure, i.e. perpendicular to the table facet. 50x.

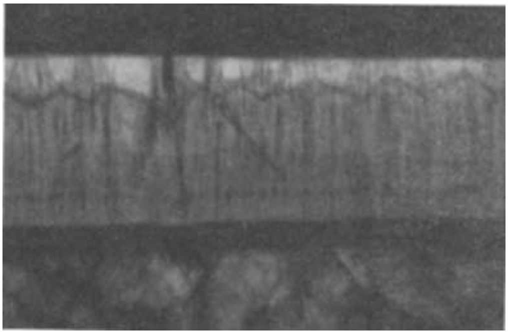

Fig. 5. Hydrothermally-grown Lechleitner fully synthetic emerald (sample 2); dominant layered structure parallel to the table facet consisting of step-like growth lines and colour zoning, subordinate irregularly changing sub-grain boundaries between sub-individuals connected with colour zoning almost perpendicular to the dominant layered structure, i.e. perpendicular to the table facet. 80x.

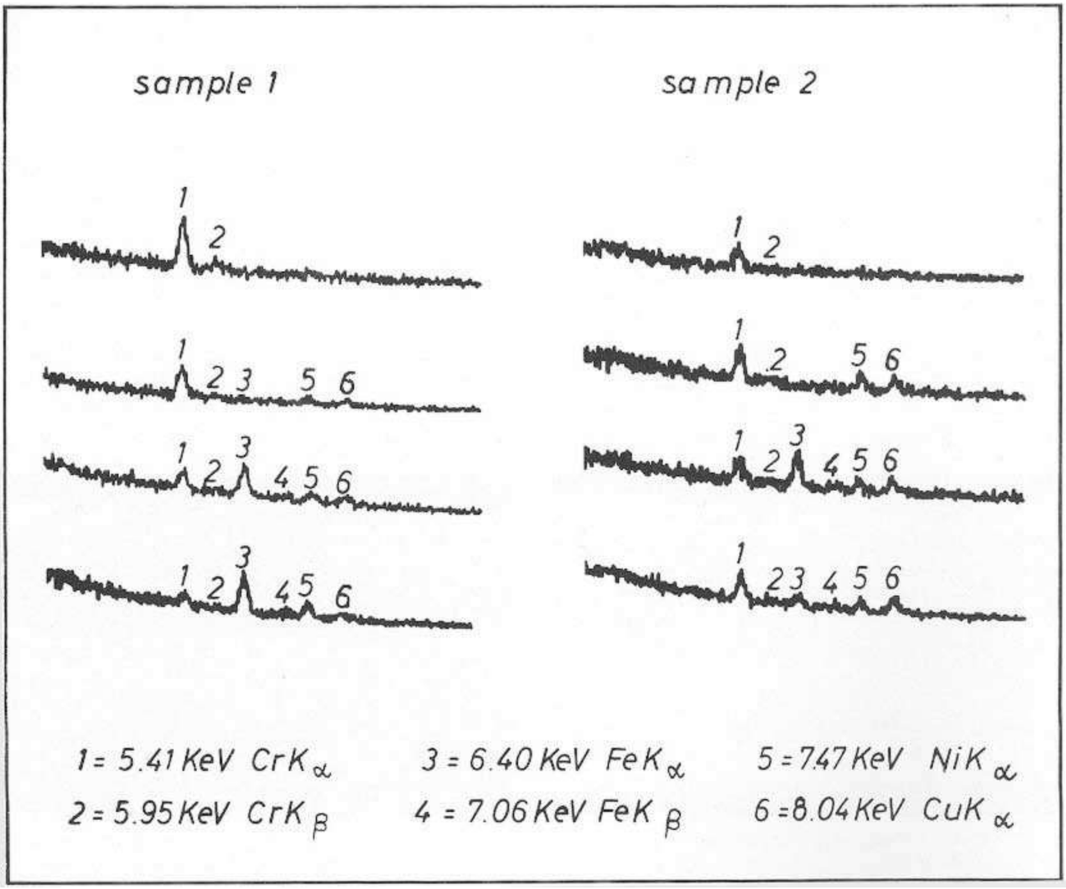

Fig. 6. Energy dispersive X-ray fluorescence spectra of colour causing trace elements (Cr, Fe, Ni, Cu) in different sub-layers of samples 1 and 2 of hydrothermally-grown Lechleitner fully synthetic emeralds indicating irregularly changing trace element contents in different growth zones.

Table 1 Physical and chemical properties of two samples of Lechleitner fully synthetic emeralds determined by non-destructive examinations

	Sample 1	Sample 2
Refractive indices n_o n_e	1.568 1.573 broad shadow edges	1.568 1.573 broad shadow edges
Birefringence Δ n	0.005	0.005
Specific gravity [g/cm^3]	2.70	2.69
Inclination of layered growth zoning versus optical axis	32°	38°
Absorption spectrum in the visible and ultraviolet range	absorption bands of Cr^{3+} and Ni^{3+} in octahedral Al^{3+} sites as well as Cu^{2+} in tetrahedral Be^{2+} sites (Fig. 9)	absorption bands of Cr^{3+} and Ni^{3+} in octahedral Al^{3+} sites as well as Cu^{2+} in tetrahedral Be^{2+} sites
Chemical properties of the table facet determined by electron microprobe [in wt.%]	Range (6 analyses) Cr 0.15-0.20 Fe 0.47-0.53 Ni 0.15-0.20 Cu 0.19-0.24 average composition (calc.) Cr 0.18 Fe 0.49 Ni 0.17 Cu 0.20	Range (5 analyses) Cr 0.23-0.30 Fe 0.03-0.08 Ni 0.14-0.21 Cu 0.40-0.58 average composition (calc.) Cr 0.27 Fe 0.05 Ni 0.16 Cu 0.52
Chemical properties of the table facet determined by X-ray fluorescence [in wt.%]	average composition (meas.) V‹ 0.01 Cr 0.19 Fe 0.52 Ni 0.18 Cu 0.22	average composition (meas.) V‹ 0.01 Cr 0.29 Fe 0.10 Ni 0.16 Cu 0.54
Chemical properties of various colour zones (layers parallel to the table facet) as determined by electron microprobe [qualitative data only]	distinctly variable amounts of chromium, iron, nickel and copper in different layers (Fig. 6)	distinctly variable amounts of chromium, iron, nickel and copper in different layers (Fig. 6)

(Figures 4, 5). This colour zoning is caused by a distinct type of growth structure which is typical for hydrothermally-grown synthetic emeralds with seed planes inclined about 30-40° versus the *c*-axis of the beryl, e.g. for the commercial type of Russian hydrothermally-grown synthetic emeralds (cf. Schmetzer, 1988). In both samples of Lechleitner synthetic emerald described in this paper, growth lines parallel to the table facets of the stones reveal a distinct type of this step-like microstructure (Figures 4, 5). During crystal growth, sub-individuals of synthetic emerald are grown with a preferred sub-parallel orientation. The size of these sub-individuals and the form of the polycentrically growing step-like surface is continuously changed during the growth process. Thus, colour zoning in Lechleitner synthetic emerald is observed parallel to step-like growth lines as well as between neighbouring sub-individuals (Figures 4, 5).

This variability in colour within one single layer is reflected by chemical data of the table facets of both stones (Table 1), which were found by optical microscopy to lie within one single growth zone (cf. Figures 2, 3). Most surprisingly, the samples were found to contain not only the ordinary colour causing trace elements which are generally found in natural and synthetic emeralds, i.e. chromium and iron, but also distinct and slightly variable amounts of nickel and copper. The average compositions calculated from microprobe analyses of the table facets were found to be identical within the limits of error with analytical data obtained by X-ray

Fig. 8. Hydrothermally-grown Lechleitner fully synthetic emerald (sample 1) consisting of a central layer (seed) and two subsequent growth zones above and below, each of them subdivided in several sub-zones; this microphotograph corresponds to the trace element distribution in different sub-layers as indicated in Figure 7. 40x.

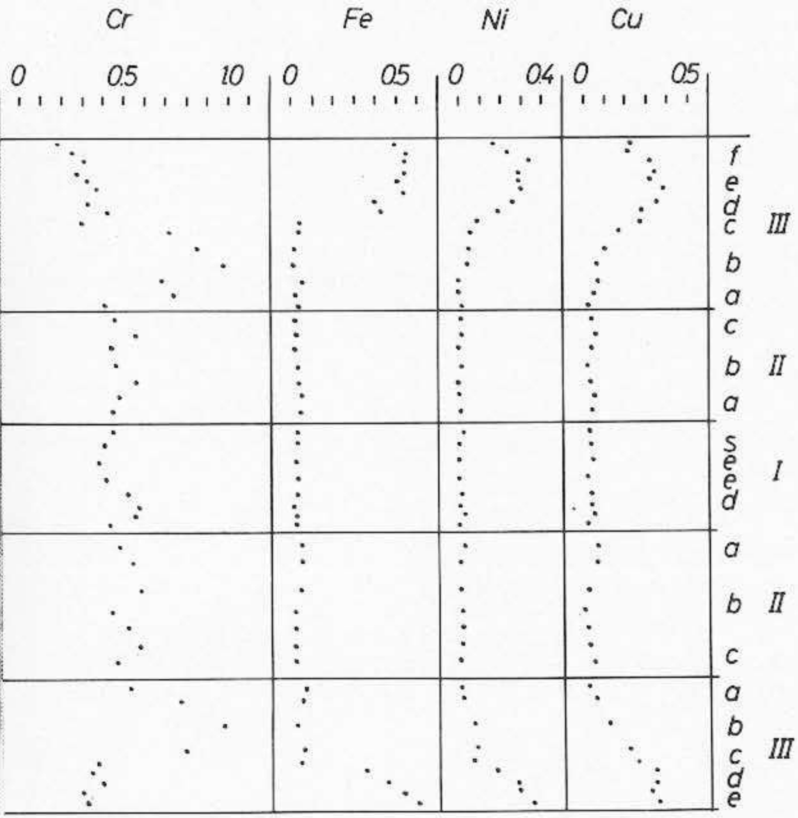

Fig. 7. Quantitative distribution of colour causing trace elements (Cr, Fe, Ni, Cu) in different layers and sub-layers of hydrothermally-grown Lechleitner fully synthetic emerald (sample 1); subsequent to a central zone, two dominant growth zones, each of them consisting of several sub-zones are symmetrically arranged. According to almost identical trace element distributions in corresponding sub-layers, the microprobe analyses indicate that in two autoclave runs, above and below the central layer I (seed), layer II (with sub-layers IIa to IIc) and layer III (with sub-layers IIIa to IIIf) were grown.

Table 2 Physical and chemical properties of Lechleitner fully synthetic emerald (sample 1) determined by partly destructive examinations

Chemical properties of different colour zones (layers parallel to the table facet) determined by electron microprobe (cf. Figs. 7,8)

Designation of layer		Number of analyses	Average composition of colour zone [wt.%]			
			Cr	Fe	Ni	Cu
	f	2	0.22	0.52	0.20	0.22
	e	4	0.32	0.53	0.30	0.34
	d	2	0.37	0.41	0.22	0.31
III	c	1	0.30	0.04	0.09	0.27
	b	3	0.85	0.02	0.05	0.11
	a	3	0.61	0.03	0.00	0.06
	c	2	0.51	0.01	0.01	0.04
II	b	3	0.48	0.02	0.00	0.03
	a	2	0.46	0.04	0.00	0.04
I (seed)		8	0.46	0.02	0.01	0.03
	a	2	0.50	0.04	0.00	0.06
II	b	3	0.51	0.02	0.01	0.01
	c	2	0.52	0.01	0.00	0.04
	a	2	0.64	0.04	0.00	0.03
	b	2	0.88	0.03	0.07	0.16
III	c	1	0.36	0.03	0.06	0.25
	d	2	0.36	0.41	0.23	0.34
	e	2	0.30	0.56	0.31	0.33
Average composition of the sample calculated from weighted analyses of different colour zones			0.52	0.11	0.06	0.11

Average composition of the sample determined by wet chemical analyses [wt.%]	Cr	Fe	Ni	Cu
	0.51	0.09	0.05	0.13
	Li	Na	K	V
	0.36	0.04	0.02	<0.02

Infrared spectrum in the range of H_2O stretching modes (KBr pressed disk technique, Fig.10)	Absorption maxima [cm^{-1}] and intensity ratios A › B » C 3694 › 3592 » 3655

fluorescence analyses of the table facets of both samples (Table 1). In addition, a slight variation in chemical composition within one single growth zone is also indicated by somewhat broader shadow edges on the refractometer (Table 1) compared with other gemstones revealing well polished tables.

The chemical variation of trace element contents between different growth zones perpendicular to the table facets of both gemstones was first examined by non-destructive microprobe analyses of both faceted samples. Placing both stones with their table facets on an ordinary microprobe sample holder, it was possible to record energy-dispersive X-ray spectra of different growth zones of both synthetic emeralds (Figure 6). Due to the oblique and variable angle between the electron beam of the microprobe and the different backside facets of both emeralds no quantitative chemical data were obtainable. However, these investigations clearly indicated a strong chemical variability between all

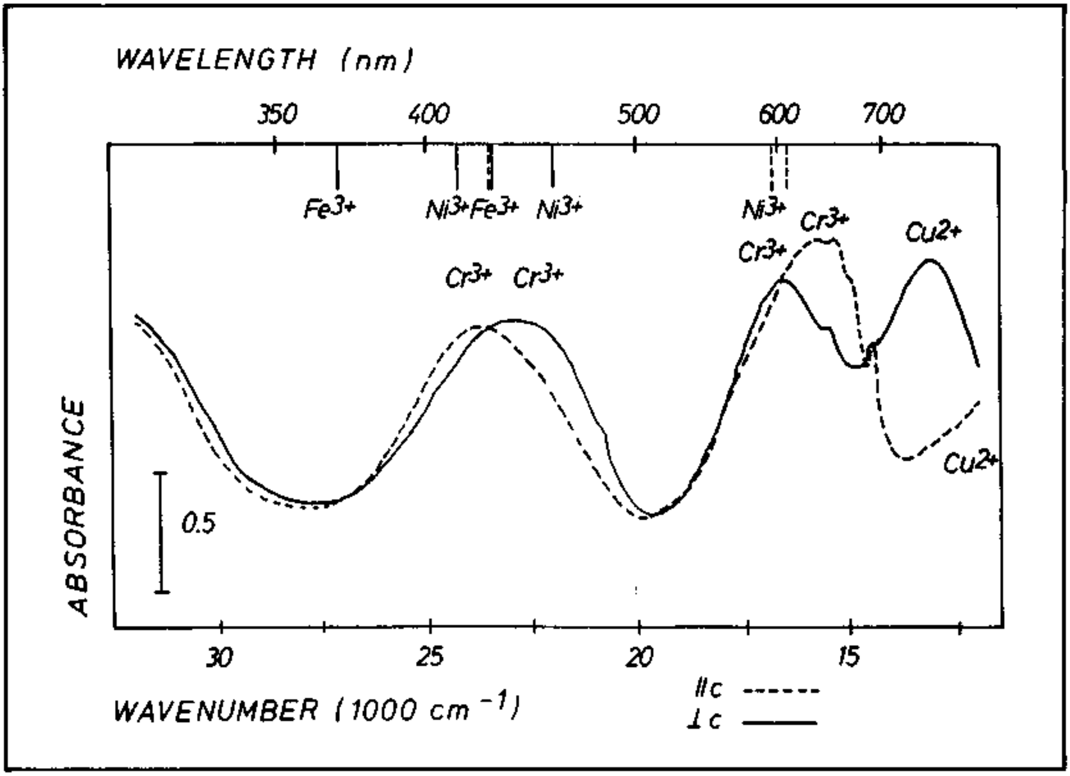

Fig. 9. Polarized absorption spectrum of Lechleitner fully synthetic emerald (sample 1); the spectrum reveals a superimposition of absorption bands of Cr^{3+} in octahedral Al^{3+} sites and Cu^{2+} in tetrahedral Be^{2+} sites; the position of Fe^{3+} and Ni^{3+} absorption maxima, which are not found in this particular spectrum, are also indicated.

four different trace elements, i.e. chromium, iron, nickel and copper, between different growth layers of the samples (Figure 6).

In order to obtain quantitative chemical data of different growth zones, sample 1 was sawn in a direction perpendicular to the table facet and quantitative chemical analyses of 46 points in different growth zones were then performable in a line from the table to the base of the synthetic emerald. Corresponding to microscopic observations, the analytical results (Table 2, Figures 7, 8) clearly indicate the presence of five dominant growth zones with several more or less distinct subzones.

Analyses of different points within the central growth zone (designated layer I) yield an almost uniform trace element distribution within that layer. According to chemical data, the two neighbouring growth zones of layer I are sub-divided into three sub-zones each (designated layers IIa to IIc), and the two growth zones subsequent to sub-layers IIc are sub-divided into six sub-zones (designated sub-layers IIIa to IIIf). The most remarkable feature of these 46 microprobe analyses is a symmetrical arrangement of growth zones from zone IIa to zone IIc and from zone IIIa to zone IIIe on both sides of the central layer I (Figures 7, 8).

These results indicate the use of a seed plate (layer I) which was cut at an angle of 32° versus the optical axis of the synthetic emerald. In two autoclave runs, zones IIa to IIc and zones IIIa to IIIf were grown on both sides of the seed plane with slightly variable thicknesses. In the first autoclave run, almost homogeneous growth conditions were present resulting in small chemical variations within sublayers IIa, IIb and IIc. In the second autoclave run, in which layers IIIa to IIIf were deposited, extremely inhomogeneous growth conditions were obviously present resulting in distinctly variable trace element contents in different sub-layers. Most probably, sub-layer IIIf was removed during the faceting process at the base of the synthetic emerald.

A careful microscopic examination of sample 2 did not reveal any symmetrical arrangement of colour zoning and growth structures parallel to a central layer (Figure 3). Most probably, this stone was grown hydrothermally in several autoclave runs

Table 3 Spectroscopic properties of Lechleitner synthetic emeralds in the visible and ultraviolet range

Position of observed absorption maxima $[cm^{-1}]$	$[nm]$	Polarization of absorption bands	Assignment
10,700	917	$\parallel c$	Cu^{2+} tetr.
13,300	752	$\perp c$	Cu^{2+} tetr.
15,900	629	$\parallel c$	Cr^{3+} oct.
16,600	602	$\perp c$	Cr^{3+} oct.
23,200	431	$\perp c$	Cr^{3+} oct.
23,800	420	$\parallel c$	Cr^{3+} oct.

Position of not observed iron and nickel absorption maxima $[cm^{-1}]$	$[nm]$	Polarization of absorption bands	Assignment
16,500	606	$\parallel c$	Ni^{3+} oct.
16,800	595	$\parallel c$	Ni^{3+} oct.
22,000	555	$\perp c$	Ni^{3+} oct.
23,500	426	$\parallel c > \perp c$	Fe^{3+} oct.
24,200	413	$\perp c$	Ni^{3+} oct.
27,000	370	$\perp c \gg \parallel c$	Fe^{3+} oct.

Position of absorption minima $[cm^{-1}]$	$[nm]$	Polarization	Colour
19,800	505	$\perp c$	yellowish-green
20,000	500	$\parallel c$	bluish-green

(in more than 2, possibly in 4 to 5 runs), and the seed plate or part of the seed plate was removed during the cutting process. Most probably, in this case two synthetic emeralds were cut from the synthetic emerald substance deposited on both sides of a seed plate. Cutting and polishing processes in between the different autoclave runs removing colourless or extremely impure parts of the emerald or beryl layers may furthermore have complicated the situation.

An average composition of sample 1 was calculated from 46 analyses of different colour zones which were weighted according to their variable thicknesses (Figures 7, 8). This calculated average composition was found to be almost identical with an average composition of the sample determined by wet chemical analyses of part of the sample (Table 2).

Polarized absorption spectra of both Lechleitner synthetic emeralds were almost identical (Figure 9). They were found to consist of dominant absorption bands of Cr^{3+} replacing Al^{3+} in octahedral sites as well as Cu^{2+} replacing Be^{2+} in tetrahedral sites (Table 3, cf. Schmetzer, 1988). This dominant absorption spectrum is superimposed by extremely weak absorption bands of Ni^{3+} in octahedral sites, and no distinct absorption bands of Fe^{3+} or Fe^{2+} were found to be present.

These spectroscopic data are consistent with the average chemical composition (Table 2) which indicates dominant absorption bands of chromium and copper and subordinate bands of nickel. The average amount of iron, however, which most probably enters the structure of this type of synthetic emerald as Fe^{3+} replacing Al^{3+} in octahedral sites (cf. Schmetzer, 1988), is too low for a distinct influence on the absorption spectrum.

Colour and pleochroism of the samples (bluish-green $\parallel c$ and yellowish-green $\perp c$) are caused by the positions of absorption minima in the green area (Table 3) which are the ordinary minima for chromium-containing, low iron-bearing natural or synthetic beryl. In the present case, the low nickel-content does not distinctly influence the absorption spectrum, the colour and the pleochroism of the samples. However, in samples with nickel-contents

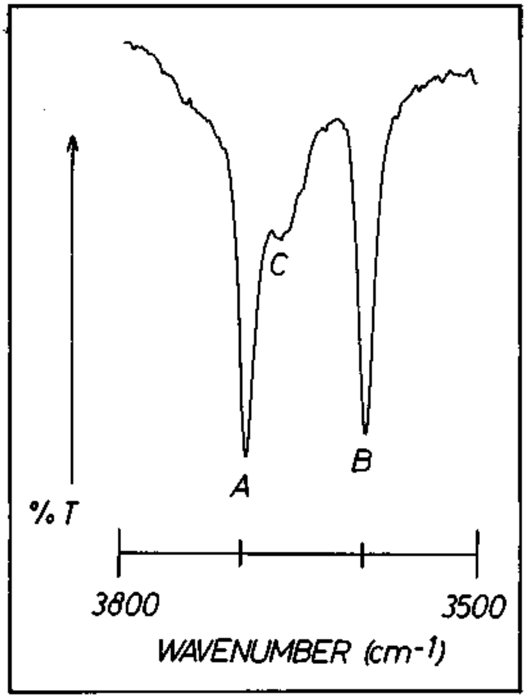

Fig. 10. Infrared spectrum of Lechleitner fully synthetic emerald in the range of water stretching modes consisting of three absorption bands A $\triangleq$ 3694 cm^{-1}, B $\triangleq$ 3592 cm^{-1}, and C $\triangleq$ 3655 cm^{-1} with intensity ratios A › B ›› C.

in the range of chromium values, e.g. in Russian hydrothermally-grown synthetic emeralds, the pleochroism is strengthened to blue or greenish-blue $\parallel$ c and yellow-green $\perp$ c (Schmetzer, 1988). Though copper-bearing chromium-free synthetic beryls are described as blue-green or turquoise coloured (Solntsev *et al.*,1976; Solntsev, 1981a,b; Lebedev *et al.*, 1986), the relatively low copper-contents in Lechleitner synthetic chromium-bearing emeralds do not influence colour and pleochroism of the samples. This is understandable by the fact that copper absorption bands with maxima in the red and near infrared (cf. Table 3) are not able to shift the absorption minima of the ordinary chromium absorption spectrum in the green area.

The infrared spectrum of sample 1 of Lechleitner synthetic emeralds (Figure 10) is typical for low alkali-bearing natural and synthetic emeralds. This type of spectrum (designated type 2 infrared spectrum of natural and synthetic beryls) is characterized by the presence of three absorption bands at 3694 $cm^{-1} \triangleq$ A, 3592 $cm^{-1} \triangleq$ B, and 3655 $cm^{-1} \triangleq$ C with intensity ratios A › B ›› C (Schmetzer, 1989; Schmetzer and Kiefert, 1989). This result is understandable by the distinct lithium- and low sodium-content of the stone (Table 2).

Discussion

Microscopic examination of both samples of Lechleitner synthetic emeralds clearly indicates the presence of different layers and sub-layers parallel to the table. Colour zoning is observed between subsequent layers and sub-layers (i.e. perpendicular to the table facet) as well as between neighbouring sub-individuals within one sub-layer (i.e. parallel to the table facet). According to these complicated microstructures, three corresponding groups of data are available (cf. Tables 1,2,3).

Microprobe analyses of the table facets represent chemical data of that particular sub-layer which is forming the table facet after cutting. The variation of chemical data within one sub-layer clearly indicates colour zoning between neighbouring sub-individuals, which is responsible for the broad shadow edges observed for n_o and n_e on the gemstone refractometer. An average composition of the table facet calculated from several point analyses by electron microprobe corresponds with the results of X-ray fluorescence analyses of the whole table facets.

The chemical variation of colour causing trace elements between different layers and sub-layers of both samples corresponds with colour zoning and growth structures observed in the immersion microscope. The symmetrical arrangement of equivalent types of layers and sub-layers on both sides of a central layer in sample 1 clearly indicates the use of layer I as seed plate and the subsequent growth of layers II and III (with sub-layers IIa to IIc and IIIa to IIIf) in two autoclave runs. According to growth inhomogeneities, a distinct variation of physical and/or chemical growth conditions (e.g. temperature, pressure, composition of nutrient) is evident during the second autoclave run.

An average chemical composition of sample 1 was calculated from 46 microprobe analyses, each of them weighted according to the thicknesses of the corresponding sub-layers. This calculated average composition is identical within the limits of error with wet chemical analyses of powdered material of sample 1 (Table 2). This average chemical composition with distinct amounts of chromium, iron, nickel and copper as well as lithium- and sodium-contents is responsible for the absorption spectrum in the visible area, as well as for the infrared spectrum and the specific gravity of both samples. Colour and pleochroism of the synthetic emeralds are caused by the high chromium contents of the samples, and the absorption bands of copper in the red and near infrared do not influence the colour and pleochroism of the stones. The infrared spectrum with three absorption bands in the range of H_2O stretching modes is understandable as a function of water and alkali- (lithium plus sodium) contents.

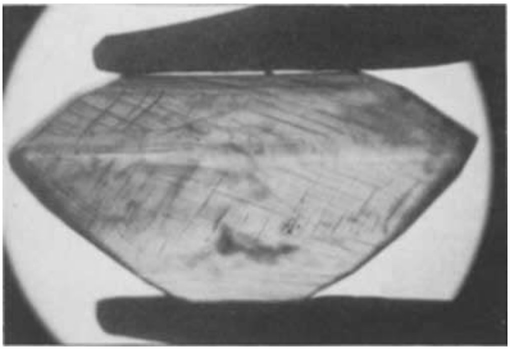

Fig. 11. Type B Lechleitner synthetic emerald; typical fissures and cracks in the hydrothermally-grown synthetic emerald skin on natural colourless beryl core. 22x.

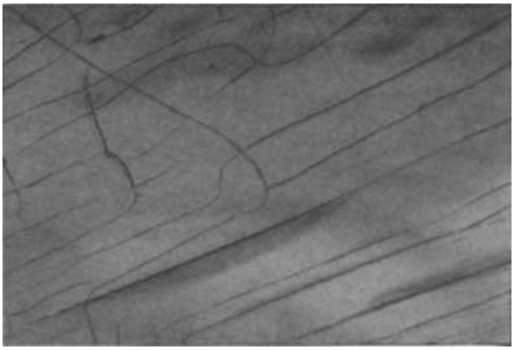

Fig. 12. Type B Lechleitner synthetic emerald; typical fissures and cracks in the hydrothermally-grown synthetic emerald skin on natural colourless beryl core. 35x.

Fig. 13. Type D Lechleitner hydrothermally-grown fully synthetic emerald; dark green central emerald layer (seed?) covered on both sides with light green synthetic emerald substance. 45x.

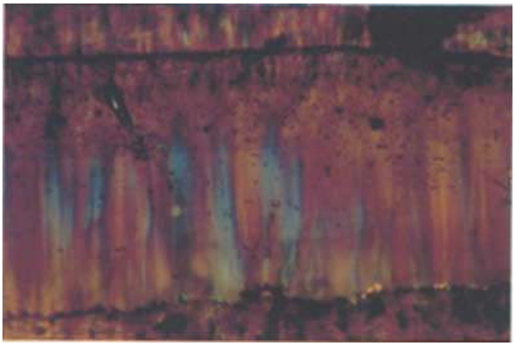

Fig. 14. Type D Lechleitner hydrothermally-grown fully synthetic emerald; irregularly changing sub-grain boundaries between sub-individuals. Crossed polarizers. 50x.

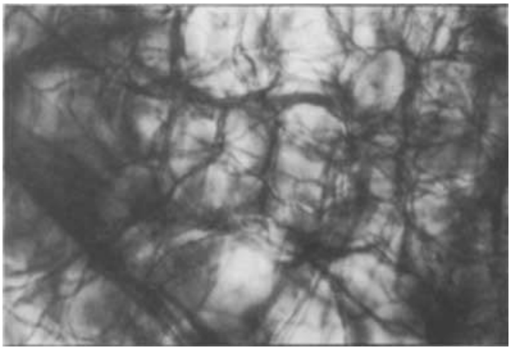

Fig. 15. Type F Lechleitner flux-grown synthetic emerald; view parallel to the *c*-axis, cellular pattern of wisp-like feathers consisting of residual flux material. 50x.

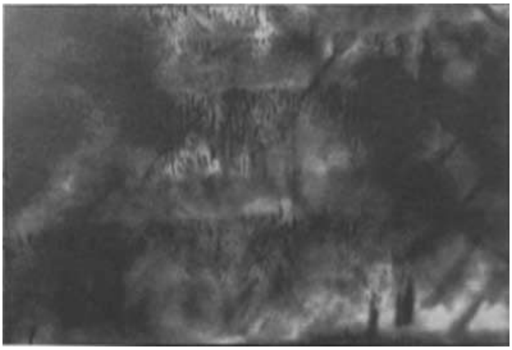

Fig. 16. Type F Lechleitner flux-grown synthetic emerald; view perpendicular to the *c*-axis, growth zoning of residual flux material parallel to the basal plane. 50x.

Comparing the physical and chemical properties of the two examined samples of Lechleitner fully synthetic emeralds with those of other types of hydrothermally-grown synthetic emeralds, some similarities are evident with the commercial type of Russian hydrothermally-grown synthetic emeralds (Schmetzer, 1988).

In addition to certain similarities in growth structures (step-like surfaces between subsequent sub-layers consisting of sub-parallel orientated sub-individuals, orientation of growth layers in the range of 30-40° versus the optic axis), both types of hydrothermally-grown synthetic emeralds reveal distinct amounts of iron, nickel and copper. In Russian synthetic emeralds, the relatively high amounts of iron, nickel and copper originate from the walls of the steel autoclaves used for industrial growth processes. These autoclaves are characterized by the lack of precious metal (platinum or gold) inserts and cause the incorporation of Fe^{3+} and Ni^{3+} in Al^{3+} sites as well as Cu^{2+} in Be^{2+} sites of the beryl lattice.

According to Lechleitner (1988), no compounds of iron, copper and nickel were added to the nutrient for hydrothermal growth of synthetic emeralds. Thus, for sample 1 of Lechleitner synthetic emerald examined in the present paper, the use of a steel autoclave without precious metal insert is evident for the second autoclave run causing the incorporation of material from the wall of the steel autoclave (Fe^{3+}, Ni^{3+} and Cu^{2+}) in the lattice of the synthetic emerald crystal. For material grown in the first run as well as for the growth of the seed plate, smaller amounts of iron, nickel and copper were analysed. This difference in chemical composition may be caused by the incorporation of smaller amounts of iron, nickel and copper due to the different physical and chemical growth conditions, which are comparable with growth conditions of sub-layer IIIa in the second autoclave run. On the other hand, the small amounts of iron, nickel and copper in the seed as well as in layer II can also be caused by impurities of the nutrient (unknown to the producer) and, thus, the use of an autoclave with precious metal insert is also possible for the first autoclave run.

In summary, the seeding technique as well as the use of autoclaves without precious metal inserts by J. Lechleitner in the late sixties is nowadays applied by Russian scientists for hydrothermal growth of high quality synthetic emeralds, and most structural and chemical properties of both types of synthetic emeralds are understandable with the basic information about growth conditions.

General survey of different types of Lechleitner synthetic emeralds

Type A Lechleitner synthetic emeralds

J. Lechleitner started his experiments in emerald synthesis in 1956 with flux growth of synthetic emeralds. Using seed plates of natural beryl, which were cut in a direction perpendicular to the *c*-axis, synthetic emerald plates up to 10mm in thickness were grown. This type of synthetic emerald was grown between 1956 and 1958, and only few samples were given to gemmological laboratories for investigation. Most probably, a plate of Lechleitner synthetic emerald with refractive indices of n_o 1.563, n_e 1.560, which was briefly mentioned by Liddicoat (1964) was a product of these early experiments in flux growth of synthetic emerald.

Type B Lechleitner synthetic emeralds

The first type of Johann Lechleitner's products, which was sold commercially, is composed of natural cores of colourless or slightly greenish beryl. These pre-shaped beryl seeds were overgrown hydrothermally in autoclaves with precious metal inserts with thin layers of synthetic emerald, and according to the producer, this type of synthesis was performed between 1959 and 1972. Variable refractive indices were described by different authors (e.g. Holmes and Crowningshield, 1960; Schlossmacher, 1960; Gübelin, 1961a,b,c; Flanigen *et al.*, 1965, 1967; Eppler, 1968, 1973), ranging from 1.571 to 1.597 for n_o and 1.566 to 1.587 for n_e, and even up to 1.610 for n_o and 1.601 for n_e (cf. also Bank, 1976, 1980; Bank and Zwetkoff, 1979; Bank and Bank, 1980). For samples, the refractive indices of the synthetic emerald skin varies in the range of 1.580 to 1.610 for n_o, and between 1.572 and 1.601 for n_e, variable chromium contents between 3.99 and 10.01 wt.% Cr_2O_3 were determined by electron microprobe (Schmetzer, 1981a,b).

According to unpublished data of the present author, type B Lechleitner synthetic emeralds are the only commercially available synthetic emeralds which reveal absorption spectra consisting of Fe^{2+} and Fe^{3+} absorption bands (due to the colourless core) which are superimposed by a typical Cr^{3+} spectrum of emerald (due to the skin). Nevertheless, this type of synthetic emerald is easily recognizable in the gem microscope (Figures 11, 12).

Type C Lechleitner synthetic emeralds

Continuing his experiments in emerald synthesis, J. Lechleitner used natural beryls which were cut at oblique and variable angles versus the *c*-axis as seed plates. The results of hydrothermal growth processes in autoclaves with noble metal inserts were described as wafer- or sandwich-type Lechleitner synthetic emeralds in gemmological literature (Liddicoat, 1964; Flanigen *et al.*, 1965, 1967; Theisen, 1966; Eppler, 1968, 1973). In general, type C Lechleitner synthetic emeralds are grown in one single autoclave run and consist of a colourless central seed with dark green synthetic emerald layers on each side. These high chromium-bearing layers fade towards the table and base of the sample into lighter green synthetic emerald or even colourless synthetic beryl with refractive indices ranging from 1.567 to 1.570 for n_o and from 1.562 to 1.566 for n_e in colourless or almost colourless layers. In greenish layers, refractive indices of 1.573 for n_o and 1.567 for n_e are described.

According to the producer, type C Lechleitner synthetic emeralds were grown in 1962 and 1963, and samples were given only to gemmological laboratories for investigation. In addition the hydrothermally-grown layers of type C Lechleitner synthetic emeralds were used as seed plates for type D Lechleitner synthetic emeralds (which are the improved form of type C synthetic emeralds).

Type D Lechleitner synthetic emeralds

Two samples of type D Lechleitner synthetic emeralds are comprehensively described in this paper. Starting in 1964, this type of fully synthetic hydrothermally-grown synthetic emerald was produced in autoclaves with or without precious metal inserts. In general, several autoclave runs were used in order to produce synthetic emerald layers which were able to be faceted according to their thickness. Cut samples of type D Lechleitner synthetic emeralds consist of several layers and sub-layers which can be arranged symmetrical or asymmetrical with respect to a central light green seed plate. Another variety of type D Lechleitner synthetic emeralds are samples with dark green central layers and lighter green overgrowths (Figure 13), but still with distinct growth structures and sub-individuals in different layers (Figure 14). Analytical data of this variety of type D synthetic emeralds are also published by Hänni (1982).

Type E Lechleitner synthetic emeralds

Only very few samples of this type were grown for internal studies of the producer in 1961 or 1962 and only one sample was given to a collector. Type E synthetic emeralds consist of flux-grown seed plates which were hydrothermally grown to an appropriate thickness in several autoclave runs as described for type D samples. No gemmological data of type E Lechleitner synthetic emeralds are available at present.

Type F Lechleitner synthetic emeralds

Crystal growth of this last type of Lechleitner's products began about 1972 and was most probably performed during the seventies until the early eighties. Unfortunately, the producer did not want to disclose any details of the processes used for the growth of this type of fully synthetic emerald.

According to its low refractive indices of n_o 1.563 and n_e 1.560, a sample of Lechleitner fully synthetic emerald, which was mentioned briefly by Eppler (1973) is one of the first samples belonging to Lechleitner type F synthetic emeralds. Four samples of Lechleitner synthetic emeralds which were described as fully synthetic emeralds by Schmetzer and Bank (1982) were found to have similar low refractive indices between 1.562 and 1.566 for n_o and from 1.559 to 1.562 for n_e. However, no experimental examination of growth conditions for this type of Lechleitner synthetic emerald was worked out until now. Due to the relatively low refractive indices of these samples with chromium contents between 0.40 and 0.84 wt.% Cr_2O_3, compared with chromium-free or low chromium-bearing outer layers of type C Lechleitner synthetic emeralds as well as with optical data of Linde, Biron and Russian hydrothermally-grown synthetic emeralds, these data are more closely related to flux-grown synthetic emeralds of different producers. Consequently, type F Lechleitner synthetic emeralds are not necessarily grown by hydrothermal processes, but may be produced by flux techniques. Thus, this latest type of Lechleitner's products is possibly regarded as an improved form of type A Lechleitner synthetic emeralds.

In order to clarify production techniques of type F Lechleitner synthetic emeralds, one sample weighing 1.29 ct with refractive indices of n_o 1.563 and n_e 1.559 was made available for investigation. This stone was bought as Lechleitner fully synthetic emerald in 1981 from a dealer who was, at that time, working with the distribution of Lechleitner synthetic emeralds.

In the gem microscope, the sample was found to contain a cellular pattern of wisp-like feathers (Figure 15), which revealed some weak growth zoning parallel to the basal plane (Figure 16). The absence of water in this sample was proved by infrared spectroscopy and, in addition, the presence of traces of molybdenum was detected by X-ray fluorescence analysis. Consequently, type F fully synthetic emeralds of Lechleitner are flux-grown samples, most probably with lithium molybdate as dominant component of the flux and basal plates of natural or synthetic beryl used as seed material.

In summary, according to the information from the producer as well as from the experimental results of the present author, three types of Lechleitner synthetic emeralds were grown and marketed commercially and three types of synthetic emeralds were grown for research and experimental studies only. The three commercially available products are:

- type B Lechleitner synthetic emeralds consisting of colourless natural preshaped beryl seeds which are hydrothermally overgrown with thin layers of synthetic high chromium-bearing emerald
- type D Lechleitner synthetic emeralds, which are characterized as hydrothermally-grown fully synthetic emeralds consisting of several layers and sub-layers arranged symmetrically or asymmetrically to a central seed of synthetic emerald
- type F Lechleitner synthetic emeralds, which were found to be flux-grown fully synthetic emeralds without significant growth structures.

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Coloration in electron-irradiated beryl

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Abstract

A bluish-green beryl has been produced through electron irradiation of colourless beryl. Absorption spectra for both the ordinary and extraordinary vibration directions show structure attributable to blue and yellow chromophores. The blue chromophore is a metastable 'Maxixe-type' colour centre. The yellow component appears to be due to ligand-metal charge transfer processes between trivalent iron and oxygen. The yellow colour is stable.

Introduction

The hexagonal and optically uniaxial cyclosilicate beryl ($Be_3Al_2Si_6O_{18}$) shows channel structure parallel to the crystallographic *c*-axis, (0001). The large channels result from the specific arrangement of the silica tetrahedra. The channel diameter varies between 0.28 and 0.57nm, which allows occupation by various metal ions and molecules. The electronic structure of the channel-occupied impurity species determines certain optical properties of the specimen, which may be altered by irradiation or thermal treatment.

Colour enhancement of beryl primarily uses the lesser valued colourless or very pale blue variety to produce a precious light to deep golden yellow hue in the specimen. Such colour changes and saturation intensification result from gamma or electron irradiation followed by thermal treatment. The latter treatment normally anneals out any undesirable irradiation effects and allows some adjustment of the level of saturation.

We are reporting here on an unusual occurrence in which an irradiated and heat treated colourless beryl, which had been coloured golden yellow, was changed to a light bluish-green hue on re-irradiation with electrons. The stone originally was part of a lot of colourless beryl which, on electron irradiation and heat treatment, resulted in three colour groups: golden yellow (40%), light bluish-green (35%) and bluish-green (25%). The referenced stone was one of the twenty-three golden yellow ones which were subsequently re-irradiated for purposes of increasing the saturation in the yellow part of the spectrum.

As to the various mechanisms and types of chromophores leading to coloration in beryl, channel Fe^{2+} was reported by Nassau and Wood (1968) to be involved in the blue coloration. Goldman *et al.* (1978) suggested that the yellow colour in beryl is most likely due to ligand-metal charge transfer (LMCT) between Fe^{3+} in the channels and ring-sited oxygens. Nassau and Wood (1973) studied Maxixe-type beryl. These beryls were originally discovered in the Maxixe mine in Brazil in 1917. Their superb blue colour faded on exposure to daylight. Blue coloured stones from other mines that fade are normally designated Maxixe type. The irradiation and heat effects were further characterized by Nassau, Prescott and Wood (1976). Edgar and Vance (1977) proposed CO_3^- as the blue chromophore in Maxixe-type beryl by correlating EPR, optical absorption and magnetic circular dichroism measurements. On the basis of further EPR work, Anderson (1979) proposed NO_3 and CO_3 as the chromophores in Maxixe and Maxixe-type beryl, respectively.

Experimental procedure and results

Twenty-three faceted beryl gemstones turned golden yellow upon electron irradiation and heat treatment with an electron beam from a 3 MeV Van de Graaff accelerator. The specimens were held in a steel mesh envelope on the periphery of a carousel which rotated at 8rpm in front of the beam window. The intermittent irradiation of the specimen allowed air-cooling, which proved sufficient at a beam window-to-specimen distance of approximately 4.5cm.

The 13 × 9mm golden yellow oval stone developed a light bluish-green coloration after a 55 minute exposure to a 100 microampere beam. At that point the total absorbed dose was approximately 330 megarad. During the next 3.0 hours of exposure the beam current was incrementally increased from 100 to 150 microamperes. After 3.25 hours of exposure, the stone was dark green with a blue overtone. The stone appeared to acquire no further saturation of bluish-green coloration up to

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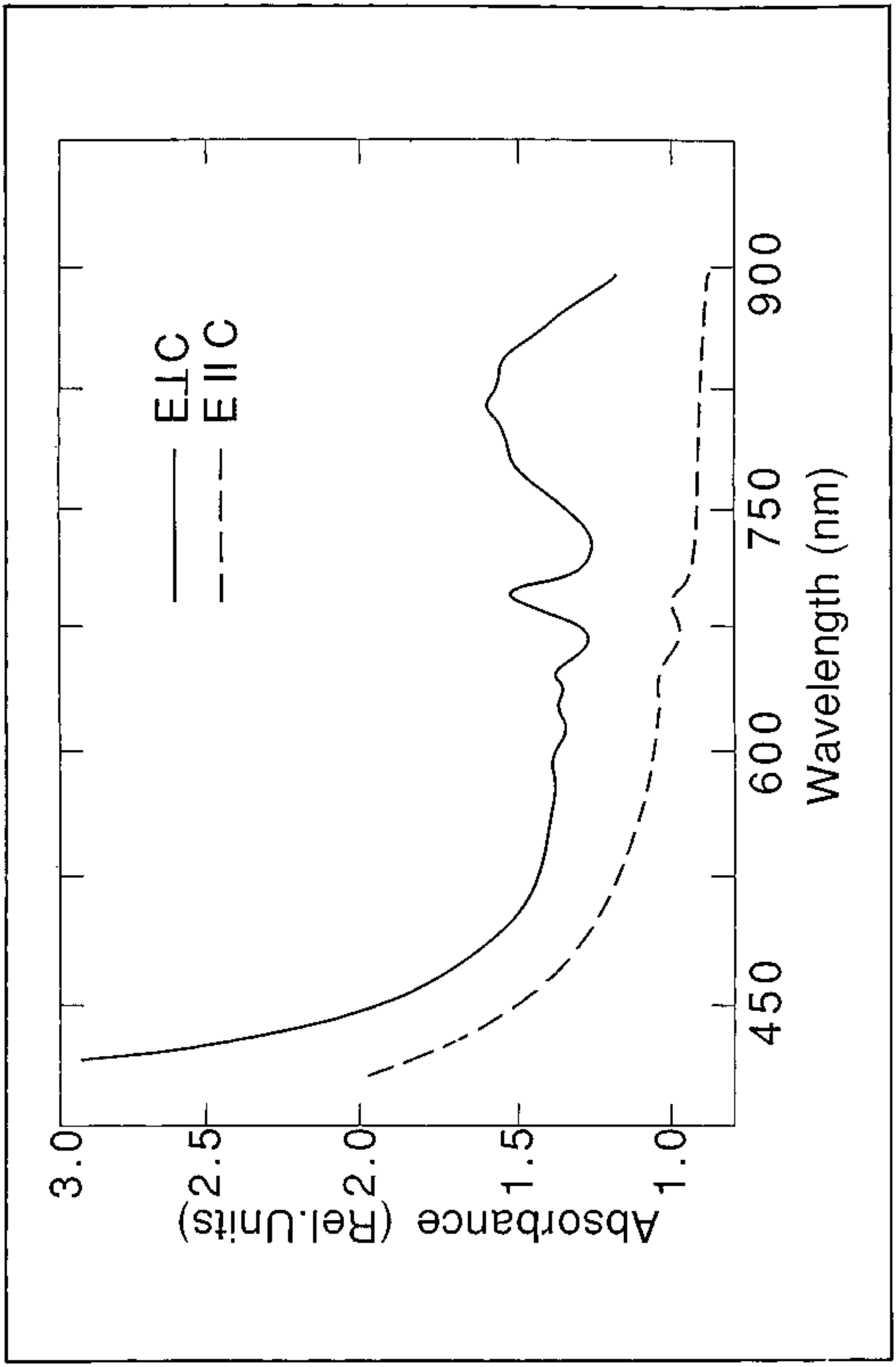

Fig. 1. Polarized absorption spectra of bluish-green beryl for the ordinary ray (E ⊥ C) and the extraordinary ray (E∥C) vibration directions.

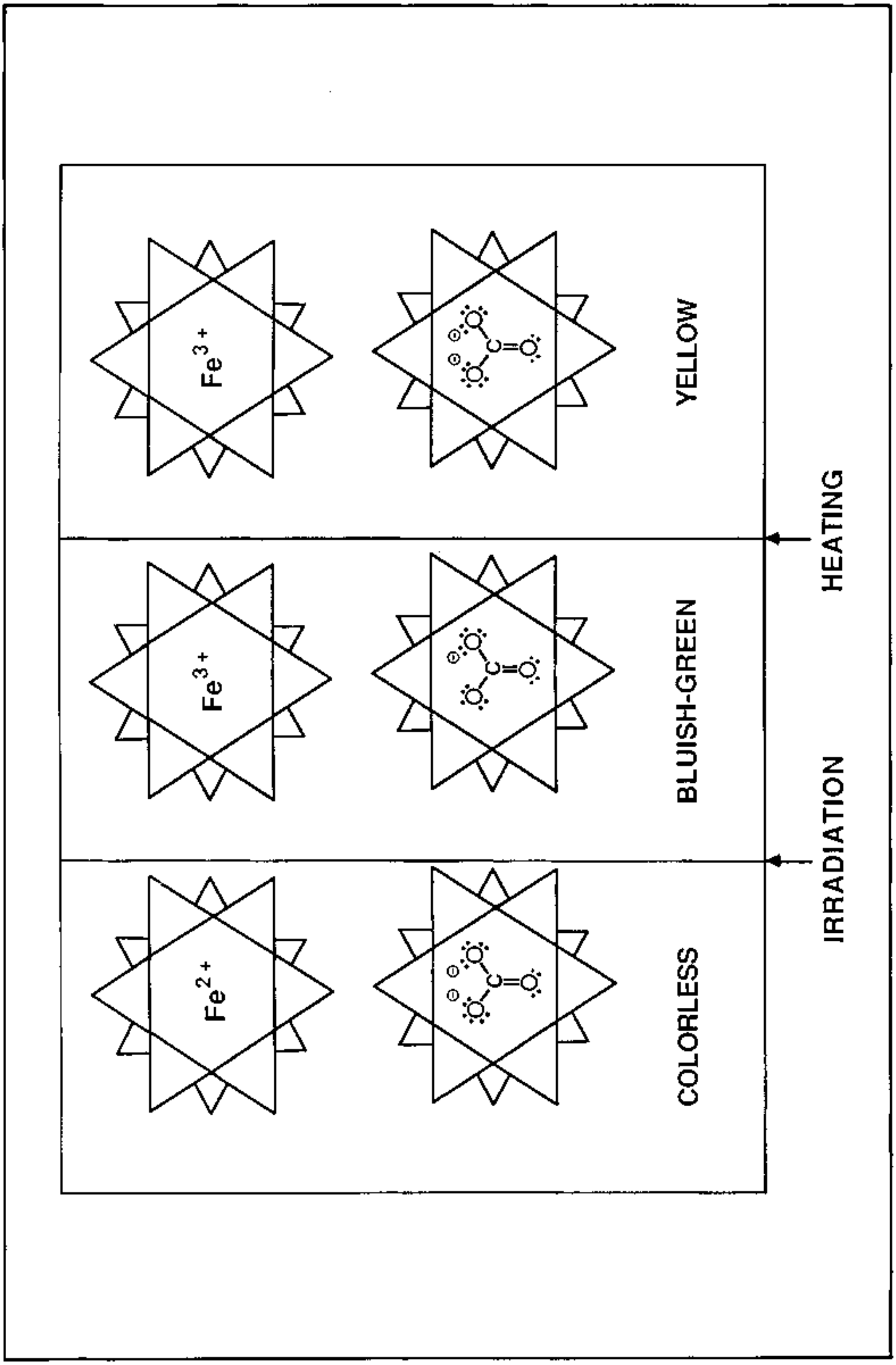

Fig. 2. Pictorial presentation of the mechanisms involved in creating colour centres in colourless beryl through electron irradiation and thermal treatment.

4.25 hours of exposure. The total dose at saturation must have been between 1450 and 2000 megarads.

The irradiated stone was optically oriented using a polarizing microscope. The crystallographic *c*-axis proved to be parallel to the 9mm width. X-ray diffraction was used to confirm this orientation after sawing. Two flat windows, parallel with each other and perpendicular to the (0001) axis, were ground on the stone to obtain the optical spectra in the ordinary and extraordinary ray directions. The polarized absorption spectra (see Figure 1) were obtained with an OLIS-converted Cary 14 double beam spectrophotometer.

After the crystallographic directions had been established but prior to the sawing operation, observations were made regarding the naked-eye-visible dichroism that had been produced by the irradiation. When viewed parallel to the *c*-axis (along the 9mm width) the stone appeared bluish-green but, when viewed perpendicular to the *c*-axis (along the 13mm length) it appeared brownish-yellow. Examination in the direction perpendicular to the *c*-axis, using a simple hand-held dichroscope, allowed further characterization of the dichroism. It was composed of two distinct colours; olive green and brownish-yellow and judged to be of moderate degree.

For the ten-month period between irradiation and optical absorption measurements, the stone retained its blue component. It also retained its naked-eye pleochroism. It had been in storage under dark laboratory conditions.

Interpretation of results

Figure 1 shows the room temperature absorption spectrum for the ordinary ray (E $\perp$ C) direction, in the range 375 to 900nm. The best resolved peak occurs at 689.9nm with a series of poorly resolved ones towards lower wavelengths, between 690 and 575nm. This structure is characteristic of the ordinary ray spectrum of Maxixe-type beryl. The broad band high wavelength absorption, centred around 810nm, has been associated with divalent iron in channel positions by Goldman *et al.* (1978). The sharp absorption increase in the violet and ultraviolet at wavelengths shorter than 450nm, could be interpreted as due to ligand-metal charge transfer between Fe^{3+} and O^{2-} in the ring structure, as postulated by Goldman *et al.* (1978). It presumably produces the yellow coloration in beryl.

Figure 1 also shows the complementary E $||$ C spectrum. There are no well resolved structures. At best there are hints of some detail, characteristic of that found for Maxixe-type beryl in the E $\perp$ C spectrum. The yellow producing (LMCT) intense absorption on the short wavelength side of 450nm appears to be the only feature of significance.

Figure 2 conceptually depicts the changes induced by electron irradiation and thermal treatment in the investigated stone. The initial oxidation state of the channel iron is 2+, the CO_3 molecules are trapped in the channels, and the beryl is colourless. Upon electron irradiation, the iron is oxidized to the 3+ state producing the yellow colour and the CO_3 molecule becomes a radical through hole trapping thus producing the Maxixe-type (unstable) blue chromophore. The composite colour is bluish-green. Further heating causes the CO_3 radical to capture an electron which destroys the blue chromophore but does not affect the oxidation state of the channel iron. The beryl turns a golden yellow. This colour is stable and can only be destroyed at temperatures well above 200°C.

The oxidation of the divalent iron is surprising in the heavily reducing environment of electron irradiation. The oxidation process may involve the trapping of a hole on a ring oxygen in the immediate vicinity of a channel iron which turns into Fe^{3+} through hole capture.

In summary, we have observed and interpreted the simultaneous occurrence of LMCT-caused yellow and Maxixe-type blue chromophores in a single beryl specimen. In commercial irradiation of colourless beryl, especially electron irradiation, one frequently observes a greenish-yellow colour, probably due to the combinations of both yellow and blue absorption. These green overtones can often be removed by thermal annealing at temperatures below 190°C. The resultant purer yellow or golden colour is likely to be due to the removal of the Maxixe-type blue chromophores.

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XXII International Gemmological Conference, Italy 1989

E. A. Jobbins

The scientific sessions of the conference were held at Tremezzo on Lake Como from 25-29 September, followed by an excursion from 30 September to 8 October. This included visits to Portofino; the marble quarries, workshops and museum in Cararra; the alabaster workshops and museum in Volterra; the Pietre Dure Museum and workshops in Florence; the alabaster mine and quarry at Castellina Marittima; the goldsmithing factory of Uno-a-Erre at Arezzo; coral and cameo factories and museum at Torre del Greco; an ascent of Vesuvius and the Vatican Museum.

The papers presented at the scientific sessions are listed below in the order in which they were presented. The proceedings at the Open Day sessions with Italian gemmologists (in Milan) are then listed.

Fig. 1. Carving translucent alabaster (gypsum) in a small workshop in Volterra, Italy.

Authors	*Title*
Jobbins, E.A., Scarratt, K.	The cultivation of freshwater pearls in Yangxin, China.
Norström, S.E.	On Swedish deposits of freshwater pearl mussel.
Sobolev, N.	A relative abundance of crystalline inclusions in small and large diamonds from Mir and Udachinaya pipes, Yakutia.
Meyer, H.O.A., Zhang, A.	Diamonds and kimberlites of North East China.
Peterson, D.L.	The American 'Yogo' sapphire.
Tombs, G.A.	Comparisons and similarities between Kenyan, Australian and Ceylon sapphires.
Saul, J.	The Taita-Tsavo-Umba gem area of East Africa.
Becker, G.	Observations of fluorescence on different rubies from African occurrences.
Becker, G.	Comparison of behaviour of two new occurrences of apatite from Madagascar after (or during) heat treatment.

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Arps, C.E.S.	Hessonites from Sri Lanka.
Schwarz, D.	The chemical properties of the Brazilian emeralds.
Zwaan, P.C.	More data on the orthopyroxenes from Embilipitiya, Sri Lanka.
Norström, S.E.	On Swedish deposits of rhodonite.
Harding, R.R.	Rhodonite and argillite from British Columbia, Canada.
Segnit, E.R.	Prehnite from Wave Hill, Northern Territory, Australia.
Pienaar, H.S.	On the gem-quality sodalite occurrences near Swart-booisdrif, Namibia.
Henn, U., Bank, H.	A study on gemstones of the plagioclase group.
Bank, H., Henn, U.	Correlation between physical features and chemical composition of some gemstones.
Kanis, J.	Fascinating gemstone occurrences in Central Nigeria.
Chikayama, A.	Gemstones from Madagascar.
Zoysa, E.G.	Current research and statistics data on Sri Lankan gem deposits.
Arps, C.E.S.	So-called natural glasses from Sri Lanka.
MacGregor, E.	An end use of a gemstone.
Sersen, W.	Buying and selling gems: which light is best?
Eliezri, I.	On the question of the boundary between ruby and pink sapphire, and between emerald and green beryl.
Shin, K.S.	Any better way to decide clarity grade of diamonds?
Van Bockstael, M.	Layered growth in diamonds as demonstrated by optical and physical characteristics. Regional differences.
Scarratt, K.	Naturally coloured blue non-conducting diamond crystals and faceted stones.
Schiffmann, C.A.	A note on the NIR spectrum of diamonds.
Scarratt, K.	Green diamond identification: the problems concerning the reliability of 'scientific evidence'.
Sunagawa, I.	Growth twinning in quartz – how and under what conditions they are generated.

Balitsky, V.S., Sunagawa, I., Lu, T.	Twins in synthetic amethyst, their origin and diagnostic meaning.
Koivula, J.I., Fritsch, E.	Brazil law twinned synthetic quartz.
Sunagawa, I., Taijing, L.	Origin of Brewster fringes in amethyst.
Graziani, G., Lucchesi, S., Scandale, E.	Growth marks and growth history of gem materials by X-ray topography.
Sunagawa, I., Yokogi, A.	Growth histories of pegmatitic beryls as revealed by the internal textures.
Shida, J.	Observation of heat-treated stones using laser tomography.
Miyata, T., Kitamura, M.	Scanning cathode luminescence (SCL) method and its application to gemmology.
Ponahlo, J.	Cathodoluminescence of synthetic diamonds and some (loupe-clean) coloured gemstones.
Delé-Dubois, M.L., Poirot, J.-P.	On emerald's inclusions studied by laser Raman microspectrometry.
Norström, S.E.	A new synthetic opal.
Schubnel, H.J.	Pierres de la nuit des temps (video).
Cusi, R.	Some peculiar gems.
Superchi, M.	Italian treasures.
Gübelin, E.	Mogok, valley of rubies (film).
Open day session with Italian gemmologists	
Jobbins, E.A.	Gemstones of Europe.
Liddicoat, R.T.	Observations about the gems of North America.
MacGregor, E.	An outline of recent gem province discoveries in South America.
Pienaar, H.	Gemstones and Africa.
Segnit, E.R.	Gemstones of the Island continent.
Sersen, W.J.	The gemstones of Asia.
Gemmological news:	
Koivula, J.I.	Diamond clarity enhancement by infusion.
Balitsky, V.	Jewellery-quality synthetic malachite: history of creation and the main gemmological characteristics.
Poirot, J.-P.	Raman microspectrometry: application to gemmology.

Gemmological Abstracts

ATTANASIO, D., FLAMINI, A., GRAZIANI, G., MARTINI, M., SCANDALE, E., 1989. Further observations on the Lennix synthetic emerald. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **38**, 1, 1-10, 8 figs (1 in colour), 1 table, bibl.

Some Lennix synthetic emeralds from recent batches have been investigated by the authors. The emeralds are moderately transparent and relatively homogeneous in colour. The presence of vanadium and absence of iron was noted. Inclusions were somewhat different from those present in earlier productions. A shimmer effect similar to Zambian emeralds was caused by clusters of flux remnants and there were some three-phase inclusions as in some Colombian stones. E.S.

BANK, H., 1989. Gemmologische Kurzinformationen. Hochlichtbrechender Smaragd aus Sta. Terezinha de Goiás, Brasilien. (Short gemmological notes. Emerald with high refractive index from St Terezinha de Goiás, Brazil.) *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **38**, 1, 41-3, bibl.

The stones have an RI of 1.593-1.604, SG 2.78. E.S.

BANK, H., HENN, U., 1989. Gemmologische Kurzinformationen. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **38**, 1, 43-6. (a) Andesin-Mondstein aus Indien, Id., 43-44; (b) Schleifwürdige Korunde von Ngoronghoro, Tansania, Id., 44-6.

(a) 'Moonstone' from India was identified as andesine (plagioclase). (b) Cuttable corundums from Ngoronghoro, Tanzania, with colours pink, brownish-red to red. E.S.

BANK, H., HENN, U., LIND, TH., 1989. Synthetische Smaragde aus Australien (synthetische 'Pool emeralds'). (Synthetic emerald from Australia (synthetic 'Pool emeralds'.) *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **38**, 1, 11-16, 12 figs (4 in colour), 2 graphs, bibl.

The Pool Mine in Western Australia was first worked in 1929/30, and reopened in 1979. The stones are of poor quality and are crystallized by hydrothermal synthesis (method according to Brion) into synthetic emeralds. The firm now also uses poor quality stones from Zambia, Brazil and Colombia. According to CIBJO regulations, these synthetic stones should not be called 'Pool emeralds' or treated, improved or recrystallized emeralds. The stones show curved veils consisting of two-phase inclusions, sometimes zoned, black, opaque metallic triangles or hexagonal inclusions, which can also have the shape of small rods or even dendrites, and irregular growth lines. E.S.

CROWNINGSHIELD, R., 1989. Grading the Hope diamond. *Gems & Gemology*, **25**, 2, 91-4, 5 figs in colour.

A modern assessment of the world's most famous blue diamond by a team from the New York Lab found it to be a 'fancy dark greyish-blue', weighing 45.52 ct, of VVS clarity. No fluorescence in LUV and possibly faint fluorescence in SUV, followed by strong red phosphorescence after SUV. R.K.M.

FRITSCH, E., CONNER, L., KOIVULA, J.I., 1989. A preliminary gemological study of synthetic diamond thin films. *Gems& Gemology*, **25**, 2, 84-90, 7 figs in colour.

The past two decades have seen diamond or diamond-like carbon (DLC) films grown onto surfaces by a chemical vapour deposition technique from carbo-hydrate gases. DCLs seem easier and it is thought such films might be used on gems to increase resistance to wear. They are mostly polycrystalline but Sumitomo have experimented with producing single crystal diamond on synthetic diamond [to increase size?.

Other possible gemmological uses to improve diamond simulants, or add a diamond surface to softer gems are discussed. The films seem to be detectable with little trouble, and so far there do not appear to be any commercially diamond-coated gems on the market. R.K.M.

Fritsch, E., Shigley, J., 1989. Contribution to the identification of treated colored diamonds: diamonds with peculiar color-zoned pavilions. *Gems & Gemology*, 25, 2, 95-101.

GIA Research Department has documented more than 1000 coloured diamonds to aid detection of artificially irradiated and annealed ones. Some yellow, dark green or blues are zoned, with strong colour concentration in the culet or keel area. No proven natural diamond with such zoning has been seen or reported, so it is assumed that the zoning results from laboratory treatment. In some stones this takes the well-known 'umbrella' pattern. Marked differences are seen in colour between table up and culet up positions. It is not certain whether such colour is surface only or extends into the body of the stone. A marked colour zone only in the culet of a diamond probably indicates that it has been irradiated and heated. R.K.M.

Fryer, C.W., Ed., Crowningshield, R., Hurwitt, K.N., Kane, R.E., Hargett, D., 1989. Gem Trade Lab notes. *Gems & Gemology*, 25, 2, 102-6, 15 figs in colour.

A large chrysoberyl cat's-eye had a fainter line at right angles (star effect) when seen obliquely. A pink diamond had turned brown by a coating caused by hard water (sulphuric acid removed this). A diamond cube with a cube-shaped cloud inclusion reported in 1976 was re-photographed to record an elusive cross-formation and a vague frame of cloud not recorded in the earlier shot. An intense yellow diamond with strong Cape absorption had a green radiation stain which proved colour was natural. A natural green irradiated diamond was found to have an almost colourless area when sawn.

An emerald with a plastic-like 'infill' repair had also been oiled; infill fluoresced bluish-white, oil a strong yellow. Lapis lazuli necklace was shown to be dyed marble. Another one was X-rayed to show the beads were of two different substances, dyed calcite and Swiss lapis. A 15mm diameter 'pearl' was identified as from a 'Cherry-stone clam' by its minute honeycomb structure and colour.

A 3.02 ct ruby purporting to come from Burma proved to be a completely natural stone, untouched by heat treatment, with calcite and short rutile needle inclusions enmeshed in colour swirls of the type known as 'treacle',; 'a rare treat to see such a magnificent unaltered stone in this day and age!'. A zircon from Orissa State, India, had rutile and hematite inclusions [part of the text is missing so this entry is difficult to understand]. R.K.M.

Koivula, J.I., Kammerling, R.C., 1989. Gem news. *Gems & Gemology*, 25, 2, 110-18, 12 figs in colour.

Gives diamond news from Angola, Australia and China, and says that sub-micro crystals of diamond have been found in enormous quantities when 'primitive meteorites' were dissolved with acid.

Coloured stones:

One of two identical amethysts cut by Bart Curran was heated to 525°C for six hours in air to produce a fine citrine colour, both stones illustrated.

Aquamarine found in Big Horn Mountains. Doug Parsons on a China visit reported aquamarine, citrine, amethyst, blue and green tourmaline and pyrope from Altay region. In Yunnan province white topaz, and some blue; good tourmaline crystals, topaz and aquamarine in Inner Mongolia; fine diopside crystals reported from Kunlun Mountains near Kashmir and Pakistan borders. Muzo emerald mine in Colombia encountering problems with debris from strip mining and are opening up shafts to locate emerald veins which may have been covered; rock is soft and wet so these need heavy reinforcement.

The interesting mineral hackmannite seen at the Tucson Gem and Mineral Show is pale yellow, but flushed immediately to bright orange under LUV, leaving a saturated pink which fades rapidly in ordinary light. The two colours are illustrated, with difficulty for photo lights caused rapid fade!

March rains in the opal fields at Coober Pedy, Mintabie and Andamooka have flooded mines and destroyed heavy machinery, seriously disrupting production, and will force prices up. May take up to a year to return to normal.

Fine Herkima type quartz crystals have been found near Oaxaca, Mexico, some with 'fenester' or window-like growth; fine rose quartz is being mined in Fairfield County, Connecticut. Fine sapphire and star sapphire reported from two new discoveries in Kenya. A yellow sapphire crystal from Anakie, Australia, was multi-zoned unusually in blue, orange and yellow. A pleasing 10 ct padparadschah was seen at the Tucson Show. Himalaya Mine, San Diego County, California, reports finding of a large pocket of specimen grade pink and bi-coloured tourmaline crystals. *Pearls:*

Two remarkable freshwater pink pearls from the Concho River were examined; colour due to manganese, but expected fluorescence in X-rays was not seen, possibly due to the dark colour.

Synthetics and simulants:

Synthetic berlinite, structurally isomorphous with quartz, showed similar bull's-eye interference (circular polarization) figure between crossed polarizers. A blue and white cameo of exceptional hardness proved to be ceramic corundum with vague RI of 1.75-1.76. An imitation emerald crystal shown to have been broken across the prism, the two pieces hollowed out and filled with dyed epoxy or other green plastic, then cemented together again; low SG 2.36, and lack of residual red through emerald filter, plus gas bubbles, gave away a rather convincing fake. Chatham are now cutting their synthetics both in Hong Kong and in Thailand and are producing the crystals outside the US; over 10 000 ct a month were sold in 1988. Union Carbide are growing colourless and pink sapphire to 20 cm diameter by a Czochralski pulling technique, principally for laser and other commercial uses, but lesser quality trimmings are being sold by bid to the gem trade. R.K.M.

KOIVULA, J.I., KAMMERLING, R.C., FRITSCH, E., FRYER, C.W., HARGETT, D., KANE, R.E., 1989. The characteristics and identification of filled diamonds. *Gems & Gemology,* 25, 2, 68-83, 21 figs, mostly in colour.

Many diamonds with surfacing flaws filled to improve their apparent clarity have been seen by the GIA Labs in the past two years, and some at least have been treated by a method developed by Zvi Yehudi of Ramat Gan, Israel. This important paper describes investigations into several stones, finding clarity in most greatly improved by filling, but with lower colour grade due to the yellowish-brown glass compound of lead, bismuth, oxygen and chlorine used as a filler. This has an RI almost equal to that of diamond so that reflecting surfaces of cleavage cracks and other fissures practically disappear.

The filling is attacked by sulphuric acid, e.g. processing pickle, and is also damaged by heat, as in a claw re-tipping situation where the diamond is not removed. The first will leach the filling out near the surface, while the heat will cause it to exude.

Under microscopic examination filled flaws were yellow against a dark background, but flashed a reciprocal bright blue when lighting was shifted to give a light background.

Since filling can make formerly obvious cleavages and other cracks much more difficult to see, this careful investigation has to be seen as a great service to the Diamond Trade in alerting it to the practice. Other vendors may be using this service and there are rumours of lead glass fillings in India, while some stones show evidence of less expert and imperfect filling.

Such fillings should always be disclosed at every level of sale and should not be used to enhance prices unreasonably. R.K.M.

LEPOLD, M., SCHRAMM, M., 1989. Gemmologische Kurzinformationen. Schleifwürdige, grüne Peridote aus Lanzarote. (Short gemmological notes. Cuttable, green peridots from Lanzarote.) *Zeitschrift der Deutschen Gemmologischen Gesellschaft,* **38,** 1, 40-1.

These stones have a low RI (1.649-1.688) and low SG 3.29. E.S.

MRÁZEK, I., 1989. Gemstones of Nicaragua. *Zeitschrift der Deutschen Gemmologischen Gesellschaft,* **38,** 1, 17-30, 9 figs, bibl.

The most attractive gemstone found in Nicaragua is a malachite from the Rosita Mine in the northeast of the country. All other stones seem to come from the west part. The malachites have a banded structure with different shades of green and a silky lustre caused by the divergent fibrous structure. More important are the jaspers, as well as chalcedonies and agates. Other less important finds of stones used for decorative purposes and cabochons are silicified palms, fibrous gypsum, rose quartz, tourmalines, some common opal. Various types of volcanic, sedimentary and metamorphic rocks are also worked by lapidaries. E.S.

NATKANIEC-NOWAK, L., HEFLIK, W., SOBCZAK, N., SOBCZAK, T., 1989. Ein Beitrag zur Farbe niederschlesischer Chrysoprase. (A contribution to the discussion regarding the colour of chrysoprase.) *Zeitschrift der Deutschen Gemmologischen Gesellschaft,* **38,** 1, 31-6, 2 figs, bibl.

The chrysoprase being discussed comes from the Szklary massive in lower Silesia and has been known since 1425. It is only since the Australian Marlborough Creek was discovered in 1960, that chrysoprase of similar quality and quantity has become commercially available. Much work has been done to find the real cause of the colour, but no definite answer has yet been found. The authors suggest that the colour is caused by nickel in the SiO_2 position. E.S.

PONAHLO, J., 1989. Gemmologische Kurzinformationen. Quantitative Kathodolumineszenz von Rubinen aus Malawi. (Short gemmological notes. Quantitative cathodoluminescence in rubies from Malawi.) *Zeitschrift der Deutschen Gemmologischen Gesellschaft,* **38,** 1, 340, 2 figs.

The cathodoluminescence seems to be due to high chromium content. With the help of the described method the author states that these natural rubies can easily be distinguished from synthetics. E.S.

Proceedings of the Gemmological Association of Great Britain and Association Notices

OBITUARY

A tribute to the late Mr F.E. Lawson Clarke

Mr F.E. Lawson Clarke.

I first met Lawson in the summer of 1955 when I was given the day off from school to travel to London for an interview with him, the hope being that I would be offered an apprenticeship with Wilson & Gill. He was very kind to me, took me out to lunch I remember, and then told me that I was not the person he was looking for. I am sure he was right! As it happened I began work that same autumn just round the corner from Wilson & Gill, at Hancocks & Co., as an apprentice. It wasn't until I became Chairman of the National Association of Goldsmiths that I really came to know Lawson well for he was to be NAG President during my term of office.

Lawson Clarke was very closely connected with the trade from his youth because his father, Victor Clarke, was already in the trade at Wilson & Gill in Regent Street. Lawson qualified in opthalmic optics, not an unusual entry into the trade at that time, and in 1924 he joined his father at Wilson & Gill. His father was very active in trade affairs being Chairman and President of the NAG, and then from 1931-1943 Treasurer of the Gemmological Association and then Chairman from 1943-1946. Lawson was to follow closely in his footsteps because he was also NAG Chairman (1949/1950) and the Treasurer of the GA from 1950-1983.

This catalogue of service to the trade is a very statistical story, and in no way conveys the charming character of Lawson. He always had a warmth to his welcome, a great interest in young people, a lively open mind to new ideas and yet always seemed so able to play the part of 'the elder statesman'. He had a great sense of honour and fun and his interest in the world of gemstones was one of a person always ready to enquire. He was a practical man and had a great interest in horology, a practical interest rather than just theoretical. He used to maintain his own car, for instance, and was also a keen gardener. He even built the most elaborate brick and tile circular arch in his garden and this stood the test of many years only to be finally beaten in the great storm two years ago. All in all he was a man of many parts, but for me I shall always remember him for his manner. He was a true gentleman, polite, charming, elegantly dressed with a distinctive walk that was part of his instantly recognized character. He even managed to wear his bowler hat in a jaunty manner, and yet remained the proper businessman. So, by virtue of the fact that he and I were closely involved with the NAG we did come to work together, and then when I became Chairman of the GA we worked together for a while longer as he was still Treasurer. When in 1968 Wilson & Gill was sold he joined his son Christopher in a new venture when the firm of Hesters was bought, and they began the very successful company re-named Hester Clarke.

Christopher and his wife Ann were to be joined by their daughters in the business and the very rare three generation team came together. It can only have been Lawson's own love of the trade that brought his own son into the business and in turn his granddaughters. He did love the trade and the people in it and those of us who knew him could only but love and admire him too. He and his wife Frances – they were married in 1974 widower and widow alike – travelled all over the UK as President and his lady, and Frances quickly established herself in people's affection.

Early in 1989 I heard that Lawson had not been at all well the previous year and had spent some time in hospital following an unexplained collapse. He had written to me earlier on a typewriter and it was clear that he had not quite mastered that 'machine', saying that he should resign from the GA because of his age. I replied, refusing him such 'nonsense' and he suggested that my wife Mary and I might like to go to see him and Frances to renew our friendship. So we did, and the four of us had a marvellous time talking about the friends and the characters we had met over the years. He told me of the changes he had seen in Regent Street and we had a thoroughly enjoyable afternoon together. We had planned to go again during the August Bank holiday but sadly this was not to be. However, I am lucky because I shall always be able to remember that convivial afternoon that was to be the last time that I was to see him. All of us who knew him, had the pleasure of working with him, and the admiration for his style have had a real privilege. I do not think it is likely that we shall meet another Lawson Clarke for times have changed, but he was able to bridge the gap between the old ways and the new. He and his family have given an enormous amount to the trade, and Christopher himself is doing so too, having served the NAG for nearly 30 years, and now on the Court of the Worshipful Company of Clockmakers.

So we have lost a special man, gemmologist, clockmaker, good team man, all rolled into one, but for those of you in the future who just come across the name do ask any of us who know him to tell just our own special memory and then you will meet for just a while a unique man who had the love and interest of the trade for over 65 years and has passed that on to others who in turn enjoy it all the more for having known him. D.J.Callaghan

★ ★ ★

Miss Elsie A. Short, FGA (D.1952), Twickenham, died on 1 October 1989 after a long and painful illness. Following four years of war service with the Royal Air Force, Miss Short joined George Lindley & Co., London, in 1947. Some thirty years to her retirement in 1976 were spent in developing the export business of the company in precious stones, with meticulous attention to the high quality and grading standards required in a wide international market. W.C.B.

Mr K.C. Cole, FGA (D.1965), Swanage, died during August 1989.

GIFT TO THE ASSOCIATION

The Council of the Association is indebted to Mr R. Holt of R. Holt & Co. Ltd, London, for his gift of various stones including a synthetic uncut emerald, a chrysoberyl cat's-eye and an opalized shell.

NEWS OF FELLOWS

On 12 September 1989 Mr Michael O'Donoghue spoke to members of the Guildford Gem, Mineral and Lapidary Club. His subject was 'Gemstones of northern Pakistan', and representative samples, some self-collected, were displayed. On 20 September 1989 Mr O'Donoghue gave a talk entitled 'Gemstones' to the Ightman and District Historical Society. On 4 November 1989 at the Flett Theatre, Geological Museum, Exhibition Road, South Kensington, London SW7, Roger Harding, Alan Jobbins and Ken Scarratt gave illustrated lectures on the Crown Jewels. On 5 November 1989 at the Flett Theatre Alan Jobbins gave an illustrated lecture entitled 'European gemstones'. On 11 November 1989 at the Society of Antiquaries of London, Burlington House, Piccadilly, a symposium was held, organized by the Society of Jewellery Historians, entitled 'Gemstones in Jewellery'. Lecturers included David Callaghan, Robert Crowningshield, Alan Jobbins, Jack Ogden and Ken Scarratt.

MEMBERS' MEETINGS

London

On 11 October 1989 at the Flett Theatre, Geological Museum, Exhibition Road, South Kensington, London SW7, Mr John I. Koivula, FGA, of the Gemological Institute of America, gave an illustrated lecture entitled 'An evening of microgemmology'.

Midlands Branch

On 20 October 1989 at the Society of Friends, Dr Johnson House, Colmore Circus, Birmingham, Mr S. Mather gave a talk on 'The gems and minerals of Norway'.

On 22 October 1989 the Branch organized a gem testing equipment seminar at the Cobden Hotel which was well supported by students and the trade. On 17 November 1989 at the Society of Friends Mr Gwillam Jones, FGA, gave an illustrated lecture entitled 'Gemmological Mish-Mash'.

ANNUAL REUNION OF MEMBERS AND PRESENTATION OF AWARDS

Fig. 1. Mr Robert Crowningshield giving his address.

The Annual Reunion of Members and Presentation of Awards was held on 6 November 1989 at the Guildhall, Gresham Street, London EC2. Mr David J. Callaghan, Chairman of the Association, presided at the Presentation and welcomed those present. He explained that, for the second time, the awards ceremony was being held at the Guildhall as Goldsmiths' Hall, where the event usually takes place, was being refurbished. The Chairman called upon Mr Robert Crowningshield, Vice-President of the Gemological Institute of America, to present the awards. During his address Mr Crowningshield explained the advances made in gemmology since he qualified in the Association's examinations in 1947. He discussed many of the new synthetic and simulated gemstones that had not been invented in 1947, as well as the various forms of gemstone treatment now used. Although there is the necessity for advanced instrumentation in the specialist laboratories to distinguish these stones, he stressed the importance of the microscope and advised students to work at improving their microscopic skills.

Mr Crowningshield congratulated the successful candidates and said that they now had to keep up-to-date with their gemmological knowledge, and suggested that they study the enormous amount of literature published on the subject.

The Vice-Chairman of the Association, Mr Noel Deeks, gave the vote of thanks.

GEM DIAMOND EXAMINATION 1989

In the 1989 Gem Diamond Examination 55 candidates sat and 53 qualified, two with Distinction. Their names are as follows:

Qualified with Distinction

Cadavid Tortosa, Manuel, Barcelona, Spain.
Vila Torrejon, Ma Enriqueta, Barcelona, Spain.

Qualified

Amiel Fresneda, Josefa, Barcelona, Spain.
Birchall, Steven, Hyde.
Booker, Martin, London.
Bramham, Kathleen, London.
Carracedo Oliva, Robert, Barcelona, Spain.
Castro, Ana, London.
Climent Coscolluela, Nuria, Barcelona, Spain.
Cowdrey, John, Harrow.
Easterbrook, Steven, Bridgend.
Escalona I Larroy, Josep A., Barcelona, Spain.
Farinos Folgado, Ramon, Barcelona, Spain.
Farrow, Karen, Great Yarmouth.
Fox, Julie, Maidstone.
Gomes Da Silveira, Luiz A., Barcelona, Spain.
Harrison, Roger, Kings Langley.
Hayes, Alan, Stockport.
Hitcham, Peter, Kingston-upon-Thames.
Heatlie, James, Edinburgh.
Holloway, Sarah, London.
Ivanoff Landovski, Tatiana, Barcelona, Spain.
Iquaz Esteban, Yolanda, Barcelona, Spain.
Kramer, Stephen, Bradford.
Kyriakidou, Katherine, London.
Larcher, David, Sutton Coldfield.
Lekamge, Neil, London.
Lewis, Rachel, Stockport.
Longden, Sharon, Sheffield.
McCleland, Susan, Bognor Regis.
Mairal Nebot, Susana Ma, Barcelona, Spain.
Marti Gomez, Emilio A., Barcelona, Spain.
Martinez Masip, Amelia, Barcelona, Spain.
Meler Ardiaca, Ma Teresa, Barcelona, Spain.
Mills, Edwin, Ely.
Mistry, Mukesh, London.
Naylor, Tina, Wigan.
Parker, Vaughan, King's Lynn.
Potts, James, Telford.
Renieblas I Salo, Sara, Barcelona, Spain.
Roig Miguel, David, Barcelona, Spain.
Serra I Badia, Lluis, Barcelona, Spain.
Slack, Richard, Cardiff.

PRESENTATION OF AWARDS CEREMONY

Fig. 2. Tully Medallist, Helen Plumb, receiving her award from Mr. Robert Crowningshield.

Fig. 3. Rayner Diploma Prize winner Andrew Cope.

Fig. 4. Rayner Preliminary Prize winner Robert Murray.

Socias Barenya, Ma Angela, Barcelona, Spain.
Torrance, Claire, Surrey.
Tyler, Elizabeth, London.
Vcte P. Fenollosa, Enrique, Barcelona, Spain.
Walker, James, Edinburgh.
Walker, Jeremy, Cumbria.
Webster, David, Glasgow.
Weiss, Anthony, Bushy.
Weston, Jonathan, Birmingham.
Wilson, Sandra, Edinburgh.

EXAMINATION IN GEMMOLOGY 1989

In the 1989 Examinations in Gemmology, 511 candidates sat the Preliminary Examination and 329 succeeded in qualifying, 372 candidates sat the Diploma Examination and of these 185 succeeded in qualifying, 20 with Distinction.

The Tully Medal for the candidate (trade or non trade) who submits the best set of answers in the Diploma Examination has been awarded to Helen Louise Plumb of London. The **Anderson/Bank Prize** for the best non-trade candidate of the year in the Diploma Examination has been awarded to Karen Jill Lewis of Hong Kong.

The **Rayner Diploma Prize** for the best candidate of the year who derives his main income from activities essentially connected with the jewellery trade has been awarded to Andrew Richard Cope of Nottingham.

The **Anderson Medal** for the best candidate of the year in the Preliminary Examination has been awarded to Anja Kaarina Pehkonen of Helsinki.

The **Rayner Preliminary Prize** for the best candidate who is under the age of 21 years on 1 June 1989, who derives his main income from activities essentially connected with the jewellery trade has been awarded to Robert Andrew Murray of London. The names of the successful candidates are as follows:

DIPLOMA

Tully Medal
Plumb, Helen L., London.

Anderson/Bank Prize
Lewis, Karen J., Hong Kong.

Rayner Diploma Prize
Cope, Andrew R., Nottingham.

Qualified with Distinction
Andrews, Suzanne, Cheadle Hulme.
Chan, Mazie Man-Wah, Hong Kong.
Chawla, Ishita, Bhudaneswar, Fung, Eleanor So-Wan Au, Hong Kong.
Galibert, Olivier, Bangkok, Thailand.
Hughes, David J., Cardiff.
Langdon, Ingrid B., Corpus Christi, Texas, USA.
Lilly, Gregory R., Hawera, New Zealand.
Pfister, Hans, Zurich, Switzerland.
Roberts, Kate, Harrow.
Ruff, Agnes, Hong Kong.
Seaton, Johanna L., Hong Kong.
Taylor, Sarah J.W., Birmingham.
Tse, Matthew Kwok Fung, Hong Kong.
Veecumsee, Dipal D., Madras, India.
Whitney, Mary A., London.
Zanardi-Landi, Sabina, London.

Qualified
Achakane, Abelaaziz, Birmingham.
Adams, Jacqueline E., London.
Andrews, Fern, London.
Arranz Garcia, Felix, Barcelona, Spain.
Athanassopoulos, Joanna D.E., Athens, Greece.
Barbara Solé, Ma Rosa, Barcelona, Spain.
Barrabes Lacarda, Silvia, Barcelona, Spain.
Bauco, Robert, London. Bieri, Joisane, Athens, Greece.
Bofil Montoro, Ana Ma, Barcelona, Spain.
Boira Roges, Berta, Barcelona, Spain.
Bourdillon, Catriona C.C., London.
Bowis, Mark L., London.
Boyadjian, Liza, London.
Brantly, Rhona, Rio de Janeiro, Brazil.
Brown, Naomi A., Willowdale, Canada.
Carroll, Patricia E., Hong Kong.
Chan, Linda A.Y., Hong Kong.
Chan, Yoke L., Hong Kong.
Chiu, Fung Mei Janis, Hong Kong.
Chiu, Sau King Doris, Hong Kong.
Chiu, Yuk Lan Rafia, Hong Kong.
Chow, Kevin Kar Wai, Hong Kong.
Chow, Rita Yuen-Ching, Hong Kong.
Civitello, Odile, Montreal, Quebec, Canada.
Clover, Wai Ying, Hong Kong.
Cocke, David D., London.
Collins, Jessica, London.
Corta Alonso, Ma Lina, Barcelona, Spain.
Cox, Vann S., Bedford.
Danis Terra, Rut, Barcelona, Spain.
de Crecenzio, Alejandre, Schoonhoven, The Netherlands.
Dwyer, Katherine, Oregon House, Calif., USA.
Edie, Tong Wai Man Annie, Brighton.
Edwards, Jennifer L., Hong Kong.
Ellis, Phillipa, London.
Fan, Siu Kam, Hong Kong.
Farzan, Ali Reza, London.
Frampton, James, London.
Frederick, Helen Marie, Wellington.
Fuller, Mark R., London.
Fung, Kam Man, Hong Kong.

Furne, Neus Gambin, Barcelona, Spain.
Garbouchian, Lilian J., Bangkok, Thailand.
Garcia Ferrandiz, Javier, Barcelona, Spain.
Garty, Annemarie, Dundee.
Gellini, Delio, Harrogate.
George, Wanda M., Nairobi, Kenya.
Ghaffar, Gulnefer, Hong Kong.
Girardi, Josephine C., Hong Kong.
Gould, Jean, H.I., London.
Hapugaskumbura, Asanga, Sri Lanka.
Hasan, Zia-Ul, Toronto, Ont., Canada. Hausler, Rebecca, Bangkok, Thailand.
Hawkins, Richard A., Sutton.
Hirst, Jenny, London.
Hitchin, Peter, Bangkok, Thailand.
Ho, Kar Fai Patrick, Hong Kong.
Ho, Kiam Fong Steve, Singapore.
Hossen, Iqbal Hamid, Port Louis, Mauritius.
Howard, David, Preston.
Isern Truy, Enric, Barcelona, Spain.
Jackson, Mark, Worcester.
Jarvis, Hilary A., London.
Kangasniemi, Arto J., Helsinki, Finland.
Karkkulainen, Kari, Oulu, Finland.
Keerthi, Koku Hannadige, Idar-Oberstein, W. Germany.
Keusch, Shohred, Hong Kong.
Keys, Malcolm, Manchester.
Komai, Rie, Saitama Pref., Japan.
Koslowski, Peter C., Bangkok, Thailand.
Laborda Ferrer, Ma Angeles, Barcelona, Spain.
Lau, Yuet Yung Ellen, Hong Kong.
Law, Patricia M., London.
Lazaro Anglada, Ma Jose, Barcelona, Spain.
Leddicoat, Andrew, Guiseley.
Lee, Sheung Wah, Hong Kong.
Lehtinen, Kirsi, Helsinki, Finland.
Leon Martin, Josefa, Barcelona, Spain.
Levin, Igor, Toronto, Ont., Canada.
Lewis, Richard D.F., London.
Lieftinck, Felicia A., Rotterham, The Netherlands.
Lindqvist, Thérese, Stockholm, Sweden.
Ling, Lai C. A., Hong Kong.
Lintunen, Eva, Helsinki, Finland.
Lockie, Debra A., Auckland, New Zealand.
McIlwraith, Philomena M., Hong Kong.
MacGregor, Rory, Rio de Janeiro, Brazil.
McKenna, Joseph T., London.
Mariona De Urquijo, Victoria E., Barcelona, Spain.
Marshall, A.T. Douglas, Cambridge.
Mas Lillo, Javier F., Barcelona, Spain.
Maung, Thet Oo, Bangkok, Thailand. Meeles, Frederik Q.A., Rotterdam, The Netherlands.
Merchant, Arti R., Bombay, India.
Mohideen, Mohamed F., Colombo, Sri Lanka.
More, Deepak K., Hong Kong.
Morris, David C., Dover.
Murray, Robert, Kensington.
Nakamura, Chiyo, Hokkaido, Japan.
Nakao, Kimitoshi, Osaka, Japan.
Ng, Ai Moi, Hong Kong.
Nevalainen, Tuula, Helsinki, Finland.
Nottingham, Peter R., Leeds.
Osborne, Sean J., Pimlico, London.
Osmond, Catherine, Bangkok, Thailand.
Ozaki, Keiko, Hyogo Pref., Japan.
Page, Christopher D., Newmarket.
Pak Ching-Yuen, Bernard, Hong Kong.
Panayiotis, Panayi, Manchester.
Parikka, Pekka J., Helsinki, Finland.
Pattni, Minakshi, Harrow.
Pedersen, Gunhild R., Oslo, Norway.
Peter, Christina, Bangkok, Thailand.
Petrides, Eugene P., London.
Pette, Jan W., Arnhem, The Netherlands.
Pfeiffer, Brigitte C.E., London.
Pring, Amanda L., Birmingham.
Pun, Yuk Ling, Hong Kong.
Puviharan, Mylvaganam, Idar-Oberstein, W. Germany.
Ravindran, Mahaluxmy, Bangkok, Thailand.
Reuser, Laetitia, Schoonhoven, The Netherlands.
Rieger, Catherine J., Maidstone.
Richardson, Cathryn, Silsden.
Ruiz Belver, Antonio J., Barcelona, Spain.
Ruusunen, Petri S., Helsinki, Finland.
Santacreu Rull, Montserrat, Barcelona, Spain.
Schaetzle-Parisod, Arlette, Kaiseraugst, Switzerland.
Schat, Ellen M., Schoonhoven, The Netherlands.
Scott, Kenneth MacDonald, Carluke.
Seifert, Jannice, Hong Kong.
Sempere Leal, Esther, Barcelona, Spain.
Sergoulopoulos, Alexandros, Athens, Greece.
Shigeoka, Mayumi, Tokyo, Japan.
Shimoda, Tetsuhiro, Fukuoka Pref., Japan.
Shimoe, Yasuhiro, Osaka, Japan.
Singh, Runbir, Hong Kong.
Stanley, Sylvia, Hong Kong.
Stanton, Zoe, Andreas, Isle of Man.
Sullivan, Patricia, Toronto, Ont., Canada.
Sutton, Susan A., Stowmarket.
Tachibana, Hirogi, Osaka, Japan.
Tayara, Mona D., Athens, Greece.
Thornton, Shirley, Bangor.
Tielinen, Tarja H., Ylamaa, Finland.
Tielinen, Teuvo K., Ylamaa, Finland.
Turner, Susan E., Hong Kong.
Turunen, Kirsi, Helsinki, Finland.
Usechi Espinosa De Los Monteros, Amp, Barcelona, Spain.
Van Der Klauw, Angela, Utrecht, The Netherlands.
Van Sterkenburg, Sandra, Schoonhoven, The Netherlands.

Vataru, Monica, London.
Velaz Azpilicueta, Mercedes, Barcelona, Spain.
Vidal Ramia, Enriqueta, Barcelona, Spain.
Vildiridis, Athanassios N., London.
Wat, Wanda Hoi-Chi, Hong Kong.
Wiborg-Jenssen, Nellie, Tunbridge Wells.
Worthington, Louise, Sowerby Bridge.
Xanthopoulou, Paraskevi, Athens, Greece.
Yeung, Chan Siu Ling, Hong Kong.
Yim, Tae Young, Republic of Korea.
Yoheswaran-Poulin, Bangkok, Thailand.
Yoo, Ok Hee Han, Korea.
Yount, Henrietta S., Hong Kong.
Yuill, J. Martin, Lanark.

PRELIMINARY

Anderson Medal
Pehkonen, Anja K., Helsinki, Finland.

Rayner Preliminary Prize
Murray, Robert A., London.

Qualified
Adachi, Kouichi, Osaka, Japan.
Alabaster, Andrew G., London.
Alcover Falco, Anna, Barcelona, Spain.
Alejo, Deirdre K., Hong Kong.
Altena, Frances R., Amsterdam, The Netherlands.
Alvarez Suarez, Fernando, Oviedo, Spain.
Anderson, Aud Naes, Grimstad, Norway.
Andres Gomez, Andres, Sant Adria Del Besos, Spain.
Anjali, Javeri, Bombay, India.
Arbisman, Alexander R., Surrey.
Argirakou, Ioulia, Volos, Greece.
Aryatilake, Bamunuarachchige L., Sri Lanka.
Askew, Cheryl G., Wigan.
Aspasis, Gini, Athens, Greece.
Auberni Serra, Gemma, Barcelona, Spain.
Baldock, Janine R., Crawley.
Barker, Damon A.N., Winchester.
Barrie, Lindsay M.O., London.
Bashour, Hiyam, London.
Beentjes, Theodorus P.C., Uitgeest, The Netherlands.
Bendel, Helle, Sao Paulo, Brazil.
Berk, Merle, Pennsylvania, USA.
Berlioz, Roger F.B., Kandy, Sri Lanka.
Bernad Soria, Jose M., Barcelona, Spain.
Bertolin Marti, Carlos, Barcelona, Spain.
Beveliotis, Christos, Athens, Greece.
Bing, Sara V., Exeter.
Birrell, Andrew T., London.
Boaden, Richard J., Hexham.
Bolano Cid, Jordi, Barcelona, Spain.
Bowler, Simon R., Birmingham.
Boyd, Stephen D., Bournemouth.
Brooks, Anna T., Watford.
Brown, Naomi A., Ontario, Canada.
Buckland, Christine J., Wilmslow.
Bullen, Anne, Ontario, Canada.
Canero Sesar, Inmaculada, Barcelona, Spain.
Cardo Sabater, Elisabeth, Barcelona, Spain.
Carr, Owen, Coventry.
Carter, Maurice W., Ontario, Canada.
Cases Canes, Josep R., Barcelona, Spain.
Casas Royo, Jose A., Alfaro, Spain.
Chalmers, Rachael A., Knutsford.
Chauhan, Mahaveer S., Bombay, India.
Chawla, Ishita, Orissa, India.
Chen, Xiugin, Wuhan, China.
Cheng, Kit Ling Connie, Kowloon, Hong Kong.
Chiu, Fung Mei Janis, Hong Kong.
Chiu, Lai Sim Sarah, Hong Kong.
Chiu, Roy Shuk-Hung, Hong Kong.
Chiu, Shuk Han, Hong Kong.
Choy, Yuen Yee Margaret, Hong Kong.
Christaki, Ourania, Volos, Greece.
Chu, Sin Yi Christine, Hong Kong.
Chung, Josephine Mei-chee Mak, Hong Kong.
Cipriani, Tony, Quebec, Canada.
Clifton, Sarah E., Birmingham.
Colomina Hernandez, Roberto, Alicante, Spain.
Copestick, Bruce J., Harpenden.
Craghill, William, Northampton.
D'Alessandro, Martha A., Rio de Janeiro, Brazil.
Davidson, Anthony, Newcastle-upon-Tyne.
Desir Valen, Aline, Zaragoza.
de Vilhena, Manuel J. Sousa, London.
Doran, Sean F., Liverpool.
Downer, Martyn D., London.
Edwards, Susan M., London.
Egner, Valerie S., London.
Einstoss, Philip Michael, Toronto, Canada.
Eldridge, Lawrence, Maryland, USA.
Ellis, Phillipa R., London.
Elola Lekuona, Juan J., Barcelona, Spain.
Everest, Deborah, Aldershot.
Ewart, Jane W., Broadway.
Farrett, Kirsten J., Dover.
Farzan, Ali-Reza, London.
Fernandes, Bevelyn E., Bombay, India.
Filazzola, Anthony, Ontario, Canada.
Fitzmaurice, Karl, Castlerea.
Flack, Inger, Hosle, Norway.
Folgado Reig, Vicente, Valencia, Spain.
Fortea Bellido, Javier, Valencia, Spain.
Frampton, James J.M., Bakewell.
Fraser, James W., Glasgow.
Fu, Lintang, Wuhan, China.
Fung, Chung Min Newson, Kowloon, Hong Kong.
Fung, Wai Yin, Hong Kong.

Galibert, Olivier, Calas, France.
Ganzabal Hernandez, Amparo, Barcelona, Spain.
Garbouchian, Lilian J., Bangkok, Thailand.
Garrido Cardenal, Juan J., Alicante, Spain.
Garty, Annemarie, Dundee.
Gasco Galindo, Teresa, Valencia, Spain.
Gau, Robert Ben-Rong, Taiwan, China.
Gaynor, Geoffrey, Peterborough.
Georgiadou, Elizabeth, Volos, Greece.
Ghisi, Maria, Athens, Greece.
Gibson, Bracken G., London.
Gledhill, Paul, York.
Gorro Felip, Eva Maria, Tarrega, Spain.
Gowan, Joanne C., Sawbridgeworth.
Green, Sheila M., Glasgow.
Grootjans, Sandra, Schoonhoven, The Netherlands.
Gunasekara, Rajasinghe S., Sri Lanka.
Hakansson, Ulf J.M., Noorkopine, Sweden.
Haribachi, Naoki, Japan.
Hasasnoot, Annette, Utrecht, The Netherlands.
Hasegawa, Tamio, Osaka, Japan.
Hassan, Ali R., Manchester.
Hastings, Duncan J., Oxford.
Hausler, Rebecca, Bangkok, Thailand.
Hester, Colette L., Schoonhoven, The Netherlands.
Hitchin, Peter F., Bangkok, Thailand.
Holen, Yvonne, Schoonhoven, The Netherlands.
Hollanders, David J., Maidenhead.
Holst, Frank L., Kolding, Denmark.
Hoogeboom, Paulus N., Hoogland, The Netherlands.
Hoogendoorn-Van der Wijaard, Elisabeth G., The Netherlands.
Howard, J., London.
Huang, Qian, Wuhan, China.
Huebra Chico, Antonio, Alicante, Spain.
Huerta Sanchez, Ana Ma., Barcelona, Spain.
Hughes, Josephine M.H., Dublin, Eire.
Hugi, Michael F., Switzerland.
Hung, Chi Ling Vivian, Hong Kong.
Ibanez Pueyo, Jordi, Barcelona, Spain.
Inagaki, Saeko, Osaka, Japan.
Inkpen, Michael S., Kingsbridge.
Jakobsson, Thomas A., Huddinge, Sweden.
Janse, Theodora J., Rotterham, The Netherlands.
Javeri, Anjali, Bombay, India.
Jhaveri, Devang, London.
Joensuu, Anne H., Ilamaa, Finland.
Jones-Brunet, Catherine E., Ontario, Canada.
Jongerius, Joost J.W., Schoonhoven, The Netherlands.
Jurado Garcia, Ma del Carmen, Valencia, Spain.
Kadowaki, Kayoko, Osaka, Japan.
Kangas, Anne K., Helsinki, Finland.
Kermorgant, Claire, Stain Renan, France.
Keys, Malcolm H., Manchester.
Killias, Andree, Hong Kong.
King, Andrew W., Glenfield.
Ko, So Ling Amy, Hong Kong.
Kohara, Sanae, Osaka, Japan.
Komiya, Keiko, Tokyo, Japan.
Komppa-Vigar, Leena M., Bedford.
Korsten, Paul H.J., Ontario, Canada.
Koslowski, Peter C., Bangkok, Thailand.
Kozlowsky, Lida A., Ontario, Canada.
Kung, Kwai, Hong Kong.
Kwok, Yee Man Emily, Hong Kong.
Lai, Tik Shan Sana, Hong Kong.
Lancaster, Wendy, London.
Lankadeva, Gardiye H.G.A., Sri Lanka.
Lati, Seppo I., Espoo, Finland.
Lati, Melody Sau-Ha, Hong Kong.
Lavin, Padraic, Ballaghaderreen.
Le Cornu, Elizabeth B., Jersey, CI.
Lee, Kevin Yat-Kin, Hong Kong.
Lee, King To., Hong Kong.
Lee, Mei Ling, Hong Kong.
Lee, Rowena Yuen Fee, Hong Kong.
Lees, John A., Virginia, USA.
Lehnert, Annette I., Schoonhoven, The Netherlands.
Lentz, Janine, Schoonhoven, The Netherlands.
Leung, Chee Wing, Hong Kong.
Levin,Igor, Ontario, Canada.
Levy, Aaron N., London.
Lewis, Richard D.F., Epsom.
Li, Fung Mei Sarah, Hong Kong.
Li, Kam Yiu Dick, Hong Kong.
Li, Yali, Wuhan, China.
Liao, Xiangjun, Wuhan, China.
Lindberg, Marja Leena, Espoo, Finland.
Linden, Vanessa, London.
Lindqvist, Kristian V., Siuntio, Finland.
Li-Ran, Dorit, Nairobi, Kenya.
Liv, Shang I., Hong Kong.
Lo, Mun Shan Ivy, Hong Kong.
Lonka, Valtteri A., Kuopio, Finland.
Lopez Gracia, Anna Ma, Barcelona, Spain.
Lu, Lianzhong, Wuhan, China.
Ludlow, Andrew P., Buckhurst Hill.
Lui, Kin Wah Kelvin, Hong Kong.
Lynch, Kieran J., Coventry.
McConnachie, David C., Glasgow.
McQueen, Amanda J., Hong Kong.
Malani, Sajina, London.
Mallett, Gillian E., Cambridge.
Marcos Pascual, Celia, Oviedo, Spain.
Martin, Julie, Glasgow.
Martinez Bautista, Santiago, Barcelona, Spain.
Matthews, Lisa J., Winchester.
May, Catherine J., Torquay.
Meeles, Frederik Q.A., Rotterdam, The Netherlands.

Michallat, Mark, Shipley.
Milstein, Alan G., Solihull.
Mira Sanchis, Margarita, Alicante, Spain.
Miralles Duch, Jordi, Barcelona, Spain.
Moreiras Blanco, Damaso-Baldomero, Oviedo, Spain.
Moreno Rastrero, Eduardo, Logrono, Spain.
Mori, Junko, Hyogo, Japan.
Mori, Keiko, Nara, Japan.
Moriyama, Yoshiko, Nara, Japan.
Mourogiannis, Stephanos, Volos, Greece.
Nathorst, Marie O.A., Stockholm, Sweden.
Ng, Ai Moi, Hong Kong.
Ng, Hung Lai, Hong Kong.
Ni, Ruilan, Wuhan, China.
Nicholson, Annie Yim Wan, Hong Kong.
Niiniharju, Juhani, Siikaranta, Finland.
Nishiura, Hisako, Osaka, Japan.
Noyori, Kazuhiko, Fukuoka City, Japan.
Nuotio, Rauno Martti, Helsinki, Finland.
Obiols Navarry, Enrique, Barcelona, Spain.
O'Brien, Gillian M., North Berwick.
Oldershaw, Caroline J., Penn.
Osmond, Catherine, Bangkok, Thailand.
O'Sullivan, Beatrice, Rugeley.
Oura, Mamiko, London.
Owen, Margaret E., Pietermaritzburg, South Africa.
Palmer, Guendolen C., Hassocks.
Panayi, Panayiotis, Manchester.
Park, Myoung-Ok, Daejon, Korea.
Patel, Kokila R., Nairobi, Kenya.
Patel, Pankajkumar, Manchester.
Patterson, Debra A., Ontario Canada.
Pawlik, Tammy J., Ontario, Canada.
Peter, Christina, Bangkok, Thailand.
Petrides, Eugene P., London.
Pettigrew, Louise, Glasgow.
Pool, Richard J., York.
Pourgouris, Evangelos, London.
Qi, Lijian, Wuhan, China.
Quek, Cho Siang Jessie, Hong Kong.
Rackley, Trevor, Wantage.
Ratnakumara, Dodangodage, Sri Lanka.
Ravindran, Mahaluxmy, Bangkok, Thailand.
Reveliotis, Christos, Athens, Greece.
Ripley, Thomas, Stockton-on-Tees.
Rodriguez Fernandez, Margarita, Asturias, Spain.
Ronkainen, Maija R., Lohja, Finland.
Rowlands, Alan F., London.
Rudolphy, Willemine P.C., Schoonhoven, The Netherlands.
Ruiz Domenech, Anaa Ma, Tarrega, Spain.
Ruuthunen, Tuula K., Helsinki, Finland.
Saito, Takako, Osaka, Japan.
Sanchez Comerma, Juana Ma, Alicante, Spain.
Sancroft-Baker, Raymond S., London.
Sanson, Steven N.J., London.
Santacreu Rull, Elisenda N., Barcelona, Spain.
Saywell, Neil, West Bridgford.
Schaapherder, Robertus C., Blarcum, The Netherlands.
Senarath, Pragnarathna K.A., Sri Lanka.
Shammas, Siham, London.
Sim, Evelyn, Harlow.
Simmons, Charlotte R., Maryland, USA.
Singh, Runbir, Hong Kong.
Skilton, Margaret, Auckland, New Zealand.
Skinner, Lesley, Stenhousemuir.
Skrablin, Lada L., London.
Smith, Karen, Dewsbury.
Smith, Michael, Seaton Sluice.
Smookler, Sheryl, Pinner.
Spencer, Stephen R., Nottingham.
Spentzas, Alexandra, Athens, Greece.
Steele, Janice P., Alberta, Canada.
Stewart, Carolyn L., Hong Kong.
Sullivan-Humphrey, Patricia E., Toronto, Ont., Canada.
Taavila, Aino-Inkeri, Iisalmi, Finland.
Takahashi, Yasushi, Kofu, Japan.
Takano, Hirofumi, Tokyo, Japan.
Tan, Ming, Wuhan, China.
Tang, Suk Chun Jenny, Hong Kong.
Tannahill, James, Croydon.
Tanzawa, Megumi, Yamanashi, Japan.
Thoma, Carol A., Ontario, Canada.
Thornley, Charisse M., Ontario, Canada.
Trathen, John E., Ontario, Canada.
Tsang, Wai Ming, Hong Kong.
Tsujimoto, Toshiaki, Osaka, Japan.
Tuovinen, Risto P.J., Kouvola, Finland.
Uribe Molto, Ma Victoria, Barcelona, Spain.
Valero de la Nuela, Ignacio, Barcelona, Spain.
Valero Sebastian, Alicia, Barcelona, Spain.
Valethuizen, Irmine H.S., Arnhem, The Netherlands.
Valora Miqueo, Tatiana Ma, Barcelona, Spain.
Van Acker, Adriaan A.M.A., Tilburg, The Netherlands.
Van Heesewijk, Jacqueline W., London.
Van Putten, Rozanne C., The Netherlands.
Vartiainen, Risto K., Rovaniemi, Finland.
Vela Clemente, Fernando, Barcelona, Spain.
Vernon, Susan A., Kirk Langley.
Vilabella Fernandez, Ramon, Barcelona, Spain.
Wang, Manjun, Wuhan, China.
Watambe, Tatsuo, Tokyo, Japan.
Wates, Peter J., Coulsdon.
Watson, Muriel, Durham.
Weston, A.L., Maryland, USA.
Wightman, Ian E., Kenton.
Williams, Jason F., Cobham.
Wilson, Nean E., Longniddry.

Wong, Hon Chung, Hong Kong.
Wong, King Suen, Hong Kong.
Wong, Ming Chu Constance, Hong Kong.
Wong, Waikiu, Hong Kong.
Wong, Yin Wah Ziggy, Hong Kong.
Woodham, Sharon, Birmingham.
Wright, Michael J., Watford.
Wright, Wendy E., Ontario, Canada.
Wu, Haiou, Wuhan, China.
Wu, Mei Wan, Harlow.
Yamamoto, Keiko, Otsu City, Japan.
Yau, Wai Ling Janet, Hong Kong.
Yen, Weixuan, Wuhan, China.
Yoheswaran-Poulin, Vinodhini S., Bangkok, Thailand.
Yoo, Ok Hee Han, Bangkok, Thailand.
Young, Roy T., Dunedin, New Zealand.
Yu, Sum Pui, Hong Kong.
Zander, Marie-Claire M., Sao Paulo, Brazil.
Zeeman, Walentin, Bunnik, The Netherlands.
Zhang, Fan, Wuhan, China.
Zhang, Liang Ju, Wuhan, China.
Zhang, Youxu, Wuhan, China.
Zoeter, Johannes S., Rotterdam, The Netherlands.

EXECUTIVE COMMITTEE MEETING

At a meeting of the Executive Committee held on 15 November 1989 at Saint Dunstan's House, the business transacted included the election to membership of the following:

Fellowship

Adams, Jacqueline E., London. 1989
Athanassopoulos, Joanna D.E., Athens, Greece. 1989
Bieri, Joisane, Athens, Greece. 1989
Bowis, Mark L., London. 1989
Boyadjian, Liza A., London. 1989
Brantly, Rhona, Rio de Janeiro, Brazil. 1989
Brown, Naomi A., Willowdale, Canada. 1989
Carroll, Patricia E., Kowloon Hong Kong. 1989
Chan, Linda A.Y., Hong Kong. 1989
Chan, Mazie M.W., Stanley, Hong Kong. 1989
Chan, Yoke L., North Point, Hong Kong. 1989
Chiu, Fung Mei Janis, Hong Kong. 1989
Chiu, Yuk Lan Rafia, Hong Kong. 1989
Chow, Kevin Kar Wai, Hong Kong. 1989
Chow, Rita Yuen-Ching, Hong Kong. 1989
Clover, Wai Ying, Hong Kong. 1989
Collins, Jessica M., London. 1989
Dwyer, Katherine, Oregon House, Calif., USA. 1989
Edwards, Jennifer L., Hong Kong. 1989
Farzan, Ali Reza, London. 1989
Frampton, James J.M., London. 1989
Fung, Eleanor S.W.A., N. Vancouver, Canada. 1989
Fung, Kam Man, Hong Kong. 1989
Gellini, Delio, Harrogate. 1989
Gould, Jean, H.I., London. 1989
Ho, Kar Fai Patrick, North Point, Hong Kong. 1989
Jackson, A.V. Mark, Birmingham. 1989 Keerthi, Koku H.U.J., Kelaniya, Sri Lanka. 1989
Keusch, Shohred, Hong Kong. 1989
Keys, Malcolm, Manchester. 1989
Lee, Sheung Wah, Kowloon, Hong Kong. 1989
Lehtinen, Kirsi, Helsinki, Finland. 1989
Levin, Igor, Thornhill, Canada. 1989
Lindqvist, Thérese, Stockholm, Sweden. 1989
Ling, Lai C. A., Kowloon, Hong Kong. 1989
Mak, Yim M., Windsor, Canada. 1989
Medlicott (née Taylor), Sarah J.W., Birmingham. 1989
More, Deepak K., Hong Kong. 1989
Morris, David C., Dover. 1989
Nakao, Kimitoshi, Osaka, Japan. 1989
Ng, Ai Moi, Hong Kong. 1989
Osborne, Sean J., Pimlico, London. 1989
Osmond, Catherine, Bangkok, Thailand. 1989
Page, Christopher D., Newmarket. 1989
Pak Ching-Yuen, Bernard, Pokfulam, Hong Kong. 1989
Park, Stephen W., Romford. 1983
Pattni, Minakshi, Stanmore. 1989
Pfeiffer, Brigitte C.E., London. 1989
Pfister, Hans, Zurich, Switzerland. 1989
Puviharan, Mylvaganam, Colombo, Sri Lanka. 1989
Richardson, Cathryn, Silsden. 1989
Roberts, Kate, South Harrow. 1989
Ruff, Agnes, Realty Gardens, Hong Kong. 1989
Ruusunen, Petri S., Kiukainen, Finland. 1989
Scott, Kenneth MacDonald, Carluke. 1989
Seaton, Johanna L., Kowloon, Hong Kong. 1989
Seifert, Jannice L., Hong Kong. 1989
Singh, Runbir, North Point,ong Kong. 1989
Stanton, Zoe, Andreas, Isle of Man. 1989
Styles, Suzanne S., Romford. 1983
Sutton, Susan A., Cotton, Nr Stowmarket. 1989
Tielinen, Tarja H., Ylijarvi, Finland. 1989
Tielinen, Teuvo K., Ylijarvi, Finland. 1989
Tse. Kwok F.M., Kowloon, Hong Kong. 1989
Van Der Klauw, Angela V., Utrecht, The Netherlands. 1989
Vataru, Monica, London. 1989
Wat, Wanda Hoi-Chi, Wanchai, Hong Kong. 1989
Worthington, Sally L., Sowerby Bridge. 1989
Yeung, Chan Siu Ling, Kowloon, Hong Kong. 1989
Yoo, Ok Hee Han, Bangkok, Thailand. 1989
Yount, Henrietta S., Atlanta, GA, USA. 1989
Zanardi-Landi, Sabina, Rome, Italy. 1989

Transfers from Ordinary Membership to Fellowship

Andrews, Fern, London. 1989
Bourdillon, Catriona C.C., London. 1989
Cox, Vann S., Bedford. 1989
D'Alessandro, Martha A., Houston, Tex., USA. 1989
Edie, Tong Wai Man Annie, Brighton. 1989
George, Wanda M., Nairobi, Kenya. 1989
Girardi, Josephine C., Hong Kong. 1989
Hamid Hossen, Iqbal, London. 1989
Hirst, Jenny E., London. 1989
Howard, David, Preston. 1989
Hughes, David J., Cardiff. 1989
Jarvis, Hilary A., London. 1989
Komai, Rie, Saitama Pref., Japan. 1989
Law, Patricia M., Cambridge. 1989
Leddicoat, Andrew, Guiseley. 1989
Lewis, Karen J., Shatin, Hong Kong. 1989
Lewis, Richard D.F., Epsom. 1989
Lilly, Gregory R., Taranaki, New Zealand. 1989
Lockie, Debra L., Auckland, New Zealand. 1989
McIlwraith, Philomena M., Chorley. 1989
McKenna, Joseph T., London. 1989
Mackinnon (née Pring), Amanda L., Birmingham. 1989
Murray, Robert A., London. 1989
Nakamura, Chiyo, Hokkaido, Japan. 1989
Ozaki, Keiko, Hyogo Pref., Japan. 1989
Pedersen, Gunhild R., Nattland, Norway. 1989
Petrides, Eugene P., London. 1989
Plumb, Helen L., London. 1989
Ravindran, Muhaluxmy, Victoria, Australia. 1989
Schaetzle-Parisod, Arlette, Kaiseraugst, Switzerland. 1989
Shimoda, Tetsuhiro, Fukuoka Pref., Japan. 1989
Stanley, Sylvia, Clearwater Bay, Hong Kong. 1989
Tachibana, Hirogi, Osaka, Japan. 1989
Tayara, Mona D., Outremont, Canada. 1989
Vildiridis, Athanassios N., Thessaloniki, Greece. 1989
Wiborg-Jenssen, Nellie, Tunbridge Wells. 1989
Yim, Tae Young, Tokyo, Japan. 1989
Yuill, Martin J., Lanark. 1989

Ordinary Membership

Bellamy, Michelle L., Swansea.
Bendel, Helle, Sao Paulo, Brazil.
Bubshait, Ahmed I., Bahrain.
Cangardel, Linda, London.
Carbray, Marianne E., Maidenhead.
Connor, Arthur, London.
Degaiffier, Edmond, Washington DC, USA.
Dugmore, Andrea M., Northland, New Zealand.
George, Kenneth P., Boothstown.
Grant, Miranda J., Edinburgh.
Jurukov, Vasil, London.
Laklia, Andrew T., Greenhithe.
Lang, Bernhard, Basle, Switzerland.
Ling, Chock S., Singapore.
Lycouris, Anna M., Esher.
Mitchell, John O., London.
Nicolaidis, Nicholas, Harare, Zimbabwe.
Nillegoda, Lakshman N., Colombo, Sri Lanka.
Patel, Jagdish I., London.
Scott, Sarah L., Norwich.
Shepherd, Genevieve R., York.
Stock, Robert G., Kidderminster.
Wakefield, Melanie K., Horsham.
Wear, William F., Northallerton.

EXAMINATIONS 1990

The examination dates for 1990 are as follows:

Gem Diamond Examination:
Theory – Monday 4 June
Practical – Monday 4 June and Monday 11 June.

Examinations in Gemmology:
Preliminary – Tuesday 26 June
Diploma Theory – Wednesday 27 June
Diploma Practical – Tuesday 26 June and Thursday 28 June.

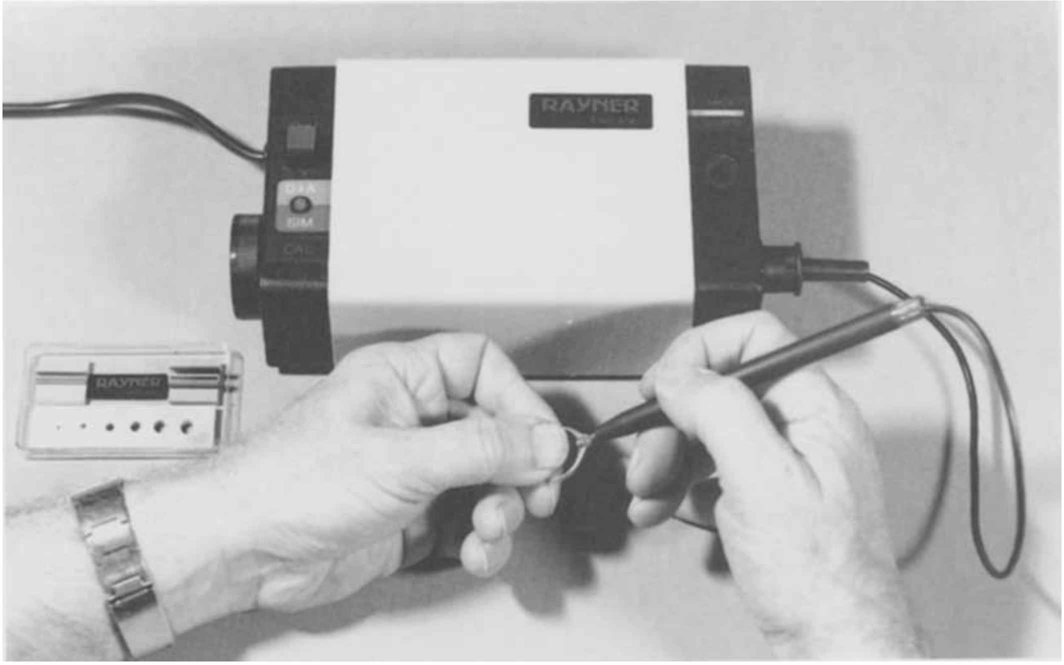
The final date for receiving examination entry forms is **31 March.**

NEW INSTRUMENTS FROM THE ASSOCIATION

The Association has launched three new products – a diamond tester, a mini gem testing kit, and a gem and jewellery loupe.

The **Rayner Diamond Tester Mk 4** is a unit for the positive and rapid identification of diamond by means of its high thermal conductivity. The detachable probe of the Mk 4 tester is fitted with a spring-loaded tip which will stand up to vigorous use. The visual diamond/simulant indicator is a two-colour LED lamp that flashes red when the unit detects the poor thermal conductivity of a simulant, and green when it identifies a diamond. As a further aid to rapid testing, the visual indication is reinforced by a buzzer which operates when the high thermal conductivity of a diamond is detected.

The unit is also fitted with a sensitivity control which enables its calibration to be maintained over a wide range of ambient temperatures. A metal heat sink is provided, for use when checking an unmounted gem, plus two plastic clips for use with shank-mounted stones. The tester can be supplied



The Rayner Diamond Tester Mk 4.

for use on either 220/240 volt or 110 volt supplies and costs £195.00 plus VAT and postage.

The new portable mini **Gem Testing Kit**, designed for the professional jeweller and valuer, is supplied in a rigid lightweight moulded carry case. It consists of an illuminated dialdex refractometer (mains or battery powered), with polarizing and wide-angle filters and a hand-held polariscope. The kit also has a battery operated scopelight with OPL diffraction grating spectroscope, Zeiss 10x loupe, Chelsea colour filter, Moe diamond gauge, a calcite dichroscope and a pair of stone tongs. The price of the mini-laboratory is £560.00 plus VAT and postage.

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To obtain a catalogue and price list of instruments or to place an order for the new products contact the **Gemmological Association of Great Britain, Saint Dunstan's House, Carey Lane, London EC2V 8AB. Phone: 01-726 4374. Fax: 01-726 4837.** Payment can be made by the major credit/charge cards.

The mini gem testing kit.

CORRIGENDUM

In *Journal of Gemmology*, **21**, 7, p. 404, right-hand column, line 14, for 'Schneider and Bank, 1980' read 'Schmetzer and Bank, 1980'

Letter to the Editor

From Philip A. Sadler

Dear Sir,

May I be permitted to use the columns of the *Journal* to express my thanks to Dr Hänni and his colleagues in Switzerland. I am sure the *Journal's* readers noticed not only the article by Dr Hänni on iridescent glasses but also the spectacular cover of the October '89 issue showing this resplendent gem.

Acting through Ken Scarratt, I made contact with Dr Hänni over a minor query concerning his paper. Immediately a specimen was dispatched and I found my doubts laid to rest and agreeing with Dr Hänni's observations. But perhaps most importantly, it allowed about 30 British gemmologists to see the iridescent effect for themselves and to appreciate the quality of the work needed to produce the article.

For the fortunate few who were able to see the effect it makes Henry Hänni's contribution more memorable and of greater interest than for those who were not so lucky.

Yours etc.,
P.A. Sadler

14 December 1989
MPFS Laboratory, London SE1 7LP.

ADVERTISING IN THE JOURNAL OF GEMMOLOGY

The Editors of the *Journal* invite advertisements from gemstone and mineral dealers, scientific instrument makers, publishers and others with interests in the gemmological, mineralogical, lapidary and jewellery fields.

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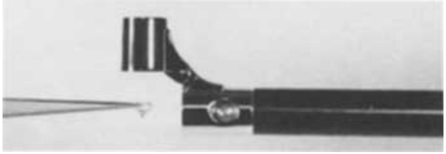

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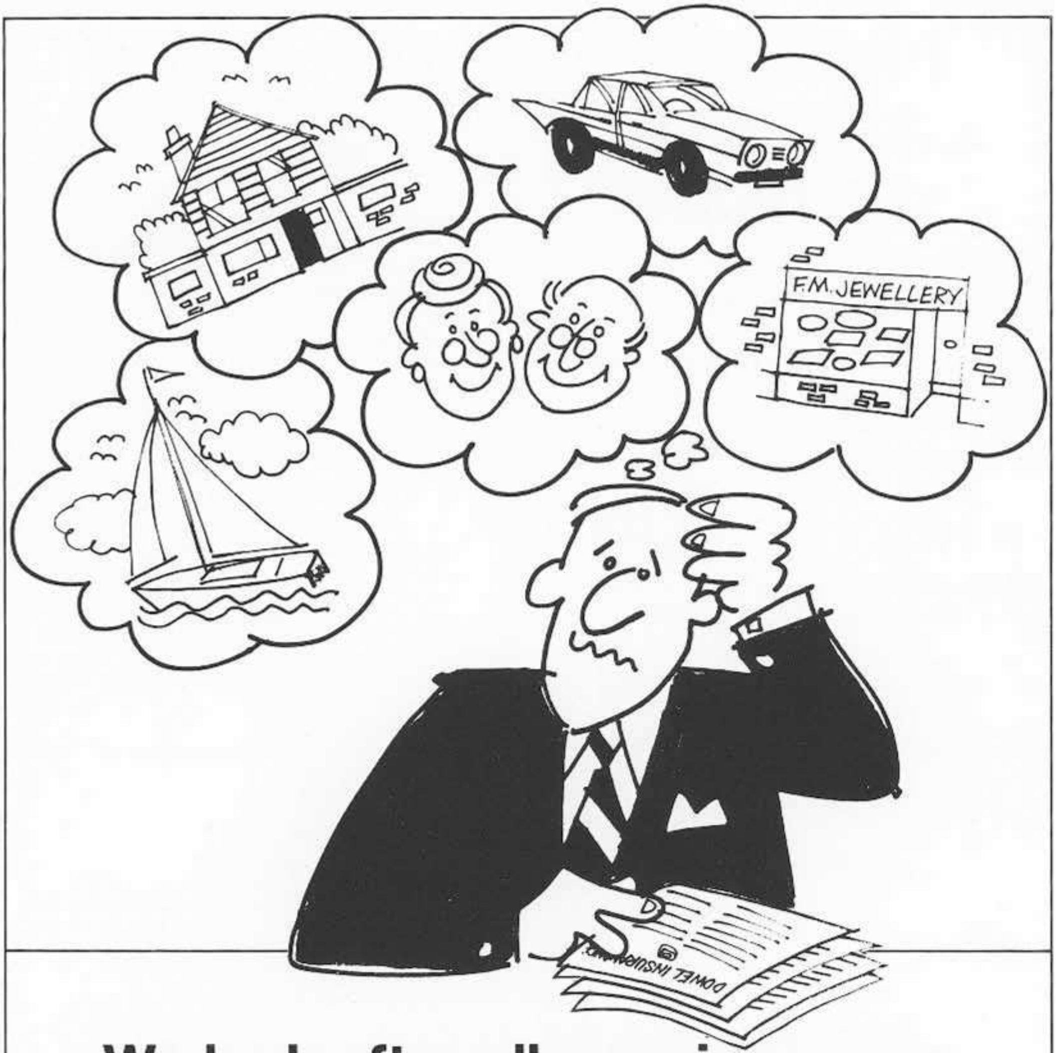

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GEMMOLOGICAL ASSOCIATION OF GREAT BRITAIN

The Arms and Crest of the Association, conferred by a grant of Arms made by the Kings of Arms under royal authority. The cross is a variation of that in the Arms of the National Association of Goldsmiths of Great Britain and Ireland. In the middle is a gold jewelled book representing the study of gemmology and the examination work of the Association. Above it is a top plan of a rose-cut diamond inside a ring, suggesting the scrutiny of gems by magnification under a lens. The lozenges represent uncut octahedra and the gem-set ring indicates the use of gems in ornamentation. The lynx of the crest at the top was credited, in ancient times, with being able to see through opaque substances. He represents the lapidary and the student scrutinizing every aspect of gemmology. In the paws is one of the oldest heraldic emblems, an escarbuncle, to represent a very brilliant jewel, usually a ruby. The radiating arms suggest light diffused by the escarbuncle and their tips are shown as jewels representing the colours of the spectrum.

Historical Note

The Gemmological Association of Great Britain was originally founded in 1908 as the Education Committee of the National Association of Goldsmiths and reconstituted in 1931 as the Gemmological Association. Its name was extended to Gemmological Association of Great Britain in 1938, and finally in 1944 it was incorporated in that name under the Companies Acts as a company limited by guarantee (registered in England, no. 433063).

Affiliated Associations are the Gemmological Association of Australia, the Canadian Gemmological Association, the Gem and Mineral Society of Zimbabwe, the Gemmological Association of Hong Kong, the Gemmological Association of South Africa and the Singapore Gemologist Society.

The *Journal of Gemmology* was first published by the Association in 1947. It is a quarterly, published in January, April, July, and October each year, and is issued free to Fellows and Members of the Association. Opinions expressed by authors are not necessarily endorsed by the Association.

Notes for Contributors

The Editors are 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 Editors.

Papers should be submitted in duplicate on A4 paper. They should be typed with double line spacing with ample margins of at least 25mm all round. 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. A short abstract of 50–100 words should be provided. 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.

Twenty five copies of individual papers are provided on request free of charge; additional copies may be supplied, but they must be ordered at first proof stage or earlier.

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The Journal of
Gemmology

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