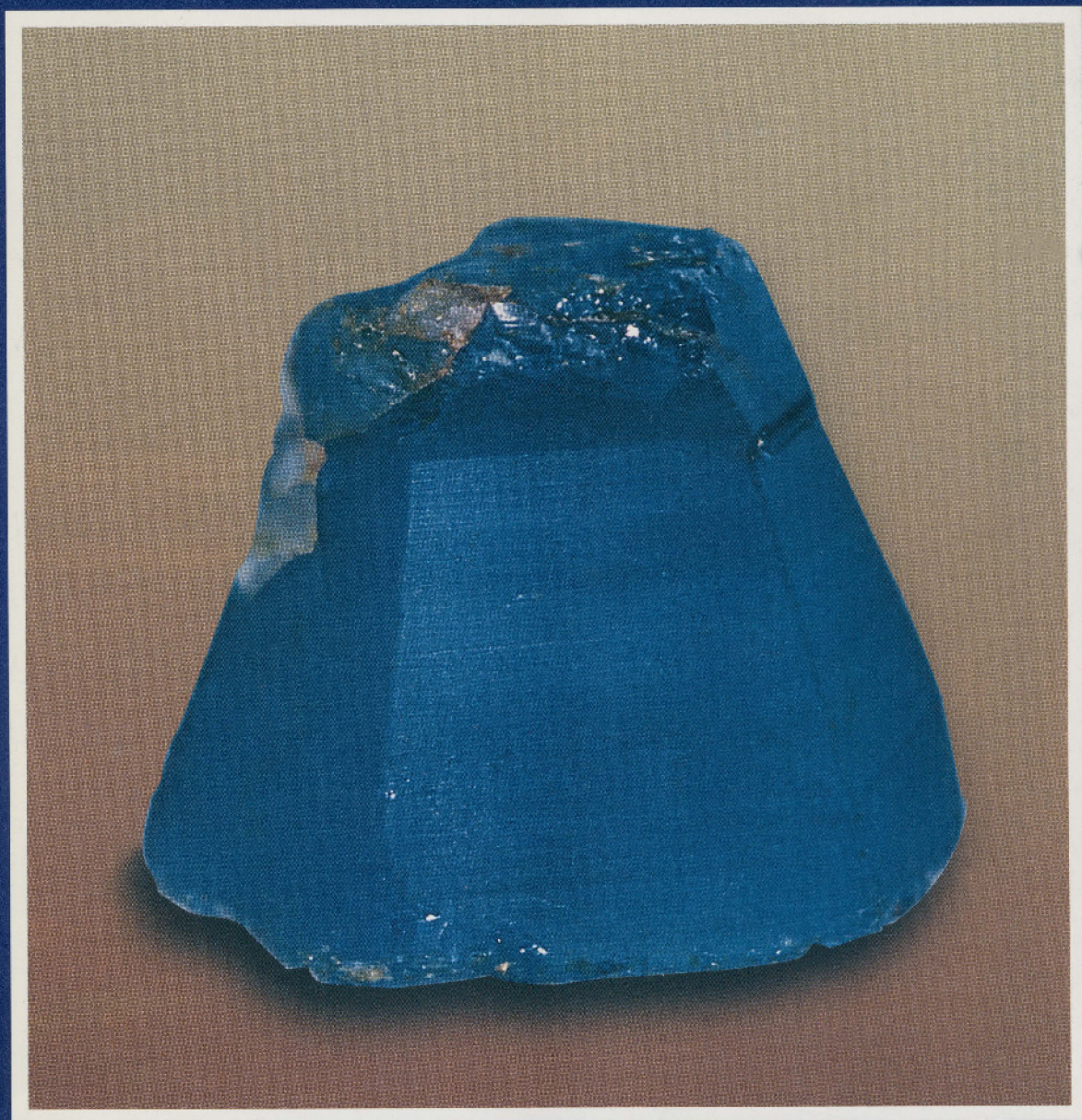


Volume 24 No. 8.

October 1995



# The Journal of Gemmology



The Gemmological Association and  
Gem Testing Laboratory of Great Britain



**President**  
E.M. Bruton

**Vice-Presidents**  
A.E. Farn, D.G. Kent, R.K. Mitchell

**Honorary Fellows**  
R.T. Liddicoat Jnr., E. Miles, K. Nassau, E.A. Thomson

**Honorary Life Members**  
D.J. Callaghan, E.A. Jobbins

**Council of Management**  
C.R. Cavey, T.J. Davidson, N.W. Deeks, E.C. Emms,  
R.R. Harding, I. Thomson, V.P. Watson

**Members' Council**  
A.J. Allnutt, P.J.E. Daly, P. Dwyer-Hickey,  
R. Fuller, B. Jackson, J. Kessler, G. Monnickendam,  
L. Music, J.B. Nelson, K. Penton, P.G. Read, I. Roberts,  
R. Shepherd, R. Velden, C.H. Winter

**Branch Chairmen**  
Midlands: J.W. Porter  
North West: I. Knight

**Examiners**

A.J. Allnutt, M.Sc., Ph.D., FGA	L. Bartlett, B.Sc., M.Phil., FGA, DGA
E.M. Bruton, FGA, DGA	C.R. Cavey, FGA
S. Coelho, B.Sc., FGA, DGA	A.T. Collins, B.Sc., Ph.D.
B. Jackson, FGA,	E.A. Jobbins, B.Sc., C.Eng., FIMM, FGA
G.H. Jones, B.Sc., Ph.D., FGA	D.G. Kent, FGA
R.D. Ross, B.Sc., FGA	P. Sadler, B.Sc., FGS, FGA, DGA
E. Stern, FGA, DGA	Prof. I. Sunagawa, D.Sc.
M. Tilley, GG, FGA	C. Woodward, B.Sc., FGA, DGA

**The Gemmological Association and Gem Testing Laboratory of Great Britain**  
27 Greville Street, London EC1N 8SU  
Telephone: 071-404 3334 Fax: 071-404 8843

---

# The Journal of Gemmology

VOLUME 24

NUMBER 8 OCTOBER 1995

## Editor

Dr R.R. Harding

## Production Editor

M.A. Burland

## Assistant Editors

M.J. O'Donoghue

P.G. Read

## Associate Editors

S.M. Anderson	London	Dr C.E.S. Arps	Leiden
G. Bosshart	Lucerne	Dr A.T. Collins	London
Dr J.W. Harris	Glasgow	Prof. R.A. Howie	Derbyshire
Dr J.M. Ogden	Cambridge	Dr J.E. Shigley	Santa Monica
Prof. D.C. Smith	Paris	E. Stern	London
Prof. I. Sunagawa	Tokyo	Dr M. Superchi	Milan
C.M. Woodward	London		

Any opinions expressed in *The Journal of Gemmology* are understood to be the views of the contributors and not necessarily of the publishers.

## Cover Picture

Burmese sapphire crystal weighing 502 ct, unearthed in 1994 at Khabine, near Gwebin, in Burma's Mogok Stone Tract. (See *Burmese sapphire giants*, p. 551)

*Photo by U Khin Mg Win*

ISSN: 1355-4565

## In this issue...

---

This issue completes volume 24 of the *Journal* in which 43 original papers from 58 authors in 21 countries have been published. Five hundred abstracts and 99 book reviews have also appeared and together these figures offer a convincing testimony to the expanding activity across the whole spectrum of gemmology. The papers in the *Journal* have ranged from a comprehensive review of gems from Myanmar to origin determination for cut gemstones, and from historical gemmology in Afghanistan, Sri Lanka or the UK to the criteria for distinguishing natural from synthetic diamond.

In this issue Dr Gübelin discusses a synthesis of recent practical study and theoretical ideas of pearl formation, reviewing the current position and indicating a possible sequence of formation not involving a grain of sand! This paper is followed by a comprehensive description of the nephrite jade produced at Chuncheon, Korea, since 1976.

As East Africa continues to yield more gems from different localities, thirteen gem species are recorded here as stars or cat's-eyes. Their properties are listed and the variety of inclusions, including those responsible for optical effects are described. As yet the region has not yielded a corundum crystal large enough to be included in the list of sapphire giants discussed in the Burmese sapphire paper. But with verified occurrences of large corundums in the Transvaal perhaps it is only a matter of time and recognition.

The world of materials science is of growing influence in the gem market and if it is not laser development or space

research that is generating new and interesting crystals, it is some other branch of activity such as those concerned with insulators or fibre optics. The latest challenge to the gemmologist's testing skills reportedly comes from the chimney of a kiln used in paint manufacture, and the zincite which condensed on the chimney walls is now on the market in a range of yellow and orange crystals and cut stones. Features are described which should enable its rapid identification.

The final form of each of these papers and indeed of most of the contributions in this volume owes a great deal to the expertise and wisdom of the Associate Editors. With their constructive comments and pertinent advice they have contributed significantly to the value of the papers; it is a privilege to have their support. A brief look at the initials following an abstract or book review will remind readers of the dedicated hard work put in by a wide range of experts, and among those who supply such a readable source of condensed information I would particularly like to record our appreciation of the efforts of Michael O'Donoghue, Evelyne Stern, Peter Read, Professor Bob Howie and Reg Peace.

Papers for the new volume are already in preparation and will include important contributions on rubies, emeralds and collectors' gems. Plans are in hand for further improvements in the design of the *Journal* and we would welcome your comments on these or any other matters gemmological.

R.R.H.

# An attempt to explain the instigation of the formation of the natural pearl

E.J. Gübelin

Lucerne, Switzerland

## Abstract

Biological research discloses that the instigation of the formation of a natural pearl is based upon the excrescence of epithelial cells which, while accumulating and slowly forming a pearl bag, secrete substances to create pearl and shell in the same succession. During this process the organic substance 'conchin' is continuously secreted to wrap the inorganic crystals of calcite and aragonite as a sponge embraces its voids. There is no evidence of a sand grain being the original stimulus of the formation of the natural pearl.

**Keywords:** Epithelium, nacre, periostracum, protein.

## Introduction

The following article is based upon studies carried out in Germany between the two world wars, but not continued later, and first published by F. Haas (1931). The pearl is the most perfect of all jewels nature presents us with. Other than gemstones, which are caused to sparkle and shine only by the artistic styles of cut, the pearl does not require the help of human hands to obtain its fullest beauty. Already in its original form, the pearl is of accomplished splendour. In the same form as it is extracted from the mollusc – noble, promising and enigmatic – it is mounted onto a ring or strung onto a necklace, together with its sisters.

Where the play of water, the rise and fall of the waves, the teasing to and fro of the sunbeams, the roaring of the riverbed and the quiet trickle of sand on the bottom of the sea stir up everlasting motion – there lies the cradle of the pearl – the Aphrodite gift of the water.

Many legends have been spun about the origin of the pearl. The least romantic but most persistent yarn about its formation is that a sand grain is the instigator of the pearl's formation. This is as erroneous as another story nurtured by Christopher Columbus that during his third voyage, when he circumnavigated the island of Trinidad, one morning during low tide, he observed open shells lying among the roots of the mangrove trees. He thought that pearls were dew drops which had fallen off the mangrove leaves into the open shells where they 'crystallized', but of course we know that this idea is fantasy.

## The anatomy of the mollusc and the formation of the shell

If one considers how the mollusc develops its shell, it is possible to understand how difficult it would be for a grain of sand to enter between the shell and the mantle. Figure 1 depicts a longitudinal cross section of an adult mollusc. The centre consists of the animal's body and three muscular wings on each side, of which the outer one is the 'mantle'. The mantle is coated on the inner and outer side by a thin skin of epithelium, which has its origin in the mantle's fold, situated immediately below and inside the lip of the

shell, whether the latter is tiny or large. From this fold two different types of epithelia wrap as a mono-cell layer all over the inside and outside of the mantle. On the mantle's inner surface is the endoderm, a passive mono-layered skin whose purpose it is to protect the inner side of the mantle. The outer monolayer is the active 'ectoderm', whose task it is to build up the shell. It covers the mantle from the fold to the hinge of the shell and from its cells the shell-forming substances are secreted in three subsequent phases (Figure 2).

The shell is composed of three layers of different substances: the first layer, the periostracum, consists of a dark leathery, protective matter composed of the organic substance conchiolin ( $C_{32}H_{48}O_{11}$ ) whose correct biological term is now 'conchin'. It is a scleroprotein of the keratin type. The second layer of the shell is inorganic and is made up of oriented prismatic columns of crystalline calcium carbonate ( $CaCO_3$ ), usually in the form of calcite. The prisms of this layer are perpendicular to the inner side of the periostracum. The correct name for this layer is the prismatic layer or 'calcite primer'. The third and innermost layer forms the internal surface of the shell. It is normally secreted by the entire length and width of the ectoderm epithelium and it increases during the entire span of the animal's life. This layer also consists of calcium carbonate ( $CaCO_3$ ), but is the orthorhombic form 'aragonite'. The aragonite layer accumulates by crystallization of a large number of flakes and forms the smooth iridescent inside of the shell called 'nacre' or 'mother of pearl'. The principal axis of these flakes or platy crystals is orientated parallel to the *c*-axis of the calcite prisms, or in other words at right angles to the inner shell surface. Being the third and innermost part of the shell the nacre lies in direct contact with the secreting monocell ectoderm (Hänni, 1982).

During growth of the mollusc and its shell from its tiniest shape as a spat and from its hinge towards its rim, the

youngest epithelial cells at the tip of the mantle secrete the periostracum (forming the outside of the shell), while the oldest are responsible for forming the aragonite (nacre) which lines the inside of the shell. In other words, the product of the epithelium changes with the latter's age from conchin via calcite to aragonite. This has been vaguely known for a long time, but only recently has it been precisely defined and explained by Gutmannsbauer (1992).

The switch from the prismatic calcite layer to the tabular aragonite nacre was investigated and explained by Fritz *et al.* (1994), in their description of biofabrication of highly organic composite flat pearls on synthetic materials, which they had inserted into abalone molluscs. Nevertheless, they did not gain knowledge of the nature of this process. They postulate a dynamic relationship at the cell-mineral interface in which cell recognition of the inorganic surface governs the genetic reversal controlling the structure of the new mineral (aragonite). This results first in the precipitation of a prismatic calcite layer succeeded by the tabular aragonite crystals.

Along its rim the shell is directly connected to the ectoderm – not only during the continued growth of the shell, but as long as the mollusc is alive. Consequently, the boundary between the ectoderm and the nacre has no gaps, and no passive substance, such as a sand grain, withered plant matter or dead animals can penetrate this region (Gübelin, 1987) unless forced by some external agency. It is possible that certain adhesive barnacles might drill a hole through the shell and thus irritate the ectoderm, which would react by secreting the three shell substances in the aforementioned sequence. In most cases the mollusc would be killed by the barnacle. However, an irritation caused by a barnacle is relatively rare and does not normally result in the formation of a baroque or spherical pearl, but rather in the attached so-called 'blister pearl'. The possible devastating

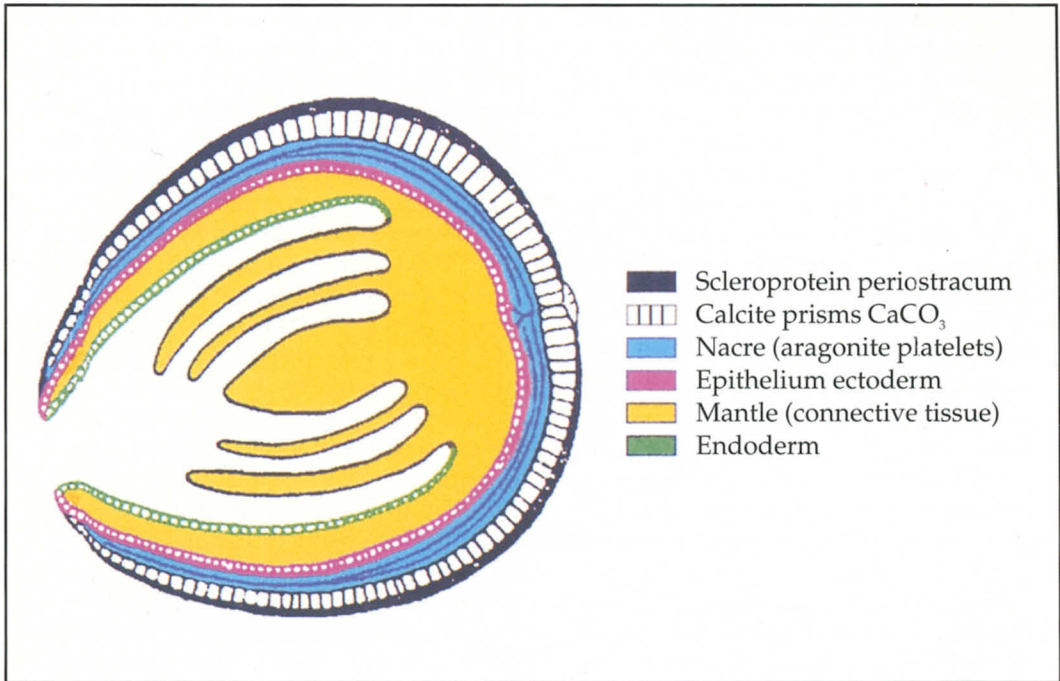


Fig. 1. A longitudinal cross section of an adult mollusc.

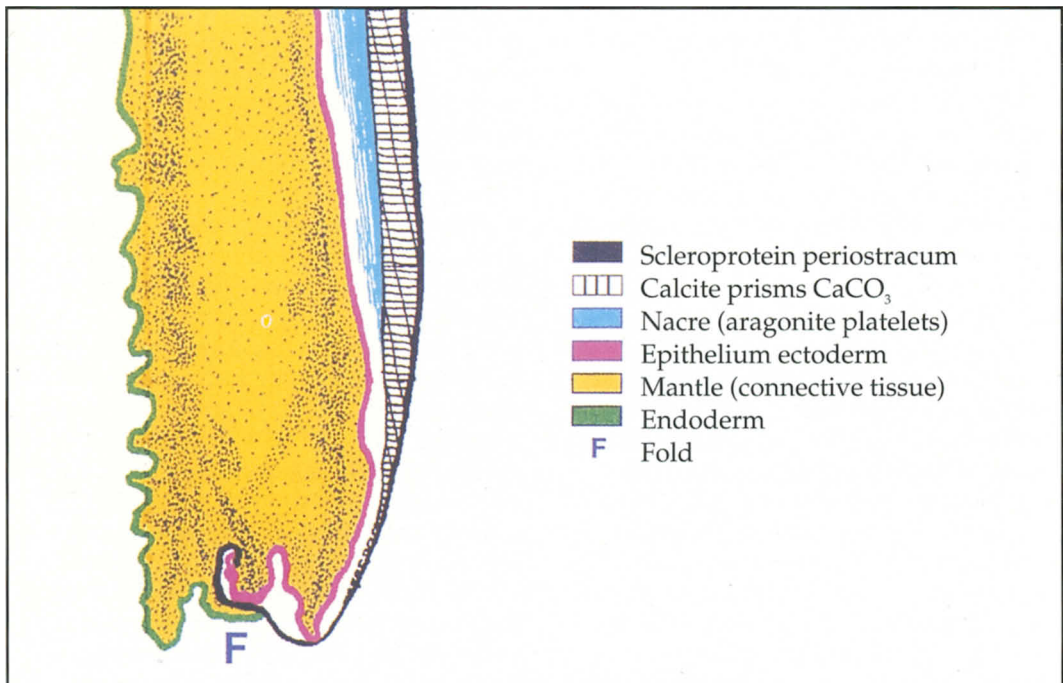


Fig. 2. Detail of the growth pattern of cells from the mantle fold.

action of barnacles however is well known to the cultivators of cultured pearls and is the reason why the molluscs used for cultivating pearls must be cleaned regularly while suspended in wire baskets from the rafts. The risk of obtaining a baroque, blister or freak pearl is the reason why the nucleus is implanted into a gonad of the Akoya bivalve by the cultivators instead of inserting it between the ectoderm and the shell.

In the pearl as well as in the shell, the inorganic elements (i.e. the calcite prisms as well as the aragonite platelets) are 'cemented' together by very thin films of conchin which forms a kind of mortar (Gutmannsbauer *et al.*, 1994). They call the conchin 'periostracum' (while the author of the present article limits this term to the conchin covering the outermost surface of the shell), whereas to the conchin 'scaffoldings', mortaring the inorganic carbonate crystals together, they give the name 'matrix'. The author of the present article likes to compare the conchin wrapping the carbonate crystals to a sponge, in the voids of which the calcite prisms and the aragonite platelets are embedded.

The effect of this sponge-like scleroprotein is to prevent the aragonite from lining the inner side of the shell as one large sheet-like crystal of aragonite, but rather to limit its size to innumerable tiny platelets.

### **The instigation of the formation of the natural pearl**

All previous opinions published seem to agree about the stimulation of the natural pearl as a consequence of an intruded sand grain which somehow had penetrated the region between the shell and the shell-building ectoderm. The possibility of passive transfer of pieces of epithelium, or of the so-called 'yellow particles' (hardened grains of conchin) into the connective tissue of the mantle as growth nuclei for pearls has also been discussed.

Biological studies have revealed another possible cause of exciting epithelial cells;

this is in the form of an excrescence, a kind of epithelial tumour resulting either from some injury or arising from a natural stimulus (benign tumour). The repeated permanent development of such benign tumours within the epithelium seems to be a genetic heritage of some species of marine molluscs and freshwater mussels.

Biologists still do not seem to know the precise cause whereby the ectoderm cells form monolayered tumours at certain places, although the molecular mechanisms of the process are known in principle. Very recent research has revealed that certain proteins bonding guanylnucleotides – called G-proteins – play a central role as converters, multipliers and messengers of signals. Disturbances of the normal functions of G-proteins are directly connected with diseases such as cholera and some forms of cancer (Brunner, 1994). The excrescences of the ectoderm cells can therefore be interpreted as a kind of benign cancer, and it may be feasible that ectoderm cells receive signals from G-proteins to excresce. Also nobody seems to have asked the question why these benign tumours expand as monolayers instead of accumulating clusters of cells. Modern laboratory experiments with tissue cultivation may yield the answer.

According to observations on the mechanisms of formation of the monolayered tumour, the substratum – i.e. the connective mantle tissue, upon which the ectoderm as well as the tumour cells spread – is essential in that it exerts an attractive, positively chemotactic stimulus upon the epithelial cells. This was perceived in the course of cultivation experiments. The two different tissues (mantle and epithelium) seem to act as competitors and force their own cells as well as the cells of the other tissue to differentiate in a manner characteristic of each tissue. Mono-cultivation causes proliferation, while mixed cultivation leads to a differentiation of the cells. Differentiation



is exactly what happens between the epithelium and the mantle tissue. The epithelial cells do not, therefore, form clumps, but on account of the competition from the mantle tissue, the epithelial cells can only multiply as a one-layered skin. The presence of the underlying tissue, mostly of mesodermal origin – as in our case the mantle tissue – exerts such an attractive positively chemotactic and stimulating influence upon the epithelial cells that these cannot help arranging themselves and settle with their bases upon the mantle tissue as a monolayered skin. Consequently, in view of the regularly flat, tabular shape of the individual ectoderm cells, the evenly arranged one-layered epithelium must spread on and over the outer surface of the mantle tissue.

**The encystation of the natural pearl**

Hence, while proliferating rampantly, the epithelial cells cannot form random accumulations of irregularly stacked cells,

but are forced by nature to align themselves side by side to expand as a monocell layer over its substratum. The epithelial cells, however, cannot spread towards the hard shell, but must do so in the direction of the soft mantle tissue (see Figure 3a). As a result of continuous multiplication of the excrescent cells the original depression deepens into the connective tissue of the soft mantle, slowly forming a kind of bag – the so-called ‘pearl bag’, (see Figure 3b). Following nature’s tendency to favour shapes with the largest volume but smallest surface – and simultaneously assisted by the accrescent pearl, the pearl bag, under ideal conditions, assumes the shape of a sphere which in biological terms is called a ‘blastula’ (see Figure 3c). The pearl itself consists of exactly the same substances as the shell and forms also in precisely the same sequence: first, conchin is secreted in a smaller or larger quantity by the excrescent ectoderm cells. This ‘embryo’ of a natural pearl is usually

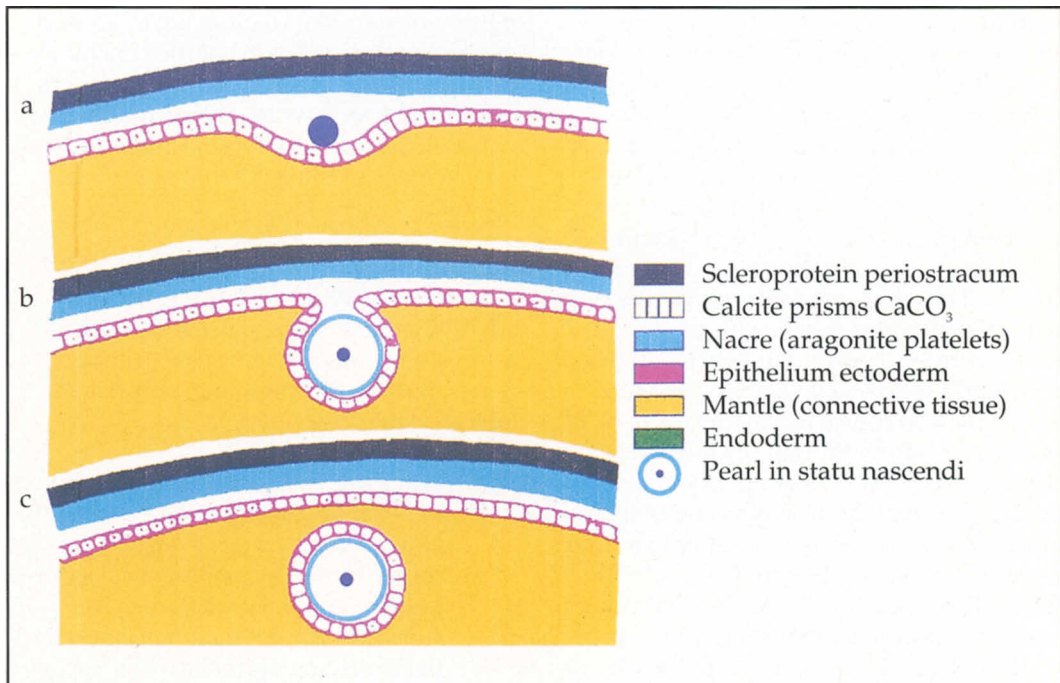


Fig. 3. The encystation of the natural pearl.

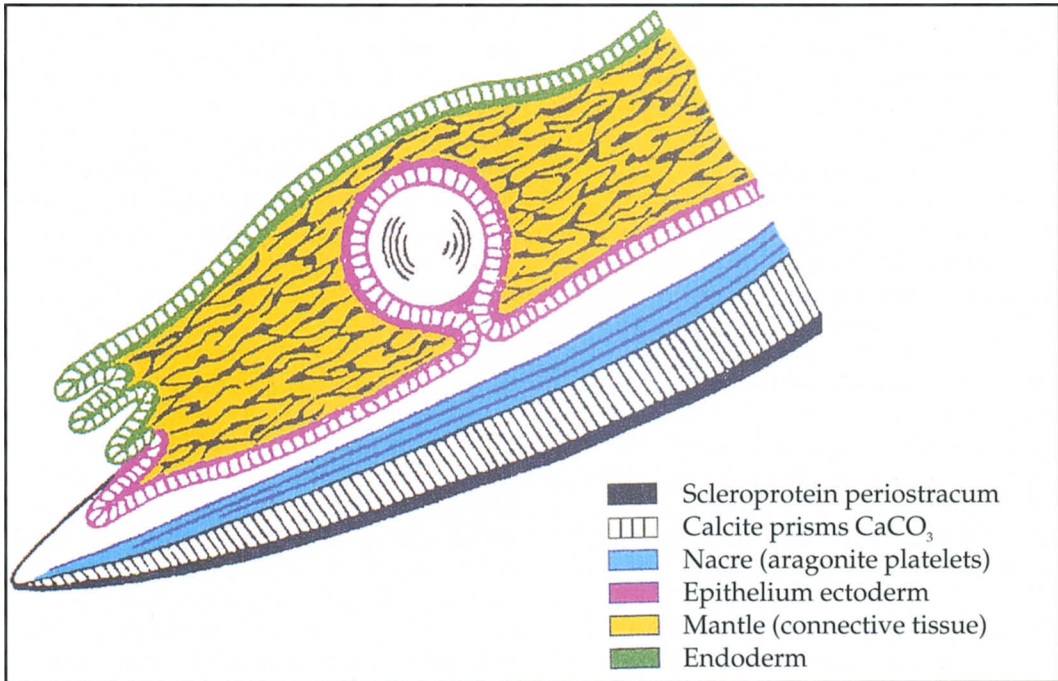


Fig. 4. The ideal result of the instigation of the natural pearl is a spherical product consisting of the three shell substances conchium, calcite primer and aragonite nacre.

extremely tiny and commonly not even visible by X-rays. Pearls containing a relatively large centre of conchium are called 'blue pearls' in the trade, and in X-ray shadowgraphs their centre appears darker than the surrounding body of the natural pearl. This 'core' is then overgrown by layers of prismatic calcite, which themselves are covered by layers of aragonite (nacre). However, the formation of the natural pearl does not take place as an uninterrupted, continuous process in that concentric spherical layers are deposited which may be compared to the layers of an onion, but rather through the intermittent deposits in the form of small calottes or skull caps which quite commonly overlap one another. This seems to testify to a regional activity of the ectoderm cells depending upon their age. The results may easily be observed when examining the walls of the drillhole of a natural pearl. These walls reveal an irregular, successive

pattern of step-like semicircles, enhanced by the interlayered skins of the conchium. Yet, sometimes there are aragonite layers on natural pearls which may envelope the entire surface due to the simultaneous and total activity of the epithelial cells of the blastula.

### Summary

In summarizing, we may now acknowledge that the natural pearl is the astonishing result of various natural processes, partly still enigmatic, occurring in logical sequences:

- (a) first a secret signal seems to be given to certain ectoderm cells – maybe by G-proteins – to start excrescence;
- (b) on account of a chemotactical, competitive correlation between the substratum – the mantle tissue – and the overlying epithelial cells, the latter do not form clumps but

expand as a monolayer, first forming an indentation in the mantle and later deepening and widening into a pearl bag;

- (c) while multiplying, the epithelial cells secrete shell substances in exactly the same sequence in the pearl as in the shell, and in both, the inorganic components (calcite prisms and aragonite platelets) are wrapped by ultra-thin films of the scleroprotein conchin.

The author has based this article partly on actual experimentations and partly on theoretical reflections. Yet, until it is possible to film the actual process of pearl formation, we must depend upon this combination of practical experience and hypothesis to advance our understanding

of one of the mysteries of nature.

### References

- Brunner, J., 1994. G-Proteine: Zelluläre Umwandler, Verstärker und Übermittler von Signalen. *NZZ*, Nr. 286, p. 45
- Fritz, M., 1994. Flat pearls from biofabrication of organized composites on inorganic substrates. *Nature*, 371(6492), 49-51
- Gübelin, E., 1987. Origin of natural pearls. *Lapidary Journal*, 1987, 4
- Gutmanssbauer, W., 1992. *Morphologische, strukturelle und chemische Untersuchungen an Perlmutter und Perlen einiger perlenbildender Muscheln*. Diplomarbeit, Mineralogisch-Petrographisches Institut der Universität Basel
- Gutmanssbauer, W., and Hänni, H.A., 1994. Structural and chemical investigation on shells and pearls of nacre forming salt-and fresh-water bivalve molluscs. *Journal of Gemmology*, 1994, 24, 4
- Haas, F., 1931. *Bau und Bildung der Perlen*, Akadem. Verlagsgesellschaft mbH, Leipzig
- Hänni, H.A., 1982. Perlendiagnose mit Laue-Aufnahmen. *Zeitschrift der Deutschen Gemmologischen Gesellschaft.*, 3, 131-42
- Rutland, E.H., 1971. The constituents of the pearl. *Journal of Gemmology*, 12, 6



## Gemmological Association and Gem Testing Laboratory of Great Britain

\* Gem Tutorial Centre \*



### YOUR GAGTL HOME STUDY RE-TAKE PROGRAMME

This re-take programme provides you with a second chance to gain your Diploma in Gemmology by continuing with the help of your correspondence tutor.

*You will be issued with a new set of homework assignments*

*Preliminary retake: £385.00*

*Diploma retake: £515.00*

Start whenever you like - all examinations are available twice a year in January and June. Fee includes an appointed correspondence tutor for a maximum period of two years for each part of the course, and examination fees.

*Telephone 0171-404-3334 or Fax 0171-404-8843 and ask us for latest information and details or write to GAGTL, 27 Greville Street, London EC1N 8SU*

# SHINDLER LOUPE



- Estimates weight of diamonds set in jewellery
- Indicates the size/weight ratio of diamonds in the 0.01-5.00ct range allowing instant evaluation of set stones
- In handy case with full instructions
- Now with spare scale

**£39.00 plus VAT, postage and packing**

Remember your membership number for your 10% discount.

**Gemmological Instruments Limited**

◆ SECOND FLOOR, 27 GREVILLE STREET (SAFFRON HILL ENTRANCE), LONDON EC1N 8SU ◆

Tel: 0171-404 3334

Fax: 0171-404 8843

## Nephrite from Chuncheon, Korea

*Won-Sa Kim, FGA, Ph.D.*

Department of Geology, Chungnam National University, Taejon 305-764, Korea

### Abstract

Nephrite from Chuncheon, Korea, and traded under the name 'Chuncheon Ok' (meaning Chuncheon jade) or 'Baek Ok' (meaning white jade) has been produced since 1976. The high-quality nephrite is monomineralic consisting almost entirely of tremolite, whereas the poor-quality nephrite is polymineralic, containing small amounts of diopside, calcite and chlorite. Gemmological properties and electron microprobe analyses of the nephrite are given.

**Keywords:** Nephrite, Chuncheon jade, Korea jade, nephrite jade, Baek Ok

### Introduction

Nephrite jade has been produced since 1976 from the Chuncheon area, north east of Seoul, in the Province of Kangwondo, which is in the central part of the Korean peninsula (in some atlases the name is spelt Ch'unch'on). Annual production of the nephrite mine (the Daeil Mine) is reported to be approximately 80 000–90 000kg. The nephrite has been fashioned mainly as rings, beads, bracelets, tabs, cabochons, brooches, drop earrings and carvings (Figure 1).



Fig. 1. Fashioned nephrite jade from Chuncheon, Korea. Bracelets, a string of prayer beads (top), curved ornaments for crowns, rings, and buttons (bottom).

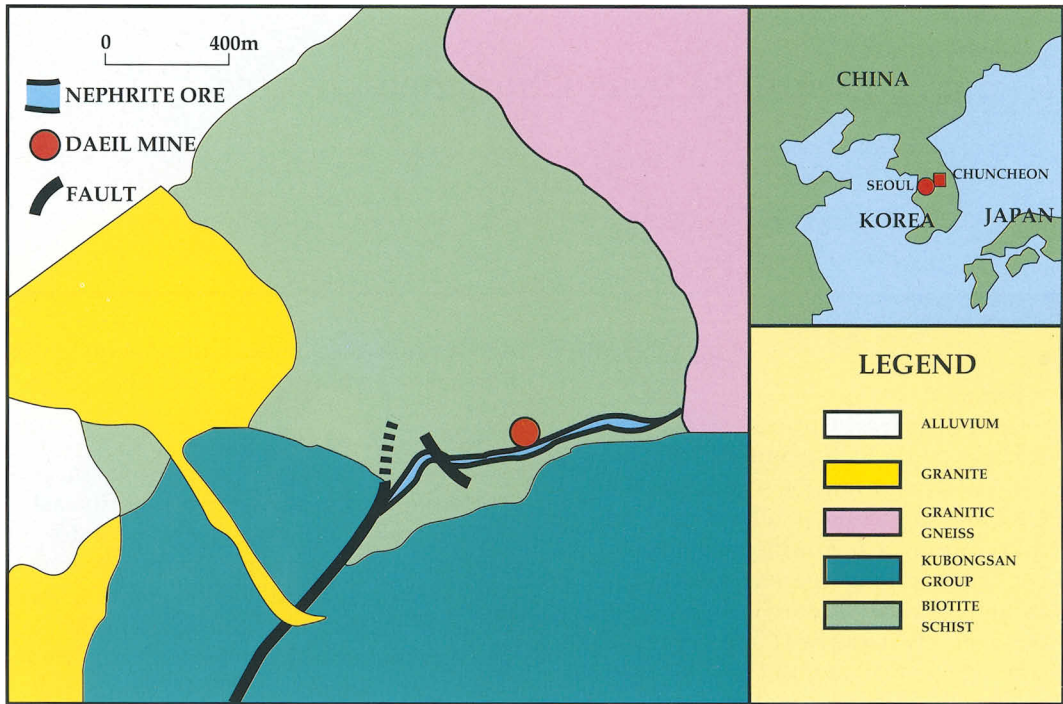


Fig. 2. Geological map of nephrite mine area, Chuncheon, Korea.

### Occurrences

The geology of the nephrite mine area consists largely of Precambrian biotite schist (Youngduri Complex), amphibolite, limestone and quartzite (Kubongsan Group), granitic gneiss of unknown age and Jurassic granite (Figure 2). Nephrite has developed along the contact between the dolomitic marble lens and the enclosing biotite schist (Figure 3), and attains a maximum thickness of 3m with a confirmed extension of 1km at the surface. Investigations using polarizing microscopy, X-ray diffraction and electron microprobe analysis are reported also by Kim *et al.*, 1986; Noh *et al.*, 1993; see also Park *et al.*, 1974.

### Gemmological properties

#### *Colour, diaphaneity and lustre*

The Chuncheon nephrite varies in colour from greenish-white and pale yellowish-green to pale green. It is rarely deep green.

Colour distribution is quite uniform and the material is translucent. It shows a resinous or waxy lustre. Very recently, nephrite dyed green has appeared on the market.

#### *Mineral composition of nephrite*

Under a polarizing microscope, the pure (high-quality) nephrite is found to consist essentially of tremolite in the form of aggregates of minute fibres (Figure 4).

Tremolite aggregates are sometimes bounded by rounded or rhombic outlines, most clearly seen in plane polarized light, indicating that tremolite was formed by alteration of pre-existing diopside and calcite (Figure 5). However, impure (low-quality) nephrite is polymineralic, containing small amounts of calcite, diopside and chlorite in the nephrite matrix. All the mineral constituents described above were identified by X-ray diffraction analysis as well as from thin section observations. Depending upon the

Fig. 3.  
Mine workers remove nephrite ore at the Daeil Mine, Chuncheon, Korea. The nephrite ore develops along the contact between the dolomite marble bed and the enclosing biotite schist.



amounts of accessory minerals present in the nephrite matrix, refractive indices, specific gravity and hardness may vary slightly.

It should be emphasized that the so-called 'Korean jade', referring to serpentine material, should not be confused with the Chuncheon jade.

#### *Refractive indices*

Owing to the aggregated nature of the microscopically small tremolite crystals, only a single reading of about 1.62 can be obtained on a standard gemmological refractometer.

#### *Hardness and toughness*

The hardness is measured at 6-6½ on Mohs' scale. Due to the felted nature of the crystal aggregates, it is extremely tough.

#### *Specific gravity*

The specific gravity determined by the hydrostatic weighing technique ranges from 2.96 to 3.01.

#### *Absorption spectrum*

No distinctive absorption spectrum is displayed by the natural nephrite. However, some nephrite dyed green shows a marked absorption band at 630 - 650nm.

#### *Ultraviolet luminescence*

The nephrite shows no luminescence under ultraviolet light.

#### *Chemical composition*

The general chemical formula  $\text{Ca}_2(\text{Mg}, \text{Fe})_5(\text{Si}_4\text{O}_{11})_2(\text{OH})_2$  is assigned to the tremolite-actinolite solid solution series. Electron microprobe analyses of four nephrite specimens (Table I) each with slightly different colours show that all lie in the tremolite composition range. It is generally believed that a deepening of the green colour in nephrite is attributable to an increase in the amount of ferrous iron present. Although the Fe/Mg ratio for each analysis, 0.0178(1), 0.0167(2), 0.0196(3) and 0.0221(4), appears to be consistent with this assumption, it should be remembered that the iron contents shown in Table I are values calculated on the

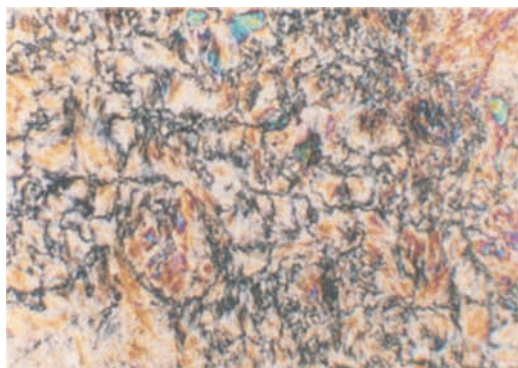


Fig. 4. Thin section photomicrograph of Chuncheon nephrite, Korea. It is made up of fibrous aggregates of tremolite. Crossed polars. x20.



Fig. 5. The same Chuncheon nephrite as Fig. 4, but taken under plane polarized light. Crystal shapes of pre-existing diopside, now replaced by tremolite, are visible. x20.

**Table I. Electron microprobe analyses of nephrite from Chuncheon, Korea.**

Wt % oxide	1	2	3	4
SiO <sub>2</sub>	57.62	57.54	57.76	56.98
MgO	24.11	23.26	24.38	23.06
CaO	13.10	13.42	13.34	13.29
Al <sub>2</sub> O <sub>3</sub>	0.54	0.61	0.68	0.59
FeO	0.43	0.39	0.48	0.51
MnO	0.08	0.12	0.08	0.10
Na <sub>2</sub> O	0.03	0.07	0.09	0.06
K <sub>2</sub> O	0.03	0.05	0.01	0.03
TiO <sub>2</sub>	0.01	0.02	0.03	0.01
Total	95.95	95.48	96.85	94.63

1. greenish-white
2. pale yellowish-green
3. pale green
4. pale green

assumption that all the iron present in the mineral exists in the ferrous state. This may not be so and the iron values reported in the Table may also represent some iron in the ferric state.

### Acknowledgements

I thank the Daeil Mine for allowing access to the mine. Thanks are also due to S.E. Lee, Y.W. Lee, J.Y. Lee and K.H. Kim, who assisted the author during field work. I am indebted to an anonymous referee for providing useful comments that improved the manuscript. Financial support was given by the Center for Mineral Resources Research and the Basic Science Research Institute Program (BSRI 95-5418), Ministry of Education of Korea.

### References

- Kim, S.J., Lee, D.J. and Chang, S.W., 1986. A mineralogical and gemmological characterization of the Korea jade from Chuncheon, Korea. *Journal of Geological Society of Korea*, **22**, 3, 278-88
- Noh, J.W., Yu, J.Y. and Choi, J.B., 1993. Genesis of nephrite and associated calc-silicate minerals in the Chuncheon area. *Journal of Geological Society of Korea*, **29**, 3, 199-224
- Park, H.I., Chang, K.H., Ji, J.M. and Ko, I.S., 1974. *The geological map of Naepyeong sheet*. Geological Survey of Korea



## Burmese sapphire giants

Richard W. Hughes\* and U Hla Win\*\*

\* 4894 Briar Ridge Court, Boulder, CO 80301-3980, USA

\*\* No. 724, 1st Floor, Merchant St., Yangon, Myanmar

### Abstract

The Mogok area of Myanmar (Burma) has long been noted for producing some of the world's finest blue sapphires. Burmese sapphire mining is reviewed, along with some of the most important blue sapphires from Burma, particularly those of large size. Mention is also made of some giant corundum crystals from other localities. The article contains sections based upon eyewitness accounts and discussions with some of Mogok's long-time gem dealers.

**Keywords:** Burma, Myanmar, Mogok, sapphire, large gems, corundum, precious stones

### Introduction to Burmese sapphires

Although it is rubies for which Burma is famous, some of the world's finest blue sapphires are also mined in the Mogok area. Today the world gem trade recognizes the quality of Burmese sapphires, but this was not always the case. Edwin Streeter (1892) described Burmese sapphires as being overly dark. Unfortunately this error was later repeated by Max Bauer and others. G. Herbert Smith wrote:

While the Burma ruby is famed throughout the world as the finest of its kind the Burma sapphire has been ignominiously, but unjustly, dismissed as of poor quality. In actual fact nowhere in the world are such superb sapphires produced as in Burma.

G.F. Herbert Smith, *Gemstones*, 1972

While this statement must be qualified by adding that the finest Kashmir sapphires are in a class by themselves, those from Burma are also magnificent. J. Coggin Brown (1955) said:

It has been stated that Burmese sapphires as a whole are usually too dark for general approval, but this is quite incorrect; next to the Kashmir sapphires they are unsurpassed. Speaking generally, Ceylon sapphires are too light and Siamese sapphires too dark, and it is more than probable that many of the best 'Ceylon' stones first saw the light of day from the mountainsides of the Mogok Stone Tract.

J. Coggin Brown and A.K. Dey,  
*India's mineral wealth*, 1955

Not all Burma sapphires are deep in colour. The best display a rich, intense, slightly violetish blue, but some are quite light, similar to those from Sri Lanka. The key difference between Burma and Sri Lankan sapphires is saturation, with those from Burma possessing much more colour in the stone. Colour banding, so prominent in Ceylon stones, may be entirely absent in Burma sapphires.

### Burmese sapphires

Although rubies are found with much greater frequency at Mogok (rubies form about 80-90 per cent of the total output), sapphires may reach larger sizes. Cut gems of over 100 carats are not unknown. Large fine star sapphires are also found at Mogok, in addition to star rubies. Near

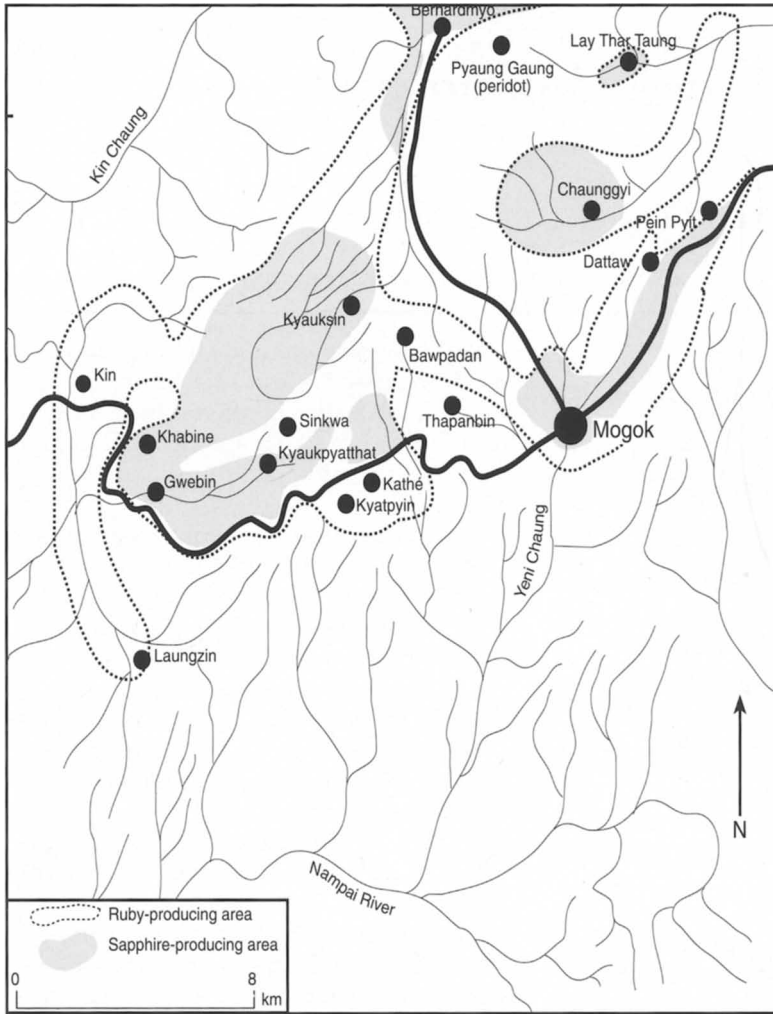


Fig. 1. Map of the sapphire-producing regions of Burma's Mogok Stone Tract. (Modified from Halford-Watkins, 1935b).

Kabaing (Khabine), at Kin, is located a mine famous for star sapphires (see Figure 1).

The sapphires of Burma occur in intimate association with rubies in virtually all alluvial deposits throughout the Mogok area, but are found in quantity at only a few localities, particularly 8 miles (13 km) west of Mogok, near Kathé (Kathe). At Kyaungdwin, near Kathé, in 1926 a small pocket was discovered that yielded 'many thousand of pounds' [sterling] worth of magnificent sapphires within a few weeks' (Halford-Watkins, 1935b).

According to Halford-Watkins (1935b), the majority of fine sapphires were derived from the area between Ingaung and Gwebin. Sapphires have also been found near Bernardmyo.<sup>1</sup> According to Halford-Watkins (1935b):

Bernardmyo itself at one time produced large quantities of sapphires, many of which

1. The plateau of Bernardmyo was chosen by the first British expedition to Mogok as a suitable place for a sanatorium for British troops. It was thought that the climate was more suitable for Europeans and that eventually the place would develop into the Simla of Burma. Bernardmyo was Christened after the first British Chief Commissioner of Upper Burma, Sir Charles Bernard (G.S. Streeter, 1887, 1889).

## An interview with U Thu Daw

Longtime Mogok gem dealer, U Thu Daw, a contemporary of A.C.D. Pain (of *painite* fame), was interviewed by one of the authors (U Hla Win). The following are some of his edited comments on Burmese sapphires:

H Hla Win: 'Were there any big sapphires found in the pre- World War II days?'

U Thu Daw: 'Yes, including some famous stones. U Kyauk Lon from Gwebin village found one and sold it to Albert Ramsay for one lakh of kyats (US\$13,000). [Ramsay later named the 958ct giant the *Gem of the Jungle*.]'

UHW: 'Isn't he the one who was famous for star sapphires?'

UTD: 'Yes. U Shwe Hlaing of Zeyi found one which weighed over 100ct after cutting. I saw it with my own eyes and it was quite beautiful.'

UHW: 'How much did it sell for?'

UTD: 'U Shwe Hlaing did not sell it in Mogok. After attempting to sell the gem in England, it was eventually sold to U Shwe Kin, owner of Rangoon's Kwan Louk Hotel, for under one lakh kyats. U Shwe Kin reportedly later sold it in Hong Kong.'

UHW: 'Any other sapphires?'

UTD: 'Of course. U Kan from Ze Haung (Old Market) had one which weighed 1450ct. U Shwe Kin also bought this one, for 70,000 kyats. But this time he wasn't so lucky. I think he cut it on a Saturday, U Shwe Kin's brother took it to Hong Kong. He was killed in a train wreck there and the stone lost. It was a fine sapphire and might have fetched 10,000 kyats.'

UHW: 'Were there any famous sapphires in the post-war period?'

UTD: I did not notice much. The famous sapphire mines are Loke Khat (Kaday-kadar), Chaunggyi (north of Mogok) and Lay Thar Taung. At Lay Thar Taung, the brothers, U Thein and U Ba Thaw, made a successful sapphire mine. There were so many sapphires mined that they had to be moved by horses. Those brothers were so kind-hearted that those who came to buy sapphires were sold bucketfuls. Many got rich because of those brothers.'

UHW: 'Were the sapphires of good quality?'

UTD: 'They were Lay Thar Taung sapphires are famous in Mogok.'



Fig. 2. U Thu Daw of Mogok with his microscope formerly owned by A.C.D. Pain  
Photo by U Khin Mg Win

were of magnificent colour and quality, though a number were of a peculiar indigo shade, which appeared either very dark or an objectionable greenish tint by artificial light. During an extensive native mining rush to Bernardmyo in 1913 a number of these stones were placed on the London market.

Many of the stones found in this area were coated with a thin skin of almost opaque indigo colour which, on being ground off, revealed a centre sometimes of a fine gem quality, but in many cases of greenish shade. The method of occurrence was different from that anywhere else as the majority of stones were taken from a hard black iron-cemented conglomerate, which was found in layers a few inches thick, often only a few feet below the surface. This area now appears to be exhausted, and little mining is carried on there today except for peridots, which are abundant.

Another isolated local deposit which has

produced some fine sapphires occurs at Chaunggyi, four miles north of Mogok, and about a thousand feet higher.

As well as blue, sapphires also occur in violet, purple, colourless and yellow colours at Mogok. The violet and purple stones may be fine; yellows tend to be on the light side and are not common. Green sapphires are known, but rare.

#### Orientation of sapphire rough

While stones from localities such as Kyauk Pyat That retain their rich blue hue in various orientations, those from Chaunggyi and Painpyit take on a greenish tint when the *c*-axis is not exactly perpendicular to the table so correct orientation for cutting is important. Many Mogok dealers attribute this phenomenon to 'invisible black silk' and currently (1994) pay strict attention to locality when buying sapphire rough.



Fig. 3. Sapphire mine of U Mya Mg at Khabine, near Gwebin, Mogok, Burma. In February of 1994 this mine yielded the 502ct sapphire crystal in Figure 6. Photo by U Khin Mg Win.



Fig.4. Left: U Tun, one of the most prominent sapphire dealers in Mogok in colonial times. Right: U Thein, one of the brothers who mined sapphires at Lay Thar Taung. Photos by U Khin Mg Win, Mogok.

### Famous Burmese sapphires

S.M. Tagore in his classic work, *Mani-Málá* (1879), described several celebrated sapphires. One of these was a fabulous stone of 951ct, and was seen by an English ambassador to the Court of Ava (Burma). Tagore also mentions a curious custom among the Hindus of India. They were said to have a prejudice against sapphires, believing the blue gem to be the bringer of misfortune.

In consequence of this notion, some of them would invariably keep a stone on trial for several days before they would make final settlement with the sellers. Hence, perhaps, the paucity in the numbers of sapphires in their possession.

S.M. Tagore, *Mani-Málá*, 1879

One magnificent Gwebin gem was scratched up from just below the grass in 1929 by miners preparing a site for digging. Found by U Kyauk Lon, it was a water-worn, doubly-truncated pyramid weighing an incredible 958ct. Purchased for \$13,000 by Albert Ramsay, who dubbed it the *Gem of the Jungle*, the rough produced nine fine cut stones, weighing 66.53, 20.25, 20.00, 13.11, 12.25, 11.33, 11.11, 5.50 and 4.33ct. All stones were personally cut by Ramsay and were said to be of exceptional colour. A marvellous account of the purchase and cutting of the Gem of the Jungle was published in the *Saturday Evening Post* in 1934 (Ramsay and Sparkes, 1934).

About 1967, a 12.6kg (63,000 ct) crystal surfaced at Mogok. Today this sapphire colossus is on display at the Myanma Gems Enterprise (MGE) office. Like virtu-



Fig. 5. The 12.6kg sapphire giant owned by Myanmar Gems Enterprise. Note the large central piece which was removed in an attempt to see if gem material might lie within. Photos by U Khin Mg Win.

ally all giant specimens, it is far from gem quality. In order to see if something of gem quality might be lurking within, MGE staff disembowelled it with drill and saw. Alas, the interior was just as opaque as the skin (see Figure 5). While this piece is billed by MGE as the 'world's largest sapphire crystal', in fact a number of much larger specimens are known, including a 40.3kg crystal from Sri Lanka which contains gemmy portions (see Table II).

On 22 February 1994, a large sapphire of 502ct was unearthed at Khabine, about 2.4kms from Gwebin. The crystal is a single pyramid of rich blue colour, and slightly silky (see Figure 6).

Table I is a first attempt to catalogue some of the more famous Burmese sapphires. Criteria for listing include titled specimens, specimens large or fine enough to merit mention in newspaper/magazine

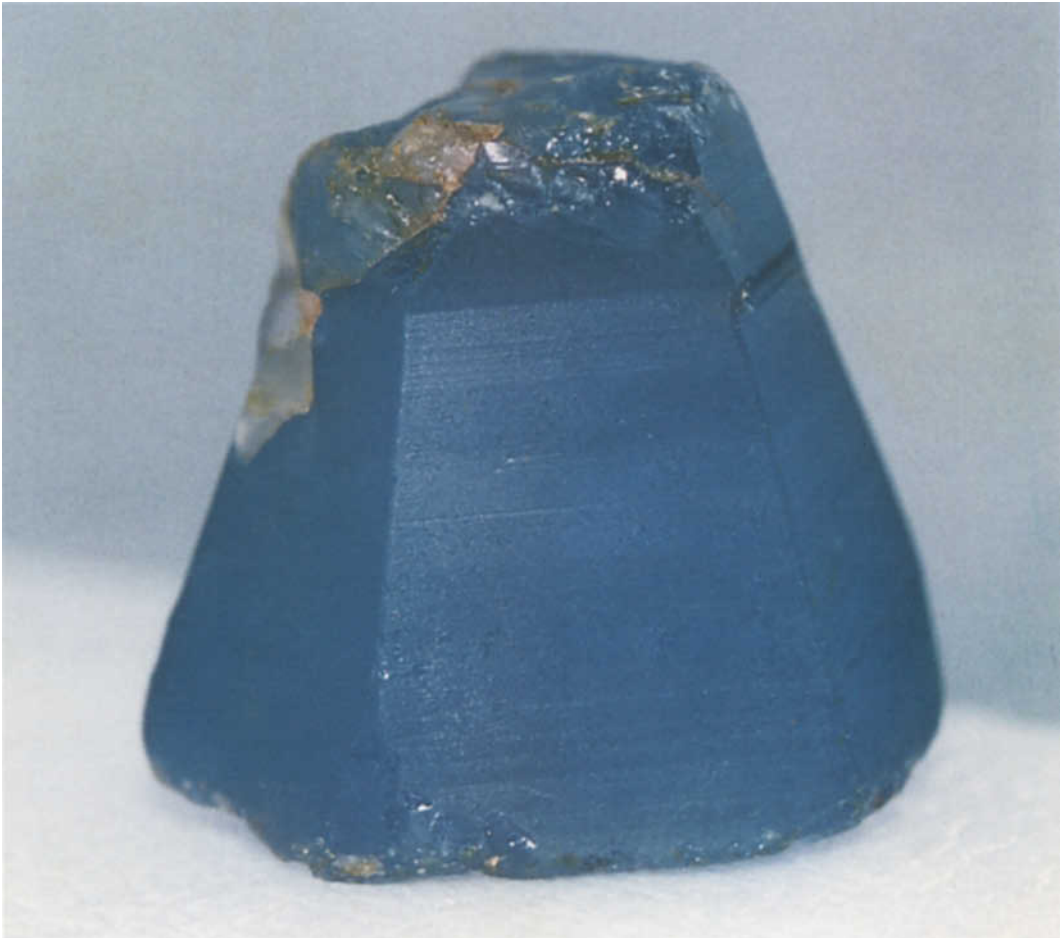
articles and those which have set auction records. Unfortunately, due to the secretive nature of the gem business, many fine specimens have never been publicly described. The authors would love to hear from readers with additional information.

#### Acknowledgements

U Hla Win would like to give thanks to U Thu Daw for educating him about Burmese sapphires and to U Khin Mg Win for the photographs.

Richard Hughes would like to thank Bob Frey, expert in various things Chinese and founding member of HAW HAW, who has gone above and beyond the call of duty in both editing and locating obscure references.

Fig. 6. Below: 502ct Burmese sapphire crystal. This was unearthed on 22 February 1994, at Khabine, near Gwebin, in Burma's Mogok Stone Tract. Right: the Base of the crystal, showing concentrations of silk. *Photos by U Khin Mg Win.*



**Table I: Summary of famous Burmese blue sapphires**

<i>Name, weight, description and sale price<sup>a</sup></i>	<i>Source &amp; date found</i>	<i>Current location</i>	<i>Reference</i>
<i>Ruspoli's Sapphire</i> ( ' Wooden spoon Seller's Sapphire' or ' Great Sapphire of Louis XIV' ) 135.8ct; faceted; rhomb shaped (only six facets); said to have been found by a wooden spoon seller in Bengal; sold by the House of Ruspoli (Rospoli?) of Rome to a German prince (salesman?), who in turn sold it to the French jeweller Perret for 170,000 francs. Later purchased by Louis XIV.	Said to be Bengal; probably Burma or Sri Lanka Date unknown	Muséum National D'Histoire Naturelle, Paris. Valued at 100,000 pounds in 1791	Tagore, 1879, 1881; Streeter, 1892; Bank, 1973; H.-J. Schubnel (pers. comm., 16 December 1994; 5 January 1995)
Unnamed 951 ct; rough or cut unknown; seen in 1827 in the treasury of the King of Ava	Unknown (Burma?) Date unknown	Unknown	Smith, 1913
Unnamed Rough, weight unknown; sold for Rs28,000 (£1,870)	Redhill Mine Mogok, Burma, 1917	Unknown	<i>Times of London</i> , 11 July 1917
Unnamed 113ct; rough; sold for Rs45,000	Bernardmyo, Mogok, Burma, 10 May 1919	Unknown	<i>Times of London</i> , 15 July 1919
Unnamed Weight unknown; rough; sold for Rs40,000	Mogok, Burma 1919	Unknown	<i>Times of London</i> , 15 July 1919
Unnamed 437ct; not stated whether rough or cut; valued at over £11,000	Mogok, Burma 1928	Unknown	<i>Mineral Industry</i> , 1929
<i>Gem of the Jungle</i> 958ct rough; cut stones of 66.50 (66.53?), 20.25, 20.00, 13.11, 12.25, 11.33, 11.11, 5.50 and 4.33ct; purchased by Albert Ramsay for over £13,000	Gwebin, Mogok, Burma August 1929 (or July 1930)	Unknown	<i>Mineral Industry</i> , 1930, 1931; Ramsay and Sparkes, 1934; Halford- Watkins, 1935a
<i>Star of Asia</i> 330ct; cabochon cut; blue-violet star sapphire; acquired in 1961 from Martin Ehrmann; once said to belong to the Maharajah of Jodhpur	Burma Date unknown	Smithsonian	Desautels, 1972; White, 1991
Unnamed 630ct rough (upon breaking up for cutting, it proved less valuable than expected)	Kathé, Mogok, Burma May 1930	Unknown	<i>Times of London</i> , 31 May 1930 <i>Mineral Industry</i> , 1930, 1932
Unnamed 293ct rough	Kathé, Mogok, Burma 1930	Unknown	Brown, 1933



**Table I: Summary of famous Burmese blue sapphires (continued)**

<i>Name, weight, description and sale price<sup>a</sup></i>	<i>Source &amp; date found</i>	<i>Current location</i>	<i>Reference</i>
Unnamed nearly 1000ct rough	Gwebin, Mogok, Burma 12 August 1932	Unknown	Brown 1933
Unnamed 514ct rough	Mogok, Burma December 1932	Unknown	Brown 1933
Unnamed star sapphire 435ct; not known whether rough or cut	Kathé, Mogok, Burma December 1932	Unknown	<i>Mineral Industry</i> , 1934
Unnamed 390ct; rough; sold for over £3,000	Mogok, Burma 1930s	Unknown	Halford-Watkins, 1935b
Unnamed about 99ct; faceted; round; offered for sale in Bangkok in early 1980s for \$10,000/ct	Burma Date unknown	Unknown	Author, R.W.H.
Unnamed 41.04ct; faceted; emerald-cut; sold at Sotheby's New York, October 1986 for \$924,000 (\$22,515/ct)	Burma Date unknown	Purchased by American retailer	Anonymous, 1986
<i>Rockefeller Sapphire</i> 62.02ct; faceted, rectangular step-cut; mounted in diamond ring; sold at Sotheby's St. Moritz, 20 February 1988, for \$2,828,546 (\$45,607/ct). <b>Per carat and total price world record for a single blue sapphire</b>	Burma Date unknown	Unknown	Hughes and Sersen, 1988; Matthews, 1993
Unnamed 4145ct; rough; offered for sale at 1993 Myanma Gems Enterprise Emporium (Lot 95; reserve price \$300,000)	Burma Date unknown	Unknown	Author, U H.W.
Unnamed 14,387ct; rough; offered for sale at 1993 Myanma Gems Enterprise Emporium (Lot 96; reserve price \$50,000)	Burma Date unknown	Unknown	Author, U H.W.
Unnamed 251.60ct; star cabochon; offered for sale at 1993 Myanma Gems Enterprise Emporium (Lot 165; reserve price \$300,000)	Burma Date unknown	Unknown	Author, U H.W.
Unnamed 502ct; rough, pyramid- shaped crystal, silky, of good colour	Kabaing, Mogok, Burma 22 February 1994	Unknown	Author, U H.W.

**Table II: Summary of rough corundum giants (not gem quality)**

<i>Name, weight, description and sale price<sup>a</sup></i>	<i>Source &amp; date found</i>	<i>Current location</i>	<i>Reference</i>
Unnamed 312lb (141.5kg; 707,500ct); opaque, red and blue crystal (not gem quality)	Franklin, NC Before 1882	Shepard Collection Amherst College, USA	Kunz, 1892
Unnamed Over 10lb (4.5kg); sapphire crystal	Mogok, Burma 1928	Unknown	<i>Mineral Industry</i> , 1929
Unnamed 335lb (152kg); hexagonal bipyramid crystal (not gem quality); 2ft 3in (68.58cm) in width. <b>This is the largest corundum crystal on record.</b>	Leydsdorp, Northern Transvaal, South Africa Date unknown	Geological Survey Museum, Pretoria, South Africa	Spencer, 1933 Anonymous, 1951
Unnamed 42lb (19kg); crystal said to be in the shape of the island of Sri Lanka	Sri Lanka Date unknown	American Museum of Natural History?	Anonymous, 1936 Wijesekera, 1980
Unnamed 136.5lb (61.92kg); crystal	18km from Santa Barbara, Minas Gerais, Brazil	Natural History Museum London	Personal communication
Unnamed 63,000 ct (12.6kg; 27.783lb); rough crystal, bluish-grey pyramid (not gem quality); 27 x 14.25 x 6.75 in (68.58 x 36.195 x 17.145 cm)	Mogok, Burma <i>ca.</i> 1967	Myanma Gems Enterprise, Burma	Anonymous, 1967
Unnamed 40.3kg; rough, doubly- terminated bipyramid crystal	Rakwana, Sri Lanka Date unknown	Unknown	Koivula and Kammerling, 1989
Unnamed 4.230ct; rough; bluish bipyramidal crystals, not gemmy	Lokekhet (‘Kadegadar’) Mogok, Burma September 1990	Myanma Gems Enterprise, Burma	<i>Working People’s Daily</i> , 5 February 1991 Clark, 1991, p. 68

<sup>a</sup> On 1 April 1914, the carat was standardized as 200 milligrams. Weights before that date are approximate only. All dollar prices in US dollars unless stated otherwise.

## References<sup>2</sup>

- Anonymous, 1936. Largest sapphire to be cut. *The Gemmologist*, 5, 58, 247, RWHL
- Anonymous, 1951. Famous sapphires. *The Gemmologist*, 20, 240, 165, RWHL
- Anonymous, 1967. Gemological digests: world’s largest star sapphire. *Gems & Gemology*, 12, 5, 158, RWHL
- Anonymous, 1986. Sotheby’s sets records with ruby and diamond. *Jewelers’ Circular-Keystone*, December, 75, RWHL\*
- Bank, H., 1973. *From the world of gemstones*. Trans. by E.H. Rutland, Pinguin-Verlag, Innsbruck, 178 pp, RWHL
- Brown, J.C., 1933. Ruby mining in Upper Burma. *Mining Magazine*, June, pp. 329-40, RWHL\*
- Brown, J.C. and Dey A.K., 1955. *India’s mineral wealth*. 2nd ed. Oxford University Press, Bombay, 761 pp, RWHL\*
- Clark, C., 1991. Burma Emporium: the ultimate treasure hunt. *JewelSiam*, 2, April/May, pp 58-71, RWHL
- Desautels, P.E., 1972. *Gems in the Smithsonian*. Smithsonian Institution Press, Washington, D.C., 63 pp, RWHL

- Halford-Watkins, J.F., 1935a. Burma sapphires - in defence of a much-abused name. *The Gemmologist*, 5, 50, September, pp 39-43, RWHL\*
- Halford-Watkins, J.F., 1935b. Burma sapphires - locations and characteristics. *The Gemmologist*, 5, 52, November, pp 89-98, RWHL\*
- Hughes, R.W. and Sersen, W.J. 1988. Bangkok gem market review. *Gemological Digest*, 2, 1 & 2, 20-2, RWHL
- Koivula, J.I. and Kammerling, R.C., 1989. Gem news: Huge, doubly-terminated sapphire crystal. *Gems and Gemology*, 25, 4, 247, RWHL
- Kunz, G.F. 1892. *Gems and precious stones of North America*. Reprinted by Dover, 1968 (367 pp), The Scientific Publishing Co., New York, 336 pp., RWHL
- Matthews, P., (ed.), 1993. *The Guinness Book of Records 1993*, Bantam Books, New York, 847pp., RWHL
- Mineral Industry, 1893-1942. Precious and semi-precious stones [famous gems]. In *The mineral industry, its statistics, technology and trade during ...*, Ed. by G.F. Kunz and G.A. Roush, McGraw-Hill, New York, 1924: pp. 579-82; 1929: pp. 532-4; 1930: pp. 549-50; 1931: pp. 524-5; 1932: pp. 478-9; 1934: pp. 508-9; 1935: p. 508; 1942: p. 483, RWHL
- Ramsay, A., and Sparkes, B., 1934. Bright jewels of the mine. *The Saturday Evening Post*, Parts 1-3, 15 Sept.: pp. 10-11, 65-66, 69; 29 Sept.: pp. 26, 28, 34, 36, 39; 20 Oct.: pp 26-27, 76, 78, 80; RWHL\*
- Smith, G.F.H., 1913. *Gem-stones and their distinctive characters*. Methuen & Co., London, 2nd edn (1st edn. 1912), 312 pp., RWHL\*
- Smith G.F.H., 1972. *Gemstones*. 14th edn, revised by F.C. Phillips, Chapman and Hall, London, 580pp., RWHL
- Spencer, L.J., 1933. Nation acquires large ruby. *The Gemmologist*, 2, 18, 176-8, RWHL
- Streeter, G.S., 1887. The ruby mines of Burma. *Journal of the Manchester Geographic Society*, No. 3, pp. 216-20, map, RWHL\*
- Streeter, G.S., 1889. The ruby mines of Burma. *Journal of the Society of Arts*, No. 37, 22 February, pp. 266-75; RWHL\*
- Streeter, E.W., 1892. *Precious stones and gems*. 5th edn, Bell, London, 355pp., RWHL\*
- Tagore, S.M., 1879, 1881. *Manji-Málá, or a Treatise on Gems*. I.C. Bose & Co., Calcutta, 2 vols, 1046pp, RWHL\*
- Times of London 1878-1933* [Important rubies and sapphires]. *The Times*, London, 1878, Dec. 20, p. 6d; 1880, 5 March, p. 7d; 6 March, p. 5e; 22 June, p. 10f; 11 Oct, p. 5b; 1885, Dec, 5, p. 5; 1886, March 17, p. 5; 1889, 1917, 11 July, p. 13c; 1918, July 10, 12e; 1919, July 15, p. 20a; Aug. 25, p. 9f; 1920, July 12, p. 22f; July 20, p. 20e; 1921, 23 June, p. 12c; 1924, 12 Nov, p. 11b, 11g, 3\*, 4\*; 1930, 31 May, p. 12e; 1931, 4 June, p. 13g; 1932, 27 April, p. 13g; 1933, 3 Feb., RWHL
- White, J.S., 1991. *The Smithsonian treasury: minerals and gems*. Smithsonian Institution Press, Washington, D.C., 96pp, RWHL
- Wijesekera, N., 1980. Gemstones of Sri Lanka. *Lapidary Journal*, pp. 1616-18, RWHL
- Working People's Daily*, 1991. SLORC Chairman Senior General Saw Maung inspects world's largest sapphire. *Working People's Daily*, Rangoon, 5 February.

<sup>‡</sup> RWHL = References contained in the personal library of Richard W. Hughes

\* = References of particular merit

## WORLD EDUCATION IN GEMS AND DIAMONDS

### Worldwide Allied Teaching Centres

Learn about precious stones and how to identify them - gain confidence to buy and advise  
Study diamonds and learn how they are graded - gain further insight and knowledge

### Home Study Correspondence Course

Personal tutor

Flexible study programme - start at any time

### Examinations

Held at centres throughout the world during January and June each year

For details apply to the Education Department, GAGTL,  
27 Greville Street, London EC1N 8SU

Telephone: 0171-404 3334 (international +44-171 404 3334)

Fax: 0171-404 8843 (international +44-171 404 8843)

# The centre of *Excellence...*

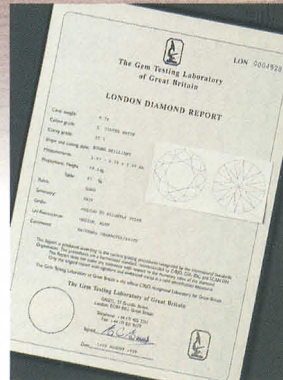
## ... for diamonds

The London Gem Testing Laboratory was founded in 1925 and from the start established a reputation for integrity and excellence.

Diamond grading services were established in 1980 and the Laboratory has built up an enviable international reputation for consistency and quality.

The London Diamond Report is based on the new harmonized system for grading colour and clarity of diamonds and gives the most essential and up-to-date information required by the trade.

The Laboratory is also proficient in the grading of fancy-cut diamonds and in colour origin determination.



**With a London Diamond Report your diamond's prestige is assured**



**The Gem Testing Laboratory**

GAGTL, 27 GREVILLE STREET,  
LONDON EC1N 8SU, UK

Tel: +44 (0) 171-405 3351

Fax: +44 (0) 171-831 9479

## An examination of 'serendipitous' synthetic zincite

Robert C. Kammerling, GG, CG, and Mary L. Johnson, Ph.D.

GIA Gem Trade Laboratory, Santa Monica, California, USA

### Abstract

This article describes the gemmological investigation of synthetic zincite from Poland. The material is reported to have formed as an accidental by-product of an industrial process.

**Keywords:** gem mineral, gemstone, mineral, synthetic, zincite.

### Introduction

A *mineral* may be defined as a naturally occurring, crystallized chemical element or compound having either a definite chemical composition or range in composition and usually formed as a product of inorganic processes (Hurlbut and Kammerling, 1991). When a mineral is deemed to be sufficiently attractive and durable to be used for personal adornment, it may be referred to as a *gem material*, with the fashioned product generally called a *gemstone*. (Sometimes minerals with the requisite beauty but lacking in durability are also fashioned and are sometimes referred to as *collectors' gemstones*.)

A *synthetic mineral* or *gemstone*, on the other hand, is an artificial or manufactured (that is, non-natural) product. Unlike imitations which merely resemble a natural gem, synthetic gemstones duplicate their natural counterpart's chemical composition and crystal structure (resulting in the same optical and physical properties) (Nassau, 1980; Hurlbut and Kammerling, 1991).

Some natural minerals are formed under somewhat exotic conditions, including fumaroles and volcanic vents (e.g. cotunnite and scacchite: Palache *et al.*, 1951); in guano deposits (struvite, which was first found in bat deposits in a church basement, and newberryite: Palache *et al.*, 1951; urea: Bridge, 1973); and in lichen colonies (moolooite: Chisholm *et al.*, 1987).

Isolated synthetic crystals or crystal aggregates may also form in artificial environments. However, in the absence of other considerations, these are not considered minerals (and, by extension, would not qualify in fashioned form as natural gemstones). For example, both mullite and brownmillerite crystals form in ceramics, but until they were found in natural environments, were not considered minerals (Bowen, 1924; Johnson *et al.*, 1994; Hentschel, 1964). Similarly, phases found only in weathered slags (e.g. barium sulphite, BaSO<sub>3</sub>; Braithwaite *et al.*, 1993) are not currently accepted as minerals (Jambor, 1994).

### Current study

In February 1995, while attending the many concurrent gem and mineral shows in Tucson, Arizona, USA, the authors encountered a considerable amount of synthetic zincite. (Small quantities had been noticed at the Tucson shows in previous years and have occasionally been submitted to the GIA Gem Trade Laboratory for examination, including material reported to be from Poland [Crowningshield, 1985].) Although the majority of this material was



Fig. 1. These crystals (95.85 and 179.65ct) are accidental by-products of an industrial kiln in Silesia, Poland. *Photo by Maha DeMaggio © GIA*



Fig. 2. These three gems (1.35 to 3.26ct), fashioned from single crystals of synthetic zincite, were the subjects of the current investigation. *Photo by Maha DeMaggio © GIA*

in the form of single crystals up to 15cm in length and as complex crystal aggregates (Figure 1), faceted stones were also being sold. The colour of the material ranged from a medium-toned yellow through orange and dark orangey red, with a very few yellowish-green crystals seen as well.

Discussions with representatives of the Krakow Poland-based firm Minerals and Gemstones shed some light on this material (D. and J. Wachowiak, pers. comm., 1995). They reported that it was an accidental by-product of an industrial kiln in

Silesia, Poland, used to produce zinc-based paint. The synthetic zincite would form spontaneously and randomly by vapour deposition in the kiln's chimney/air vents due to some undetermined error in the commercial production process.

Both rough and faceted samples were purchased for examination. Gemmological properties were determined for three modified round brilliant-cuts weighing 1.35, 3.18, and 3.26ct (Figure 2).

## Gemmological Properties

### *Appearance*

All three specimens have a sub-adamantine lustre and are transparent, as were others seen by the authors but not examined in detail. The colours of the three are medium-light yellow, medium orange and medium-dark reddish-orange, all of high saturation and even distribution. These samples were felt to be representative of the range of hues and depths of colour exhibited by the material being offered at the Tucson shows. These properties are generally consistent with those reported in the literature for the rare natural zincite

Table I. Ultraviolet fluorescence of samples

	<i>Long wave</i>	<i>Short wave</i>
Medium-light yellow specimen	Moderate yellow	Weak to moderate yellow
Medium orange specimen	Very weak yellowish-orange	Very weak orange
Medium-dark reddish-orange specimen	Very weak yellowish-orange	Inert

(Webster, 1983; Arem, 1987), although cuttable natural material is described as being slightly cloudy to translucent, and frequently darker or more brownish in colour.

#### *Refractive indices*

All three stones are over the limits of a standard Duplex II refractometer, i.e. with a refractive index of more than 1.80. Such a determination is consistent with the values  $\omega = 2.013$ ,  $\epsilon = 2.029$  reported for natural zincite (Webster, 1983; Arem, 1987).

#### *Optic character*

The material was determined to be doubly refractive, by observing weak doubling of back facet edges under magnification and by the presence of weak pleochroism (see below). In addition, two of the three stones were confirmed to be uniaxial by resolving an optical interference figure between crossed polarizers. These data are consistent with those for natural zincite which crystallizes in the hexagonal crystal system and has a birefringence of 0.016 (Webster, 1983; Arem, 1987).

#### *Pleochroism*

Dichroism is very weak, in two tones of the body colour. It should be noted that both Webster (1983) and Arem (1987) report natural zincite as having no pleochroism. This apparent inconsistency

may be explained by the very weak reaction of the synthetic material noted by the authors and by the fact that natural zincite is rarely transparent, for even minor scattering of light in the natural material could obscure a weak pleochroic reaction. Webster (1983) also reports that small crystals of synthetic zincite showed no apparent dichroism; here, the combination of a weak reaction in possibly pale-coloured specimens might account for the differences noted.

#### *Ultraviolet fluorescence*

In all three stones, the reaction to long wave was stronger than the reaction to short wave (see Table I).

Furthermore, the strengths of the reactions were inversely proportional to the depth of body colour. Both Webster (1983) and Arem (1987) report that natural zincite does not fluoresce. This lack of reaction in natural zincite is most likely caused by one or more fluorescence-quenching impurities. Webster (1983) reports a dull to bright yellow fluorescent reaction for small synthetic specimens, although the excitation wavelength(s) is not specified.

#### *Chelsea filter reaction*

The appearance through the Chelsea filter varied with the body colour of the test sample. The medium-light yellow stone gave no reaction (that is, it appeared yellowish-green, the colour of the filter).

**Table II. Summary of gemmological properties of synthetic zincite**

Colour	Medium-light yellow, medium orange, medium-dark reddish-orange
Diaphaneity	Transparent
Lustre	Sub-adamantine
RI	Over the limits of standard refractometer (1.80+)
Optic character	Doubly refractive, uniaxial
Pleochroism	Very weak, in two tones of body colour
UV Fluorescence:	
Long wave	Very weak to moderate, yellow to yellow-orange
Short wave	Inert to very weak to moderate, yellow to orange
	LWUV > SWUV; both inversely proportional to depth of body colour
Chelsea filter reaction	Yellow stone: no reaction (appears yellowish-green) Orange stone: weak pink Reddish-orange stone: moderate red
Absorption spectra	Weak general absorption to about 430nm and a weak band centred at 500nm (lightest-coloured stone); Weak general absorption to about 510 or 530nm (other two stones)
SG	5.70 ± 0.02
Electrical conduction	Non-conducting (two lighter-coloured stones) Conducting (darkest-coloured stone)
Magnification	Dislocations; cloud of small particles; small crystals, some acicular

The medium orange stone appeared weak pink while the medium-dark reddish-orange specimen appeared moderate red.

#### *Absorption spectra*

These were observed using a Beck prism-type spectroscope mounted on a GIA GEM transmitted/fibre-optic light base. The lightest-toned specimen showed weak general absorption from 400 to about 430nm plus a diffused band centred at

approximately 500nm. The other two showed weak general absorption from 400 to 510 and 530nm respectively. Webster (1983) reports no distinctive absorption features for small specimens of synthetic material, although this may be due to their relatively light body colour (they are described as being yellow).

#### *Specific gravity*

This was determined through hydro-



static weighing on a Mettler AM100 electronic balance, with three separate sets of calculations performed for each stone. Values obtained were  $5.70 \pm 0.02$  and are consistent with the 5.68 value reported by Arem (1987) and close to the 5.66 value Webster (1983) reports for gem-quality natural material.

#### *Electrical conduction*

Electrical conduction was measured qualitatively using a GIA Gem Instruments electrical conductivity meter. The medium-light yellow and medium orange stones gave a negative reaction (i.e. did not conduct electricity), but the medium-dark reddish-orange stone gave a positive reaction (i.e. did conduct electricity).

#### *Magnification*

The lightest-toned stone contained only a cloud of small particles (Figure 3). The two darker stones showed dislocations and small included crystals that could only be seen under fairly high magnification (Figure 4). The darkest stone also contained acicular inclusions (Figure 5). As none of the inclusions broke the surface, they were not further characterized.

The gemmological properties are summarized in Table II.

#### *Chemistry*

Qualitative chemical analyses were performed using a Tracor X-ray Spectrace 5000 EDXRF spectrometer. The only element revealed was zinc (Zn), which is consistent with the chemistry of zincite ( $\text{ZnO}$ ), as oxygen and other light elements are not detectable with this method of analysis.

For comparison purposes, a dark brownish red faceted natural zincite from Franklin, New Jersey, USA, was also tested using the EDXRF system; this stone contained manganese (Mn) as well as Zn. Microprobe analysis of a natural 'light green' zincite from Sterling Hill, New Jersey, USA, showed contents of 98.88% ZnO, 0.23% iron (Fe) as FeO, and 0.29% Mn as MnO (Dunn, 1979).

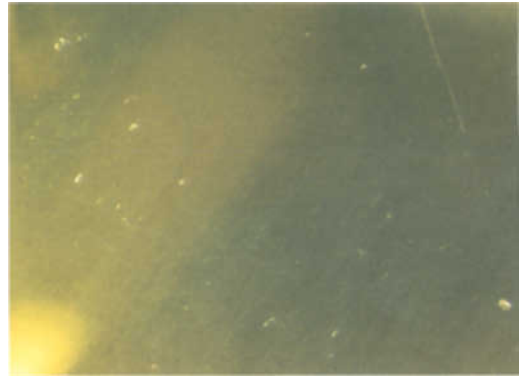


Fig. 3. A cloud of minute particles was noted in the 3.18ct light yellow specimen. 60x. Photomicrograph by John I. Koivula © GIA



Fig. 4. Veil-like dislocations and small included crystals of undetermined nature were detected in two of the test samples. 50x. Photomicrograph by John I. Koivula © GIA



Fig. 5. One of the three samples contained acicular inclusions. 60x. Photomicrograph by John I. Koivula © GIA

### Discussion

The gemmological properties of the synthetic zincites described in this investigation were in their essentials consistent with those reported in the literature for the rare, gem-quality facetable natural zincite from Franklin, New Jersey, USA. The data obtained are also in agreement with what is documented in the literature for synthetic material.

Although the red colour in many natural zincites is thought to be due to Mn (Webster, 1983), none of the three faceted synthetic stones examined by the authors contained any detectable Mn. We suspect that the yellow, orange and reddish-orange colours, and corresponding absorption spectra, may be due to increasing amounts of band-gap absorption from defect states within zincite (see, for instance, Fritsch and Rossman, 1988); in agreement with this model, the darkest stone conducts electricity.

The synthetic zincite examined by the authors is unusual in that it is reported to have formed as an accidental by-product of a commercial manufacturing process, rather than having been grown for a specific gem or industrial application. However, *intent* is not a consideration in the definition of a synthetic gem material. For instance, additional synthetic crystals form under conditions meant to grow other materials including, for example, the synthetic phenakite crystals found in synthetic emeralds, and the synthetic acmite and eucryptite 'breadcrumb' inclusions sometimes found in synthetic quartz.

It is worth noting that this is not the first such occurrence of synthetic zincite crystallizing by accident. In an article titled 'A modern miracle' (Kennedy, 1983), the author describes yellow and red-orange amber-coloured crystals of synthetic zincite that were found at the Blackwell Zinc Smelter in Blackwell, Oklahoma, USA, when an old furnace used to produce zinc ore concentrates was torn down.

### Acknowledgements

The authors wish to thank Dino DeGhionno, staff gemmologist in the GIA Gem Trade Laboratory (GIA GTL), for assisting with the gemmological characterization. Dr Sang-Ho Lee of GIA GTL and Sam Muhlmeister of GIA Research performed the EDXRF analyses. Mark Parisi of the Jet Propulsion Laboratory, Pasadena, California, suggested the term 'serendipitous synthetic'.

### References

- Arem, J., 1987. *Color encyclopedia of gemstones*. Van Nostrand Reinhold Company, New York, 2nd. ed., 207-8
- Bowen, N.L., 1924. Mullite, a silicate of alumina. *Journal of the Washington Academy of Sciences*, **14**, 9, 183-91
- Braithwaite, R.S.W., Kampf, A.R., Prichard, R.G., and Lamb, R.P.H., 1993. The occurrence of thiosulphates and other unstable sulphur species as natural weathering products of old smelting slags. *Mineralogy and Petrology*, **47**, 255-61
- Bridge, P.J., 1973. Urea, a new mineral, and neotype phosphammite from Western Australia. *Mineralogical Magazine*, **39**, 346-8
- Chisholm, J.E., Jones, G.C., and Purvis, O.W., 1987. Hydrated copper oxalate, moolooite, in lichens. *Mineralogical Magazine*, **51**, 5, 715-18
- Crowningshield, R., 1985. Gem Trade Lab notes: synthetic zincite. *Gems & Gemology*, **21**, 4, 237-8
- Dunn, P.J., 1979. Light green zincite from Sterling Hill, Ogdensburg, New Jersey. *Mineralogical Record*, **10**, 1, 45-7
- Fritsch, E., and Rossman, G.R., 1988. An update on color in gems. Part 3: Colors caused by band gaps and physical phenomena. *Gems & Gemology*, **24**, 2, 81-102
- Hentschel, G., 1964. Mayenit,  $12\text{CaO} \cdot 7\text{Al}_2\text{O}_3$ , und Browmillerit,  $2\text{CaO} \cdot (\text{Al}, \text{Fe})_2\text{O}_7$ , zwei neue Minerale in den Kalksteineinschlüssen der Lava des Ettringer Belleberg. *Neues Jahrbuch für Mineralogie Monatshefte*, 22-9
- Hurlbut, C.S., and Kammerling, R.C., 1991. *Gemology*. John Wiley & Sons, New York, 2nd ed., 2, 6
- Jambor, J.L., 1994.  $\text{Ba}_2\text{S}_2\text{O}_7$ ,  $\text{H}_2\text{O}$ ,  $\text{Ba}_2\text{S}_2\text{O}_7\text{F}_2$ ,  $\text{Ba}_2\text{Al}_2\text{S}_6(\text{OH})_8 \cdot 8\text{H}_2\text{O}$ : discussion; in Jambor, J.L. and Vanko, D.A., New mineral names. *American Mineralogist*, **79**, 11-12, 1318
- Johnson, M.L., DeGhionno, D., and Maddison, P., 1994. Gem Trade Lab notes: Ceramic statue. *Gems & Gemology*, **30**, 3, 184
- Kennedy, M., 1983. A modern miracle. *Lapidary Journal*, **36**, 12, 1974-9
- Lausen, C., 1928. Hydrous sulfates formed under fumerolic conditions at the United Verde Mine. *American Mineralogist*, **13**, 6, 203-29
- Nassau, K., 1980. *Gems made by man*. Chilton Book Company, Radnor, Pennsylvania, USA, 4
- Palache, C., Berman, H., and Frondel, C., 1951. *The system of mineralogy of James Dwight Dana and Edward Salisbury Dana, Yale University 1837-1892*, Vol. II: halides, nitrates, borates, carbonates, sulfates, phosphates, arsenates, tungstates, molybdates, etc., John Wiley & Sons, New York, 7th ed.
- Webster, R., 1983. *Gems, their sources, descriptions and identification*, 4th ed. revised by B.W. Anderson, Butterworth, London, pp. 369, 434-5

# Cat's-eye and asteriated gemstones from East Africa

*N.R. Barot<sup>1</sup>, G. Graziani<sup>2</sup>, E. Gübelin<sup>3</sup> and M. Rettighieri<sup>2</sup>*

1. Ruby Centre (Kenya) Ltd., Fedha Tower, 2nd Floor, Muindi Mbingu St., PO Box 47928, Nairobi, Kenya
2. Dipartimento di Scienze della Terra, Università degli Studi di Roma 'La Sapienza', P.le A. Moro 5, 00185 Rome, Italy
3. Résidence Suite 436, Haldenstrasse 4, 6002 Lucerne, Switzerland

## Abstract

The study was carried out on nineteen cat's-eye or asteriated cabochon-cut examples of the following gems from Tanzania and Kenya: almandine, apatite, aquamarine, beryl, grossular, kyanite, kornerupine, rhodolite, ruby, sapphire, scapolite, tourmaline and zoisite.

Optical observations, electron microprobe and X-ray analyses were carried out to investigate chemical compositions of the bulk crystals and the role of the inclusions.

Inclusions, responsible for the optical effects, i.e. tubes, acicular inclusions, lamellae, laminae and platelets, are described and some deductions about conditions of growth of the gems are made.

**Keywords:** Gemstones, cat's-eye, chatoyancy, asterism, cabochon, inclusions.

## Introduction

Tanzania and Kenya now contribute significantly to the world market in supplying unusual gemstones which display chatoyancy and asterism.

For several years, cabochon-cut gemstones of different mineral species producing these optical phenomena have appeared on the Kenyan market.

A group of 19 cabochon-cut gemstones of

different mineral species, selected according to their origin, weight, size and with evident cat's-eye or asterian effect, were examined.

This article describes the physical and chemical properties of the gems with particular emphasis on the inclusions responsible for the optical effects.

## Sample location and geology

The samples were obtained by N.R. Barot from North Tanzania and South Kenya and are of known origin (Figure 1). The regional geology is complicated and has not been mapped in detail.

Sample 1 is from the Ngorongoro volcanic complex at Lake Manyara, in north central Tanzania. The erosion of the metamorphic rocks, which lie on the northern border of the Masai Steppe, produced the neogenic deposits in which the sample was found.

Samples 7, 12, 13, 14 and 15 are from the Dodoma area, 17, 18 and 19 from the Lelatema District and 2, 9 and 11 from the Pare and Usambara Mountains, all in Tanzania.

Samples 3, 6, 8, 10 and 16 are from the Taita Mountains and 4 and 5 from the Embu and Meru areas respectively, in Kenya.

These areas are part of the central system of the Rift Valley (Pangani Rift). The rocks are affected by extensive tensional tectonic events and consist of high grade gneisses (granulite facies) of Tertiary age, and lower grade metamorphic rocks (amphibolite

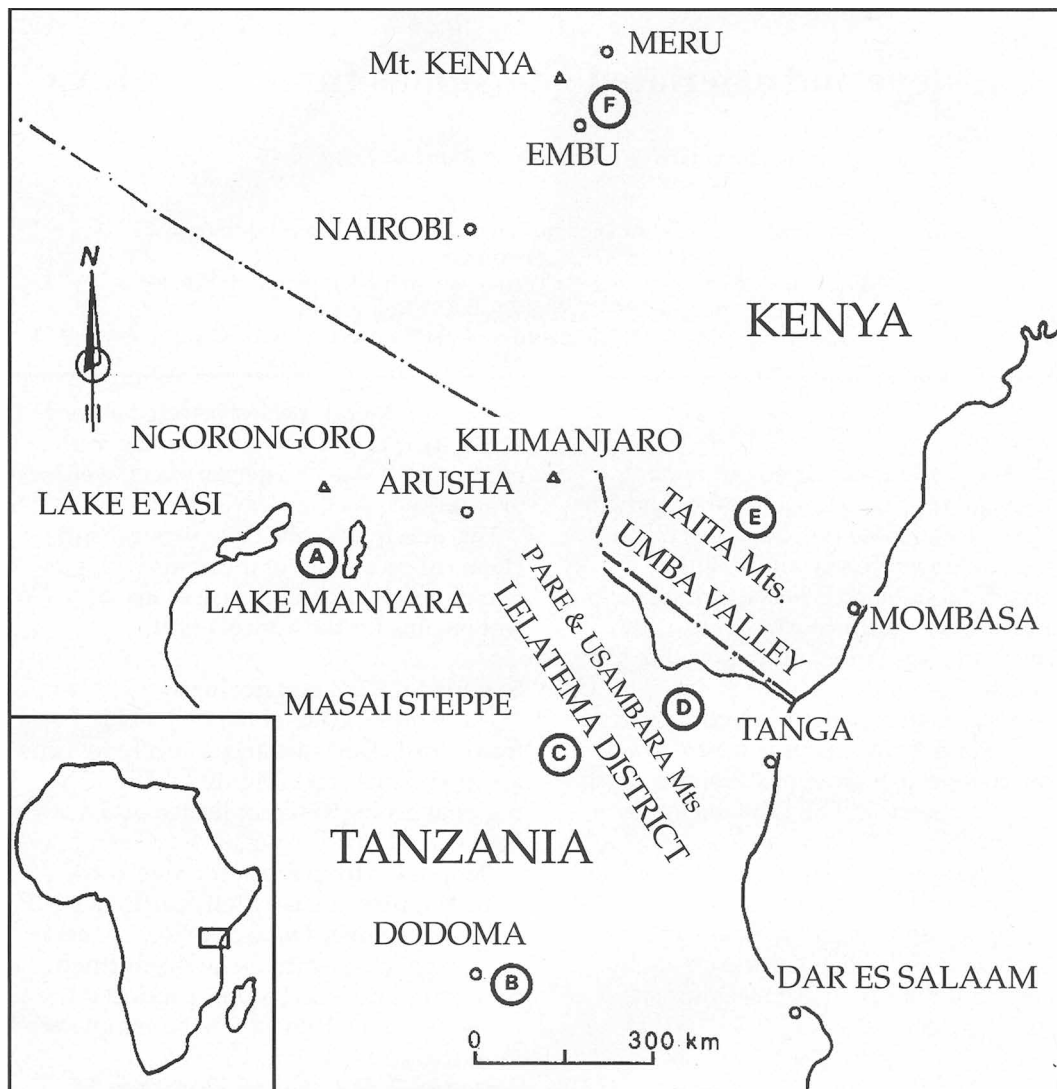


Fig. 1. The map shows the origin of the gemstones studied from East Africa. A: Sample 1; B: Samples 7, 12, 13, 14 and 15; C: Samples 17, 18 and 19; D: Samples 2, 9 and 11; E: Samples 3, 6, 8, 10 and 16; F: Samples 4 and 5

facies) of Precambrian age. In particular they comprise pyroxene granulites, gneisses with kyanite, amphibolites, crystalline limestones with graphite, serpentine and sporadic pegmatite complexes of syn-orogenic metasomatic or post-orogenic magmatic origin.

All the gems are oval cabochon-cuts, ranging in size from 5.40x5.20x4.90mm

(sample 6) to 12.80x10.27x6.67mm (sample 15). Their weights vary between 0.58ct (sample 17) and 6.37ct (sample 15).

Elongate, thin inclusions parallel to the base of the cabochons cause the cat's-eye effect in samples 1, 2, 3, 4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 16, 17, 18 and 19 and traverse the whole body of the host crystal (Figures 2, 3, 5 and 10). Also, a hazy six-pointed star, not



Fig. 2. Sample 2. This almandine from Mt. Pare (Tanzania) is decorated by syngenetic intergrowth of rutile needles with a crystallographically dictated arrangement along the edges of the rhombododecahedral faces. 60x.

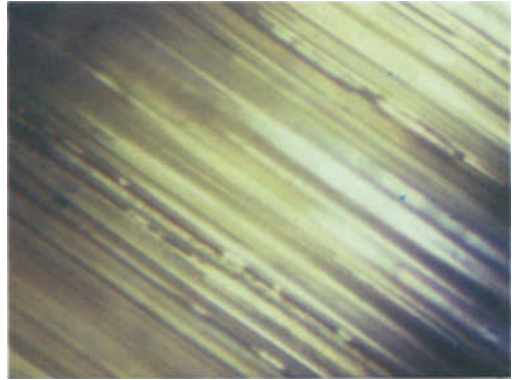


Fig. 3. Sample 3. In this yellow fluorapatite from Mt. Taita (Kenya), the tubes are parallel to the *c*-axis, partly filled with epigenetic laminae of iron compounds, and are considered to be mainly responsible for the cat's-eye. 50x.



Fig. 4. Sample 4. In this aquamarine from Embu and Meru area (Kenya), the cat's-eye effect is caused by massed parallel, hair-like tubes. 20x.



Fig. 5. Sample 8. Healing fissures of different patterns, narrow tubes and some crystals, with a vaporous appearance, decorate this green kornerupine from Mt. Taita (Kenya). 30x.



Fig. 6. Sample 10. The straight edged growth zoning, present in this ruby from Mt. Taita (Kenya), indicates many changes in the physico-chemical environment of the host gem. Inclusions of fine rutile needles were confined to growth zoning. 20x.



Fig. 7. Sample 10. In this ruby from Mt. Taita (Kenya), the crystallographically dictated arrangement of syngenetic rutile needles and lamellar structures cause the hazy asterism displayed by this cabochon. 10x.

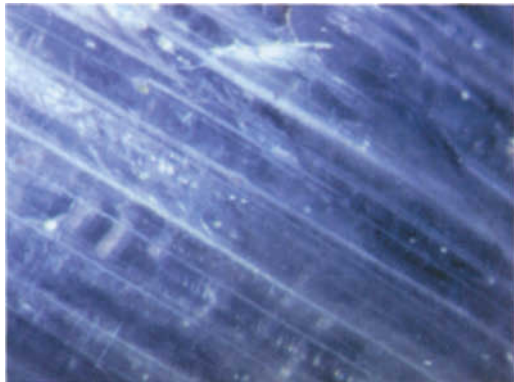


Fig. 8. Sample 11. Broad hollow tubes and boehmite laminae traverse this lilac sapphire from Mt. Pare (Tanzania), and produce the cat's-eye effect. 30x.



Fig. 9. Sample 13. In a yellowish scapolite, 45% Me content, from Dodoma (Tanzania), the filled cleavage laths are yellow, reddish-brown and black due to iron oxides and hydroxides. The opaque laminae consist of pyrrhotite and have the appearance of stripes. The laths and the laminae are parallel and crystallographically oriented. 20x.



Fig. 10. Sample 17. Systems of parallel tubes and healing fissures cross this brownish-yellow zoisite from Lelatema District (Tanzania). 30x.

extending fully, is displayed by samples 9 and 10. The width and the shortness of these rays may be related to three factors.

First, many stones are quite transparent with patchy development of inclusions; secondly, some stones are poorly cut; and thirdly, variation of alignment of the elongate inclusions tends to make the chatoyancy or asterism less well-defined (Figure 6).

### Gemmological and analytical tests

The cabochon-cut gemstones were submitted to standard gemmological and appropriate analytical tests (see Table I).

#### *Visual appearance and absorption spectra*

The samples present different grades of clarity and are classified as cabochon-cut gemstones either transparent (samples 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18 and 19), semi-transparent (samples 1, 2, 6 and 7), or translucent (sample 16). To the unaided eye, the samples appear of medium hue, only one being dark (sample 16).

The visible-light absorption spectrum of all the cabochons was observed through the hand-held spectroscope and measured with the Cary 219 dual-beam spectrophotometer over the spectral range 400 to 800 nm.

#### *Refractive index, pleochroism and luminescence*

The refractive indices of the cabochons were assessed by means of a gemmological refractometer using the distant vision method. It was possible to determine only average values.

Pleochroism and luminescence under long and short wave were observed and evaluated.

#### *Specific gravity*

The specific gravity of all the samples was measured with a Berman balance. Due to the variable inclusion content of the cabochons, the results should be interpreted with caution.

**Table I. Gemmological properties and mineralogical classification of the cat's-eye and asteriated gemstones from East Africa.**

<i>Sample number</i>	<i>Refractive index (average value)</i>	<i>Pleochroism</i>	<i>Absorption (nm)</i>	<i>Luminescence (UV)</i>	<i>Specific gravity</i>	<i>Gem</i>
1	1.75	Reddish Greenish	Broad band: 430 Broad band: 450 Narrow lines: 488, 503	Long wave: faint Short wave: greenish	3.71	Alexandrite
2	1.76	—	Indistinct band: 420 Narrow line: 460 Bands: 500, 520, 576 Faint lines: 470, 605	—	3.96	Almandine
3	1.64	Blue Yellowish	Indistinct band: 450 Narrow line: 478 Faint bands: 520 Strong band: 580	Long wave: greenish Short wave: greenish	3.21	Apatite
4	1.57	Bluish Colourless	Broad band: 427 Diffuse band: 456 Narrow line: 537	—	2.68	Aqua-marine
5	1.58	Sea-green Yellowish	No characteristic	—	2.72	Beryl
6	1.74	—	Main bands: 410, 421, 435 Weak bands: 460, 480, 504 Weak line: 520 Broad band: 573	—	3.93	Grossular
7	1.72	Colourless Blue	Vague lines: 450-500 Vague line at 700	Long wave: dim red Short wave: inert	3.68	Kyanite
8	1.67	Greenish Reddish	Indistinct band: 430 Faint line: 445 Band: 503	Long wave: yellow glow Short wave: yellow glow	3.30	Kornerupine
9	1.75	—	Indistinct band: 460 Main band: 500 Broad bands: 520, 576	—	3.84	Rhodolite
10	1.77	Yellowish Purple	Indistinct band: 463 Narrow lines: 475, 469 Absorption area: 485-600 Weak line: 663 Strong line: 694	Long wave: crimson Short wave: weaker red	3.99	Ruby

Table I. continued

11	1.77	Yellowish Blue	Indistinct band: 435 Complex band: 450	—	4.00	Sapphire
12	1.56	Yellowish Colourless	Broad band: 530-590 Weak line: 650	Long wave: inert Short wave: vague pink	2.68	Scapolite
13	1.56	Yellow Colourless	Broad band: 530-590 Weak line: 650	Long wave: inert Short wave: vague pink	2.72	Scapolite
14	1.55	Yellow Yellowish	Broad band: 530-590 Weak line: 650	Long wave: inert Short wave: vague pink	2.63	Scapolite
15	1.56	Yellow Colourless	Broad band: 530-590 Weak line: 650	Long wave: inert Short wave: vague pink	2.68	Scapolite
16	1.63	Dark green Yellowish	Strong line: 498	Long wave: faint Short wave: yellow	3.04	Tourmaline
17	1.70	Blue Sage-green	Broad band: 590 Faint bands: 530, 455	—	3.36	Zoisite
18	1.70	Blue Sage-green	Broad band: 590 Faint bands: 530, 455	—	3.35	Zoisite
19	1.69	Blue Sage-green	Broad band: 590 Faint bands: 530, 455	— —	3.35	Zoisite

Note: — means no pleochroism or fluorescence was observed

#### *Electron microprobe, X-ray diffraction and thermal analyses*

Electron microprobe analyses and X-ray powder diffraction measurements were carried out on all samples to investigate any chemical variation and possible structural change of the host gems and of the inclusions, whenever they were exposed at the surface of the cabochons.

Electron microprobe analyses were carried out on a Jeol JMS-50A. Matrix corrections were made according to the EMPADR VII programme described by Rucklidge and Gasparrini (1969). Total iron was calculated as FeO; beryllium and boron were not detectable by the microprobe.

The unit cell parameters were calculated by means of X-ray powder diffractometry, using nickel-filtered copper  $K_{\alpha}$  radiation

with five oscillatory scans at  $1/4^{\circ} 2\theta$  per minute from  $10^{\circ}$  to  $80^{\circ} 2\theta$ . Pure semiconductor grade crystalline silicon metal (Jarrel Ash JM, spectroscopy impurity less than 300 ppm) was used as an internal standard. The lattice constants were estimated using a least-squares refinement (Appleman and Evans, 1973) of the X-ray data, indexed by comparison with the data listed by the JCPDS files.

Thermogravimetric analyses were performed with a TGS-2 Perkin Elmer system using about 0.10mg of material for each analysis. The  $H_2O$  content was estimated by assessing the difference between the thermogravimetric results and the chemical data for the other volatile components, i.e.  $CO_2$ , F, Cl and S.

The  $CO_2$  content of the total gaseous phase emitted by the substance after



heating at 1000°C was determined by means of the high sensitivity analyzer of Scarano and Calcagno (1975), using an air current with constant CO<sub>2</sub> content as carrier.

### Identification of the gems

The specimens were submitted to the standard gemmological tests, thus identifying the mineral species (Table I). Detailed analytical features are given in Table II and Appendix.

*Sample 1* is a chrysoberyl. The iron content (1.36%) and the small amount of chromium are responsible for the dark greenish colour of the gem (Schmetzer, 1985). The reddish colour of the sample in transmitted light (Dana, 1944) and the X-ray powder diffraction data (Vlasov, 1966) suggest that it may be the alexandrite variety.

*Samples 2, 6 and 9* are red, greenish-red and brownish-red garnets respectively. On the basis of the lattice constants, refractive index and specific gravity values, they are classified as almandine, grossular (Bank, 1979; Deer *et al.*, 1982) and rhodolite, a mixed crystal within the pyrope-almandine isomorphous series (Anderson, 1959; Bank and Henn, 1989) with a notable pyrope molecular percent end member (62.7%). The calculation was performed according to the dominant molecular content of the end-member components present in each garnet (Table II). The per-

centage of the andradite end-member was calculated on the basis of Fe<sup>3+</sup> estimated according to Droop, 1987. The calculated Fe<sub>2</sub>O<sub>3</sub> contents were: 0.34, 2.26 and 0.69 wt.% for samples 2, 6 and 9 respectively.

*Sample 3* is a yellow apatite. The microchemical analyses, the amount of fluorine (3.15%) and the lattice constants values ( $c/a = 0.736$ ) identify it as a fluorapatite (Deer *et al.*, 1967; Altschuler *et al.*, 1953).

*Samples 4 and 5* are beryls with very similar optical properties, specific gravity, microchemical and lattice constants (Deer *et al.*, 1986; Radcliffe, 1969; Winchell and Winchell, 1953). The relatively high content of MgO and the pale bluish appearance of sample number 4 allows its classification as an aquamarine (Schaller *et al.*, 1962).

*Sample 7* is a moderately blue kyanite. The low iron and titanium content may be responsible for the faint colour of the host cabochon and consists of an aggregate of colour patches spread in a colourless matrix (Ghera *et al.*, 1986).

*Sample 8* is a dark green kornerupine on the basis of the optical properties, microchemical analyses and lattice constants (Hey *et al.*, 1941; Girault, 1952).

*Samples 10 and 11* are ruby and lilac sapphire, based on their appearance and the presence of chromium, iron and traces of titanium, respectively.

*Samples 12, 13, 14 and 15*, are colourless or yellowish scapolites. The microchemical analyses and lattice constants allow esti-

Table II. Molecular percentage end member and X-ray data of cat's-eye and asteriated garnets from East Africa

Sample number	Lattice constant $a$ (Å)	Alm.	molecular percent end member				
			Andr.	Gross	Pyr.	Spess.	Uv.
2	11.566 ± 0.004	45.7	1.0	21.4	30.3	1.6	—
6	11.495 ± 0.005	32.6	4.3	55.6	5.7	1.8	—
9	11.495 ± 0.004	19.3	1.1	16.4	61.9	1.1	—

mates following the relationship proposed by Shaw (1960) and Burley *et al.* (1961), of the percentage of meionite, namely, 39, 48, 28 and 41%, respectively.

*Sample 16* is a dark green tourmaline. The chemical data and the lattice constants ( $c/a = 0.451$ ) indicate that it is a member of the schorl–dravite series (Dunn *et al.*, 1975; Epprecht, 1953; Sahama *et al.*, 1979).

*Samples 17, 18 and 19* are brownish-yellow zoisites on the basis of their compositions and lattice constants (Deer *et al.*, 1986).

### Examination of the inclusions

The cabochons were examined by means of a stereoscopic microscope and the inclusions were analyzed by the electron microprobe, wherever they intersected the surface.

The specimens were observed in immersion and often showed the presence of a colour pattern unevenly distributed in bands. Broader zones and colour areas are exhibited by the clustering of tiny needles.

A multitude of inclusions were observed and segregated into six main categories. The different types of inclusions are listed in Table III. Only the inclusions in groups 1, 2, 3 and 4 are involved in producing cat's-eyes or asterism.

#### 1. Tube like inclusions

These inclusions are present in numerous cabochons of different mineral species and are the main cause of the chatoyancy (samples 3, 4, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18 and 19).

They are primary cavities which are normally caused by irregularities in the growth process of the host crystal. Such tubes may be filled by scaly aggregates with a colour varying from brownish-red to yellow and variously mixed (Figures 3, 4, 5, 8, 9 and 10), by two-phase inclusions (Schmetzer *et al.*, 1977; Graziani and Gübelin, 1981; Schmetzer and Bank, 1983) or by powdery birefringent material (Graziani *et al.*, 1982).

Around these cavities, 'fingerprint' veils are often present, and also healing fractures, surrounded by brown or reddish-brown vague haloes which alter the appearance both of the cat's-eye or star effect.

Electron microprobe analyses indicate the presence of iron, therefore the haloes were attributed to iron oxides or hydroxides. This has been documented by Schmetzer and Bank, 1983; Ghera *et al.*, 1988, and is common to numerous minerals.

#### 2. Acicular inclusions

Analysis of the fine (<30µm diameter) acicular inclusions is experimentally difficult and results are commonly similar to composition of the host crystal (samples 1, 2, 3, 6, 9, 10, 11 and 16).

Analyzing the acicular inclusions of maximum diameter, the semi-quantitative microprobe analyses showed small amounts of titanium. Considering the visually estimated high birefringence, the growth conditions and the high formation temperature, the inclusions are probably rutile.

The colour hue of the cabochons appears to be linked to these acicular inclusions which are responsible for the clear or for the opalescent appearance of the samples (Figures 2, 6 and 7).

Optical and electron microprobe observations showed the presence (samples 1 and 16) of bunches of yellowish brucite fibres (Koivula and Fryer, 1985) and (sample 3) of acicular goethite (Gübelin and Schmetzer, 1982).

#### 3. Lamellae

Some specimens (samples 1, 2, 3, 6, 10, 11, 17, 18 and 19) showed planar textures. These are polysynthetic lamellar structures with the same microchemical composition of the host crystals and are either twinning or cleavage surfaces.

The individual lamellae are often limited both by an incipient decomposition along

Table III. Recognized inclusions in the cat's-eye and asteriated gemstones from East Africa

Sample number	Host gem	Inclusions						
		Tubes	Lamellae	Laminae	Feathers	Minerals	other habits	
1	Alexandrite	---	Present	---	Present	Brucite Rutile Rutile Goethite Rutile	Diopside Unidentified Unidentified Unidentified	
2	Almandine	---	Present	---	Present	---	---	
3	Apatite	Present	Present	---	---	---	---	
4	Aquamarine	Present	---	Biotite	---	---	---	
5	Beryl	---	---	Hematite	---	---	Apatite	
6	Grossular	---	Present	---	Present	Rutile	Diopside, Unidentified	
7	Kyanite	---	---	Hematite	---	---	Unidentified	
8	Kornerupine	Present	---	Graphite	Present	---	Apatite	
9	Rhodolite	Present	---	---	Present	Rutile	Apatite, Unidentified	
10	Ruby	---	Present	---	Present	Rutile	Apatite	
11	Sapphire	Present	Boehmite	---	Present	Rutile	Apatite	
12	Scapolite	Present	---	Muscovite	Present	---	---	
13	Scapolite	Present	---	Pyrrhotite	Present	---	---	
14	Scapolite	Present	---	Biotite	---	---	Unidentified-	
15	Scapolite	Present	---	---	Present	---	---	
16	Tourmaline	Present	---	Graphite	---	Brucite	---	
17	Zoisite	Present	Present	Graphite	Present	---	---	
18	Zoisite	Present	Present	Graphite Hematite	Present	---	---	
19	Zoisite	Present	Present	Graphite	Present	---	---	

these planes (samples 10 and 11), by parallel arrangements of laminae (samples 2, 3, 6, 17, 18 and 19), or may be covered with disseminated, lenticular, colourless lamellae, (sample 11), probably boehmite (Eppler, 1974; Hänni and Schmetzer, 1991) (Figure 8).

#### 4. Laminae and platelets

Brown laminae of biotite and transparent, colourless platelets of biotite and muscovite occur in samples 4, 12 and 14.

Dark grey, pseudo-hexagonal laminae of hematite and pyrrhotite, often partially decomposed and surrounded by rings of yellow-orange iron hydroxides, represent common epigenetic inclusions (samples 5, 7, 13 and 18) and when present, darken the colour of the cabochon.

Rounded black platelets of graphite often forming groups, are present in some cabochons from East Africa (samples 8, 16, 17, 18 and 19) as a product of intense metamorphism.

#### 5. Feathers and healed fractures

Healed fractures are indicated by cleavages or veil-like feathers of fluid remnants and by haloes of a yellow or brownish-red matter (samples 1, 2, 6, 8, 9, 10, 11, 12, 13, 15, 17, 18 and 19) and are generally unrelated to the cat's-eye or asterism effect.

Electron microprobe analyses of the fractures showed the almost exclusive presence of iron, and consequently the haloes were ascribed to iron oxides or hydroxides.

#### 6. Mineral inclusions

Sporadic transparent and opaque inclusions are present in almost all the cabochon-cut gemstones (Figures 9 and 10). The crystals (approx.  $0.03 \times 0.06\text{mm}$ ), are often elusive or difficult to study, they seem to disappear like vapour and occur singly (Figure 10). Careful optical observations may enable one to identify these peculiar inclusions (samples 1, 2, 3, 6, 7, 9 and 14), and so far, diopside (samples 1

and 6) and apatite (samples 5, 8, 9, 10 and 11) prismatic crystals have been recognized (diameter: min.:  $0.01\text{mm}$ ; max.:  $0.2\text{mm}$ ).

### Discussion and conclusions

The cabochon-cut gemstones are remarkable for the presence in all samples of a multitude of inclusions, many of which are responsible for the chatoyancy or star effects (Table III).

The straight-edged colour bands and growth zoning (Figures 7 and 8) are due to the sporadic variations in the physico-chemical growth conditions and document intermittent episodes of the host crystal's growth (samples 10 and 19).

Tubes, acicular inclusions and lamellae, sometimes with a crystallographically dictated parallel arrangement of minute lines, decorate the host minerals and represent the main cause of these optical effects.

Laminae and platelets are related to the cat's-eye effect only if they are oriented perpendicularly to the base of an elliptical cabochon.

Feathers, healed fractures and mineral inclusions are not confined to stones with the cat's-eye or star effect and are present incidentally.

Nevertheless, tubes, acicular inclusions, healed fractures and feathers are responsible for the yellowish appearance of the cabochons. This colour is due to iron oxides or hydroxides and indicates that the latter iron minerals crystallized after a late-stage filling of these cavities. Sporadic alterations of the physico-chemical conditions probably produced fractures into which the mother fluid penetrated and where iron compounds segregated. The colour variability of the haloes, from yellowish to reddish, also probably indicate a possible sequence of transformation of iron hydroxides into iron oxides due to an increase of the environmental temperature.

The presence of hematite in samples 5, 7 and 18 shows that the temperature of crystallization was more than  $500^\circ\text{C}$  (Kulp *et al.*, 1951).

The frequent occurrence of graphite platelets (samples 8, 16, 17, 18 and 19) is witness to intense metamorphic events which characterized the East African geological situation.

The data obtained from the cabochon-cut gemstones and their identified inclusions are consistent with their derivation from medium- to high-grade metamorphic rocks which are common throughout the whole East African region.

## References

- Altschuler, Z.S., Cisney, E.A., and Barlow, I.H., 1953. X-ray evidence of the nature of carbonate apatite. *American Mineralogist*, **38**, 328
- Anderson, B.W., 1959. Properties and classification of individual garnets. *Journal of Gemmology*, **7**, 1-7
- Appleman, D.E., and Evans, H.T., 1973. Job. 9214: Indexing and least-squares refinement of powder diffraction data. U.S. Department of Commerce, National Technological Information Service, Document No PB-216 188
- Bank, H., 1979. Orange-('Padparascha') und andersfarbige Granate aus Ostafrika. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **28**, 146-7
- Bank, H., and Henn, U., 1989. Gemmologische Kurzinformationen. Ein ungewöhnlicher Granat aus Ostafrika. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **38**, 161-8
- Burley, B.J., Freeman, E.B., and Shaw, D.M., 1961. Studies on scapolite. *Canadian Mineralogist*, **6**, 670-9
- Dana, J.D., 1944. *The system of mineralogy*, Vol. 1. Wiley & Sons, New York
- Deer, W.A., Howie, R.A., and Zussman, J., 1967. *Rock forming minerals*, Vol. 5, *Non silicates*. Longman, London
- Deer, W.A., Howie, R.A., and Zussman, J., 1982. *Rock forming minerals*, Vol. 1A, *Orthosilicates*. Longman, London
- Deer, W.A., Howie, R.A., and Zussman, J., 1986. *Rock forming minerals*, Vol. 1B, *Disilicates and ring silicates*. Longman, London
- Droop, G.T.R., 1987. A general equation for estimating Fe<sup>3+</sup> concentration in ferromagnesian silicates and oxides from microprobe analyses using stoichiometric criteria. *Mineralogical Magazine*, **51**, 431-5
- Dunn, P.J., Arem, J.E., and Saul, J., 1975. Red dravite from Kenya. *Journal of Gemmology*, **14**, 386-7
- Eppler, W.F., 1974. Über einige Einschlüsse in Birma-Rubin. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **23**, 102-8
- Epprecht, W., 1953. Die Gitterkonstanten der Turmalin. *Schweizerische Mineralogische und Petrographische Mitteilungen*, **33**, 481-505
- Ghera, A., Graziani, G., and Gübelin, E., 1988. Notes on the inclusions in a greyish kyanite. *Journal of Gemmology*, **21**, 83-7
- Ghera, A., Graziani, G., and Lucchesi, S., 1986. Uneven distribution of blue colour in kyanite. *Neues Jahrbuch für Mineralogie Abhandlungen*, **155**, 109-27
- Girault, J.F., 1952. Korerupine from Lac Ste. Marie, Quebec, Canada. *American Mineralogist*, **37**, 531-41
- Graziani, G., Gübelin, E., 1981. Observations on some scapolites of Central Tanzania. *Journal of Gemmology*, **17**, 395-405
- Graziani, G., and Gübelin, E., and Lucchesi, S., 1982. Tourmaline chatoyancy. *Journal of Gemmology*, **18**, 181-93
- Graziani, G., Gübelin, E., and Lucchesi, S., 1983. Observations on some scapolites of Central Tanzania: further investigations. *Journal of Gemmology*, **18**, 379-81
- Gübelin, E., and Schmetzer, K., 1982. Eine neue Edelstein-Varietät aus Tansania: Gelbe, grüne und rotlich-braune Apatit-Katzenaugen. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **31**, 261-3
- Hänni, H.A., and Schmetzer, K., 1991. New rubies from the Morogoro Area, Tanzania. *Gems & Gemology*, **27**, 156-67
- Hey, M.H., Anderson, B.W., and Payne, C.J., 1941. Some new data concerning korerupine and its chemistry. *Mineralogical Magazine*, **26**, 119-30
- Koivula, I., and Fryer, C.W., 1985. Interesting red tourmaline from Zambia. *Gems & Gemology*, **21**, 40-2
- Kulp, J.L., and Trites, A.F., 1951. Differential thermal analysis of natural hydrous ferric oxides. *American Mineralogist*, **36**, 23-44
- Radcliffe, D., 1969. Cell constants of Birch Portage beryl, Saskatchewan. *Canadian Mineralogist*, **8**, 493-505
- Rucklidge, J., and Gasparrini, E.L., 1969. *Electron microprobe analytical data reduction. EMPADR VII. Manual reissue*. Dep. of Geology, University of Toronto, Toronto, Canada
- Sahama, Th. G., Von Knorring, O., and Tornroos, R., 1979. On tourmaline. *Lithos*, **12**, 109-14
- Scarano, E., and Calcagno, C., 1975. High sensitivity carbon dioxide analyzer. *Analytical Chemistry*, **47**, 1055-65
- Schaller, W.T., Stevens, R.E., and Jahns, R.H., 1962. An unusual beryl from Arizona. *American Mineralogist*, **47**, 672-99
- Schmetzer, K., 1985. Colourless chrysoberyl natural or synthetic. *Journal of Gemmology*, **19**, 682-91
- Schmetzer, K., and Bank, H., 1983. Investigation of a cat's-eye scapolite from Sri Lanka. *Gems & Gemology*, **19**, 108-10
- Schmetzer, K., Gübelin, E., Medenbach, O., and Krupp, H., 1977. Skapolith Katzenauge und Sternskapolith aus Zentral Tansania. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **26**, 3-5
- Shaw, D.M., 1960. The geochemistry of scapolite. Previous work and general mineralogy. *Journal of Petrology*, **1**, 218-60
- Vlasov, K.A., 1966. *Mineralogy of rare elements*. Vol. II. Israel Program for Scientific Translations, Jerusalem
- Winchell, A.N., and Winchell, H., 1951. *Elements of optical mineralogy: an introduction to microscopic petrography*. Part. II. *Descriptions of minerals, with special reference to their optical and microscopical characters*. IV Edition. John Wiley & Sons, New York

## Further reading

- Barot, N.R., Flamini, A., Graziani, G., and Gübelin, E.J., 1989. Star sapphire from Kenya. *Journal of Gemmology*, **21**, 467-73
- Cassedanne, J., and Roditi, M., 1993. The location, geology, mineralogy and gem deposits of alexandrite, cat's-eye and chrysoberyl in Brazil. *Journal of Gemmology*, **23**, 333-54
- De Kun, N., 1965. *The mineral resources of Africa*. Elsevier Publishing Company, Amsterdam
- Kammerling, R.C., and Koivula, J.I., 1990. Star rhodolite garnet from Tanzania. *Journal of Gemmology*, **22**, 16-18
- Kammerling, R.C., and Koivula, J.I., 1991. Two strongly pleochroic chatoyant gems. *Journal of Gemmology*, **22**, 395-8
- Koivula, J.I., Kammerling, R.C., and Fritsch, E., 1993. Two interesting 'double star' sapphires. *Australian Gemmologist*, **18**, 7, 235-6

**Appendix**  
**Electron microprobe analyses of cat's-eye and asteriated gemstones from East Africa**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
SiO <sub>2</sub>	0.50	39.48	-	65.40	65.92	38.00	37.70	32.10	41.31	0.22	0.20	52.85	52.58	57.12	52.67	37.38	40.10	41.10	41.76
TiO <sub>2</sub>	0.00	tr.	-	0.00	0.00	0.00	0.05	0.16	0.00	0.06	0.03	0.04	0.04	0.04	0.05	0.23	0.05	0.09	0.14
Al <sub>2</sub> O <sub>3</sub>	78.76	21.48	-	18.25	18.90	21.80	61.79	44.43	24.17	98.65	98.46	24.81	24.07	22.05	23.46	31.39	33.40	32.47	32.95
FeO <sup>1</sup>	1.36	21.92	0.14	0.70	0.64	17.50	0.40	0.17	10.29	0.06	1.02	0.27	0.09	0.11	0.06	3.50	1.11	0.05	0.07
MnO	0.00	0.75	0.00	0.00	0.06	0.85	0.00	0.00	0.54	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.05
MgO	0.00	8.04	0.25	0.45	0.06	1.52	-	19.90	17.36	0.00	0.01	0.11	0.10	0.00	0.14	10.87	0.14	0.15	0.17
CaO	0.30	8.18	52.54	0.50	0.00	20.60	-	0.05	6.41	0.00	0.00	12.92	11.62	6.80	10.22	1.03	23.50	23.91	24.01
Na <sub>2</sub> O	0.00	-	0.27	0.70	0.55	-	0.00	0.02	-	-	-	3.94	6.23	9.22	7.19	2.01	0.10	0.74	0.53
K <sub>2</sub> O	0.00	-	0.00	0.30	0.09	-	0.10	0.03	0.00	-	-	1.08	1.25	0.86	1.25	0.08	tr.	0.21	0.20
P <sub>2</sub> O <sub>5</sub>	-	0.00	41.90	-	-	0.00	0.00	0.00	-	-	-	-	-	-	-	-	0.00	0.00	0.00
SO <sub>3</sub>	-	-	-	-	-	-	tr.	tr.	-	-	-	0.57	0.76	0.05	0.72	-	-	-	-
Cr <sub>2</sub> O <sub>3</sub>	0.18	0.00	-	0.03	0.04	0.00	0.00	0.05	-	0.45	0.09	-	-	-	-	0.19	tr.	tr.	tr.
V <sub>2</sub> O <sub>5</sub>	tr.	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.05	0.02	-	-	-	-	tr.	tr.	tr.	tr.
Cl	tr.	-	1.15	-	-	-	tr.	0.18	-	-	-	1.56	1.70	3.03	1.85	-	-	-	-
F	0.00	-	3.15	0.00	-	-	0.00	0.00	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BeO <sup>(1)</sup>	18.85	-	-	12.25	12.63	-	0.00	0.00	-	-	-	-	-	-	-	-	-	-	-
B <sub>2</sub> O <sub>3</sub> <sup>(2)</sup>	0.00	-	-	0.00	-	-	0.00	3.17	-	-	-	-	-	-	-	10.76	-	-	-
CO <sub>2</sub> <sup>(3)</sup>	0.00	-	1.00	-	-	-	0.00	0.00	-	-	-	2.00	1.50	0.85	2.15	0.00	-	-	-
H <sub>2</sub> O <sup>(4)</sup>	0.00	0.00	0.00	1.47	1.47	0.00	0.00	0.00	0.00	-	-	0.10	0.19	0.15	0.15	3.30	1.10	1.13	0.14
H <sub>2</sub> O <sub>2</sub>																			
O≡Cl,F	99.95	99.85	100.40	100.05	100.36	100.27	100.04	100.26	100.08	99.49	99.89	100.25	100.13	100.28	99.91	100.74	99.54	99.89	100.02
			0.13									0.35	0.38	0.68	0.42				
TOTAL	99.95	99.85	100.27	100.02	100.36	100.27	100.04	100.26	100.08	99.49	99.89	99.90	99.75	99.60	99.49	100.74	99.54	99.89	100.02

See Table I for sample identities 1-19

<sup>(1)</sup> Total iron recorded as FeO

<sup>(2)</sup> Calculated

<sup>(3)</sup> Measured with CO<sub>2</sub> analyser

<sup>(4)</sup> Determined with a thermogravimetric analyser

## A note on red beryl

R.R. Harding

Gemmological Association and Gem Testing Laboratory of Great Britain

### Abstract

The gemmological characteristics of a 4.66ct cut red beryl are described. Electron microprobe analyses of the beryl indicate contents of 2.8 per cent FeO (total iron) and 0.8 per cent MnO<sub>2</sub>, and a complex inclusion cluster of opaque minerals comprising bixbyite, columbite and two unidentified species, one largely composed of manganese and cerium oxides, the other containing these two elements together with significant uranium and thorium.

### Introduction

The recent publication of Hosaka, Tubokawa, Hatushika and Yamashita on red beryl crystals from Utah (*Journal of Gemmology*, July 1993) complements the earlier work of Shigley and Foord in 1984 (*Gems & Gemology*, Winter 1984). Recently Alan Hodgkinson provided the opportunity to examine one of the larger faceted red beryls in existence and it is appropriate to comment briefly on both the spectrum displayed by this stone and the complexity of its inclusions.

### Gemmology and composition

The stone is a deep mixed-cut of fine colour (Figure 1) weighing 4.66ct, with RI of 1.568 – 1.572 and DR of 0.004. Through a hand-held spectroscope the absorption pattern appears as shown in Figure 2 with a wide absorption band from 590–500nm, a

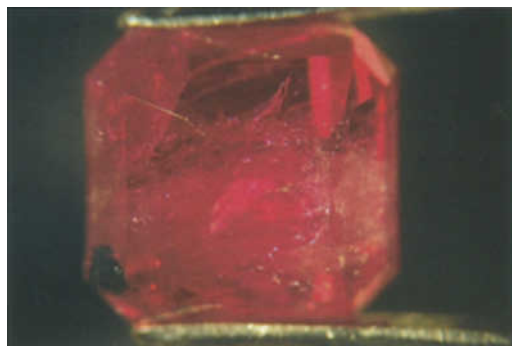


Fig. 1. Red beryl of 4.66ct, viewed from pavilion side, with cluster of opaque inclusions located just below the girdle. Photo: R.R. Harding

weak band at 455nm, a stronger band at 430nm, and general absorption from 420–400nm.

These data are consistent with the spectrophotometer traces published by Shigley and Foord (1984) and by Hosaka *et al.* (1993), although the absorption peaks of the polarized spectra given by Shigley and Foord are slightly different in detail. This variability may be related to the differences in iron content between the stones measured (see below).

Analyses of the red beryl were carried out on a Hitachi scanning electron microscope (SEM) with Link Systems energy dispersive system (EDS) and the mean of 3 spot analyses is given in Table I, column 1. As indicated above, the main difference between the composition of this red beryl and of those reported in the papers cited is the iron content – 2.8 per cent compared with 1.3 per cent (Hosaka *et al.*) and 1.5 – 1.8 per cent (Shigley and Foord).

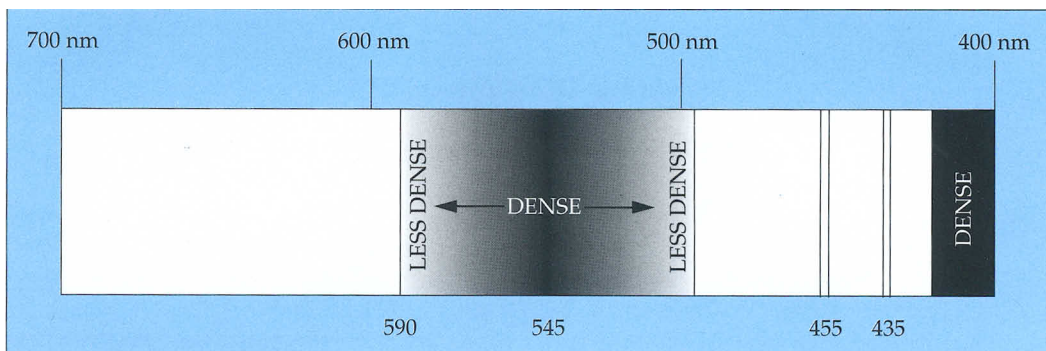


Fig. 2. Visible absorption spectrum of red beryl through diffraction grating spectroscope. The 455nm line is weak.

Manganese (0.8 per cent) is also higher in Alan Hodgkinson's stone and these higher minor element contents may be responsible for the appearance of a spectral absorption band at 455nm.

The red beryl contains a number of black inclusions and conveniently for SEM-EDS analysis, some intersect the surface close to the girdle (Figures 3 and 4). They are rounded or equant polygonal in polished section, and most consist of the iron manganese oxide bixbyite (Table I, column 2).

However, not all the grains are bixbyite, and both within and at the rims of the bixbyite are opaque grains of other species, some not yet identified.

At the core of one bixbyite grain is ferrocolumbite whose composition is given in Table I, column 3; the high total may be a combination of some experimental error and perhaps different oxidation states of the niobium and tantalum. Within and at the edges of the bixbyite are unidentified minerals variably rich in cerium, uranium

Table I: Electron microprobe analyses of 4.66ct red beryl and inclusions

Red Beryl (mean of 3)		Bixbyite (mean of 3)		Columbite		Unidentified mineral UA		Unidentified Mineral UB (mean of 5)	
SiO <sub>2</sub>	67.17	SiO <sub>2</sub>	2.41	SiO <sub>2</sub>	1.69	SiO <sub>2</sub>	1.06	SiO <sub>2</sub>	6.35
TiO <sub>2</sub>	0.29	TiO <sub>2</sub>	1.48	TiO <sub>2</sub>	7.47	TiO <sub>2</sub>	0.25	TiO <sub>2</sub>	0.59
Al <sub>2</sub> O <sub>3</sub>	16.75	Al <sub>2</sub> O <sub>3</sub>	1.71	FeO	19.92	Al <sub>2</sub> O <sub>3</sub>	0.58	Al <sub>2</sub> O <sub>3</sub>	2.31
FeO	2.81	Fe <sub>2</sub> O <sub>3</sub>	44.37	MnO	8.21	FeO	3.50	FeO	5.50
MnO	0.82	Mn <sub>2</sub> O <sub>3</sub>	49.02	CaO	0.27	MnO	9.42	MnO	37.01
CaO	0.13	CaO	0.31	SrO	2.40	CaO	0.56	CaO	1.07
K <sub>2</sub> O	0.10	Na <sub>2</sub> O	0.40	ZrO <sub>2</sub>	2.69	K <sub>2</sub> O	0.40	K <sub>2</sub> O	2.29
		ZrO <sub>2</sub>	0.48	SnO <sub>2</sub>	1.43	ZrO <sub>2</sub>	3.55	SrO	0.90
		MgO	0.07	UO <sub>2</sub>	0.89	UO <sub>2</sub>	15.60	PbO	3.62
				Nb <sub>2</sub> O <sub>5</sub>	54.09	ThO <sub>2</sub>	14.26	Ce <sub>2</sub> O <sub>3</sub>	22.05
				Ta <sub>2</sub> O <sub>5</sub>	4.08	Ce <sub>2</sub> O <sub>3</sub>	47.77	SO <sub>3</sub>	0.85
						SO <sub>3</sub>	0.23		
Total	88.07		100.25		103.14		97.18		82.54



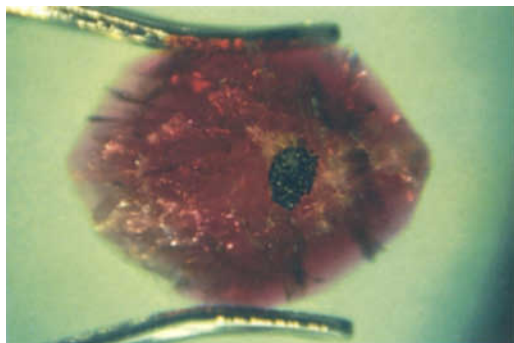


Fig. 3. Red beryl immersed in fluid with opaque inclusions visible just beneath the girdle. *Photo: A. Hodgkinson*



Fig. 4. Cluster of opaque inclusions intersecting the facets of the red beryl show a range of reflectivities. *Photo: R.R. Harding*

or thorium and two compositions are given in columns 4 and 5 of Table I. The composition given in column 5 is the mean of the analyses of 5 spots which gave consistently low totals; these may be due to the presence of low atomic number elements such as lithium or beryllium or hydrogen (water), none of which are detectable by this method of analysis.

### Conclusion

Other methods of analysis would be needed to fully identify these minerals but the SEM-EDS has revealed some of the complexity that may be present among opaque inclusions in gemstones. The presence of cerium-bearing inclusions brings to mind the brown cerium carbonate parasite

which is found in association with the Muzo emeralds in Colombia.

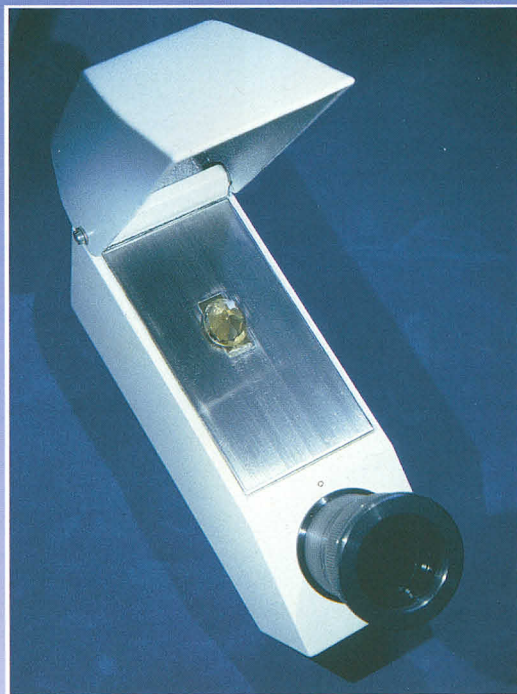
### Acknowledgements

I would like to thank Alan Hodgkinson for the opportunity to examine this rare cut stone, and Ana Castro and Stephen Kennedy for discussion in the laboratory, and Frances Wall and Terry Williams, Natural History Museum, for assistance with microprobe analyses.

### References

- Hosaka, M., Tubokawa, K., Hatushika, T., Yamashita, T., 1993. Observations of red beryl crystals from the Wah Wah mountains, Utah. *Journal of Gemmology*, **23**, 7, 409-11
- Shigley J.E., Foord, E.E., 1984. Gem quality red beryl from the Wah Wah mountains, Utah. *Gems & Gemology*, **XX**, 4, 208-21

# REFRACTOMETER



- Easy to read scale
- Fine definition readings
- Wide prism for large stones
- Built-in monochromatic filter

**Comes with travel case, RI liquid and polarizing filter**

**£275.00 plus VAT, postage and packing**

Members are entitled to a 10% discount.

Remember to quote your membership number

**Gemmological Instruments Limited**

◆ SECOND FLOOR, 27 GREVILLE STREET (SAFFRON HILL ENTRANCE), LONDON EC1N 8SU ◆

Tel: 0171-404 3334

Fax: 0171-404 8843

## Abstracts

Diamonds

Gems and Minerals

Instruments and Techniques

Synthetics and Simulants

Diamonds

### Crystal morphology identification of diamond and ABN.

M.W. BAILEY AND L.K. HEDGES. *Industrial Diamond Review*, 55(1), 1995, 11-14.

The structures of diamond and cubic boron nitride are similar in that they are both strongly bonded covalently with tetrahedral bonding, but are dissimilar in that diamond has a centre of symmetry whereas cBN does not. Crystals of each can be described and distinguished by a simple crystallographic system referred to as the 'morphology index'. This index has been used by De Beers for many years to characterize the extensive range of diamond and ABN (abrasive boron nitride) offered on the market. The morphology index describes the basic characteristics of a crystal in terms of the growth of different crystal faces, which have different mechanical properties (indentation hardness, abrasion resistance and polishing rates, cleavage or fracture energy), and different chemical properties (absorption of chemical species and chemical reactions with oxygen or, for diamond, with carbon solvent metals or carbide formers).

R.A.H.

### Carbon dioxide in strongly silica undersaturated melts and origin of kimberlite magmas.

G.P. BREY AND I.D. RYABCHIKOV. *Neues Jahrbuch für Mineralogie, Monatshefte*, (10), 1994, pp 449-63.

The solubility of CO<sub>2</sub> in melts on the olivine-

melilitite-(CaCO<sub>3</sub>-MgCO<sub>3</sub>) join has been determined at 5-30 kbar. The CO<sub>2</sub> content of gas-saturated melts increases almost linearly with (Ca + Mg) from 9 to 37 wt.% at 30 kbar; at 10 kbar it increases non-linearly with (Ca + Mg), and more rapidly on the carbonate-rich side of the join. A simple thermodynamic model is proposed for CO<sub>2</sub> solubility, which takes into account the higher stability of CaCO<sub>3</sub> compared with (Mg,Fe)CO<sub>3</sub> complexes in the melt. The CO<sub>2</sub> solubility for compositions similar to type 1A kimberlites (characterized by high MgO and relatively low CaO levels) changes sharply in the *P*-range corresponding with the stability field of diamond. The vigorous degassing resulting in hydraulic fracturing of wall rocks may explain the diamondiferous character of these MgO-rich melts.

R.A.H.

### Dating lower crust and upper mantle events: an ion microprobe study of xenoliths from kimberlitic pipes, South Australia.

Y.D. CHEN, S.Y. O'REILLY, P.D. KINNY AND W.L. GRIFFIN. *Lithos*, 32(1-2), 1994, pp 77-94.

Zircons separated from five xenoliths from the Calcutteroo kimberlitic pipes (167-174 m.y.) (three quartzofeldspathic granulites, one mafic granulite and one eclogite) were dated using the SHRIMP ion microprobe. The zircon data indicate that different types of xenoliths had different origins and formed at different times. The combined data-set of all zircon U-Pb ages from all the xenoliths records four major tectonic events associated with zircon formation, recrystallization or

### ABSTRACTORS

R.K. Harrison

R.K.H.

R.J. Peace

R.J.P.

K.A. Riggs

K.A.R.

R.A. Howie

R.A.H.

G. Raade

G.R.

R.E. Samson

R.E.S.

M. O'Donoghue

M.O'D.

P.G. Read

P.G.R.

For further information on many of the topics referred to consult *Mineralogical Abstracts* or *Industrial Diamond Review*.

Pb loss. These events at about 1600-1500, 780, 620 or earlier and 330 m.y., correlate with large-scale tectonic events recorded in adjacent crustal and mantle rocks. The identification of multiple zircon-forming events and the inferred different times of formation of different xenolith assemblages show that Sm-Nd isochron ages based on an assumption of a cogenetic relationship are invalid. G.R.

#### **Majhgawan diamondiferous pipe, Madhya Pradesh, India - a review.**

A.K. CHATTERJEE AND K.S. RAO. *Journal of Geological Society of India*, **45**(2), 1995, 175-89, 2 maps.

The alkaline ultrabasic Majhgawan diatreme was intruded into the Kaimur sandstones of the Lower Vindhyan supergroup (1400-1100 m.y.) overlying the cratonic Bundelkhand granite basement (2550 m.y.), which is a typical archon; recent Rb/Sr age data indicate 1042-1067 m.y. for the Majhgawan pipe. This pipe has a surface dimension of 500 x 320m, and is a carrot-shaped body reminiscent of a typical kimberlite. The rock has been classified as an olivine lamproite lapilli tuff of crater facies. High TiO<sub>2</sub> (4-6%), less abundant heavy indicator minerals such as pyrope and ilmenite, and overall petrological character of the pipe reflect its lamproite nature, as do high amounts of Ba (3000 ppm), Sr (1000 ppm) and REE. On the other hand, the almost concentric distribution of diamonds, mode of occurrence of mantle-derived xenocrysts and overall geochemistry, with high MgO (25%), low K<sub>2</sub>O (1%) and fair amounts of Cr and Ni, are characteristics of a kimberlite. The garnet population and composition are intermediate in character between kimberlite and lamproite. The Majhgawan diamonds (42% of gem grade) have predominantly curved faces and modified forms indicative of resorption. R.A.H.

#### **Origin of vein graphite in high-grade metamorphic terrains. Role of organic matter and sediment subduction.**

C.G. DISSANAYAKE. *Mineralium Deposita*, **29**(1), 1994, 57-67, 2 maps.

A voluminous source of mantle-derived CO<sub>2</sub> has been suggested for the phenomenon of granulite formation. Recent studies on the granulite terrain of Sri Lanka have clearly shown that it is only an upper crustal section and that it was subjected to a much smaller influx of CO<sub>2</sub> than

previously envisaged. The close association of graphite with the granulites, and the recent discovery of grain-boundary graphite in the lower crust, implies graphite as a major source of CO<sub>2</sub>. Recent reports on the discovery of alluvial diamonds within the granulite belt of the Highland complex of Sri Lanka, where graphite is abundant, may indicate penetration of the graphite-diamond inversion line. R.E.S.

#### **Nitrogen aggregation in metamorphic diamonds from Kazakhstan.**

K.S. FINNIE, D. FISHER, W.L. GRIFFIN, J.W. HARRIS AND N.V. SOBOLEV. *Geochimica Cosmochimica Acta*, **58**(23), 1994, 5173-77.

Proton-probe analyses are presented of diamonds separated from Tertiary sands 20km from the type locality of the diamondiferous rocks of the Kokchetav massif; for K, Ca, Ti, Cr, Cu, Zn, Zr and Fe the results are compared to those of diamonds from Zaire, South Africa and the Argyle field. IR and visible absorption spectra show ~48-63% aggregation of single N substitution to A centres. Calculated residence times assuming peak metamorphic *T* of 800-900°C are <0.5 m.y. to 40 m.y. These times, together with petrographical evidence, indicate that the diamonds formed during high-*P* metamorphism rather than being derived from pre-metamorphic sediments. R.K.H.

#### **An atomistic model for stepped diamond growth.**

M. FRANKLACH, S. SKOKOV AND B. WEINER. *Nature*, **372**(6506), 1994, 535-7.

Theoretically, bridging methylene (CH<sub>2</sub>) groups on the {100} plane of diamond growing in the presence of hydrogen can migrate in a manner analogous to surface diffusion. It is shown that this theory can be developed into an atomistic model accounting for stepped growth in diamond through the formation of surface-bound species from gaseous precursors, followed by their migration through surface chemical reactions involving covalent bond breaking and formation. R.K.H.

#### **Trace elements in garnets and chromites: diamond formation in the Siberian lithosphere.**

W.L. GRIFFIN, N.V. SOBOLEV, C.G. RYAN, N.P. POKHILENKO, T.T. WIN AND E.S. YEFIMOVA. *Lithos*, **29**(3-4), 1993, 235-56.

Proton EPMA of trace elements in garnet and

chromite inclusions in diamonds from the Mir, Udachnaya, Aikhal and Sytykansкая kimberlites in Yakutia provide new insights into the processes that form diamond. Equivalent data on garnet and chromite concentrates from these pipes yield information on the thermal state and chemical stratification of the Siberian lithosphere. Peridotite-suite diamonds from Yakutia have formed over a  $T$  interval of  $\sim 600^\circ\text{C}$ , as measured by Ni and Zn thermometry on garnet and chromite inclusions. Individual diamonds contain inclusions recording  $T$  intervals of  $>400^\circ\text{C}$ ; ranges of  $>100^\circ\text{C}$  are common. Diamond formation followed a severe depletion event, and a separate enrichment in Sr. Comparison of  $T$  on garnet and spinel inclusions with  $T$  derived from diamondiferous harzburgites, exposed inclusions in boart and concentrate minerals suggest that the diamond-containing part of the lithosphere has cooled significantly since the Siberian diamonds crystallized. The peridotite-suite diamonds probably formed mainly in response to one or more relatively short-lived events, related to magmatic intrusion. The  $N$  part of the Daldyn-Alakit district may have had a typical cratonic geotherm at the time of diamond formation, and during kimberlite intrusion. The  $S$  part of the district, and the Malo-Botuobiya kimberlite field, probably had a relatively low geotherm ( $\sim 35 \text{ mW/m}^2$ ). The vertical distribution of garnet and chromite types indicates that the mantle above 120 km depth is dominated by lherzolites, whereas the deeper parts of the lithosphere are a mixture of lherzolite and more depleted harzburgites and dunites. G.R.

#### Trace elements in diamond inclusions from eclogites reveal link to Archean granites.

T.R. IRELAND, R.L. RUDNICK AND Z. SPETSIUS. *Earth & Planetary Science Letters*, **128**(3-4), 1994, 199-213.

Trace element data are reported for rare inclusions of garnet and clinopyroxene in diamonds in eclogite xenoliths from the Udachnaya pipe in the Daldyn-Alakit kimberlite field of Siberia. These inclusions are more depleted in incompatible trace elements and have lower  $mg$  numbers than the eclogite host minerals, reflecting metasomatic enrichment of the eclogites after diamond formation.

Experimental studies are interpreted as showing that eclogites of this type are in equilibrium with silicic melts such as tonalites or trondhjemites. Thus, both the trace element data

and petrological considerations are consistent with the eclogites forming in equilibrium with Archean tonalitic or trondhjemitic magmas.

R.A.H.

#### Gem Trade Lab notes.

R.C. KAMMERLING AND C.W. FRYER. *Gems & Gemology*, **31**(1), 1995, pp 52-8, 15 illus. in colour.

A marquise-cut diamond showed an unusual fracture with thin film iridescence and natural colour staining which might be confused with the flash effect of a filled diamond. However, the 'feathery' appearance was typical of an unfilled break.

A new type triangular inclusion in a diamond is described. A triangular plane containing separate trigons was seen to be one of the octahedral faces of a phantom crystal within the host. The high relief of the trigons was attributed to gas trapped in the triangular voids formed at the interface of the phantom crystal and the host.

A dark red brilliant-cut diamond could be picked up with a hand magnet and contained inclusions with metallic lustre. Long wave UV revealed a cross-shaped area with green fluorescence whilst the rest of the stone remained inert; the stone fluoresced a faint orange under short wave UV. Visible spectroscopy revealed several absorption lines between 500 and 660 nm including lines at 595 and 635 nm with an emission line at 580 nm. This pattern is typical of a treated stone. R.J.P.

#### Gem news.

J.I. KOIVULA, R.C. KAMMERLING AND E. FRITSCH. *Gems & Gemology*, **30**(4), 1994, pp 271-80, 16 illus. in colour.

The occasional diamond found in the Appalachian Mountains has been suggested to have local sources. Previous explanations include glacial transport and deposition by migratory birds.

Initial surveying on the Kahama/Shinyanga diamond leases in Tanzania by Serengeti Diamonds shows that diamond concentration in these secondary deposits is higher than that in the initial pipe due to wind action with an estimated deposit of 258 000 ct. A US\$8 million upgrade of the Mwadui mine discovered by Dr J. Williamson in 1940 is to be carried out since superficial reserves were exhausted in the 1980s.

United Reef Ltd of South Africa have reported results of valuations on diamonds from its Bamingui Project showing US\$150 per carat

making this one of the world's highest in terms of dollars per carat.

Canadian diamond prospects received a major setback in August 1994 when sampling at the Tli Kwi Cho kimberlite pipe in the Lac de Gras area of the Northwest Territories showed unexpectedly low results. A further poor report from the Torrie pipe in the Yamba Lake area produced a crash in diamond stocks which hurt investor confidence. However encouraging results have been obtained from a cluster of pipes in the Corridor of Hope which cuts through the Lac De Gras area. BHP/Dia Met are starting a feasibility study and hope to start mining before the year 2000.

Prospecting in Finland has received increased interest after Ashton Mining (Australia) discovered 21 kimberlite pipes and recovered several diamonds over 2 carats. R.J.P.

#### **Geoscience 1994 and beyond: thoughts on geology and exploration for world-class ore deposits.**

P.J. LEGGE. *Australian Journal of Earth Sciences*, 42(1), 1995, 1-10.

In this Presidential Address, the use of new technologies is highlighted in a summary of developing concepts for exploration criteria. By determining the Ni content of a suite of kimberlite pyropes, it is possible to estimate the *P-T* conditions of garnet formation and hence judge the probability of formation in the diamond window of 850-1200°C at 150-200km depth depending on the geotherm. This work has been extended to estimate maximum grade (carats/tonne) in a kimberlite, based on the mix of mantle rocks entrained and the degree of metasomatism as measured by the Zr content of a suite Cr-pyropes from a pipe. R.A.H.

#### **Diamonds and their sources in the Venezuelan portion of the Guyana Shield.**

H.O.A. MEYER AND M.E. MCCALLUM. *Economic Geology*, 88 (5), 1993, pp 989-98, 5 maps.

Two sources are suggested for the diamonds. The secondary source is the 2000m thick Roraima group of Proterozoic age. The main sources probably are unknown Proterozoic kimberlites or lamproites in the Guyana Shield of the Amazonian craton. No evidence exists to support an African source. K.A.R.

#### **Paleomagnetism of some Indian kimberlites and lamproites.**

K.C. MILLER AND R.B. HARGRAVES. *Precambrian Research*, 69(1-4), 1994, pp 259-67, 1 map.

Consistent vectors have been isolated by AF demagnetization of 22 cores from two sites in Proterozoic kimberlites in the Wajrakarur district of the Dharwar craton (pole at 45.4°S, 121.5°W), and 12 cores from two sites from the mine at Majhgawan in the Panna district of the Aravalli craton (pole at 38.9°N, 216.5°E). Surprisingly, these 1200-1000 m.y. poles fall close to roughly coeval points on the APW curve for the Kalahari craton in a Gondwana reconstruction. If the poles and their ages are correct, these data constrain Mesoproterozoic supercontinental reconstructions. R.E.S.

#### **Compositions of garnet and spinel from the Aries diamondiferous kimberlite pipe, central Kimberley block, Western Australia - implications for exploration.**

R.R. RAMSAY, D. EDWARDS, W.R. TAYLOR, N.M.S. ROCK AND B.J. GRIFFIN. *Journal of Geochemical Exploration*, 51(1), 1994, 59-78, 2 maps.

This weathered, micaceous kimberlite pipe is the largest and most diamondiferous of the few kimberlites currently known in Australia. It contains abundant country rock xenoliths, but the only mantle-type inclusions so far recovered are individual grains of Cr-spinel, rare chromian pyrope and diamond. Aries differs from other kimberlites of similar age in the block in the absence of megacrystic minerals. Chromian pyrope has compositions which indicate garnet lherzolite and garnet wehrlite in the upper mantle, but harzburgitic 'G10' garnets, considered the paramount indicator of diamondiferous kimberlite in S. Africa, have not been recovered at Aries where spinel has been the most important indicator mineral in the discovery. This can be distinguished, morphologically and compositionally, from spinel in local basaltic country rocks. The spinels in the pipe have a range of internal features which can be allocated to six types which in turn can be combined into two broader classes. Both Class 1 and 2 spinels may be associated with Ti-rich Cr-spinel which is compositionally similar to titaniferous Cr-spinel from the groundmass. R.E.S.

#### **[Mineralogical and petrological features of alkali-ultramafic lamprophyres and kimberlites of Kola Peninsula.] (Russian with English Abstract.)**

S.K. SIMAKOV, E.A. BAGDASAROV AND L.I.

LUKJANOVA. *Proceedings of the Russian Mineralogical Society*, 123(1), 1994, 26-40.

Dykes and explosion pipes of alkali-ultramafic lamprophyres and kimberlites occur mainly in the S part of the Kola Peninsula, controlled by deep fault structures. Their formation corresponds with the final stage of alkali magmatism in the Palaeozoic Kandalaksha graben. Geochemically, these lamprophyres are rich in Fe and Ti, with high Na content. In kimberlites the  $Al_2O_3$ ,  $\Sigma Fe$  and  $SiO_2$  decrease with increasing MgO content and  $K_2O/Na_2O$  ratio. Numerous EPMA results are reported for olivines, clinopyroxenes, garnets, chrome spinels, ilmenites and micas, together with clinopyroxenes, garnets and amphiboles from xenoliths in the explosion pipes, and native gold from a melteigite dyke, and native copper, silver, argentite, chalcocite and gersdorffite from a fine-grained kimberlite. The *P-T* conditions for lamprophyre magma formation are estimated to be in the range 10-40 kbar, 1425-1320°C, corresponding with a depth for the magma chamber of 40-130km. For kimberlitic magma, the formation *T* is estimated at 1360-1450°C, the *P* 30-51 kbar and the depth of magma chamber 110-160km. In general, there is a tendency for increase in chamber depth from W to E, towards the Archangelsky kimberlite province; this is reflected in the chemistry of the rocks and minerals, with increasing Mg, reduction in Ti and Na and a decrease of Ca in the olivines.

R.A.H.

### Story on the 'Cross of Asia' fancy yellow radiant cut diamond.

A. SZYMANSKI. *Archiwum Mineralogiczne*, 50(1), 1994, 137-8.

An examination by the author of this diamond (fifteenth on the GIA list of clearly yellow coloured diamonds) is reported. Found in Jagersfontein mine, South Africa, in 1902, this stone originally weighed 280ct; it was cut first to 142ct and later recut three times to 112, 109.28 and finally to 79.12ct. It now has a rectangular shape (28.67 x 22.21 x 15.77mm) and the play of colours on the table facet create the outline of a Maltese cross.

R.A.H.

### The generation of kimberlites, lamproites and their source rocks.

K.M. TAINTON AND D. MCKENZIE. *Journal of Petrology*, 35(3), 1994, 787-817, 1 map.

Measurements of the REE concentrations in South African kimberlites and in the Argyle lam-

proite from Western Australia constrain the composition of the source rocks from which these melts originate. To account for the amounts of Tm, Yb and Lu in these magmas, their sources must first have been strongly depleted by ~20% melting in the garnet stability field, and then enriched by a metasomatic melt rich in LREE and other incompatible elements. The calculated source compositions strongly resemble those of coarse, low-*T*, depleted peridotite nodules that are the commonest nodules in kimberlites. The REE composition of the metasomatic melt calculated from the diopsides and garnets in the sheared nodules, from the diopside megacrysts and from majorite garnet inclusions in diamonds is in excellent agreement with that expected for a melt produced by melting ~0.5% of the source region of ocean ridge basalts. The initial depletion event requires the extraction of ~20% melt from a region in which garnet and chrome-spinel were stable. The melt distribution obtained from the inversion of komatiite composition satisfies both these conditions. Kimberlite source rocks are shallower than the layer from which fertile nodules originate. Such nodules must therefore be transported by entrainment of the lower boundary of the layer that became unstable.

R.A.H.

### The Luanda diamond fields [Part 1].

A. THOMAS. *South African Gemmologist*, 9(2), 1995, pp 10-23, 3 maps (2 in colour).

First part of an account of the author's study of the history of exploration for diamonds in north-east Angola giving notes on the history of diamond recovery, export and marketing from this area. The bibliography is less helpful than at first appears, with some citations mistranscribed.

M.O'D.

### UV-induced colour change in pink diamonds.

J. VAN ROYEN. *Antwerp facets*, March 1995, 21-4, 4 photos in colour, 3 figs. in colour.

This issue contains the 1994 annual report of the Diamond High Council.

Some pink diamonds have been found to change to a brown colour when exposed to intense UV radiation, the pink colour returning after a period of time. The absorption band near 550nm is reduced in strength by the irradiation. Heating to approximately 250°C will restore the original colour more quickly.

M.O'D.

**Analysis of diamonds and indicator minerals for diamond exploration by laser ablation inductively coupled plasma mass spectrometry.**

R.J. WATLING, H.K. HERBERT, I.S. BARROW AND A.G. THOMAS. *Analyst*, **120**(5), 1995, pp 1357-64.

A method has been developed, using laser ablation – inductively coupled plasma – mass spectrometry (LA-ICP-MS), for the semiquantitative determination of 43 elements in diamonds, chromites and garnets. Samples of diamonds from five different countries and the interrelationship between their trace elements gives distinctive patterns for each source. This should allow the tracing of stolen diamonds and can also be used to establish the trace element distribution in indicator minerals for diamond exploration, such as garnets and chromites. The relative distributions of the REE, Ta and Hf indicate a consistent inter-element relationship for garnets associated with diamondiferous kimberlites; the trace element partitioning pattern of chromites can be used to establish a kimberlite or non-kimberlite provenance of this mineral. R.A.H.

West Africa, has produced specimens in a wide range of colour. X-ray diffraction and X-ray fluorescence analysis confirmed it as grossular but the refractive indices of a number of specimens ranged from 1.764 to 1.782 which are in excess of the range up to 1.760 quoted by Stockton and Manson (1985). Specific gravity determinations were within the quoted range of 3.65 to 3.67. All the specimens showed an absorption band at 440 - 445 nm (attributed to iron), which is not normally expected in grossular garnet. R.J.P.

**A further update on value-enhanced jadeite.**

G. BROWN. *South African Gemmologist*, **9**(1), 1995, pp 8, 17-18, 26-27, 30-31.

Notes on CIBJO rulings on value-enhanced jadeite, the enhancement commonly arising through waxing, resin coatings or epoxy-type fracture fillings. The writer feels that disclosure of enhancement should always be made. Details of some treatments and methods of identification are given. M.O'D.

**An unusual sapphire-zircon-magnetite xenolith from the Chanthaburi gem province, Thailand.**

R.R. COENRAADS, P. VICHIT AND F.L. SUTHERLAND. *Mineralogical Magazine*, **59**(3), 1995, pp 467-81.

A sapphire-, zircon- and magnetite-bearing xenolith is reported from alkali basalt at Khao Wua, near Chanthaburi, and is taken to demonstrate a common origin for sapphire, zircon and magnetite found in alluvial deposits in the Chanthaburi gem fields. The original Al- and Ti-rich octahedral magnetite crystal in the xenolith exsolved into hercynite, magnetite and hematite during cooling; it includes minor anhedral jarosite-alunite, possibly from an iron-sulphide-rich immiscible liquid. U-Pb dating of zircon in the xenolith gives an age of 1-2 ( $\pm$  1) m.y., falling within the fission-track ages for alluvial zircons ( $2.57 \pm 0.20$  m.y.) from the Chanthaburi-Trat gem fields and within the K-Ar ages of 0.44-3.0 m.y. for the alkali basalt volcanism in the Chanthaburi province. These data suggest a common origin for sapphire, zircon and magnetite, and link them with the processes involved in alkali basaltic magma generation. The high Fe and Zr, low Mg, and the inferred sulphides suggest pegmatite-like crystallization in an incompatible-element-enriched, silica-poor magma (partial melt or fractionation product) in the deep crust or upper mantle. Etch features on exposed surfaces of the xenolith indicate that it

Gems and Minerals

**Die Cabochonsammlung, eine interessante Variante des Sammlung von Mineralien.**

W. BECK. *Aufschluss*, **46**, 1995, pp 181-3, 6 photos (3 in colour).

A review of the fashioning and collecting of cabochon-cut gem and ornamental minerals, with particular reference to agate. M.O'D.

**Gems around Australia - part 10.**

H. BRACEWELL. *Australian Gemmologist*, **19**(1), 1995, pp 23-4, 6 illus. in colour.

This section describes a visit to the Marra Mamba tiger's-eye deposit 6km south of the majestic Hamersley Range main escarpment in the Pilbara area of Western Australia. Specimens range from a rich coppery coloured tiger's-eye to tiger's-eye with an attractive picture jasper. Although extensive deposits of blue asbestos or crocidolite are present, it takes a silica enrichment to leach into the seams to produce golden tiger's-eye. R.J.P.

**A new variety of grossular garnet with extended gemmological constants.**

R. BRIGHTMAN. *Australian Gemmologist*, **19**(1), 1995, pp 19-22, 1 table, 3 illus. in colour.

A new source of grossular garnet from Mali,



was transported out of its equilibrium environment by the rise of later magma. R.A.H.

### **Alteración de las inclusiones de zircón, apatito y vidrio en el tratamiento térmico de rubies y zafiros.**

J.S. CÓZAR AND I. DE VICENTE-MINGARRO. *Boletín del Instituto Gemológico Español*, **36**, 1995, pp 47-54, illus. in colour.

Alteration of mineral inclusions is one of the indications of the heat treatment of corundum. Features of the alteration of zircon, apatite and glass are discussed. M.O'D.

### **A la recherche de la glyptique moderne.**

M. DUCHAMP. *Revue de Gemmologie*, **123**, 1995, pp 4-8, 8 photos (2 in colour).

Description of the work of some contemporary glyptic artists with notes on the ornamental materials used. M.O'D.

### **Pink topaz from the Thomas Range, Juab County, Utah.**

E.E. FOORD, W. CHIRNSIDE, F.E. LICHTER AND P.H. BRIGGS. *Mineralogical Record*, **26**(1), 1995, 57-60, illus. in colour.

Topaz is found in lithophysal cavities in rhyolite in the Thomas Range, Juab County, Utah, USA. The geology and mineralogy of the area are described and there is a list of minerals identified from the Topaz Mountain rhyolite. Topaz crystals showing a sherry-brown colour typically fade to colourless within weeks: some other crystals show a more or less uniform pink colour and are of gem quality. Some crystals show a pink-red colour masked to some degree by a sherry-brown colour which fades on exposure to sunlight: the underlying pink-red colour in such cases does not fade. The topaz is extremely fluoride-rich and contains almost no water. The pink colour is not ascribed, as formerly, to Cr as a trace element but to the substitution of  $Al^{3+}$  by  $Mn^{3+}$  or  $Fe^{3+}$ . M.O'D.

### **Occurrences of boron-free and boron-poor kornerupine.**

C.R.L. FRIEND. *Mineralogical Magazine*, **59**(1), 1995, pp 163-6.

The problem of kornerupine virtually free of B is discussed and a new analysis is reported of a cream-coloured kornerupine from an area of amphibolite-facies rocks 50km E of Fiskensæset, SW Greenland; this mineral has  $B_2O_3$  0.38 wt.%, equivalent to B 0.081 pfu. It is suggested that a

new term 'boron-free' kornerupine be introduced to cover those samples with 0.2 B pfu. R.A.H.

### **An evaporitic origin of the parent brines of Colombian emeralds: fluid inclusion and sulphur isotope evidence.**

G. GIULIANI, A. CHEILLETZ, C. ARBOLEDA, V. CARRILLO, F. RUEDA AND J.H. BAKER. *European Journal of Mineralogy*, **7**(1), 1995, 151-165.

The fluids trapped by emerald, dolomite and pyrite in the Colombian emerald deposits consist predominantly of Na-Ca brines with some KCl; the similarity of the fluid composition in the E and W emerald zones demonstrates the homogeneity of the parent fluids. The Na-Ca-K chemistry of the brines gives strong support for an evaporitic origin of the parent hydrothermal fluids. The  $\delta^{34}S$  values of  $H_2S$  in solution in equilibrium with pyrite from six emerald deposits range from 14.8 to 19.4‰ whereas sedimentary pyrite from the enclosing black shales yield a  $\delta^{34}S$  of -2.4‰. The narrow range in  $\delta^{34}S_{H_2S}$  between the different deposits suggests a uniform and probably unique source for the sulphide-sulphur. The high  $\delta^{34}S_{H_2S}$  values suggest the non-participation of magmatic or early Cretaceous black-shale sulphur sources. Saline diapirs occur in the emeraldiferous areas and the most likely explanation for high  $\delta^{34}S$  involves the reduction of sedimentary marine evaporitic sulphates. This type of unique emerald deposit corresponds with mesothermal deposits (300°C), formed in a sedimentary environment and produced through thermochemical reaction of sulphate-rich brines to  $H_2S$  by interaction with organic-rich strata.

R.A.H.

### **The symmetry of vesuvianite.**

L.A. GROAT, F.C. HAWTHORNE, T.S. ERCIT AND A. PUTNIS. *Canadian Mineralogist*, **31**(3), 1993, pp 617-35.

Examination of the physical and chemical properties of 76 samples of vesuvianite from 50 localities is reported. On the basis of optical properties, three groups are recognized: 1) normal crystals which show uniform extinction and small (0-5o) 2V, 2) blocky crystals showing irregularly-shaped areas of variable birefringence in a (001) section, with 2V 5-35°, and 3) sector-zoned crystals showing {001}, {101} and {100} sectors with low (~5°), intermediate (20-35°) and high (40-60°) 2V, respectively. A combination of optical and XRD evidence indicates that the symmetry of vesuvianite is  $P2/n$  (or  $Pn$ ). It is

suggested that there is a virtually continuous ferroelastic phase transition between a high- $T$   $P4/nnc$  structure and a low- $T$   $P2/n$  or  $Pn$  structure. The variety of optical types of vesuvianite results from different relationships between the  $T$  interval of crystallization and the  $T$  of the phase transition. R.A.H.

**Precious layer opal with a complex sedimentary formation process as colloid chemical precipitation, sedimentation and evaporation.**

H. HARDER. *Neues Jahrbuch für Mineralogie, Monatshefte*, (3), 1995, pp 121-6.

Experimental work leads to the conclusion that the formation of layer opal in desert conditions is controlled not only by evaporation but also by the enrichment and separation of  $\text{SiO}_2$  from the primary alkaline weathering solutions. Neutralization by  $\text{CO}_2$  vapour may result in an oversaturation and a slow precipitation of  $\text{Al}(\text{OH})_3$  together with a strong colloid chemical enrichment of  $\text{SiO}_2$ . After deposition as porous jelly opal, the primary water-rich layer opal can slowly dry out to a solid opal, which may rarely form a layer of precious opal. R.A.H.

**Influence of chemistry on the pyroelectric effect in tourmaline.**

K.D. HAWKINS, I.D.R. MACKINNON AND H. SCHNEEBERGER. *American Mineralogist*, 80, 1995, pp 491-501, 5 figs.

In tourmaline the pyroelectric coefficient is variously affected by elements occupying the X, Y and Z cation sites in the structure. The effect is strong when Fe occupies the octahedral Y site since Fe prefers this position and the effect increases when Fe and Mg cations are added to the smaller Z octahedral site. Whether or not this indicates a determinable trend is hard to distinguish since in tourmaline in almost all samples Al occupies the Z site to the exclusion of other cations. Occupancy of the X site does not affect pyroelectricity. M.O'D.

**Eindrücke und mineralogisch-geologische Notizen von der Tansanit-Grube in Mirerani bei Arusha/Tansania.**

B. HERGARTEN AND M. HERGARTEN. *Aufschluss*, 46, 1995, 43-6, 5 photos, 1 map.

Account of the tanzanite deposits of Mirerani in the area of Arusha, Tanzania, and their working. M.O'D.

**Alexandrite chrysoberyl surprises.**

A. HODGKINSON. *Australian Gemmologist*, 19(1), 1995, pp 25-8, 1 illus. in black-and-white, 5 in colour.

Attention was drawn to the striking trichroism shown by natural alexandrite but refractive indices of  $\alpha = 1.761$ ,  $\beta = 1.770$  and  $\gamma = 1.773$  not only showed anomalously high values but also that it was biaxial negative rather than positive. These properties were attributed to a higher than normal iron content. Alexandrite and ruby absorption spectra are normally quite similar but in this stone there is a strong band at 444nm typical of chrysoberyl. Examination of a synthetic alexandrite showed that it possessed properties identical to those of natural alexandrite. Another stone, a Uralian alexandrite, appeared red in incandescent light but blue rather than green in daylight conditions. It has normal constants for chrysoberyl and its chromium content was confirmed by chemical analysis. In this case the iron content was greater than that of chromium. A synthetic green chrysoberyl with chromium provided additional interest and prompted the suggestion that despite a Cr spectrum its lack of colour change could be attributed to nickel and iron being leached from the walls of the growth cylinders. R.J.P.

**Gem Trade Lab notes.**

R.C. KAMMERLING AND C.W. FRYER. *Gems & Gemology*, 30(4), 1994, 264-70, 17 illus. in colour.

A light yellow diamond was shown to have been treated by examination of the mid-infrared spectrum which revealed H1b and H1c lines. A carved emerald fetish from a pre-Columbian necklace was confirmed as natural with no clarity enhancement. A feldspar represented as sanidine was shown to be labradorite with refractive index values of 1.559-1.568. A simple test to distinguish some plagioclase feldspars from alkali feldspars is the appearance of brilliant multi-coloured stripes showing polysynthetic twinning which only occurs in feldspars of the triclinic system, thus microcline and the plagioclases show twinning but not sanidine or orthoclase. A grossular-andradite garnet from Mali West Africa as yellow-green rough had a single RI value of 1.77 an SG of 3.65 and strong ADR. Microscopy showed an unusual pattern resembling dodecahedral growth and a wispy horse-tail inclusion. Its nature was confirmed by X-ray powder diffraction and EDXRF analysis. A

jadeite bracelet was shown to be bleached and impregnated. Removal of impurities with acid had left a honeycomb surface. A drop of hydrochloric acid remained intact and infra-red spectroscopy showed evidence of polymer treatment. A synthetic malachite necklace had a spot RI of 1.55 and only slight effervescence with hydrochloric acid. It showed a conchoidal fracture and fluoresced green to both long and short-wave UV. Destructive tests with a hot needle turned the material a chalky white with melting. A genuine malachite necklace showed a strong birefringent blink on the refractometer and effervesced strongly with hydrochloric acid. It was inert to both forms of UV and with a hot needle produced a brown spot with no melting.

Abalone 'Mabe' pearls made with blister pearls cultivated in the abalone shell showed a fine cellular structure in the blister portion while strong yellow fluorescence to long wave UV showed its derivation from abalone. A non-nacreous cultured pearl described as resembling a shiny black marble from the black-lipped oyster harvested in French Polynesia was thought to be the result of an unusual culture in which critical epithelial cells were missing.

A sapphire with an unusual reddish-brown colour, similar to that of alexandrite in incandescent light but with no colour change was due to pink and green-blue bands with some influence from the stone's dichroism. The high RI values of 1.775-1.784 still fell within the quoted limits for natural brown sapphire. A synthetic pink sapphire showed a strong red fluorescence but the typical bluish-white reaction to short-wave UV was uneven and confined to clearly defined curved colour bands. R.J.P.

#### **Gem Trade Lab notes.**

R.C. KAMMERLING AND C.W. FRYER. *Gems & Gemology*, 31(1), 1995, pp 52-8, 15 illus. in colour.

An alexandrite with a green to purple colour change had optical properties typical of alexandrite but twinning was shown by brightly coloured irregularly-shaped worm-like areas under magnification and using a polar.

A filled emerald with unusual flash-effect colours showed orange to pinkish-purple in one direction and a blue and orange effect in another. The reason may be that emerald, being uniaxial with two distinct refractive indices, produced two crossing dispersion curves in conjunction with a non-crystalline filler. The flashes occur at the wavelength at which the refractive indices

match. Bright field illumination produces blue whilst dark field illumination gives the complementary colour orange, these forming a colour pair. In the other orientation orange to pink forms the dark field colour. The expected bright field colour green to blue green was probably masked by the body colour.

A mottled green cabochon with typical jadeite properties was shown to be bleached and polymer impregnated. Microscopically, certain grains were shown to be eroded, whilst infrared spectroscopy confirmed the presence of a polymer. A jadeite necklace was shown to contain both natural and treated beads. Of the two jades, jadeite is much more commonly colour-enhanced, so it was unusual to come across nephrite cabochons dyed green. The visible spectrum showed a dye band in the red centred at 660nm. A purple sapphire cabochon with diffusion induced colour and star on immersion in methylene iodide showed a red colour confined to the surface and a number of red spots near the centre of the star which suggested that the original intention was to produce ruby.

A green star sapphire was described with an absorption line at 670nm attributed to cobalt and showing uneven asterism. Energy dispersive X-ray fluorescence spectroscopy (EDXRF) indicated cobalt as the colouring agent. A natural spinel with a dendritic iron stain which could be confused with yellowish-white or yellowish-brown flux was confirmed by EDXRF spectroscopy. In addition the stone had inclusions in the form of octahedral crystals as well as large feathers. In some flux-grown synthetic spinels pyramid-shaped phantoms in near perfect alignment with external faces and edges of the octahedra are present and could be confused with octahedral inclusions present in the natural stone. R.J.P.

#### **Ruby and sapphire from the southern Ural Mountains, Russia.**

A.J. KISSIN. *Gems & Gemology*, 30(4), 243-52, 2 tables, 10 illus. in colour.

Ruby and sapphire have been known in the South Urals for over a century and were presumed to be in pegmatites. In 1978 the author postulated that these may have originated in the marbles which were widespread in the Kootchinskoye area. Ruby and sapphire mineralization is now known to occur in marbles within four metamorphic complexes in the Urals. These gemstones were found *in situ* as well as in alluvial deposits. From the known geology other

corundum bearing areas are believed to exist in the 600km linear belt including Ekaterinburg, Chelyabinsk and Plast. At present gem quality stones are being evaluated prior to commercial extraction.

A detailed examination of the Kootchinskoye marbles revealed that of three types only dolomitic calcite marble contained corundum. Rubies and sapphires could be grouped in three main classes but only two had good enough colour and clarity for faceting. One class consisted of ruby in thick platy well formed crystals with inclusions of pyrites and gas. The other consisted of rounded and acicular pink sapphires with pyrites, black rutile and gas inclusions.

Some corundum deposits in Myanmar, Pakistan, Afghanistan and Tanzania are similar. In the system corundum + dolomite = spinel + calcite + carbon changes in pressure and temperature are important and the magnesium content of the marble will have a major influence on whether spinel is the preferred (stable) mineral phase. R.J.P.

#### **Inclusions in quartz.**

J.I. KOIVULA AND R.C. KAMMERLING. *South African Gemmologist*, 9(1), 1995, pp 7-16, 12 photos in colour.

An illustrated summary of mineral and other inclusions in quartz with a table of minerals so far identified. M.O'D.

#### **Inclusions in garnets.**

J.I. KOIVULA AND R.C. KAMMERLING. *South African Gemmologist*, 9(2), 1995, pp 24-32, 12 photos in colour.

Illustrated general survey of the main inclusions in gemstones of the garnet group. The horsetail effect in the demantoid variety of andradite is now ascribed to tremolite-actinolite or to chrysotile. In orange spessartine recently found in Namibia black grains are identified as manganese oxide, and transparent virtually colourless needles as tremolite. M.O'D.

#### **Gem news.**

J.I. KOIVULA, R.C. KAMMERLING AND E. FRITSCH. *Gems & Gemology*, 30(4), 1994, pp 271-80, 16 illus. in colour.

A new source of amethyst from North Namibia yields several tons annually but mining can only take place in the six-month dry season. An unusual chatoyant demantoid garnet had the horsetail inclusions orientated in a parallel

fashion with some inclusions 'bending back' on themselves. A colour-change diaspore from Turkey showed a distinct colour change from brownish-pink in incandescent light to brownish-green in daylight. The brown colour was attributed to Fe<sup>3+</sup> whilst Cr<sup>3+</sup> caused the colour change. White translucent cabochons with red crystal inclusions from Myanmar were shown by X-ray diffraction analysis to be plagioclase feldspar with ruby. Gems from North Carolina included cabochons of emerald matrix and of kyanite of greenish-blue to blue with colourless areas. Peridot from Pakistan in the far western Himalayas has standard gemmological properties. On the basis of RI and SG values the material is 90 per cent forsterite and 10 per cent fayalite. Black rod-like inclusions present in the rough proved to be the magnesium iron borate mineral ludwigite. Large blue sapphire crystals were reported from the Isle of Lewis, Scotland, including one of 242 carats. A blue cobalt-coloured spinel from Burma showed abundant iron, a trace of manganese and unusually high nickel content; cobalt was not detected.

A general shortage of gems from Sri Lanka has been blamed on unusual weather conditions. Large reserves of 'zebra stone' are reported from Arizona consisting of actinolite or tremolite amphibole and plagioclase feldspar. R.J.P.

#### **Gem corundum in alkali basalt: origin and occurrence.**

A.A. LEVINSON AND F.A. COOK. *Gems & Gemology*, 30(4), 1994, 253-63, 1 table, 7 illus. in colour.

The majority of gem corundums in the jewellery industry are derived from secondary deposits in SE Asia and Australia, and are associated with alkali basalts which are uncommon geologically. The mineralogy and chemistry of the basalts are well reviewed; the basalts are silica-deficient and do not contain visible quartz. From the theory of plate tectonics the subduction of oceanic basalts beneath a continental plate may eventually give rise to tholeiite basalts and alkali basalts with the latter forming at depths greater than 50-60km. Although associated with alkali basalt, sapphires may not have crystallized from it, being xenocrysts derived from broken or molten xenoliths. Other xenocrysts in alkali basalts include zircon, some garnets and spinel. Two mechanisms of corundum formation each involving a different starting material are discussed. One mechanism involves subduction of

aluminium-rich shales with muscovite which breaks down to give orthoclase feldspar and corundum, providing that quartz is absent. A second mechanism involves hydrated aluminium oxides such as gibbsite and diaspore. Conditions for this may exist at depths as shallow as 24km. The mechanism for the transport of corundum to the surface is described in detail.

Alternative theories based on studies on Australian deposits attach great importance to associated inclusions such as zircon. A model involving two magmas was evolved by Coenraads. The first, a carbonate-enriched mafic magma containing metals not associated with common rock forming minerals, allows corundum to crystallize within it. The second magma of alkali basalt entrains the corundum on eruption. Guo developed a more complex multi-stage model involving four magmas and possibly too many special conditions to occur on a large scale. It is hoped that the use of such models will enable future sites of corundum deposits to be predicted. R.J.P.

#### Farbenstehung und -verteilung in fluorit.

W. LIEBER. *Aufschluss*, 46, 1995, 1-11, 18 photos (15 in colour).

The cause of colour in fluorite is discussed with examples taken from a variety of locations.

M.O'D.

#### Hanneman-Hodgkinson synthetic emerald filter.

T. LINTON AND A. SHIELDS. *Australian Gemmologist*, 19(2), 1995, pp 65-8, 1 table, 5 illus. in black-and-white.

The Hanneman-Hodgkinson synthetic emerald filter (referred to as the H-H filter) holds two gelatin filters, one an orange-yellow and the other blue. These combined filters allow transmission of 3 per cent of the 480-560nm wavelengths and 66 per cent of all red wavelengths above 670nm. Essentially it transmits more red, yellow and green wavelengths than the Chelsea Filter. Whilst the Chelsea Filter spots most emeralds by a pink/red response, the H-H Filter distinguishes all synthetics from natural by the pinkish/reddish response of the synthetics (with stated exceptions of the Biron/Pool hydrothermal synthetic emeralds, unspecified Russian hydrothermal synthetics and Lechleitner coated beryl). The manufacturers suggest that the stone should have its optical properties checked to confirm its identity as an emerald and

that a microscopic examination be made before a positive judgement is made. The Evaluation Committee coopted several competent students whose pooled results showed that the Chelsea Filter detected most emeralds and the H-H Filter reacted to most synthetics as the inventors suggested. It appears that 60 years after the introduction of the Chelsea Filter, emeralds still defy a definitive means of identification using filters of this type. R.J.P.

#### Mineralization and potential of the gemstone industry of Zambia.

S.H. MAMBWE AND C. SIKATALI. In *Industrial minerals in developing countries*, S.J. MATHERS AND A.J.G. NOTHOLT, eds. British Geological Survey/Association of Geoscientists for International Development: AGID Report Series No. 18, 1994, 265-72, 1 map.

Gemstones are found in all nine provinces of Zambia, hosted in pegmatites and veins in Pre-Karoo rocks. They include emerald, aquamarine, amethyst, beryl, tourmaline and garnet. There is some potential for ruby and sapphire, as well as for the recovery of rose quartz and other silica varieties. R.A.H.

#### The mineralogy, geology and occurrence of topaz.

M.A. MENZIES. *Mineralogical record*, 26(1), 1995, 5-53, illus. in colour.

A major study of topaz, the paper discusses geology, mineralogy and occurrence of topaz with a good deal of comment on gem-quality crystals, a number of which are illustrated in colour. The major topaz-producing areas are described with historical notes on locations such as Schneckenstein. A table lists gem topaz deposits worldwide with references to the literature and there is also an 11-column bibliography. Among the coloured illustrations are reproductions from older mineralogical books, including Richard Braun's *The mineral kingdom* (1908). Figures in the text draw comprehensively from Goldschmidt's *Atlas der Krystallformen*. Maps and figures illustrate major deposits generally and particularly. M.O'D.

#### What's new in minerals?

T. MOORE. *Mineralogical Record*, 26(2), 1995, 147-53, 14 photos in colour.

Among specimens on display at the 1995 Tucson Gem and Mineral Show were fine elbaïtes, with one crystal 8cm long, from the

Himalaya Mine, California; red beryl from the Wah Wah Mountains, Beaver County, Utah, with some crystals up to 6cm long; emerald crystals on a calcite matrix from the Coscuez Mine, Boyact, Colombia. The matrix in which the crystals are found, in underground working at the Coscuez-Los Gavilanes mine, 12 miles from the Muzo mine, may be calcite or black shale or both. Orange scapolite from the Mpwampwe mine, Morogoro, Tanzania, and loose dodecahedrons of what is probably andradite from Mali, dias-pore from what is said to be the Aydin-Mugla region of Turkey, golden beryl and blue beryl from Volodarsk, Ukraine, with reddish-brown vesuvianite from an as yet unspecified locality in Pakistan, complete the gem mineral portion of the report - apart from further praise for the Pakistan peridot. M.O'D.

#### What's new in minerals?

T. MOORE. *Mineralogical Record*, 26(3), 1995, pp 215-30, 45 photos (42 in colour).

Minerals exhibited at the 1995 Tucson Gem & Mineral Show included peridot crystals from Pakistan: the locality is now placed as Suppatt, between Kamila and Naran, North West Frontier Province. The site is reported to be a string of prospect pits with Dasu the closest town. It is believed that some peridot hitherto attributed to China and to Afghanistan may come from this site in Pakistan. Colourless prisms of hambergite are reported from Drot, Gilgit-Skardu Road, Northern Areas of Pakistan. Fine rhodochrosite crystals were exhibited from the Sweet Home mine, Colorado, and yellow apatite crystals from the Sceptre Claims, Emerald Lake, Yukon, Canada. Reddish-pink grossular crystals from Sierra de las Cruces, Coahuila, Mexico, appear to be of gem quality and there was some attractive green smithsonite from the 79 mine in Arizona. Red beryl from the Maynard claim in the Thomas Range in Utah was prominent along with topaz crystals from the same area of the state. Diamond crystals in matrix were shown from both China and Russia: fine clear yellow beryl crystals were shown from mine no 2, Volodarsk-Volynsk, Zhitomir region, Ukraine. M.O'D.

#### The Yogo sapphire deposit.

K.A. MYCHALUK. *Gems & Gemology*, 31(1), 1995, pp 28-41, 14 illus. in colour.

Sapphires were discovered at Yogo Gulch over a century ago and the deposit is one of four major sapphire producing areas in Montana, USA. The

Yogo sapphires are noted for their uniform well-saturated blue colour ('corn flower' blue) and a relative absence of inclusions and zonation. They do not require heat treatment and their flat rough crystals generally weigh less than one carat. Unlike other Montana deposits the Yogo deposits are primary with the sapphires being mined directly from at least six parallel dykes of lamprophyre rock. In one hundred years the Yogo deposit has produced 18.2 million carats of rough which has yielded more than 0.5 million carats of cut stones.

The history of the deposit is described. Now the Vortex Mine is the only active underground mine and Yogo sapphires are marketed as the world's only sapphires guaranteed not to have been heat treated. An early theory of the origin of the sapphires was their direct formation from the Yogo magma as phenocrysts in which silica-deficient Yogo magma incorporated large amounts of Al-rich shales as it rose towards the surface. Later it was suggested that the Yogo magma incorporated fragments of kyanite bearing gneiss instead of shales. The kyanite, a source of aluminium, was then consumed by the magma and later crystallized as corundum. Observed inclusions such as carbon dioxide gas and analcime are consistent with the direct formation of sapphires from the magma. However it is also possible that the sapphires were incorporated as xenocrysts by a Yogo magma which captured fragments of the corundum-bearing gneiss and transported it upwards as xenoliths. Support for this theory has come from computer simulations of multi-component crystallization but additional research will be required to finally resolve the question. R.J.P.

#### Einschlusse-Phänomene im Quarz.

G. NIEDERMAYR. *Mineralien Welt*, 6(4), 1995, pp 15-16, 3 photos (2 in colour).

The presence and types of mineral inclusion in quartz are discussed. Lepidocrocite, antimonite, rutile and ilmenite are illustrated. M.O'D.

#### Mineralogische Reise nach Pakistan.

P. PAULITSCH. *Aufschluss*, 46, 1995, 37-41, 2 photos (1 in colour).

Short account of an excursion to Pakistan with particular reference to emerald deposits, emerald synthesis and tourmaline. M.O'D.

#### Rubies from Mong Hsu.

A. PERETTI, K. SCHMETZER, B. HEINZ-JÜRGEN AND

F. MOUAWAD. *Gems & Gemology*, **31**(1), 1995, pp 2-26, 4 tables, 4 illus. in black- and-white, 30 in colour.

Since 1992 a primary source of ruby has been Mong Hsu in north eastern Myanmar. Untreated samples showed a distinctive dark violet to almost black cores with ruby rims.

Geological studies in the Mong Hsu area showed that the ruby deposits occurred in upper Palaeozoic marbles. Other minerals found with the ruby rough include green and brown tourmaline, andalusite, almandine, quartz and tremolite and they indicate that the deposits are metamorphic. Associated secondary deposits occurred as gravels which are removed and processed for gems by using elaborate sluicing systems.

Cut stones are usually heat treated and many have glass fillings. The stones are heated to remove the violet colour and then in borax to fill any fissures. Typical crystals were well-terminated barrel shaped and the distinctive colour distribution was reflected in some of their gemmological properties. The commonest inclusions are whitish particles; rutile, fluorite and spinel were rarely found. Whitish streamers orientated perpendicularly to growth planes extend from the outermost edge of the violet core. Heat treatment not only removes the violet colour but may cause additional fractures due to decrepitation of entrapped solid matter which decreases the transparency of the stone. Second stage heating in the presence of borax can result in solution of alumina and healing of open fracture planes.

X-ray fluorescence analysis and electron probe analysis showed significant trace concentrations of chromium, iron, titanium, vanadium and gallium; refractive indices correlated with the total concentration of these.

Spectra of the violet cores showed a Cr<sup>3+</sup> absorption spectrum with a superimposed broad Fe<sup>2+</sup>/Ti<sup>4+</sup> charge transfer absorption and an additional line at 675nm whose cause is unknown.

R.J.P.

#### **Eudialyte crystals from the Kola Peninsula.**

N.A. PEKOVA. *World of Stones*, **5/6**, 1995, pp 8-11, 5 photos in colour, 8 figs.

Near-gem quality eudialyte crystals have been recovered from underground mines in the Yukspor and Rasvumchorr mountains, Kola Peninsula, Russia. Crystals reach no more than 7mm in size but are a transparent red. Fine quality crystals are described from other loca-

tions in the same region and the properties and crystallography of eudialyte are discussed.

M.O'D.

#### **En direct de Madagascar.**

D. PIAT AND M.-P. BOUQUEAU. *Revue de Gemmologie*, **123**, 1995, pp 12-13, 3 photos (1 in colour), 1 map (in colour).

Brief account of a visit to a sapphire-bearing mine at Andranondambo, Malagasy Republic. Gem-bearing sites in the vicinity are reported to be controlled by Swiss, Thai and Israeli enterprises.

M.O'D.

#### **Euhedral sinhalite crystals from Sri Lanka.**

L.C. PITMAN, C.S. HURLBUT AND C.A. FRANCIS. *Mineralogical Record*, **26**(2), 1995, 91-4, 3 photos (2 in colour) 1 fig.

Morphological details of two euhedral sinhalite crystals from Sri Lanka (the first recorded from this location) accord with data given for a crystal from Burma. There are 32 faces, giving 13 forms for one crystal and 31 faces and 9 forms for another. The pale brown colour is attributed to ferric iron. One specimen was a pale transparent pebble of 36ct and measuring 2.6 x 1.6 x 1.2cm, the other was one of a pair of transparent pale brown crystals. The location is reported to be Balangoda, about 25km east of Ratnapura.

M.O'D.

#### **Porcelanite - ein neuer Landschaftsmarmor aus Tschechien.**

L. REJL AND A. TUMA. *Lapis*, **20**(3), 1995, 42-4, 4 photos in colour, 1 map.

A marble with landscape patterning has been given the name porcelanite, the location being in the Bučník area of the Czech Republic.

M.O'D.

#### **Zur Entstehung der sternförmigen Achate in sauren Vulkaniten.**

R. RYKART. *Aufschluss*, **46**, 1995, 33-6, 7 photos (6 in colour), 1 fig.

Formation of agate with a star-shaped interior is discussed with examples taken from acidic volcanic rocks.

M.O'D.

#### **Meerschaum from Eskisehir Province, Turkey.**

K. SARIIZ AND I. ISIK. *Gems & Gemology*, **31**(1), 1995, pp 42-51, 11 illus. in colour.

Sepiolite, a hydrated magnesium silicate, is commonly known as meerschaum in its massive compact form. It has a very low specific gravity and hardness, and is easily carved and polished.

The Eskisehir deposits have been used since the eighteenth century and the meerschaum is mined using rudimentary mining methods. Examination of sepiolite nodules shows that many have a magnesite core indicating that magnesite formed first and was later replaced by sepiolite. The physico-chemical behaviour of  $Mg^{2+}$ ,  $SiO_{2(aq)}$  and  $H_2O$  has been thoroughly investigated and it is concluded that meerschaum nodules probably formed at shallow depths under alkaline conditions in the vicinity of paleo-shorelines of a large inland lake.

During carving the meerschaum has to be kept wet to maintain its softness. After carving it is slowly dried in the sun and finally for two hours in an oven at  $110^\circ C$ . After polishing with a fine abrasive it is immersed in liquid beeswax for a few minutes. The creamy-white colour of pipe bowls progressively turn yellow due to absorption of nicotine. Although the recent decline in smoking has affected the demand for pipe bowls, sepiolite has many other industrial uses including that of an ivory simulant. However, ivory is much harder than meerschaum and can bend without breaking.

R.J.P.

#### **Tucson 1995: Neues, Neues Altes, Altes.**

J. SCOVIL AND C. WEISE. *Lapis*, 20(4), 1995, 25-8, 8 photos in colour.

Among the minerals reported from the 1995 Tucson Gem & Mineral show were reddish grossular from Mexico, hambergite from Pakistan in crystals up to 1.8cm across and gem-quality olivine from Sopat, Pakistan, with a crystal 7.9cm in length pictured with a faceted stone: this material occurs in a white talc matrix.

M.O'D.

#### **[The pulse cathodoluminescence of corundums.]** (Russian with English abstract)

V.I. SOLOMONOV, S.G. MIKHAILOV, V.V. OSIPOV, V.N. AVDONIN, M.F. VASILEVSKAYA AND V.I. YAKSHIN. *Proceedings of the Russian Mineralogical Society*, 123(6), 1994, pp 39-51.

This proposed pulse cathodoluminescence (PCL) method uses nanosecond high-current, pulse-repeated e-beams, as an alternative to the usual continuous low-current electron streams. Measurements are taken in the 340-800nm range and do not involve destruction of the sample, or its previous heating. Spectra of natural and synthetic corundums (except for Vietnamese sapphires) have a strong red band with dominant chromium lines at 694.3 and 692.9nm; its

maximum intensity was shown by synthetic rubies and the minimum intensity in grey-blue natural corundum. A long wave wing of this red band is formed by N-Cr lines; S-lines are fixed in the short wave wing of the spectrum. There are two new wide bands seen in the PCL spectrum of corundums: blue (482nm) and green (555nm); they dominate the PCL spectra of Vietnam sapphires. Some PCL spectra of spinels are also presented.

R.A.H.

#### **Granatfund aus dem Täschthal bei Zermatt (VS).**

H.A. STALDER AND M. AUFDENBLATTEN. *Auschluss*, 10(7), 1995, pp 267-79, 10 photos in colour, 4 figs.

Dark red crystals of garnet from which faceted stones have been cut are found in the Täschthal, close to Zermatt in canton Valais, Switzerland. Diopside and vesuvianite are found with the garnets which occur as combinations of rhombic dodecahedra and icositetrahedra and which are classified as the hessonite variety of grossular.

M.O'D.

#### **Texture formation of agate in geode.**

L. TAIJING AND I. SUNAGAWA. *Mineralogical Journal*, 17(2), 1994, 53-76.

Optically observable individual fibres in agate bands are shown by electron microscopy to be composed of much finer fibres in which quartz crystallites, 8-100nm in length, are aligned parallel to  $\langle 11\bar{2}0 \rangle$  or  $\langle 10\bar{1}0 \rangle$ , with the *c* axes perpendicular to the fibre elongation. Both uniformly spaced systematic striations and 'Runzelbänderung' in agate bands, and coarse quartz or amethyst crystals radiating inwards to the open space in a geode have essentially the same texture as that of ordinary agate bands, and were formed when growth conditions were stabilized. The coarse quartz represents the final stage in the formation of agate bands, whereas the strata-forming horizontal banding consists of only euhedral quartz grains 0.5-4  $\mu m$  across, or spherulites with a diameter  $\leq 100 \mu m$ , or both; they were precipitated due to gravity after the formation of agate bands and coarse quartz crystals. Based on these observations, it is suggested that the quartz crystallites in agate were precipitated from a hydrothermal solution invading a geode in which polymerized embryonic particles with a quartz structure with a size of  $\sim 10nm$  were already present.

R.A.H.



**Achatähnlicher Kalkstein aus Niederösterreich.**

L. THALHAMMER. *Lapis*, 20(3), 1995, 45-6, 3 photos (2 in colour).

A limestone with patterning and colour resembling agate is reported from the Piestingtal area of Lower Austria, close to the B21 road. M.O'D.

**Heat treating sapphires from the Anakie District, Australia.**

T. THEMELIS. *Australian Gemmologist*, 19(2), 1995, pp 55-60, 5 illus. in black-and-white, 5 in colour.

The effects of heat on colour and clarity were systematically studied to determine the optimum conditions for maximizing the enhancement potential of sapphires. Regardless of the type of atmosphere used it was found that 'silk' was partially dissolved at 1400°C and was completely dissolved at 1650°C and upwards. This increased the clarity of the stones and increased their value. Green to yellow sapphires on heat treatment did not produce stones of significant value. Blue to green stones produced better results whereas near-colourless, silky and brown spotted sapphires produced the best results. Using carefully controlled rates of heating and cooling prevented cracking.

The sapphires were initially cleaned in dilute hydrofluoric acid after which orange to reddish-brown zircons were identified and removed. The sapphires were then classified into nine types according to colour and milkiness and subjected to a total of eight separate heating runs under specific conditions. From this it was deduced that four sets of conditions could satisfactorily deal with all the types.

A batch heating system was discussed and involved reheating in many cases. The author did not reveal details of the gas mixtures used but stressed their poisonous nature and highly explosive characteristics which required expert handling.

The author concluded that high quality sapphires should be treated by type whilst commercial and lower quality stones should be batch treated. The author followed a systematic approach but retained the mystique expected of such treatments. R.J.P.

**Vanadian-chromian garnet in mafic pyroclastic rocks of the Malé Karpaty Mountains, western Carpathians, Slovakia.**

P. UHER, M. CHOVAN AND J. MAJZIAN. *Canadian Mineralogist*, 32(2), 1994, 319-26, 2 maps.

Unusual examples of V-Cr garnets are described from Lower Palaeozoic metamorphosed mafic pyroclastic rocks enriched in V, Cr and C<sub>org</sub> in the Pezinok-Pernek complex of the Malé Karpaty Mts, NE of Bratislava. The garnet is emerald-green, 0.5mm in size with  $a$  11.98 Å,  $n$  1.810,  $D$  3.75 g/cm<sup>3</sup> and contains V<sub>2</sub>O<sub>5</sub> 9.5-22.1, Cr<sub>2</sub>O<sub>3</sub> 5.5-10.9, Al<sub>2</sub>O<sub>3</sub> 0.4-7.6 wt.%, corresponding with goldmanite 27-65, uvarovite 19-34, grossular 1.5-33, yamatoite 2-5 mol.%. The associated hydromica contains V<sub>2</sub>O<sub>3</sub> ≤ 9.2, Cr<sub>2</sub>O<sub>3</sub> 0.5-7.2 wt.%; coexisting chlorite and tremolite also exhibit elevated levels of V and Cr. This assemblage of V, Cr-rich minerals formed at ~500°C as a result of thermal metamorphism induced by Hercynian granitic intrusions. R.A.H.

**Die grosse Kluft am Planggenstock, UR.**

F. VON ARX. *Schweizer Strahler*, 10(6), 1995, pp 201-11, 15 photos (7 in colour).

Fine rose-coloured fluorite of gem quality is among the minerals found in the great cleft of the Planggenstock, Uri, Switzerland. Crystals range up to 3-4cm in size and occur as octahedra or twins. The most recent discovery was in 1994. M.O'D.

**Das Kalahari-Manganerzfeld und seine Mineralien. 1.**

L. VON BEZING, J. GUTZNER. *Mineralien Welt*, 5(4), 1994, pp 24-43, 5 illus. in black-and-white, 28 in colour, 2 maps in black-and-white, 1 map in colour, 2 figs.

Though for the gemmologist rhodochrosite takes pride of place among the minerals of the Kalahari area of South Africa, green opal and fine well-crystallized hematite are also found, with many other non-ornamental species. This first part of a general geological and mineralogical survey of the Kalahari lists minerals in chemical order with notes on the geology and the present state of mining. M.O'D.

**Ontario - Amethyst County.**

J. ZENZ. *Lapis*, 20(2), 1995, 35-40, 13 photos (9 in colour), 1 map.

Gem-quality amethyst is found at several sites in the Thunder Bay region of Ontario, Canada, The Panorama, Pearl Lake, Ontario gem amethyst mine, Diamond Willow mine and Blue Points mine have been involved in amethyst production which has been known from the region since the seventeenth century. M.O'D.

### <sup>23</sup>Na<sup>27</sup>Al<sup>1</sup>Be<sup>29</sup>Si solid state NMR study of tugtupite.

ZHI XU AND B.L. SHERRIFF. *Canadian Mineralogist*, **32**(4), 1994, 935-43, 9 figs.

Tugtupite was found to have a well-ordered structure with only one Si, Al, Na and Be environment when studied with the NMR techniques of MAS (magic angle spinning), DAS (dynamic angle spinning) and DOR (double rotation). Quadrupolar parameters  $C_Q$  (quadrupolar coupling constant) and  $\tau$  (asymmetry parameter) of <sup>23</sup>Na and <sup>27</sup>Al were found by a comparison of a computer simulation of the MAS central transition lineshape at two different fields with experimental results. M.O'D.

### FM-TGMS-MSA Symposium on topaz.

*Mineralogical Record*, **26**(1), 1995, pp 63-71, illus. in black-and-white.

Synopses or complete papers on topaz and other topics presented to the 16th Annual Symposium of the Friends of Mineralogy, the Tucson Gem & Mineral Society and the Mineralogical Society of America, held at Tucson 11 February 1995. Topics of papers are: the occurrence of topaz in northern New England pegmatites: the occurrence of topaz in the south-eastern United States: Colorado topaz: notes on the occurrence of topaz in Idaho: geology and occurrence of well-crystallized topaz: where's the proton? - symmetry and structure variations in topaz: topaz - environments of crystallization, crystal chemistry and infrared spectra: items of North American mineralogical and gemmological note during 1994, covering a salmon-pink colour obtained by heating cornflower blue coloured benitoite, the development of diamond pipe mining in the Northwest Territories of Canada, an option taken by Kennecott Corporation [RTZ subsidiary] on the Utah red beryl deposits, and on further recovery of tourmaline from Mt Mica, Paris, Maine. Some of the crystal drawings accompanying the reports are taken from Goldschmidt, *Atlas der Krystallformen*. M.O'D.

## Instruments and Techniques

### Optical anisotropy of cuprite caused by polishing.

E. LIBOWITZKY. *Canadian Mineralogist*, **32**(2), 1994, 353-8.

Optical investigations on bulk samples of

cuprite (Cu<sub>2</sub>O, space group  $P_{n3m}$ ), as well as on oriented single crystals, confirm that all diamond-polished sections except (111) and (100) are anisotropic. Electron channelling patterns obtained by SEM reveal that these mechanically polished surfaces of cuprite are always extremely deformed. An alternative chemomechanical polishing procedure with alkaline silica solutions, however, results in isotropic sections without exceptions. R.A.H.

### ROS/GEM Optics Model RFA 322 Refractometer; an instrument evaluation.

A. SHIELDS AND B. NEVILLE. *Australian Gemmologist*, **18**(11), 354-5, 3 illus. in black-and-white.

This new critical angle refractometer manufactured in the USA was considered to be a robust easily portable instrument due to its smaller than average dimensions. Graduations of 0.005 should increase the accuracy of the readings and appeal to many potential users. R.J.P.

### GIA evaluates progress in color detection technology.

J.E. SHIGLEY, R.C. KAMMERLING AND T.M. MOSES. *Diamond World Review*, **85**, pp 96-8, 3 photos in colour.

The authors first list the variables involved in colour description, and then describe the technical problems which occur when using instrumentation to quantify the colour of gemstones. The principles used in the two main types of colour measuring instruments (colorimeters and spectrophotometers) are then discussed. Two of the newer colour-measurement instruments, the Hitachi U4001 spectrophotometer and the Gran colorimeter, have recently been evaluated. When used to check isotropic coloured gem material, the Hitachi produced colour hue measurements consistent with visual observations. The Gran colorimeter gave quite consistent results for non-fluorescent round brilliant-cut diamonds in the Cape series. However, observations on these and other commercial gemstone colour measuring instruments indicate that instrumentation of this type cannot yet be used in place of visual colour grading. P.G.R.

### The fingerprinting of gold samples.

ANON. *Assay, magazine of the Johnson Matthey Group*, Autumn 1994, pp 21, 2 photos in colour.

A new technique, LA-ICP-MS (laser ablation -

inductively coupled plasma - mass spectrometry), is forecast to revolutionize tracing methods for the identification of stolen gold. The technique enables scientists to compare the elemental associations in any given sample of gold. The detailed analysis can be specific to precise locations and the gold sample can be related to a specific mineralising event, mine or bullion sample. Initial investigations also suggest that the technique could be equally successful in the fingerprinting of antique silver, and gold and platinum artefacts, facilitating positive identification of important stolen objects. LA-ICP-MS was pioneered by the Chemistry Centre, Western Australia in conjunction with Fisons Instruments Elemental Analysis. P.G.R.

## Synthetics and Simulants

### An interesting imitation opal.

G. BROWN. *South African Gemmologist*, 9(2), 1995, pp 7-9, 4 photos in colour.

An opal imitation in which the play-of-colour emanated from a holographic projection from an aluminised grating sandwiched between plastic covers gave an SG of 1.2, a single RI of 1.48 and felt very light. These values are taken from the plastic cover. The gemmological microscope enables the very thin grating to be observed.

M.O'D.

### Another flux-grown synthetic ruby.

I.C. CAMPBELL. *South African Gemmologist*, 9(1), 1995, pp 22-5, 5 photos in colour.

A ruby crystal offered as natural at a gem show in the United States was cut into three stones in which lead was discovered on analysis, thus proving artificial origin. M.O'D.

### An examination of Swarovgreen : a new imitation emerald from Austria.

E. FRITSCH, R.C. KAMMERLING AND J.I. KOIVULA. *Australian Gemmologist*, 19(11), 1995, pp 15-18, 2 illus. in black-and-white, 3 in colour.

This was shown to be a silicate glass with a relatively high refractive index of 1.608-1.612 attributed to calcium and aluminium. The green colour is due to a transmission window formed by  $\text{Pr}^{3+}$  and  $\text{Cu}^{2+}$ . Although it is an attractive simulant almost all its gemmological properties are quite different from those of emerald. All the samples were of a medium dark bluish-green colour and were free from inclusions. R.J.P.

### Gem news.

J.I. KOIVULA, R.C. KAMMERLING AND E. FRITSCH. *Gems & Gemology*, 30(4), 1994, pp 271-80, 16 illus. in colour.

Described as a new man-made material from Russia 'Minkovite' is monoclinic synthetic yttrium silicate with neodymium providing the blue colouring agent. A visit to the Russian synthetic research facility at Alexandrov revealed an active concern with 2000 workers. The main products are synthetic quartz and synthetic calcite. Recent laboratory grown material include a medium-dark blue GGG and 'YAP' (yttrium aluminium perovskite). An interesting variety of hydrothermal synthetic quartz was predominantly brown with a shallow green layer offered as a simulant for andalusite. R.J.P.

### The cathodoluminescence of synthetic periclase.

J. PONAHO. *Australian Gemmologist*, 19(1), 1995, pp 31-7, 1 table, 2 illus. in black-and-white, 4 in colour.

The author has presented a very detailed study of synthetic periclase (magnesium oxide) comparing its cathodoluminescence (CL) and analysis of CL spectra with trace element content. The causes of CL colour are discussed with reference to Ni, Cr, Fe and Mn contents. R.J.P.

## BOOK REVIEWS

### **Handbook of mineralogy. Volume 2. Silica, silicates.**

J.W. ANTHONY, R.A. BIDEAUX, K.W. BLADH AND M.C. NICHOLS, 1995. Mineral Data Publishing, Tucson, AZ. 2 vol. Hardcover. US\$142.50 (including shipping). ISBN 0 9622097 0 8 [from vol. 1].

The first volume of this most welcome series covered the elements, sulphides and sulphosalts. With the silicates, on which so much reclassification has been postulated over recent years and to which so many new species have been added, two volumes have been found necessary to contain all the (highly edited) data available. As in the first volume the minerals are presented in alphabetical order; also following precedent there are no crystal drawings; locality information is strictly edited and based on specimens in major collections. The aim of the book is to present data rather than to give background information on how to use it.

Members of the silicate class have increased by about three times from the 1950s and growth in the sophistication of investigative techniques has been responsible for this as well as extensions in field work with consequent finds of new species. Many of the silicate species fall into groups and while these are not set out as in Fleischer and Mandarino's *Glossary of mineral species*, group membership is indicated by a note at the top of the page devoted to each species. For cross-referencing between names and compositions the program SEARCH is available from the publishers at PO Box 37072, Tucson AZ 85740. While many of the silicate groups are quite complicated the amphiboles have always given particular problems and for this reason a classification in diagram form is provided.

Some 'rogue' silicates such as thaumasite (cut stones exist) in which silicon occurs without oxygen to bond with are included as true members of the class, this membership depending, as conventionally agreed, on the presence in a mineral of mutually bonded silicon and oxygen atoms. Diadochic substitution of  $\text{SiO}_4$  for  $\text{PO}_4$  places a species in the phosphates when the atomic ratio of the silica is subordinate to that of the phosphate and in the silicates if the reverse is the case.

The convenience of having one species per page by far outweighs the slight inconvenience of having to look elsewhere for some classes of information; the readership for this excellent book will know how to do this already. M.O'D.

### **The properties of optical glass.**

H. BACH AND N. NEUROTH (Eds), 1995. Springer, Berlin. pp xvii, 410, hardcover. DM268. ISBN 3 540 58357 2.

Forming part of the Schott series on glass and glass ceramics (the Schott Glasswerke in Mainz carries a large research group whose work is publicized in a series of *Forschungsberichte*), the book updates and consolidates material contained in the seminal *Beiträge zur angewandten Glasforschung* which began in 1959. Since that date there has been a great increase in the use of glass and glass ceramic substances.

The first part of the book describes the manufacture and use of optical glass with some historical material on its development. The bulk of the text, however, describes the optical properties, chemical composition, optical quality, mechanical and thermal properties, chemical durability, processing and applications of glass and gemmologists would expect to find a good deal of useful information in many of the sections. Probably most interest will come from the chapters on refraction and chemical composition though a later chapter on coloured glasses presents material which usefully adjoins what we know about the colouring of natural and synthetic inorganic substances. While the treatment (of dispersion, for example) is of necessity mathematical the text is quite easy to read and since each major section includes an extensive list of references the book forms a major reference tool for anyone using glass. Two further volumes, covering low thermal expansion glass ceramics and thin films on glass, will complete this part of the Schott series. M.O'D.

### **A century-plus of opal publications.**

H.E.R. DE BOER, 1994. [Published by the author] c/o Middleton Post Office, Tasmania. pp 87 [81 of text, space for notes], AU\$ 26, including air mail to Great Britain, AU\$ 23 surface mail.

Published in an edition of 500 copies, this most

useful bibliography of opal includes both monographs and papers in journals. A careful comparison with other opal books has shown that there seem to be few omissions, at least with the monographs, and citations of papers are adequately done. This is a well-produced and essential guide to an important part of gemmological literature. Later editions might well include the pagination of monographs from which the reader will get some idea of the text size. M.O'D.

### **Gemstones of Afghanistan.**

G.W. BOWERSOX AND B. CHAMBERLIN, 1995. Geoscience Press, Tucson, AZ. pp xx, 172, illus. in black-and-white and in colour, hardcover. Price on application. ISBN 0 945005 19 9.

Having co-authored the standard book on the gemstones of neighbouring and geologically-similar Pakistan, the present reviewer has been waiting a long time for this book since looking over the MS and photographs with the authors back in 1993. There have long been problems with placing the location of gem species from these countries and descriptions of the mines and their minerals have been long overdue. As always seems to happen, the finest specimens of emerald and ruby are found in places particularly difficult of access so that many attributions are merely to the name of the nearest settlement. Equally mystifying are the many travellers' tales, some dating back many centuries and prone to colourful exaggerations of the size and nature of gemstones seen in places which few readers would and few authors actually did visit.

The book opens with an account of how this area, a fruitful area for plate tectonic studies, came to produce such a wealth of major gem species. This is followed by a history of geological explorations in Afghanistan. These chapters, like those following, have their own lists of references. Major gem species of Afghanistan are then treated in fine detail, beginning with the lapis lazuli occurrences of Badakhshan and proceeding to the spinel deposits of the same area, to the ruby and sapphire deposits of Jegdalek and Gandamak, the emerald mines of the Panjshir Valley and the deposits of tourmaline, kunzite and aquamarine in Nuristan. The main text closes with an assessment of the mineral potential of Afghanistan: appendices give the properties of the gemstones described, the coordinates of the major occurrences (what a valuable feature and one increasingly necessary for a

serious study), a glossary and a general bibliography. An introductory statement outlines the pitfalls of transliteration and gives examples of some important variations. Interestingly the words panjsher and panjshir have different meanings so it is easy to see how ambiguities occur!

Such a care over detail and indication of where accounts can appear to treat quite different places while in fact pertaining to the same site parallels the care taken with the whole text. Even more remarkable, it is easy to read for relaxation and of course vital for gemmological, mineralogical and geological reference. Each occurrence is set in its geological context and the authors have actually visited them, not always the case in the gem books of not so long ago. Even better, once there, they understood the nature of the deposits. I could not wait to get into the book and wish that I had written it. M.O'D.

### **The honours of Scotland: the story of the Scottish crown jewels.**

C.J. BURNETT AND C.J. TABRAHAM, 1993. Historic Scotland, Edinburgh. pp 56, illus. in colour, softcover. ISBN 0 7480 0626 5.

The crown jewels of Scotland were re-discovered in a dramatic scene played in 1818. An oak chest, long believed to be empty and housed in a sealed room in Edinburgh Castle, was opened to reveal the Scottish regalia which had been left there in 1707, the year of the Act of Union.

On New Year's day 1651 Charles II was crowned King of Scots near Scone Palace. At this last Scottish coronation the king was presented with the Honours of Scotland, crown, sceptre and sword, with a pair of spurs. They date back at least to the reign of James IV (1488-1513) but it is believed that Scottish kings may have been crowned since the sixth century though no regalia are known to have survived for so long. When Robert the Bruce, who seized the Scottish throne in 1306 was crowned, an improvised gold circlet was used but this disappeared to the English conquerors very soon afterwards. Although legend suggests that the circlet forms part of the present Scottish crown, there is no backing for the story.

Returning to Scotland and victorious over the English at Bannockburn in 1314, Robert would have ordered new Honours to be made and the coronation of his only son David in 1331 would have included those items of regalia which later appeared at the coronation of James IV. The story

after this is unclear since the present displayed regalia took their place at some time during the reign of James IV or James V.

The present Italian-made sceptre was perhaps given to James IV by Pope Alexander VI. There had been a tradition of papal gifts to Kings of Scotland and the sceptre is said to have been presented to James in 1494. The sword of state was made in Edinburgh rather than in Italy and is known to have been ordered in 1502. In 1536 the sceptre was re-modelled by the Edinburgh goldsmith Adam Leys and includes a polished globe of rock crystal.

While the exact form of the crown inherited by James V is not known, his marriage in 1540 to Mary of Guise-Lorraine gave an impetus towards the remodelling of the crown and this was undertaken by John Mosman of Edinburgh.

These major items of regalia are fully described, together with other pieces which have joined them. The remainder of the book describes the later history of the Honours, the period during which their whereabouts was uncertain and their present state and display. There is, in addition, a great deal of ancillary material on Scottish history: there is also a short but useful bibliography. The book is a really first-class account, worthy of its unique subjects. M.O'D.

#### **Ore microscopy and ore petrography.**

J.R. CRAIG AND D.J. VAUGHAN. 1994. Wiley, New York. pp xiv, 434, illus. in black-and-white, softcover. £18.95. ISBN 0 471 11599 1.

Many gemmologists are mineral collectors too and by some chance many minerals most accessible to the collector are ore species. While this book would have been greatly enhanced by colour photographs the text is lucid and provides a wealth of detail on the operations of many types of microscope, with particular reference to specimen preparation, qualitative methods of mineral identification and reflected light optics. These sections occupy approximately half the text. The remainder is devoted to ore mineral paragenesis, formation and fluid inclusion geothermometry of ores, the nature of ore mineral assemblages in igneous rocks and vein deposits and in a variety of other environments. There are excellent lists of references and useful tables, making this a cheap and accessible text for the student. M.O'D.

#### **Meisterwerke Sächsischer Minerale.**

E. EQUIT, 1994. Eberhard Equit & Co., Berlin. pp

151, illus. in colour, hardcover. US\$120.00. ISBN 3 930874 00 8.

Full-colour paintings of 98 mineral specimens and 11 mining landscapes from Saxony, together with a short bibliography and list of Saxon minerals in public and private German collections make up a superb album for the mineral collector. Since the edition is limited to 1500 copies the book will soon have scarcity value; more costly is a leather-bound edition with included maps but the gemmologist will be quite happy with the illustrations of fluorite, smoky quartz and yellow topaz from Schneckenstein, as well as with the many specimens of native silver that Saxony had always produced. Mineral paintings are becoming more popular and it is good that photographs do not always have it their own way; the artist may very well have a particular feature in view when the camera sees everything dispassionately. M.O'D.

#### **Fabergé [Catalogue of an exhibition held at The Queen's Gallery, Buckingham Palace, 1995-96].**

1995, Merrell Holberton, London. pp 80, illus. in colour, softcover, price on application.

The Carl Fabergé shop in London's Dover St was established in 1903 and Queen Alexandra was one of the first royal customers, receiving Fabergé artefacts as birthday presents at least by 1909. Since then various members of the royal family have been assiduous collectors and the present royal collection is one of the largest and finest in existence.

The present exhibition contains 543 items and covers many ornamental materials. Nephrite, as might be expected, takes pride of place but there are some magnificent examples of rhodonite, rock crystal, various colours of chalcedony and the small diamonds, often set in dark backgrounds, with which Fabergé so often decorated his pieces.

Items selected for the catalogue are given descriptive entries containing notes of materials used, date of manufacture and craftsman's name where known, dimensions, details and translations of inscriptions and notes on provenance. A number of items are known to have been purchased from particular shops and such transactions are given. The standard of illustration is well up to that now taken as customary and the catalogue should be added to the collections of all with an interest in these distinctive productions.

*Handlist to the exhibition.* While the illustrated catalogue has selected items for inclusion the visitor needing a quick overview of all the pieces on show has a first-class, well-printed list available without charge. Apart from the illustrations, it contains virtually all the information printed in the illustrated catalogue. M.O'D.

### **Classical gems. Ancient and modern intaglios and cameos in the Fitzwilliam Museum, Cambridge.**

M. HENIG, 1994. Cambridge University Press, Cambridge. pp xxx, 538, illus. in black-and-white and in colour. £125.00. ISBN 0 521 23901 X.

This catalogue raisonné of one of the world's major collections of classical and modern intaglios and cameos was compiled by Martin Henig with major contributions by Diana Scarisbrick and Mary Whiting. The Fitzwilliam Museum is the university museum of Cambridge and the systematic acquisition of gems began in 1864 with the purchase of the Leake collection of Greek and Roman coins and antiquities, including a major collection of ancient gems. Since that time the museum has acquired many important items and even while the catalogue was in press another very large set of engraved gems was presented by the Trustees of the Wellcome Trust - this last being the largest single accession of engraved gems ever received by the museum. The present catalogue stops short of this gift but otherwise includes all artefacts acquired up to the early 1980s.

Problems of preparation are bound to be large in this kind of work and the original preface is dated 1990. An additional problem has been cost and the museum was enabled to proceed with the publication of the catalogue only after a major donation had been received from the J. Paul Getty Trust.

The history of the collections is given in the first prefatory chapter: the second gives an account of how engraved gemstones were appreciated in antiquity. Notes on English collectors of engraved gems occupy the nine pages of the third chapter while ring and ringstone typology is set out in chapter four. Extensive lists of references accompany all the introductory chapters.

The catalogue is arranged in Greek and Roman and Medieval and Modern sections. The classical collections are subdivided into intaglios, cameos and miniature sculpture in precious stones and into metal rings and stamps. The medieval and modern collections are arranged by gemstones in

intaglios, cameos, gem carvings in the round, non-mineral recipients and forgeries of ancient intaglios. Appendices describe items from the Davis collection of Iranian seals and similar items from the [first] Wellcome Trust donation. The Burges Ewer and the Burn bequest (one item) conclude the catalogue, while the book closes with lists of inventory numbers, of donors and provenances, details of proper names in Greek, Latin, Etruscan, in transcribed oriental and ancient languages and in modern European languages. Previous publications (i.e. of individual items) are listed and there are subject and general indices.

Catalogue entries give number, brief description, materials used, dimensions, provenance, date and style, followed by a full description including references. The majority of the gem materials used are varieties of the silica gems (cornelian, jasper, sard, agate and amethyst) while garnet, sapphire and glass also appear.

It is rare today for this kind of catalogue to be published at all, let alone at what is really a reasonable price. While the illustrations are almost all in black-and-white the central colour section includes high-quality photographs of 19 of the finest items. The authors and their assistants are to be congratulated for their production of a catalogue of international and lasting worth. M.O'D.

### **Chinese snuff bottles in the collection of Mary and George Bloch.**

R. KLEINER, 1995. British Museum Press, London. pp xxxix, 665, illus. in colour, hardcover. £65.00. ISBN 0 7141 14650.

The days of the sumptuous, fully-illustrated catalogue of artefacts are not over! For a very reasonable price the reader is admitted to one of the finest private collections of Chinese snuff-bottles presently extant and on view at the time of writing in The British Museum. The standard of photography and of reproduction is as high as could be expected today and all we need to establish is the importance of the snuff bottle to the gemmologist.

The Chinese snuff-bottle is often made of a material with which all gemmologists will be familiar: perhaps rock crystal, perhaps one of the opaque varieties of quartz, perhaps jade, glass, ivory, coral, enamel, shale, soapstone, turquoise, amber, horn or other things: where the bottle is not itself made from a notable ornamental substance the stopper may be good quality jade or, a popular choice, pink tourmaline: snuff-bottle

stoppers helped the Californian tourmaline mines to establish themselves.

Bottles in the collection are presented in colour together with notes on materials, size, period, details of publication where applicable, description of item and any notable points of design, fashioning, inscriptions, decoration or reign/date markings. Similar pieces are compared. There is a first-rate bibliography and introductory material gives a short biography of the owners of the collection, George and Mary Bloch. A chapter on Qing imperial glass by another author occupies 17 pages and includes its own coloured photographs, taken from another collection, not displayed at the Museum.

The charm of the small and easily-handled snuff-bottle will be appreciated by those who also admire the generally small size and beauty of jewellery and gemstones and I strongly recommend readers to take the opportunity to find out more about how these materials are worked and why they are so valued. M.O'D.

**Standard catalog of gem values. Second edition.**

A.M. MILLER AND J. SINKANKAS, 1994. Geoscience Press, Tucson, AZ. pp ix, 271. £15.99. ISBN 0 945005 16 4.

A clue to the sudden appearance of the *Catalog* came in an advertisement in the German journal *Lapis* and very soon afterwards it was upon us. I was particularly pleased to see a revised text of an old friend which was first published in 1968 and reissued with inserted price update pages in 1988. The format remains the same with tables of prices for rough, faceted, engraved and carved gem materials and a chapter devoted to pearls. Details of fashioning are among the best and clearest of any book and how prices are arrived at forms a section rarely attempted by any author.

The deadline for updated prices was 1993 so alexandrite from the Hematita mine, Brazil, the production of the Argyle diamond mine in Western Australia and the intense blue copper-bearing tourmalines from the state of Paraiba, Brazil, are not included. There will always be a new find just after a book is published so these and other examples will have to wait for a third edition. Nonetheless the information given is profuse and welcome and especially useful are the short introductions to each species, telling the reader what features establish the best quality material.

The book is well produced on the whole

though there are many misprints - the first author appears to have been born in the year that the copy deadline expired, according to the cataloguing in progress entry on the verso of the title-page! I am delighted that a new edition has been attempted and very pleased with the result.

M.O'D.

**Emerald and tanzanite buying guide.**

R. NEWMAN, 1995. International Jewelry Publications, Los Angeles. pp 155, illus. in colour, softcover. US\$19.95. ISBN 0 929975 23 5.

This book forms part of an informal series which includes buyers' guides for ruby and sapphire, for pearl, diamond rings and gold jewellery. The present book reaches the high standard set by its companions and can be highly recommended both for buying stones and for many gemmological purposes.

While emerald and tanzanite may seem unlikely bedfellows they are both sought supremely for their colour rather than for any particular effect. Some of their properties are also similar: they are both brittle and so need extra care in setting and cleaning and they both have imitators which can cause the gemmologist difficulties. Emerald, of course has its synthetic counterpart too and to make identification even more difficult there are filled and treated stones.

For the student, each chapter ends with a short set of questions which form good examination revision materials, and there is also an extensive bibliography. The book deals with many topics from the standpoint of the beginner with a view to helping the jeweller to sell his stones and the notes on judging the colour of emerald and later of tanzanite. The reader is also shown how to evaluate the cut of a stone and is then told in some detail about the treatments now commonly used. Very sensibly the author gives advice on how disclosure of treatment should be presented. The customer is also helped in the questions that should be asked when buying emerald or tanzanite.

The chapter on synthetic emeralds neatly summarizes the present position and with the help of some excellent colour photographs gives an overview for the student and even for the practised gemmologist.

Where else can you find coloured photographs of tanzanite in different lighting conditions and of inclusions, composites and set pieces as good as any so far published in specialist books? All gemmologists should get a copy at the very reasonable price.

M.O'D.



**Gemstones in Australia: a review of the industry and the first Australian assessment of gemstone resources.**

J.G. OLLIVER AND I.J. TOWNSEND, 1993. Australian Gemstone Industry Council, Sydney. pp x, 72, illus. in colour. A\$50.00. ISBN 0 644 29617 8.

This most useful book reviews resources and production of Australia's major gemstones, opal, sapphire and ruby and diamond state by state, with shorter notes on the production of jade, chrysoprase, emerald and other gem beryl, agate, garnet, rhodonite, turquoise, topaz, tourmaline, zircon and chiastolite. In addition there is an historical review of the Australian gemstone industry and details of regulations on mining imposed by South Australia, as well as maps of the locations of major species. Tables give the values of Australian gemstone production, of actual and inferred opal resources in New South Wales and in western Queensland and similar details of sapphire and diamond production and resources. Chrysoprase production is also described and South Australian opal production 1978-1990 is summarized. Each section has its own list of references and the book is a most welcome addition to the rarely-covered topic of gemstone production. M.O'D.

**Chinese jade from the Neolithic to the Qing.**

J. RAWSON, 1995. British Museum Press for the British Museum, London. pp 463, illus. in black-and-white and in colour, hardcover. £66.00. ISBN 0 7141 1469 3.

Despite the near-reverence held by so many for artefacts cut and polished in the jade minerals there has been no serious study in Western languages for many years. Since the Oriental Ceramic Society published the catalogue to the exhibition *Chinese jade throughout the ages* in 1975 (in the compilation of which the present author collaborated with John Ayers) the reader has to assume (correctly, in the main) that most of the major jade works must have been published in Chinese if not in China itself. Fortunately this book has an excellent bibliography in which Chinese studies feature largely. Before 1975 the Oriental Ceramic Society had held an exhibition in 1948, *Chinese jades*, which, like its successor exhibition, was catalogued in the Transactions of the Society. *Chinese jade throughout the ages* is by chance the title of one of Stanley C. Nott's books, first published in 1936, reprinted in 1962, and as this is the only large text in English (there are

some good but small ones) likely to have been available for years the present book can be seen to be very long overdue.

The book accompanies an exhibition of Sir Joseph Hotung's jade collection and opens with explanation not only of the nature of the jade minerals but of the high value invariably placed on them by the Chinese. It is customary to say that this is because jadeite in particular is pleasing to the touch but far greater importance attaches to the capability of jade, like bronze, for supporting and perpetually preserving inscriptions, a property which has always been of particular significance to the Chinese. The toughness and hardness of the jades suggests power, whether political or religious: it is no accident that the linguistic character for jade is the same as that indicating 'precious stone'. The introduction goes on to discuss those shapes of jade which have been fashioned since the earliest times, to describe known fashioning sites and something of the methods used in working the materials. The book then begins the period-by-period study which occupies the bulk of the text.

Over 300 artefacts from the Hotung collection are described and illustrated and where appropriate reference is made to similar objects in the major collections of The British Museum. Each chronological section has its own list of references: full descriptions, including details of publication, accompany the excellent colour and black-and-white photographs (which also give the size of the object). The descriptions also speculate on the possible uses of the objects, their shapes and the nature of the fabulous animals, as well as their provenance.

A chapter on jade mineralogy follows the catalogue and includes a map showing possible nephrite sources in China. The book ends with the bibliography and index.

In so many ways this is the book that the jade connoisseur has always wanted and perhaps it is not too serious that there has been so long a gap between the publication dates of the major English texts. Along with modern identification techniques has come a much greater familiarity with Chinese classical and later texts, so that a book published near the end of the century has been able to draw on far more material than its predecessors. We hope that more Chinese sources, geological, mineralogical and textual, will be available for a second edition. M.O'D.

### The Peking diamonds. [A tale.]

P. READ, 1995. Gembooks, Bournemouth. pp 208, softcover. £7.95 including post & packing: £8.50 surface mail overseas. ISBN 0 9525315 0 X.

Forming part of a planned trilogy (the first part was *Diamond mine*\*) this story is about the planned substitution of flux-grown spinel crystals for diamond in the pre-sight routines of the De Beers organization. Two large countries (read the book to find out which they are) are behind the operation and the whole thing is not entirely unrealistic. I found this a jolly good read, moving more quickly than *Diamond mine* and with the sort of detail which gemmologists at least will find familiar. With Dick Francis' *Straight* (1989), *The Peking diamonds* should be required reading for students who need some lighter books from time to time. Two small points of interest: flux-grown colourless corundum may also take octahedral form and show trigons; as with spinel grown in this way, the trigons echo the edges of the octahedron and diamond sorters would spot this, since in diamond crystals the trigons are reversed. While a single flux of lead fluoride might be used for spinel growth, the combination lead oxide-lead fluoride-boron oxide is perhaps preferred today. M.O'D.

### Images of the Anakie sapphire fields, Queensland.

W.L. SCHOLLER, 1993. E & W Scholler, Anakie 4702, Queensland. pp viii 136, illus. in black-and-white and in colour, softcover. ISBN 0 9589968 2 2.

For a fairly short historical account of a major gemstone locality you could not do much better than this. The Anakie fields in Queensland have produced good quality sapphire with fine blue and yellow stones predominating. The author laments the diminution of activity in the fields today (most blue sapphires on the market come from Thailand and lately from China) and suggests a number of reasons why activity has slackened. The main portion of the book, though, describes the fields, the sapphires and the miners, drawing heavily upon local newspaper accounts which would not be available anywhere else and there is a great amount of detail on personalities of the fields and a very useful bibliography, again giving information quite impossible to obtain any other way. There are many black-and-white photographs and some major finds are shown in colour. This reviewer appeals to anyone with such a personal knowledge of a gemstone loca-

tion to get the facts written down at once. If their accounts are as good as this one, gemmological history (where is it?) will start life as a subject of its own. M.O'D.

### Diamond cuts in historic jewellery 1381-1910.

H. TILLANDER, 1995. Art Books International, London. Illus. in black-and-white, hardcover. £52.00. ISBN 1 874044 07 4.

This study covers ground which has never been treated monographically before. Long-awaited and written by the acknowledged authority on the history of diamond cutting and its relation to jewellery styles, it will be welcomed by a wide readership, the gemmologist and the historian of jewellery design together with those interested in the applied arts in general who may find the study of diamond cutting of much greater interest than they could have imagined. The combination of art and technology which has led so many to undertake gemmology as a study has never been better shown than here. While the author admits that some of his conclusions are intuitive in the absence of much written material, he nevertheless manages to compile a most useful bibliography and to include many valuable citations in the text. While the illustrations are in black-and-white they none the less serve to illustrate points of argument and description at least adequately and often better than adequately.

The text is arranged by style of cutting, beginning with the use of the natural diamond point and progressing through ever more complicated cuts to the various ideal brilliants and to those cuts recently developed with a view to enhancing diamond's properties still further. Appendices describe proportioning, the rock crystal bowl of Queen Elizabeth I, the wedding ring of Albrecht V, early price lists and the relationship between artists and diamonds. Photographs are supplemented by diagrams and sketches: these are especially useful in displaying how a particular cut is obtained from the rough crystal, information which will be most useful for the student of diamonds. Particular attention is paid to some of the named diamonds such as the Sancy, Tiffany and Koh-i-Nor and the section dealing with what may be thought of as the modern brilliant discusses the various 'ideal' cuts at length, bringing in data which have either been unpublished before or which are making a welcome reappearance. It is good to see Frank B. Wade's 'finely cut diamond' with some of whose features

\*Diamond mine was reviewed in *J. Gemm.*, 23 3

Tolkowsky later disagreed, rejecting Wade's table but retaining a very visible culet spurned by Wade. This kind of history is what makes the book unique and highly desirable at a very reasonable price.

M.O'D.

**Faszination Edelstein aus den Schatzkammern der Welt. Mythos, Kunst, Wissenschaft.**

1992. Hessisches Landesmuseum, Darmstadt. pp 275, illus. in black-and-white and in colour, softcover. £36.00. ISBN 3 7165 0871 3.

Catalogue of an exhibition shown at the Hessisches Landesmuseum at Darmstadt in 1992, the book takes gemstones as its theme and describes exhibits in order of species, after some general introductory material on gemstones as ornament. Diverse topics are covered, including trade in gemstones in the Middle Ages, gemstones in the classical period and the synthesis and imitation of gemstones. The major gemstone families are described next and in all sections artefacts are shown and described. Each section too has its own list of references. Without saying that the catalogue contains enough substance to present a definite theme as thoroughly as might have been possible, a read-through shows a large number of interesting objects and commentary, with many of the exhibits getting a rare airing.

M.O'D.

**A private collection of early Chinese jade carvings 28 November to 9 December 1994.** [Catalogue].

Weisbrod Chinese Art Ltd, Weisbrod, New York, 1994. pp 85, illus. in colour, softcover, £8.00.

Very well-illustrated catalogue of an exhibition of early Chinese jades with an introductory essay, chronology and bibliography. Entries include a full description with provenance where applicable as well as notes on publication.

M.O'D.

**Jade in Chinese culture.**

Palm Springs Desert Museum, 8 February-29 April 1990 [The Museum] Palm Springs, 1990. pp 155, illus. in colour, softcover, £22.00.

With the sub-[or series] heading Magic, Art and Order this catalogue of Chinese jade artefacts illustrates an exhibition describing the development of jade working in Chinese culture from the neolithic period to 1911. Additional material covers ritual objects, animals, copies of objects in

other media, objects of aesthetic delight and objects of ornament. The standard of the photographs is high and there is a useful bibliography.

M.O'D.

**Bärnsten. Gullett fran Östersjön. Bursztyn. Zloto Baltyku.**

1992. Oficyna Wydawnicza Excalibur, Bydgoszcz. pp 77 [colour section unpagged], illus. in black-and-white, hardback. Price £40.00. ISBN 83-900152 6 9.

Magnificently illustrated by a series of colour photographs, the book forms the catalogue of an exhibition of Baltic amber artefacts assembled by two Swedish and two Polish museums and sent on tour during 1992/93. The short text (by Elzbieta Mierzwinska) is in Polish and Swedish and includes a short bibliography and a list of the objects, the best of which have been selected for reproduction in this catalogue (probably best ordered as *SHM utställningskatalog* no. 120 from the Statens Historiska Museum, Stockholm). Details of the history of amber recovery in the Baltic countries and a short account of the nature of amber form part of the text. Most readers will, however, turn straight to the illustrations; there are 122 and all forms of representation are included.

M.O'D.

**Gemme e Diamanti dal Kremlin. Gems and diamonds from the Kremlin.**

1994, Musei Statali del Kremlin, Moscow, pp 208, illus. in black-and-white, hardback. Price £45.00.

The Kremlin Museum in cooperation with an Italian printer/publisher [Ferrero Editore] has produced a magnificently-illustrated selection of some of the artefacts in its care. Readers familiar with Moscow should note that the museum concerned is the Palace of the Armoury, not the Diamond Treasury (both are in the Kremlin). Both contain jewellery and both need to be visited (visits to the Diamond Treasury need to be arranged in advance). The Museum and its history are fully described in the introduction and it is good to learn that new objects are being made by Russian jewellers and goldsmiths and added to the collections. In the illustrated section 90 items are illustrated in colour, each photograph occupying a full page with facing text; as in the rest of the book Italian and English are used.

M.O'D.

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

---

## The 1996 GAGTL Photo Competition

### Images in Gems

In the competition this year members are asked to submit pictures of gems with colour shapes, structures or inclusions that suggest a particular item to the viewer - the more spectacular the better.

Develop the range of evocative names established by 'feather', 'fingerprint', 'Chinese aeroplane', 'jardin', etc. What images are suggested to you by an unusual cut or by an unconventional arrangement of gems in jewellery?

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

The following prizes will be awarded:

<b>First Prize:</b>	<b>£100.00</b>
<b>Second Prize:</b>	<b>£75.00</b>
<b>Third Prize:</b>	<b>£50.00</b>

Entry forms and details of the rules of entry will be circulated to all members.

#### **OBITUARY**

**Mr William J. Boxall**, FGA (D.1952),  
Midcalder, West Lothian, died recently.

#### **GIFTS TO THE ASSOCIATION**

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

Mr D.H. Ariyaratna, FGA, DGA,

London, for a stained ruby crystal approximately 8mm in length.

Gina Latendresse, GG, President of the American Pearl Company, Nashville, Tennessee, for 'designer-shaped' cultured pearls.

Louise Sinclair, FGA, London, for a cubic zirconia weighing 3.22 ct.

Mr Wu Chao-Ming, Taiwan, for a piece of rough nephrite from Taiwan.

## FORTHCOMING MEETINGS

### London

Dr Grahame Brown, Editor of *The Australian Gemmologist*, will be giving the following lecture during his visit to Britain in January 1996:

1996

4 January

**Gemstones - Australia's national treasure.** Dr Grahame Brown.  
Evening lecture, charge £3.50 for members and £5.00 for non-members.

To be held in the GAGTL Gem Tutorial Centre, 2nd Floor, 27 Greville Street (entrance in Saffron Hill), London EC1N 8SU. Entry will be by ticket only, obtainable from the GAGTL.

### Midlands Branch

27 October

**Pearls – production and identification**

Stephen Kennedy

29 October

**Practical Autumn Seminar**

Beginners/refresher day. To be held at the New Cobden Hotel.

24 November

**Jewels in the hand**

James Gosling

2 December

**Annual Dinner**

To be held at Denehurst Close, Barnt Green

1996

21 January

**Gem Club – Is it the real McCoy?**

Details of venue from Gwyn Green on 0121 445 5359

26 January

**Bring and Buy, and Quiz Night**

Unless otherwise indicated meetings will be held at the new venue of the Discovery Centre, 77 Vyse Street, Birmingham 18. Further details from Mandy MacKinnon on 0121 624 3225 or Neil Rose on 0161 483 8919.

### North West Branch

15 November

**Annual General Meeting**

The meeting will be held at Church House, Hanover Street, Liverpool 1.

Further details from Joe Azzopardi on 01270 628251.

## NEWS OF FELLOWS

Michael O'Donoghue has been appointed to the Editorial Board of the German mineral journal *Lapis* and also to the Editorial Board of the Russian journal *World of stones*.

## GEM DIAMOND EXAMINATIONS

In June 1995 83 candidates sat the Gem Diamond Examination worldwide, of whom 64 qualified including seven with Distinction. The names of the successful candidates are as follows:

### *Qualified with Distinction*

Auzmendi, Amaia Garin, Madrid, Spain.  
Kassam, Sultan Mohamed S., London.  
Nicholson, Charles J., London.  
Pattni, Jilesh Hirji, Wembley Park.  
Sheng, Beili, Wuhan, China.  
Smyth, Lesley, London.  
Wu, Zhanxia, Wuhan, China.

### *Qualified*

Allberg, Mauritz, Stockholm, Sweden.  
Arulnathan, Jayabalan, London.  
Badibanga, Carine, Brussels, Belgium.  
Bagchi, Debal N., Brentford.  
Capisano, Eric, London.  
Carroll Marshall, Anne E., Hong Kong.  
Cassarino, Paul R., Rochester, NY, USA.  
Chan, Yuk Fan, Kowloon, Hong Kong.  
Chong, Gar Leok Grace, London.  
Eggleston, Avrina, London.  
Fan, Siu Kam, Hong Kong.  
Fantis, Charoulla, London.  
Farion, Jean-Christophe, South Kensington.  
Fong, Tsz Pan, Kowloon, Hong Kong.  
Fukushima, Katsue, London.  
Fung, Wai Yin, Hong Kong.  
Gantzidis, Adam, Athens, Greece.  
Garland, Annette J., London.  
Hamp-Gopsill, David, Burton-on-Trent.  
Hofer, Peter M., Northwood.  
Hui, Sze Wai, Kowloon, Hong Kong.  
Hung, Vivian Chi Ling, Hong Kong.  
Ji, Xiaoyan, Wuhan, China. Joey,  
Leung Wing Yee, Kowloon, Hong Kong.  
Kam, Chih, Hong Kong.

Kam, Ka Dung, Hong Kong.  
Keating, Elaine, London.  
Kwan, Wai Shun, Kowloon, Hong Kong.  
Lai, Mui Guk Margaret, Hong Kong.  
Lakhtaria, Yashwin, London.  
Lam Chiu Hung, David, Kowloon, Hong Kong.  
Mo Jing Lee, Grace, Wanchai, Hong Kong.  
Lu, Yefei, Wuhan, China.  
Mamo, Charles, London.  
Papadopoulos, Iraklis, London.  
Pattani, Shobna, London.  
Pawlyna, Andrea G., Hong Kong.  
Pegg, Delia, Petts Wood.  
Poon, Loi Chuen, Hong Kong.  
Ren, Jiakai, Wuhan, China.  
Roca Massotti, Joaquin J., London.  
Ruhmer, Fiona J., London.  
Spooner, Carole, Wokingham.  
Summerfield, Susan, London.  
Tsoi, Chung Ho, Kowloon, Hong Kong.  
Victor, Chau Tak Ming, Kong Kong.  
Wakefield, Melanie, Horsham.  
Wan, Stephen, Kowloon, Hong Kong.  
Wang, Hui, Wuhan, China.  
Wang, Xin, Wuhan, China.  
Warrington, Jennifer L., Palmerston North, New Zealand.  
Weng, Ping, Wuhan, China.  
Williams, Jason, Cobham.  
Wong, Mei Wai May, Kowloon, Hong Kong.  
Xi, Bo, Wuhan, China.  
Xu, Rupeng, Wuhan, China.  
Zhang, Weichao, Wuhan, China.

## EXAMINATIONS IN GEMMOLOGY

In the June 1995 Examinations in Gemmology 354 candidates sat the Preliminary Examination, 247 of whom qualified; 336 sat the Diploma Examination and 105 qualified.

The Anderson/Bank Prize for the best non-trade candidate of the year in the Diploma examination was awarded to Miss Zhou Shuzhen of Wuhan, China.

The Diploma Trade Prize for the best candidate of the year who derives her main income from activities essentially con-

nected with the jewellery trade was awarded to Miss Johanna Carlsson of London.

The Anderson Medal for the best candidate of the year in the Preliminary examination was awarded to Miss Sau Ping Pamela Cheung of Kowloon, Hong Kong.

The Preliminary Trade Prize for the best candidate under the age of 21 years on 1 June 1995 who derives her main income from activities essentially connected with the jewellery trade was awarded to Miss Seema Dayaldasani of Bombay, India.

This year no candidate was considered to be of sufficient merit for award of the Tully Medal.

The names of the successful candidates are as follows:

## **DIPLOMA**

### *Qualified*

Au, Yeung Kwok Ho, Hong Kong.  
 Baxter, Richard, Birmingham.  
 Bray, Betty A., Abilene, Tx, USA.  
 Cadby, John H.V., Trowbridge.  
 Cadby, Sarah, London.  
 Can, Cao, Wuhan, China.  
 Carlsson, Johanna A., London.  
 Carr, John R., Cheltenham.  
 Chen, Jyh-Shyang, Taipei, Taiwan, ROC.  
 Cheng, Ming Chi, Hong Kong.  
 Clay, Gretchen F., Boston.  
 Dang, Xiaoying, Wuhan, China.  
 Day, Stephen J., Peterborough, Ont., Canada.  
 Dayaldasani, Seema Kamlesh, Bombay, India.  
 Ding, Weijun, Wuhan, China.  
 Dokken, Aarrynne D.C., Sutton.  
 Everitt, Sally A., London.  
 Guo, Hui, Wuhan, China.  
 Guo, Xiaodan, Wuhan, China.  
 Haittoniemi, Mia, Helsinki, Finland.  
 Hawken, Diana B., Hong Kong.  
 Higo, Kenji, Osaka, Japan.  
 Ho, Hsiung-Chien, Taipei, Taiwan, ROC.  
 Ho, Shuk Ching Rebecca, Hong Kong.  
 Ho, Tung Tak, Hong Kong.

Iwata, Kaoru, London.  
 Javeri, Mitesh J., Bombay, India.  
 Jiang, Xinshun, Wuhan, China.  
 Kuixi, Jin, Wuhan, China.  
 Kathoon, Junaida, London.  
 Kawamura, Toshiko, Sakurai City, Japan.  
 Kennedy, Karen F., Egham.  
 Kenny, Sark, Kowloon, Hong Kong.  
 Kissoon, Sasha N., London.  
 Kleiser, Alwen M., Holyhead.  
 Lee, Angela Sau Mui, Kowloon, Hong Kong.  
 Leung, Stephen Ping-Kwong, Thornhill, Ont., Canada.  
 Li, Yuan, Wuhan, China.  
 Lin, Fiona, Taipei, Taiwan, ROC.  
 Lin, Bing, Wuhan, China.  
 Lo, Shuk Lan, Hong Kong.  
 Loungani, Jagdish, Jaipur, India.  
 Lu, Fude, Wuhan, China.  
 Luo, Yiguang, Wuhan, China.  
 Ma, Yugao, Wuhan, China.  
 Maheshwari, Ashoo, Jaipur, India.  
 Mallo Sanz, Maria Cristina, Madrid, Spain.  
 Marathe, Tanjua, Pune, India.  
 Moore, Julie L., Measham.  
 Nam, Chang Soo, Daejon, Korea.  
 Ng, Yee Mei Kathy, Hong Kong.  
 Owens, Suzanne, Dublin, Republic of Ireland.  
 Pachchigar, Dharmesh N., Bombay, India.  
 Papadopoulos, Dimitrios, Athens, Greece.  
 Pattni, Jilesh Hirji, Wembley Park.  
 Purkiss, Karen A., Colchester.  
 Qin, Shule, Wuhan, China.  
 Rabstein, Wolf I., London.  
 Rickard, Sarah V., Market Harborough.  
 Roca Massotti, Joaquin J., London.  
 Rose, Christina, Liverpool.  
 Rosier, Wendy, Hong Kong.  
 Rossiter, John T., Weston-Super-Mare.  
 Salm-Reifferscheidt, Sophie, London.  
 Sharma, Animesh, Jaipur, India.  
 Sharma, Rajeev, Jaipur, India.  
 Sim, Hoo Joung, Daejon, Korea.  
 Siu, Ming Wa, Hong Kong.  
 Smallenburg, M.A., Amsterdam, The Netherlands.  
 So, Che Shing, Hong Kong.

Solves Camara, Jose Daniel, Valencia, Spain.  
 Soo, Hoi Leung, Hong Kong.  
 Sotolongo, Sachiko Kashiba, London.  
 Stead, Graham Scott, Tillsonburg, Ont., Canada.  
 Sun, Yanling, Wuhan, China.  
 Sung, Soo Kyung, Taegu, Korea.  
 Tada, Reiko, Osaka, Japan.  
 Tan, Hongwei, Wuhan, China.  
 Tanaka, Daisuke, Kobe City, Japan.  
 Tang, Zhen Yi, Hong Kong.  
 Thornton, Timothy J., Kettering.  
 Tompkins, Alison L., Brierly Hill.  
 Turner, Caroline, London.  
 Wang, Xuqiang, Wuhan, China.  
 Wen, Li, Wuhan, China.  
 Whipp, David, London.  
 White, Michele, Birmingham.  
 Win, Mai Mu Mu, Yangon, Myanmar.  
 Winiski, Ken R., Vancouver, BC, Canada.  
 Wu, Chun-Li, Taipei, Taiwan, ROC.  
 Wu, Zhaoyang, Wuhan, China.  
 Wunna, Kyaw, Yangon, Myanmar.  
 Yates, David Hayman, Derby.  
 Yoshida, Miyuki, Hong Kong.  
 Yan, Yuan, Wuhan, China.  
 Zaw, Oo, Yangon, Myanmar.  
 Zhang, Juan, Wuhan, China.  
 Zhang, Yongwen, Wuhan, China.  
 Zheng, Bei, Wuhan, China.  
 Zhong, Liyi, Wuhan, China.  
 Zhou, Jun, Wuhan, China.  
 Zhou, Min, Wuhan, China.  
 Zhou, Shuzhen, Wuhan, China.  
 Zhu, Dawei, Wuhan, China.  
 Zou, Juan, Wuhan, China.

## PRELIMINARY

### *Qualified*

Achten, Louisa W., Horst, The Netherlands.  
 Alzamil, Farida A., London.  
 Anderson, Lesley, Wivanhoe.  
 Archibald, Mhari-Louise, Sutton.  
 Arulnathan, Jayabalan A., London.  
 Atkins, Elizabeth M., Chipperfield, Kings Langley.  
 Au-Yeung, Chi Fung, Kowloon, Hong

Kong.  
 Backstrom, Ingrid A., Frosen, Sweden.  
 Bahrani, David J., Crewe.  
 Baker, Kate E., Hornton, Nr Banbury.  
 Barnes, Patricia E., Dunkirt, Md., U.S.A.  
 Bhansali, Raju, Bombay, India.  
 Bi, Zhengyun, Wuhan, China.  
 Bienemann, A.M., Polsbroek, The Netherlands.  
 Boyle, Catherine S., Mickleham.  
 Brangulis, Peters, Riga, Latvia.  
 Brooks, Gillian E., Edinburgh.  
 Bulmer, George P., Colchester.  
 Cameron, Iain A., London.  
 Chan, Lai Min, Hong Kong.  
 Chan, Sau King, Hong Kong.  
 Chan, Yiu Pui, Hong Kong.  
 Chandaria, Anuradha Paras, Nairobi, Kenya.  
 Chang, Chiao Yi, Taipei, Taiwan, ROC.  
 Chang, Mei-Chu Joyce, Tapei, Taiwan, ROC.  
 Chang, Shiao-Fen, Tapei, Taiwan, ROC.  
 Chatta, Harvinder, Bombay, India.  
 Chen, Binghui, Guangzhou, China.  
 Chen, Yumei, Guangzhou, China.  
 Cheung, Sau Ping Pamela, Hong Kong.  
 Ching, Mei Ying, Hong Kong.  
 Choi, Hyo-Jin, Taegu, Korea.  
 Chopada, A. Dilip Anraj, Hyderabad, India.  
 Chow, Michelle Yan Wai, London.  
 Chu, Yin Yee Terry, Hong Kong.  
 Ciaralli, Tiziana, London.  
 Clark, Antony, Bolton.  
 Clarkson, James D., Reno, Nev., U.S.A.  
 Clevers, Irene L., Utrecht, The Netherlands.  
 Cragg, Steve, Shaw.  
 Damianidou, Teresa, Piraeus, Greece.  
 Dapper, Sylvia, London.  
 Das, Rajesh Shakti, Bombay, India.  
 Davis, Roberta K., Birmingham.  
 Day, Stephen J., Peterborough, Ont., Canada.  
 Dayaldasani, Seema K., Bombay, India.  
 De Klerk, Ton, Roosendaal, The Netherlands.  
 Dean, John E., Bath.  
 Dewan, Prasoon, Bombay, India.



## GAGTL GEM TUTORIAL CENTRE

### Synthetics and Enhancements Today

22-23 November

Are *you* aware of the various treated and synthetic materials that are likely to be masquerading amongst the stones you are buying and selling? Whether you are valuing, repairing or dealing, can you afford to miss these two days of insights, tips and practical investigation?

*Price £223.25 (including sandwich lunches)*

### Hand Lens Characteristics of Biological Gem Materials

5 January 2.00 - 5.00 p.m.

Dr Grahame Brown, the well known gemmologist and organic gem material specialist, will lead this fascinating afternoon seminar.

*Price £29.38*

### Two-Day Diploma Practical Workshop

6-7 January

The long-established intensive practical course to help students prepare for the Diploma practical examination or for those in the trade or elsewhere to brush up on technique. This is the course to help you practise the methods required to coax the best results from gem instruments. The course includes a half-length mock exam for you to mark yourself.

*Price £160.39 (£111.04 for GAGTL registered students) - includes sandwich lunches*

### A Day to String Your Own Beads

13 January

Learn with your own pack of beads and materials; with an expert stringer, step-by-step instruction and fascinating detail, tips and hints.

*Price £105.75 - includes your pack of beads and materials, and sandwich lunch*

### Synthetics and Enhancements Today

14-15 February

Are you aware of the various treated and synthetic materials that are likely to be masquerading amongst the stones you are buying and selling? Whether you are valuing, repairing or dealing, can you afford to miss these two days of insights, tips and practical investigation?

*Price £223.25 (including sandwich lunches)*

### Enquire Within : Emerald

6 March

A valuable and concentrated look at all aspects of emerald: natural rough and cut stones, treated, synthetic and imitation stones.

*Price £111.63 (including sandwich lunch)*

### Preliminary Workshop

13 March

A day of practical tuition for Preliminary students and anyone who needs a start with instruments, stones and crystals. You can learn to use the 10x lens at maximum efficiency, to observe the effects and results from the main gem testing instruments and to understand important aspects of crystals in gemmology.

*Price £47.00; GAGTL students £33.49 (including sandwich lunch)*

### Enquire Within : Ruby and Sapphire

20 March

A day looking at all aspects of these gems - natural, treated, synthetic and imitation.

*Price £111.63 (including sandwich lunch)*

**\*NOTE!! ALL PRICES INCLUDE VAT AT 17.5%\***

**Please ring the Education Office (0171-404 3334) for further information**

- Dey, Tapas K., Chandannagore, India.  
 Ding, Qian, Jiangsu, China.  
 Dokken, Aarrynne, D.C., Sutton.  
 Dooley, Kaeren, Manchester.  
 Duggan, Rory P., Phetchabun, Thailand.  
 Duguid, Angus K., Kadoma, Zimbabwe.  
 Duncan, Kenneth G., Reston, Va., U.S.A.  
 Dupuy, David J., Dublin, Republic of  
 Ireland.  
 Dykstra, Menno, Sluis, The Netherlands.  
 Effendi, Megawaty, Hong Kong.  
 Everitt, Sally A., London.  
 Han, Fan Suk, Hong Kong.  
 Fang, Huei Yu, Karen, Taipei, Taiwan,  
 ROC.  
 Field, Beverly, Gravesend.  
 Fok, Raymond Siu Ki, Hong Kong.  
 Fong, Ka Chun, Hong Kong.  
 Friedberg, Guy, Gants Hill, Ilford.  
 Fukuda, Kenji, Ikoma City, Japan.  
 Ghika, Jean V., London.  
 Glaser, N.V.K., Sonja I., Zurich,  
 Switzerland.  
 Goodwin, Gregory M., Wilmslow.  
 Graham-Blomgren, Berdie, Stockholm,  
 Sweden.  
 Grannudd, Stig, Lannavaara, Sweden.  
 Gray, Vivienne M., London.  
 Grimley, Andrew F., London.  
 Grondin, Daniel B., Geneva, Switzerland.  
 Grondin, Magali, Geneva, Switzerland.  
 Guan, Zichuan, Wuhan, China.  
 Hansen, Edith E., Stavanger, Norway.  
 Hui, Hao, Wuhan, China.  
 Harris, Annette Mia, Worcester.  
 He, Lin, Wuhan, China.  
 Hino, Toshiaki, Owase City, Japan.  
 Ho, Chi Tai, Hong Kong.  
 Ho, Mary Malai, London.  
 Ho, Shuk Ching, Rebecca, Hong Kong.  
 Ho, Yan Yee, Winnie, Hong Kong.  
 Honda, Takashi, Tokyo, Japan.  
 Hopkinson, Barrie, Nottingham.  
 Hopley, Katharine B., Coventry.  
 Hsieh, Chung-Wei, Taipei, Taiwan, ROC.  
 Htoo, Thidar, Yangon, Myanmar.  
 Htun, Han, Yangon, Myanmar.  
 Hung, Yu Ling, Taipei, Taiwan, ROC.  
 Hussain, Jemanzeb Khan, Diemen Zuid,  
 The Netherlands.  
 Javeri, Mitesh J., Bombay, India.  
 Johnson, Brian J., Birkenhead.  
 Joseph, Elizabeth, Hale Barns.  
 Joseph, Tomy, Cherthala, India.  
 Kafetsis, Georgios, Athens, Greece.  
 Kamani, Priscilla, Nairobi, Kenya.  
 Kaprili, Maria, Athens, Greece.  
 Kasseyet, Charles K., London.  
 Kathriarachchie, Siripalan, Idar Oberstein,  
 Germany.  
 Kato, Junko, Osaka, Japan.  
 Kawahara, Tamami, Osaka, Japan.  
 Khanbhai, Shabbir, London.  
 Khine, Kay, Yangon, Myanmar.  
 Kilian A., Den Haag, The Netherlands.  
 Kisson, Sasha N., London.  
 Kalmer, F.H.G., Oss, The Netherlands.  
 Knapkik, Paulina, Ronneby, Sweden.  
 Knight, Eloise, Kenilworth.  
 Kobayashi, Yukiko, Osaka, Japan.  
 Kodera, Yukiko, Willowdale, Ont., Canada.  
 Koh, Yeon Kyeong, Daejeon, Korea  
 Kuulman, Heli, Tallinn, Estonia.  
 Kwong, Yan Lam, Kowloon, Hong Kong.  
 Lamb, Maria Tegwen Hotung, Hong Kong.  
 Landgren, Angelica, Vichtis, Finland.  
 Lau, Wai Keung Leslie, Hong Kong.  
 Law, Chun Yip, Hong Kong.  
 Lee, Jin-Hwan, Taegu, Korea.  
 Lee, Kin Ming Jackie, Kowloon, Hong  
 Kong.  
 Lee, Shuet Fong, Hong Kong.  
 Lee, Ping (Jeff), Kowloon, Hong Kong.  
 Lee, Young Woo, Seoul, Korea.  
 Lemessiou, Maria, Nicosia, Cyprus.  
 Lennie, James, Glasgow.  
 Leung, Stephen Ping-Kwong, Thornhill,  
 Ont., Canada.  
 Leung, Vanda Mo-Lan, Kowloon, Hong  
 Kong.  
 Leung Yuen Fan, Yuen Tan, Hong Kong.  
 Li, Li-Ping, Taipei, Taiwan, ROC.  
 Li, Liung Hsing, Taipei, Taiwan, ROC.  
 Li, Ruling, Guangzhou, China.  
 Li, Kong Loon Paul, Kowloon, Hong Kong.  
 Li, Qingnian, Wuhan China.  
 Liao, Zhongting, Shanghai, China.  
 Lin, Yuk Ying, Hong Kong.
-

- Lindblom, Joachim, Turku, Finland.  
 Lindroos, Anna, Pori, Finland.  
 Liu, Kyin Han, Yangon, Myanmar.  
 Liu, Xu, Wuhan, China.  
 Lo, Sui Ying Eugenie, Hong Kong.  
 Lock, Natasha C., George, Somerset.  
 Lullin, Cedric, Geneva, Switzerland.  
 Lynch, Melissa, Glasgow.  
 Mackay, Colin A., Edinburgh.  
 Made, Lollo, Hong Kong.  
 Maheshwari Ashoo, Jaipur, India.  
 Mao, Yanying, Wuhan, China.  
 Marathe, Tanuja, Pune, India.  
 Marolla, Marianna, Athens, Greece.  
 Marshall, Andrew P., Gravesend.  
 Miller, Kenneth R., North York, Ont.,  
 Canada.  
 Moe, Kyaw, Yangon, Myanmar.  
 Mohan, T.V. Jagan, Salem, India.  
 Mucciolella, Raul, London.  
 Murphy, Ditas, Colchester.  
 Nagaoka, Mikage, Nishinomiya City,  
 Japan.  
 Ng, Yee Mei, Kathy, Hong Kong.  
 Ng, Wai Man, Kowloon, Hong Kong.  
 Niemi, Markku, Lappeenranta, Finland.  
 Orjales, Carlos Nunez, Geneva,  
 Switzerland.  
 Otsuka, Mayumi, Osaka, Japan.  
 Pachchigar, Dharmesh N., Bombay, India.  
 Pan, Jianqiang, Wuhan, China.  
 Panagopoulou, Anastasia, Athens, Greece.  
 Pang, Helen Yee Man, Colchester.  
 Pani, Tonu, Tartu, Estonia.  
 Pawlowska, Magda L., Christchurch, New  
 Zealand.  
 Pepprell, Eija-Liisa, London.  
 Pereira, Sharon A., Basildon.  
 Permal, Charles M.A., Birmingham.  
 Phillips, Sarah L., Kinross.  
 Poon, Ka Yee, Carrie, Kowloon, Hong  
 Kong.  
 Popov, Vladimir, Tallinn, Estonia.  
 Proske, Oktavio R., Amsterdam, The  
 Netherlands.  
 Qin, Zhili, Guangzhou, China.  
 Raghavendra, N.S., Bangalore, India.  
 Rai, Ashish, Jaipur, India.  
 Rimmer, Ray I., Bootle.  
 Ross, Peter M., London.  
 Rutter, Fay, Walsall.  
 Rynbergen, J.G., Utrecht, The Netherlands.  
 Salm-Reifferscheidt, Sophie, London.  
 Schjolberg, Liv, Stavanger, Norway.  
 Seki, Shoko, Osaka, Japan.  
 Seligmann, Marianne E. Heilner, Huizen,  
 The Netherlands.  
 Seng, Zau, Yangon, Myanmar.  
 Shah, Monica, Cheadle.  
 Shahani, Neeta K., Pune, India.  
 Shi, Dongsheng, Wuhan, China.  
 Silvero, Ma Rita Talao, Mandaluyong City,  
 The Philippines.  
 Siu, Ming Wa, Hong Kong.  
 Smith, Marina V., London.  
 Snyman, Johanna E.W., Pretoria, S. Africa.  
 So, Woo Sze Sze, Hong Kong.  
 Soderstrom, Jenny, Lannavaara, Sweden.  
 Song, Gyu Bong, Kyungnam, Korea.  
 Song, Sang-Hun, Taegu, Korea.  
 Soong, Jackie, Ipoh, West Malaysia.  
 Spiteri, Ruth, Sta Venera, Malta.  
 Starreveld, Francis M.M., Hilversum, The  
 Netherlands.  
 Stern, Sara, Arlington, Va., U.S.A.  
 Stopelli, Christopher J.D., Oakville, Ont.,  
 Canada.  
 Sufian, Shaffy Musnad, Galle, Sri Lanka.  
 Sundell, Johanna, Helsingfors, Finland.  
 Tam, Kam Biu, Wanchai, Hong Kong.  
 Tang, Deping, Wuhan, China.  
 Thornton, Timothy J., Kettering.  
 Tian, Lianguang, Wuhan, China.  
 Torrent, Denise, Geneva, Switzerland.  
 Triantafillos, Spiros, Athens, Greece.  
 Trivedi, Ishwar, Bombay, India.  
 Tsai, Yao Chu, Taipei, Taiwan, ROC.  
 Tsang, Wai Yi, Rita, Hong Kong.  
 Tsay, Jyh-Tsong, Taipei, Taiwan, ROC.  
 Tsoi, Yu Lum, Henry, Kowloon, Hong  
 Kong.  
 Than, Tun, Yangon, Myanmar.  
 Urm, Tanel, Voru, Estonia.  
 Van Gelder, Marie C., London.  
 Veryis, Anastassios, Athens, Greece.  
 Vincent, Arthur J., Norwich.  
 Vummidi, Sreeramakishna, Madras, India.  
 Vummidi, Nagaraj, Madras, India.
-

## MEMBERSHIP '96

Members, Fellows and Diamond Members receive *The Journal of Gemmology* and the *Gem and Jewellery News* quarterly. Fellows (members who hold our Diploma in Gemmology) may use FGA after their name and Diamond Members (members who hold the Gem Diamond Diploma) the title DGA, and both may also apply for the use of the Coat of Arms on their stationery.

Laboratory Members receive an annual membership certificate for display, *The Journal of Gemmology* and *Gem and Jewellery News* quarterly, discounted testing and grading fees, and may apply for use of the Laboratory logo on their business stationery. Overseas members are assisted with the temporary importation of gemstones for grading or testing.

All members are eligible for a 10 per cent discount on the retail price of most instruments and specimens, and a 5 per cent discount on books purchased from Gemmological Instruments Limited. Overseas Members benefit from arrangements to pay membership fees by credit card and their journals will be sent by airmail.

## Subscription Rates 1996

	UK	Overseas
Ordinary Member } Fellow } Diamond Member }	£49.50	£70.00
Laboratory Member	£225.00 + VAT	£225.00

Wang, Dequan, Wuhan, China.  
Wang, San Zen, Taipei, Taiwan, ROC.  
Wanjohi, Jacqueline W., Nairobi, Kenya.  
Wewa, Peter, Nairobi, Kenya.  
Whitewood, Steven G., Rochester.  
Wiik, Gudmund, Lannavaara, Sweden.  
Wong, Heather Ti Yin, Hong Kong.  
Wong, Siu Lai, Hong Kong.  
Wooter, Ronny, Amsterdam, The Netherlands.  
Wu, Yaoping, Jiangsu, China.  
Wu, Chin To, Constance V., Hong Kong.  
Wu, Chun-Li, Taipei, Taiwan, ROC.  
Xenos, Panagiotis, Peristeri, Greece.  
Yamada, Setsuko, Kyoto, Japan.  
Yang, Ruzhen, Wuhan, China.

Yao, Teng Long, Taipei, Taiwan, ROC.  
Yim, Yat-Hung, Cannia, Hong Kong.  
Yogalingam, Nirupa, Kandy, Sri Lanka.  
Yoshikoshi, Naoko, London.  
Yulo, Kathleen Linda Velayo, Metro Manila, Philippines.  
Zhang, Xueli, Wuhan, China.  
Zhang, Yixiang, Wuhan, China.

## MEETINGS OF THE COUNCIL OF MANAGEMENT

At a meeting of the Council of Management held on 19 July at 27 Greville Street, London EC1N 8SU, the business transacted included the election of the following:

### **Diamond Membership**

Zhenghua, Zhuang, Wuhan, China, 1995.

### **Transfer - Ordinary Membership to FGA**

Ayles, Catherine, Edinburgh, 1995.

Wren, Amanda, Edinburgh, 1995.

### **Fellowship**

Baozhen, Tian, Wuhan, China, 1995.

Bing, Zhang, Wuhan, China, 1995.

Cuihua, Cai, Wuhan, China, 1995.

Haiqing, Zhou, Wuhan, China, 1995.

Jiansen, Feng, Wuhan, China, 1995.

Meidi, Zhu, Wuhan, China, 1995.

Wei, Zhou, Wuhan, China, 1995.

### **Ordinary Membership**

Brimble, Stephen, Heanor.

Britton, Andrea L., Knaphill, Woking.

Chandaria, Anuradha, London.

Crawford, Henry David, London.

Griffiths, Robert William, Northwich.

Kalinin, Julia, Bayswater.

Mitchell, Brenda Hilary, Cosham.

Weyli, Ali A., London.

Wismayer, Lawrence Paul, St Julians,  
Malta.

### **Laboratory Membership**

Elisabeth's Antiques, London, W1Y 9AE

Kamsco Ltd, London, E7 OEX

### **Corrigenda**

On p.500 above, for '£115.00 plus VAT' read '£275.00 plus VAT'

On p.508 above, Abstract, first paragraph, last line, for '0.1 to 0.2' read '0.1 to 0.5'

On p.509 above, second column, under Trace elements in jadeite, first paragraph, line 8, add 'chromium,' before 'iron'

On p.510 above, Table I:Fe<sup>2+</sup>/Fe<sup>3+</sup> content of leaf-green jadeite, for '0.1-0.2' read '0.1-0.5'; Cr%, emerald green (chrome-rich), for '0.3-0.4' read '0.3-0.04'

On p.510 above, first column, line 6 of text, for '0.1-0.2' read '0.1-0.5'

On p.524 above, first column, last line in Gifts to the Association section, for 'serpentine' read 'nephrite from Taiwan'

## **The Journal of Gemmology**

### **Back issues**

Individual back issues of volumes 23 and 24 are available at £10.00 each.  
Issues up to and including volume 22 are £4.00 each. Most issues are available.  
Members of GAGTL are eligible for a 10% discount.

When an order is received an invoice will be sent showing cost including postage and packing.

Please contact:  
Mary Burland

## **Gemmological Association and Gem Testing Laboratory of Great Britain**

◆ FIRST FLOOR, 27 GREVILLE STREET (SAFFRON HILL ENTRANCE), LONDON EC1N 8SU ◆

Tel: 0171 404 3334

Fax: 0171 404 8843

# DIAMOND SELECTOR II



## DIAMOND TESTER

- Easy to use
- Fully portable
- Audible and visual signal
- Metal detector
- 9 volt battery included

## NEW LOWER PRICE

**£135.00 plus VAT, postage and packing**

Remember your membership number for your 10% discount.

## Gemmological Instruments Limited

◆ SECOND FLOOR, 27 GREVILLE STREET (SAFFRON HILL ENTRANCE), LONDON EC1N 8SU ◆

Tel: 0171-404 3334

Fax: 0171-404 8843

Pearls Coral Amber Bead Necklaces Carvings Cameos Mineral Specimens

The World  of Gemstones

**Ruppenthal (U.K.) Limited**

Gemstones of every kind, cultured pearls, coral, amber, ivory, bead necklaces, hardstone carvings, objets d'art, 18ct gold gemstone jewellery and antique jewellery.

We offer a first-class lapidary service.

London Showroom,  
3rd Floor, 20-24 Kirby Street,  
Hatton Garden, London EC1N 8TS  
Tel: 0171-405 8068  
Fax: 0171-831 5724

Opal Precious Topaz Ruby Star Ruby Sapphire Star Sapphire Tourmaline  
Garnets Aquamarine Alexandrite Amethyst Emerald Jade Lapis-Lazuli

Antique Jewellery Modern 18ct and 9ct Gem-set Jewellery

**Мир Камня  
World of Stones**

- *The only Russian popular science mineralogical journal*
- *Minerals, museums and much more!*
- *Printed in English with supplementary sheet of text in Russian, volume 80pp*
- *One year subscription (4 issues) \$52, including postage*

**You may subscribe at any time. Back issues are available.**

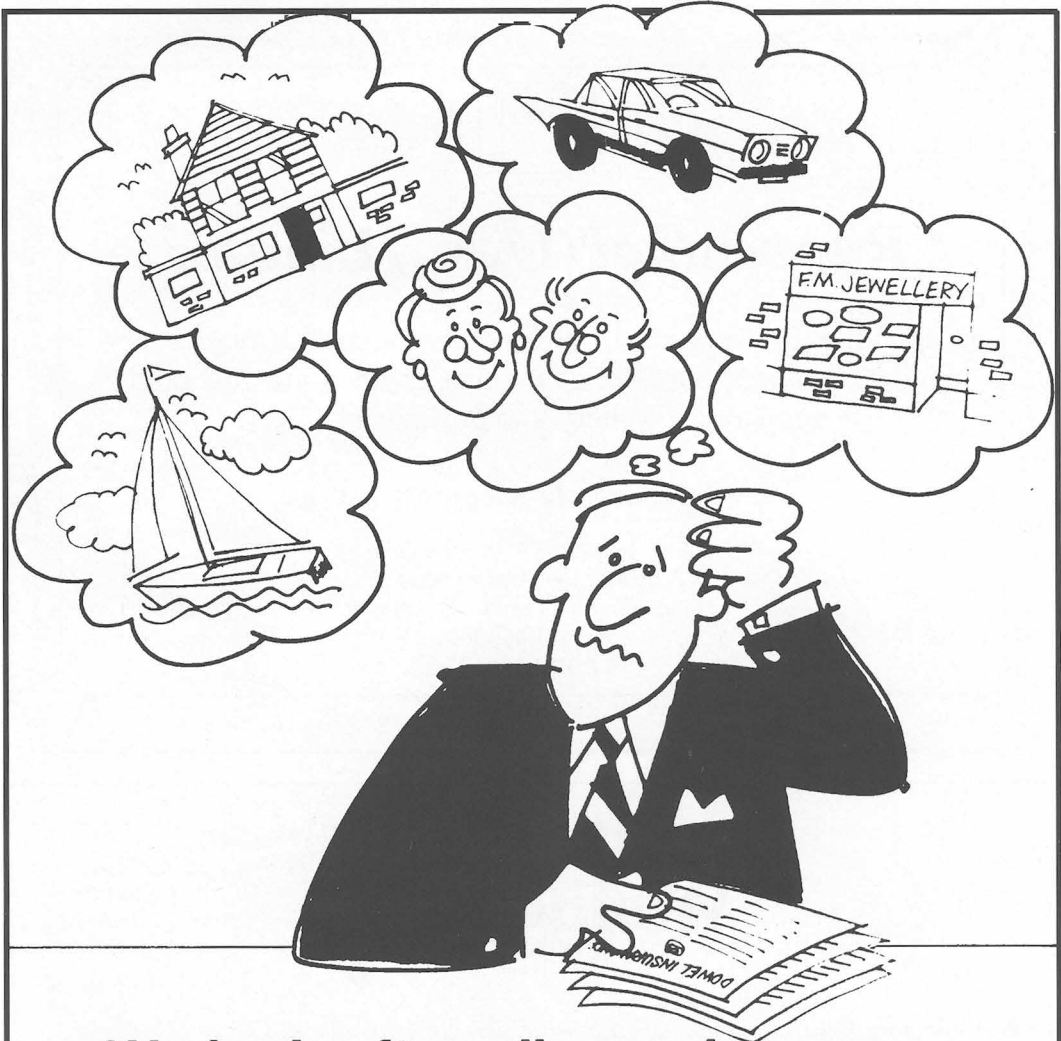
Send your subscription details and cheque to:

UK: Don Edwards, Tideswell Dale Rock Shop, Commercial Road, Tideswell, Derbys SK17 88NU, UK  
Please make cheque payable in £ Sterling to Don Edwards

Germany: L. Schneider, Hemmersweiher 5, 66386 St-Ingbert BRD.  
Please make cheque payable in DM to L. Schneider.

USA: H. Obodda, Box 51, Short Hills, NJ 07078, USA  
Please make cheque payable in US \$ to H. Obodda

**Editorial: Box 162 Moscow 103050 Russia. Telephone/Fax: (7-095) 203 3574**



## We look after all your insurance PROBLEMS

For nearly a century T. H. March has built an outstanding reputation by helping people in business. As Lloyds brokers we can offer specially tailored policies for the retail, wholesale, manufacturing and allied jewellery trades. Not only can we help you with all aspects of your business insurance but we can also take care of all your other insurance problems,

whether it be home, car, boat or pension plan.

We would be pleased to give advice and quotations for all your needs and delighted to visit your premises if required for this purpose, without obligation.

Contact us at our head office shown below.



T. H. March and Co. Ltd.  
Saint Dunstan's House, Carey Lane,  
London EC2V 8AD. Telephone 0171-606 1282  
Also at Birmingham, Manchester, Glasgow and Plymouth.  
Lloyd's Insurance Brokers

*You can't beat  
Experience*



- GEMMOLOGY
- INSTRUMENTS
- CRYSTALS
- CUT SPECIMENS
- STUDY TOURS

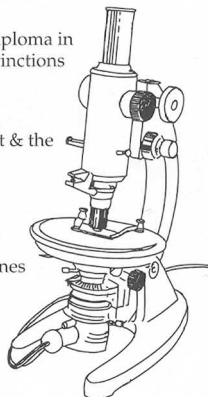


● **WORLD LEADERS IN PRIVATE GEMMOLOGICAL EDUCATION**  
 We specialize in small group intensive tuition, from scratch to F.G.A. Diploma in 9 months. we are able to claim a very high level of passes including Distinctions & prize winners amongst our students.

● **GEMMOLOGICAL STUDY TOURS**  
 We organise a comprehensive programme of study tours for the student & the practising gemmologist to areas of specific interest, including :-  
**ANTWERP, IDAR- OBERSTEIN, SRI LANKA, THAILAND & CHINA.**

● **DEALERS IN GEMSTONES/DIAMONDS & CRYSTALS**  
 We buy & sell cut and rough gemstones and diamonds, particularly for the F.G.A. syllabus, and have many rare or unusual specimens. Gemstones & Diamonds also available for commercial purposes.

● **SUPPLIERS OF GEMMOLOGICAL INSTRUMENTS**  
 We offer a comprehensive range of gem testing instruments, including inexpensive Petrological & Stereo-zoom Microscopes, Refractometers, Hand Lenses, Pocket U/V Lights, S.G. Liquids, the world famous OPL Spectroscope, and many other items including Books & Study Aids.



*Illustrated:*  
**Petrological Microscope.**  
 Mag. 20x - 650x, with full range of oculars & objectives, wavelength filters, quartz wedge, Bertrand lens, iris diaphragms, graticules etc.

**From ONLY £650 + VAT & Delivery/Carriage**

*For further details of these and our other activities, please contact-*  
**Colin Winter, F.G.A. or Hilary Taylor, B.A., F.G.A. at GENESIS, 21, West Street, Epsom, Surrey. KT18 7RL England**  
 Tel. 01372 742974 or Fax 01372 742426

## ADVERTISING IN THE JOURNAL OF GEMMOLOGY

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

Rates per insertion, excluding VAT, are as follows:

Whole page	Half page	Quarter page
£180	£100	£60

Enquiries to Mary Burland,  
 Advertising Manager  
 Gemmological Association and  
 Gem Testing Laboratory of Great Britain  
 27 Greville Street London EC1N 8SU

## PROMPT LAPIDARY SERVICE!

Gemstones and diamonds cut to your specification and repaired on our premises.

Large selection of gemstones including rare items and mineral specimens in stock.

Valuations and gem testing carried out.  
 Mail order service available.

## R. HOLT & CO. LTD

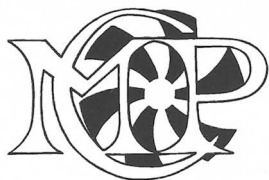
98 Hatton Garden, London EC1N 8NX  
 Telephone 0171-405 0197/5286  
 Fax 0171-430 1279

AMETHYST • AMBER • BERYL • CHRYSOBERYL • CITRINE • TOPAZ • RUBY  
 • SAPHIRE • IOLITE • AQUAMARINE • CAMEOS • PERIDOT •  
 • CORAL • OPAL • GARNET • EMERALD • PEARLS •

**E. A. Thomson (Gems) Ltd.**

Precious stone merchants  
 also representing:  
 Morris Goldman Gems Ltd.  
 Chapel House, Hatton Place,  
 Hatton Garden,  
 London EC1N 8RX, England.  
 Tel: 071-242 3181  
 Telex: 27726 THOMCO-G  
 Fax: 071-831 1776

GEMSTONES OF THE WORLD



MAGGIE CAMPBELL PEDERSEN  
 ABIPP, FGA

JEWELLERY & GEMSTONE  
 PHOTOGRAPHY

Tel: 0181-994 8341  
 Fax: 0181-723 4266

### Museums, Educational Establishments, Collectors & Students

I have what is probably the largest range of genuinely rare stones in the UK, from Analcime to Wulfenite. Also rare and modern synthetics, and inexpensive stones for students. New computerised lists available with even more detail. Please send £2 in 1st class stamps refundable on first order (overseas free).

**Two special offers for students:**  
 New Teach/Buy service and free stones on an order.

A.J. French, FGA  
 82 Brookley Road, Brockenhurst,  
 Hants SO42 7RA  
 Telephone 01590 623214

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

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

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

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

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

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

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

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

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

## A This is a first level heading

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

## B *This is a second level heading*

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

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

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

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

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

**Notes and References** Authors may choose one of two systems:

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

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

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

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

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

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



## Contents

An attempt to explain the instigation of the formation of the natural pearl	<i>E.J. Gübelin</i>	539
Nephrite from Chuncheon, Korea	<i>Won-Sa Kim</i>	547
Burmese sapphire giants	<i>Richard W. Hughes and U Hla Win</i>	551
An examination of 'serendipitous' synthetic zincite	<i>R.C. Kammerling and Mary L. Johnson</i>	563
Cat's-eye and asteriated gemstones from East Africa	<i>N.R. Barot, G. Graziani, E. Gübelin and M. Rettighieri</i>	569
A note on red beryl	<i>R.R. Harding</i>	581
Abstracts		585
Book Reviews		602
Proceedings of the Gemmological Association and Gem Testing Laboratory of Great Britain and Notices		610

Copyright © 1995

The Gemmological Association and Gem Testing Laboratory of Great Britain

Registered Office: Palladium House, 1-4 Argyll Street, London W1V 1AD

ISSN: 1355-4565



# The Journal of Gemmology

## **VOLUME 24 NUMBERS 1-8 1994-1995 INDEX**

# The Journal of Gemmology

VOLUME 24

NUMBERS 1-8 1994-1995

## CONTENTS

[No. 1, January 1994]

KAMMERLING, R.C., SCARRATT, K., BOSSHART, G., JOBBINS, E.A., KANE, R.E., GÜBELIN, E.J., LEVINSON, A.A., Myanmar and its gems - an update	3
BUBSHAIT, A., STURMAN, N., Notes from the Gem and Pearl Testing Laboratory, Bahrain - 3	42
BURLAND, M., 1993 Annual Conference	45
JOBBINS, E.A., XXIV International Gemmological Conference Paris 1993	50
Book Reviews	53
Proceedings of The Gemmological Association and Gem Testing Laboratory of Great Britain and Notices	55
Letters to the Editor	61

[No. 2, April 1994]

Alan Jobbins: Editor 1986-93	74
KANIS, J., REDMANN, M., Four hessonite occurrences in Orissa, India	75
de GOUTIÈRE, A., Fluorescent oil inclusions in quartz	84
SCHMETZNER, K., SMITH, C.P., BOSSHART, G., MEDENBACH, O., Twinning in Ramaura synthetic rubies	87
NELSON, J.B., The glass filling of diamonds. Part 2: a possible filling process	94
FARRIMOND, T., A device to facilitate the measurement of birefringence in gemstones	105
NASSAU, K., More on the antiquity of emerald oiling	109
Gemmological abstracts	112
Book reviews	119
Proceedings of The Gemmological Association and Gem Testing Laboratory of Great Britain and Notices	125
Letter to the Editor	130

[No. 3, July 1994]

Editorial	138
HÄNNI, H.A., Origin determination for gemstones: possibilities, restrictions and reliability	139
KAMMERLING, R.C., KOIVULA, J.I., FRITSCH, E., An examination of Chatham flux-grown synthetic pink sapphires	149
TAYLOR, A., Exploration gemmology	155
FARRIMOND, T., Hydrostatic measurement of specific gravity	161
BAROT, N.R., HARDING, R.R., Pink corundum from Kitui, Kenya	165
NOVAGA, M., Vesuvianite from Bellecombe and Montjovet (AO Italy): a material of gemmological interest	173
HARDER, H., Smoky moonstone: a new variety	179
Letters	183
Abstracts	187
Book reviews	212
Proceedings of The Gemmological Association and Gem Testing Laboratory of Great Britain and Notices	216

[No. 4, October 1994]

Editorial	234
KENNEDY, S.J., AKAMATSU, S., IWAHASHI, Y., The Hope Pearl	235
GUTMANNBAUER, W., HÄNNI, H.A., Structural and chemical investigations on shell and pearls of nacre forming salt- and freshwater bivalve molluscs	241
SCHMETZNER, K., SCHUPP, F.-J., Dyed natural star corundum as a ruby imitation	253
HUGHES, R.W., The rubies and spinels of Afghanistan - a brief history	256
WIN HTEIN, AYE MYO NAING, Mineral and chemical compositions of jadeite jade of Myanmar	269
MILISENDA, C.C., REDMANN, M., MALANGO, V., A new occurrence of dendritic opal in south-eastern Zambia	277
Letters	281
Abstracts	289
Book reviews	295
Proceedings of The Gemmological Association and Gem Testing Laboratory of Great Britain and Notices	297

## [No. 5, January 1995]

WIN HTEIN, AYE MYO NAING, Studies on kosmochlor, jadeite and associated minerals in jade of Myanmar	315
SMITH, C.P., A contribution to understanding the infrared spectra of rubies from Mong Hsu, Myanmar	321
MAHROOF, M.M.M., The story of Sri Lankan pearl	337
GLUSHNEV, S., Siberian sapropelic coal: a unique type of workable jet	349
KAMMERLING, R.C., KOIVULA, J.I., A preliminary investigation of peridot from Vietnam	355
SOSSO, F., Some observations on gem-quality synthetic yellow diamond produced in the region of Vladimir (Russia)	363
Letters	369
Abstracts	370
Book reviews	377
Proceedings of The Gemmological Association and Gem Testing Laboratory of Great Britain and Notices	378

## [No. 6, April 1995]

GOSLING, J.G., The Cheapside Hoard confusion	395
BUBSHAIT, A., STURMAN, N., Notes from the Gem and Pearl Testing Laboratory Bahrain - 4	401
MOLINÉ I SALA, A., The inclinometer for refractometers: the latest developments	405
GAO YAN, LI JINGZHI, ZHANG BEILI, The infrared microscope and rapid identification of gemstones	411
de GOUTIERE, A., Photogenic inclusions in moldavite	415
Abstracts	421
Book reviews	444
Proceedings of The Gemmological and Gem Testing Laboratory of Great Britain and Notices	451

## [No. 7, July 1995]

GALIBERT, O., HUGHES, R.W., Chinese ruby and sapphire - a brief history	467
TAN, T.L., TAY, T.S., LOH, F.C., TAN, K.L., TANG, S.M., Identification of bleached wax- and polymer-impregnated jadeite by X-ray photoelectron spectroscopy	475
SUNAGAWA, I., The distinction of natural from synthetic diamonds	485
SOSSO, F., PIACENZA, B., Russian hydrothermal synthetic emeralds: characterization of the inclusions	501
HARDER, H., Trace elements as colouring agents in jadeite	508
Letters	513
Abstracts	514
Book reviews	520
Proceedings of The Gemmological Association and Gem Testing Laboratory of Great Britain and Notices	523

## [No. 8, October 1995]

GÜBELIN, E.J., An attempt to explain the instigation of the formation of the natural pearl	539
WON-SA KIM, Nephrite from Chuncheon, Korea	547
HUGHES, R.W., U HLA WIN, Burmese sapphire giants	551
KAMMERLING, R.C., JOHNSON, M.L., An examination of 'serendipitous' synthetic zincite	563
BAROT, N.R., GRAZIANI, G., GÜBELIN, E., RETTIGHIERI, M., Cat's-eye and asteriated gemstones from East Africa	569
HARDING, R.R., A note on red beryl	581
Abstracts	585
Book Reviews	602
Proceedings of The Gemmological Association and Gem Testing Laboratory of Great Britain and Notices	610

## INDEX

Compiled by Robin W. Sanderson

Alphabetical arrangement is letter-by-letter.

Names of authors are printed in capitals, pages of abstracts and book reviews in italics.

Special usages:

*above* and *below* in cross-references indicate that the reference is to another subheading under the same heading, not a separate heading.

A number in brackets following a page number indicates that there is more than one reference to the subject on the page.

- aani-muthu pearls, 338  
 AASLAND, S., McMILLAN, P.F., Density-driven liquid-liquid phase separation in the system  $Al_2O_3$ - $Y_2O_3$ , 294  
 ABDUKADER, P., WANG, L., On the mineralogical characteristics of ruby and sapphire of Xinjiang, China, 371  
 ABN (Abrasive boron nitride), identification, 585  
 Absorption spectra, ruby, 143; sapphire, 142  
 Abstracts, 112, 187, 289, 370, 421, 514, 585  
 Abu'l-Abbas A. b. Ya. b. Fadallah al-'Omari Sihabaddin, d. 1349, 109  
 ACKERMANN, L. (*see* Henn, U., *et al.*)  
 Aeschynite: Ilmeny Mts, Russia, 436  
 Afghanistan:  
 —Badakhshan, 256  
 —beryllonite cat's-eye reported, 516  
 —gemstones of, 438, 603  
 —Gharan, 256  
 —Jagdalek, 256  
 —rubies and spinels, history of, 256  
 —Sar-e-Sang lapis-lazuli, 438  
 AFONINA, G.G., BOGDANOVA, L.A., MAKAGON, V.M., Changes in the Y and Z octahedra of the tourmaline structure during heating from the X-ray powder patterns, 427  
 Agate: (*see also* Chalcedony)  
 —cathodoluminescence of, 431  
 —engraved artefacts, Karlsruhe Museum, 113  
 —formation, 372  
 —Germany: 206; Dresden, Senftenberg, 428; Thuringia, 293; Birkenfeld Kreis, Hunsrück, 428  
 —Myanmar, 7  
 —in melaphyr, Hubertusberg, Saxony, 117  
 —self-organization in, 435  
 —star patterned, 597  
 —textures: formation, 598, nanometre scale, 434  
 —Uruguay, Artigas, 203  
 Agate patterned limestone, 599  
 AHMED, N. (*see* Panjekar, J., *et al.*)  
 Ajoite: inclusion in rock crystal, Ajo, Arizona, 46  
 AKAISHI, M. (*see* Arima, M., *et al.*)  
 AKAMATSU, S. (*see* Kennedy, S.J., *et al.*)  
 AKHMEDOV, M.A. (*see* Novgorodova, M.I., *et al.*)  
 Albite: (*see* Feldspar)  
 Albitite: Guatemala, Motagua Fault Zone, 373  
 Alexandrite: (*see* Chrysoberyl)  
 'alexandrite effect', 441  
 ALLAMAN, J., Spectrophotometry in gemmology, 439  
 Almandine: (*see* Garnet)  
 Al-Tajir, H.E. Mohammed Mahdi, 235  
 ALVES, J.-N. (*see* Cassedanne, J.-P., *et al.*)  
 AMARI, A., LEWIS, R.S., ANDERS, E., Interstellar grains in meteorites: I. Isolation of SiC, graphite, and diamond; size distributions of SiC and graphite, 421  
 Amazonite (*see under* Feldspar)  
 Amber:  
 —114  
 —Baltic: succinite, comparison with Burmese, 35, 203; artefacts, 609  
 —blue, 203  
 —Burmese (burmite), 6, 35  
 —chemical characterization, 437  
 —Cretaceous, 435  
 —darkening of colour, 185; 369  
 —Dominican Republic, blue, 203  
 —England, Isle of Wight, 435  
 —'Indian', 36  
 —Saxony, Bitterfeld, in brown coal, 117  
 —Ukrainian artefacts, 115  
 Amblygonite: Myanmar, 7  
 America, Central:  
 —Costa Rica, 434  
 —jade as trade medium, 434  
 Americium-241, yellow-green diamond, 514  
 Amethyst: (*see also* Quartz)  
 —445  
 —Canada, Ontario, 599  
 —gemmology, geology and mineralogy, 204  
 —grape pendants, 399  
 —irradiated quartz, 438  
 —Myanmar, 7  
 —Namibia, 114, 594  
 —Uruguay, Artigas, 203  
 Ametrine: (*see* Quartz)  
 Ammolite, ammonite shell, Alberta, 437  
 Amphibole:  
 —edenite and richterite in jade, 318  
 —ferrohornblende, 517  
 Analyses, chemical:  
 —beryl, red, 582  
 —bixbyite, 582  
 —columbite, 582  
 —emerald: Torrington, Australia, 437; Trecho Velho, Brazil, 197  
 —hessonite, Orissa, India, 78, 79  
 —jade: Myanmar, trace elements, 510  
 —jadeite, Myanmar, 271  
 —moonstone, smoky, Sri Lanka, 180  
 —nephrite, Korea, 550  
 —pearls and nacre, 250  
 —peridot, Vietnam, 360  
 —ruby inclusion in diamond, Brazil, 291  
 —sapphire: Xinjiang, China, 371  
 —spinel: Co-rich, inclusion in sapphire, 201  
 —vesuvianite: Aosta, Italy, 175  
 Analyses, neutron activation: fibrous diamond, Botswana, 426  
 Analyses, physical: vesuvianite, Aosta, Italy, 175  
 Analyses, X-ray: application to study of inclusions, 198  
 Analytical techniques, 141



- Andalusite: Myanmar, 7
- ANDERS, E. (see Amari, A., *et al.*)
- , ZINNER, E., Interstellar grains in primitive meteorites: diamond, silicon carbide, and graphite, 421
- ANDERSON, A.T., BROWN, G.G., CO<sub>2</sub> contents and formation pressures of some Kilauean melt inclusions, 427
- ANDREE, G., ANDREE, R., Achate von den Felden des Landkreises Birkenfeld, 428
- ANDREE, R. (see Andree, G., *et al.*)
- ANGEL, R.J. (see Hayward, C.L., *et al.*)
- Angola: Luanda diamond fields, 589
- ANGUS, J.C. (see Lambrecht, W.R.L., *et al.*)
- Anisotropy, optical, of cuprite, 600, in spinel, 440
- ANON:
- , A private collection of early Chinese jade carvings 28 November to 9 December 1994, 609
- , Bärnsten. Guldet fran Östersjön. Bursztyn. Złoto Bałtyku, 609
- , Een Eeuw van Schittering (A Sparkling Age): 17th century diamond jewellery, 123
- , Faszination Edelstein aus den Schatzkammern der Welt. Mythos, Kunst, Wissenschaft, 609
- , The fingerprinting of gold samples, 600
- , Fritz Klein: Smaragde unter dem Urwald, 439
- , Gem reference guide for the GIA colored stones, gem identification and colored stone grading courses, 520
- , Gemme e Diamanti dal Kremlin. Gems and diamonds of the Kremlin, 609
- , Hohe Tauern: Mineral and Erz, 520
- , Jade in Chinese culture, 609
- , Schöne Mineralien aus dem Setesdal Minal Park, 294
- , Turmalin: der Edelstein des Regensbogens. Neueste Nachrichten von der Turmalin-Gruppe, 522
- ANTHONY, J.W., BIDEAUX, R.A., BLADH, K.W., NICHOLS, M.C., Handbook of mineralogy. Volume 2. Silica, silicates, 602
- Apatite:
- Afghanistan and Pakistan, 438
- Canada, Yukon, 596
- Myanmar, 7
- Switzerland, Naret area, Ticino, 116
- Aquamarine: (see also Beryl)
- from Germany, Irfersgrunc, Saxony, 202
- in Brazil, 197
- Pakistan and Afghanistan, 438
- USA, Mt Antero-White Mts, Colorado, 212
- Aragonite: Peru, resembling pectolite, 203
- ARBOLEDA, C. (see Giuliani, G., *et al.*)
- ARIMA, M., NAKAYAMA, K., AKAISHI, M., YAMAOKA, S., KANDA, H., Crystallisation of a diamond from a silicate melt of kimberlite composition in high-pressure and high-temperature experiments, 376
- Ariyaratna, D.H., letter to Editor, 130
- Arnold, A., Preliminary Trade Prize winner, 380
- ARROUAS, S., Rubis du Vietnam, mythe ou réalité, 112
- Artificial gems (see Synthetic gems)
- ARTIOLI, G., RINALDI, R., STÄHL, K., ZANAZZI, P.F., Structure refinements of beryl by single crystal neutron and X-ray diffraction, 112
- ASHBOUGH, C.E., III, SHIGLEY, J.E., Reactor-irradiated green topaz, 197
- Asia, Central, States (CIS) (see under USSR)
- ASSELBORN, E., FOLIE, K., GEIPEL, R., GRAMACCIOLI, C.M., GRUNDMANN, G., HOCHLEITNER, R., MAISSEN, F., MULLIS, J., NIEDERMAYR, G., STRUNZ, H., WEISS, S., Kristall alpin, 119
- Asterism: (see also Chatoyancy)
- East Africa, 569
- inclusions in, 577
- ASTRIC, B. (see also Astric, H., *et al.*)
- , MERIGOUX, H., ZECCHINI, P., Studio della variazione dell'aspetto delle gemme con l'aiuto di immagini di sintesi, 112
- ASTRIC, H., ASTRIC, B., MERIGOUX, H., ZECCHINI, P., Evaluation de la masse de Dresde Vert par calcul, 421
- ATALAY, H., Le 'Pearlscop', un nouvel instrument gemmologique, 440
- AUFDENBLATTEN, M. (see Stalder, H.A., *et al.*)
- AURISICCHIO, C., GRUBESSI, O., ZECCHINI, P., Infrared spectroscopy and crystal chemistry of the beryl group, 428
- Australia: (see also Papua New Guinea)
- Anakie District: 599; images of, 608
- Argyle diamonds: microtopographic studies, 114; mine, 424
- Calcutteroo kimberlite, 585
- chrysoptase, 517
- gems, 590
- gemstones in, review and assessment, 607
- New South Wales: Lightning Ridge opal, 434; Torrington emeralds, replacement in, 437, update, 293
- opals, 212
- Queensland: boulder opal, 208; Anakie District, 599; images of, 608
- sapphires, heat treated, 599
- South, opal, 518
- Western: Kimberley, 433, Aries kimberlite pipe, garnet and spinel, 588, Yerilla district, 517
- Zebra stone, 433
- Austria:
- Bergum, South Tyrol, zircon, sphene and vesuvianite, 113
- gem materials, 292
- Habachtal emerald, 521
- Hohe Tauern, 521
- Lower, Piestingtal, 599
- quartz, smoky and morion, 435
- Salzburg, Wiesbachrinne, 435
- South Tyrol, danburite with milerite, 118
- AVDONIN, V.N. (see Solomonov, V.I., *et al.*)
- Axinite: Russia, Puiva, northern Urals, 117, 433
- AYE MYO NAING (see Win Htein, *et al.*)
- AYERS, J., A jade menagerie: creatures real and imaginary from the Worrell collection, 119
- Azurite: 516
- BACH, H., NEUROTH, N. (Eds), The properties of optical glass, 602
- BAGDASAROV, E.A. (see Simakov, S.K., *et al.*)
- Bahrain:
- Gem and Pearl Testing Laboratory, Notes, 3, 42; 4, 401
- BAI, W.-J., ZHOU, M.-F., ROBINSON, P.T., Possibly diamond-bearing mantle peridotites and podiform chromitites in the Luobusa and Donqiao ophiolites, Tibet, 187
- BAILEY, M.W., HEDGES, L.K., Crystal morphology identification of diamond and ABN, 585
- BAKER, J.H. (see Giuliani, G., *et al.*)
- Balas ruby (see Spinel)
- Ball, Valentine, 260
- BANCROFT, G.M. (see Dien, Li, *et al.*)
- BANERJEE, A., WANG, P., Structural changes of nephrites at elevated temperatures as revealed by their IR-spectra, 291
- BANK, H. (see also Henn, U., *et al.*; Lind, T., *et al.*)
- , Führer durch das Deutsche Edelsteinmuseum, 295
- BARINOV, N.N. (see Kazachenko, V.T., *et al.*)
- BARLOW, I.S. (see Watling, R.J., *et al.*)
- BAROT, N.R., GRAZIANI, G., GÜBELIN, E., RETTIGHIERI, M., Cat's-eye and asteriated gemstones from East Africa, 569
- , HARDING, R.R., Pink corundum from Kitui, Kenya, 165
- BARTON, E.S. (see Smith, C.B., *et al.*)
- Baryte: cinnabar inclusion in, Kirghisia, 46
- BECK, W., Achate aus der Lausitz, 428
- , Die Cabochonsammlung, eine interessante Variante des Sammlung von Mineralien, 590

- BEDOGNÉ, F., SCIESA, E., Die Demantoide vom Val Malenco, Sandrio/Italien, 112
- BEECK, S., (see Cuif, J.-P., *et al.*)
- BEGEMANN, F. (see Verchovsky, A.B., *et al.*)
- BELLO, R.M.S. (see Souza, J.L., *et al.*)
- Benaicha, Dr Hedi, 109
- Benitoite: large, 431
- Ben Mansur, Mohammed, 257
- BERNHARDT, H.-J. (see Schmetzer, K., *et al.*)
- Beryl: (see also Aquamarine, Emerald)
- alkali incorporation, 375
  - Brazil, spessartine inclusion in, Minas Gerais, 46
  - crystal chemistry, 428
  - Czech Republic, 293
  - Finland, Luumäki, a new gem locality, 204
  - Germany, Bavaria, zwieselite inclusion in, 46
  - India: Jammu and Kashmir, 207, 292, nature and cause of colour, 374; Rajasthan, 436
  - infrared spectroscopy, 428
  - magnetic resonance and gamma-irradiation study, 292
  - Myanmar: 6; aquamarine, 6, 34
  - Perovsky collection, 437
  - red, 581, analysis, 582
  - spessartine inclusion in, Minas Gerais, Brazil, 46
  - structure refinements by single crystal neutron and X-ray diffraction, 112
  - Switzerland, Ticino, blue, 293
  - USSR, Ukraine, Voldarsk, gold and blue, 596
  - zwieselite inclusion in, Bavaria, 46
- Beryllium minerals, Kola Peninsula, 436
- Beryllonite: cat's-eye from Afghanistan reported, 516
- BESKROVANOVA, V.V. (see Shkodzinskii, V.S., *et al.*)
- BEZBORODOV, A.M., GARANIN, V.K., KUDRYAVTSEVA, G.P., PONAHLA, J., YAGOUTS, E., Find of eclogite with two diamond generations in the Udachnaya kimberlite pipe, 187
- BIASCO, G.L., Contouring with diamond wire, 440
- BIDEAUX, R.A. (see Anthony, J.W., *et al.*)
- Birefringence, in gemstones, measurement, 105, 184, 185; sectored in almandine, 428
- BISHOP, R.L. (see Lange, F.W., *et al.*)
- Bixbyite:
- inclusion in red beryl, analysis, 582
- BLACK, J.D. (see Mathez, E.A., *et al.*)
- Blackmore, Howard L., Letter to editor, Cheapside Hoard, 513
- BLADH, K.W. (see Anthony, J.W., *et al.*)
- BLANKENBURG, H.-J. (see Götze, J., *et al.*)
- Blue John (see Fluorite)
- BOGDANOVA, L.A. (see Afonina, G.G., *et al.*)
- Bolivia: Anahi ametrine mine, 293, 515
- Bonanno, Antonio, a special tribute, 125
- Book Reviews, 53, 119, 212, 295, 377, 444, 520, 602
- BOROVEC, Z. (see Bouska, V., *et al.*)
- BOSSHART, G. (see Kammerling, R.C., *et al.*; Schmetzer, K., *et al.*)
- , Investigations modernes du diamant vert de Dresde et interprétation des résultats, 421
- Botswana:
- diamond production, 1992, 1993, 514
  - Jwaneng, fibrous diamond, 426
  - Orapa, O determination in diamonds, 115
- BOUQUEAU, M.-P. (see Piat, D., *et al.*)
- BOUSKA, V., BOROVEC, Z., CIMBALNIKOVA, A., KRAUS, I., LAJČAKOVA, A., PACESOVA, M., Natural glasses, 295
- BOVENKERK, H.P., BUNDY, F.P., CHRENKO, R.M., CODELLA, P.J., STRONG, H.M., WENTORF, R.H., Jr., Errors in diamond synthesis, 112
- BOWERSOX, G.W., CHAMBERLAIN, B., Gemstones of Afghanistan, 603
- BOYD, F.R. (see also Pearson, D.G., *et al.*; Shimizu, N., *et al.*)
- , PEARSON, D.G., NIXON, P.H., MERTZMAN, A., Low calcium garnet harzburgites from southern Africa: their relations to craton structure and diamond crystallisation, 187
- BOYD, S.R. (see also Watt, G.R., *et al.*)
- , PILLINGER, C.T., A preliminary study of <sup>15</sup>N/<sup>14</sup>N in octahedral growth form diamonds, 422
  - , PINEAU, F., JAVOY, M., Modelling the growth of natural diamonds, 440
- BOYD, W.E., The story of Russian diamond sources, 422
- BRACEWELL, H., Gems around Australia, 590
- BRANDSTAETTER, F. (see also Niedermayr, G., *et al.*)
- BRANDSTÄTTER, F., NIEDERMAYR, G., Copper and tenorite inclusions in cuprian elbaite tourmaline from Paraíba, Brazil, 428
- Brazil:
- amazonite, 291; 429
  - aquamarine in, 197
  - Bahia, Campo Formoso and Carnaíba, 431
  - barium-orthoclase, 373
  - diamond: origins, 423; ruby inclusion in, 291
  - emerald dating and chemical analysis, 197
  - herderite, 432
  - mica geochemistry, 436
  - Minas Gerais: amazonite, 291, 429; barium-orthoclase, 373; diamond origins, 423; emerald, petrographic and microthermometrical studies, 117; Felício dos Santos, 373; Indaia sapphire deposit, 291, 516; Jaguaruaçu pegmatite, 429; Santa Maria de Itabira, 291, 429; spessartine inclusion in beryl, 46; Urubu petalite pegmatite, 436; Virgem da Lapa, 432
  - mines, 444
  - Paraíba, 428
  - San Francisco craton, 423
  - Sao Luiz diamond mine, 291; 423
  - tenorite inclusions in elbaite, 428
  - tourmaline: cuprian elbaite, 428; mineralogical zoning and geochemistry, 436
  - Trecho Velho emerald, 197
- BRENNAN, W. (see Epstein, D.S., *et al.*)
- Bretschneider, 467
- BREY, G.P., RYABCHIKOV, I.D., Carbon dioxide in strongly silica undersaturated melts and origin of kimberlite magmas, 585
- BRIGGS, P.H. (see Foord, E.E., *et al.*)
- BRIGHTMAN, R., A new variety of grossular garnet with extended gemmological constants, 590
- BRISTOW, J.W. (see Smith, C.B., *et al.*)
- BROWN, D., MASON, R.A., An occurrence of sectored birefringence in almandine from the Gagon Terrane, Labrador, 428
- BROWN, G., A further update on value-enhanced jadeite, 590
- , An interesting imitation opal, 601
  - , Lapis lazuli - a long used gemstone, 112
  - , Value enhanced jadeite, 112
  - , Vietnamese ruby, 112
- BROWN, G.G. (see Anderson, A.T., *et al.*)
- BRULEY, M., Mon aventure Vietnamienne. Part I, 428
- BRYNDZIA, L.T. (see Ottaway, T.L., *et al.*)
- BUBSHAIT, A., STURMAN, N., Notes from the Gem and Pearl Testing Laboratory, Bahrain 3, 42; 4, 401
- BUKIN, G.V., Growth of crystals of beryllium oxides and silicates using fluxes, 210
- BULANOVA, G.P. (see also Rudnick, R.L., *et al.*)
- , ZAYAKINA, N.V., A graphite-cohenite-iron mineral association in the core of a diamond from the Twenty Third Soviet Communist Party Congress Pipe, 188
- Bulgaria:
- Gem and decorative minerals of, 122
  - opal and magnesite veins in serpentinite, 434
  - Rhodope Mts, 434
- BUNDY, F.P. (see Bovenkerk, H.P., *et al.*)
- BURLAND, M., 1993 Annual Conference, 45

- Burma (*see* Myanmar)  
 Burmite (*see* Amber)  
 BURNETT, C.J., TABRAHAM, C.J., The honours of Scotland: the story of the Scottish crown jewels, 603  
 BURNS, P.C., MACDONALD, D.J., HAWTHORNE, F.C., The crystal chemistry of manganese-bearing elbaite, 428  
 BURNS, R.G., Mineralogical applications of crystal field theory, 119  
 BUSTILLO, M. (*see* Bustillo, M.A., *et al.*)  
 BUSTILLO, M.A., FORT, R., BUSTILLO, M., Specific surface area and ultramicroporosity in polymorphs of silica, 372  
 BUTLER, J.E. (*see also* Messier, R., *et al.*)  
 —, WOODIN, R.L., Thin film diamond growth mechanisms, 188  
 BUTSIK, L.A. (*see* Kazachenko, V.T., *et al.*)  
 Buying guides:  
 —diamond ring, 122  
 —emerald and tanzanite, 606  
 —jewelry and gems, 121  
 —pearls, 122  
 —ruby and sapphire, 122
- Calcite:  
 —diopside inclusion, Congo, 46  
 —inclusion in natural ruby, 42  
 CALDERON, G.P. (*see* Jennings, R.H., *et al.*; Kammerling, R.C., *et al.*)  
 CALDERON, T. (*see* Rendell, H.M., *et al.*)  
 Cambodia: Bolai ruby mines, 112  
 Cameos:  
 —Content collection, 53  
 —Fitzwilliam Museum, 605  
 CAMPBELL, I.C., Another flux-grown synthetic ruby, 601  
 Canada:  
 —Alberta, ammolite, 437  
 —British Columbia: Foley Mt., scheelite, 439; Vernon, opal, 439  
 —Labrador, Gagon Terrane, 428  
 —North West Territories: new diamond pipes, 424; Nanisivik mine, Baffin Island, dolomite, 439; Tli Kwi Cho kimberlite pipe, 588  
 —Ontario, amethyst, 599  
 —Quebec: asbestos grossular, 198; Kipawa alkaline complex, eudialyte, vlasovite, 439; Mont St-Hilaire, carletonite, shortite, sodalite, villiamite, 438, 518  
 —Saskatchewan, diamondiferous kimberlite, 188  
 —Yukon: Emerald Lake apatite, 596, scheelite, 439; rhodonite reported, 517  
 Cancrinite: blue from Greenland, 204  
 CANHAM, C.D. (*see* Richardson, S.H., *et al.*)  
 Carbon:  
 —characterisation and origin in cratonic mantle, 425  
 —diamond and diamond-like, 370  
 —graphite in meteorites, 421  
 —in the Earth's core, 197  
 Carletonite: Canada, checklist, 438  
 CARRILLO, V. (*see* Giuliani, G., *et al.*)  
 CASEIRO, J. (*see* Gauthier, J.-P., *et al.*)  
 CASSEDANNE, J.-P., L'amazonite de Santa Maria de Itabira (Minas Gerais, Brésil) (part 1), 291; (continued), 429  
 —, ALVES, J.-N., L'aigue-marine au Brésil, 197  
 —, ALVES, J.-N., The Jaguarauçu pegmatite, Minas Gerais, Brazil, 429  
 Cassiterite, detection in exploration gemmology, 159  
 'Cathaystone', fibre-optic glass, 433  
 Cathodoluminescence (CL):  
 —agate, 431  
 —De Beers experimental diamonds, 192; 440  
 —corundums, 598  
 —diamond, dependence on deposition temperature, 194  
 —identification of natural and synthetic diamonds, 190  
 —natural and synthetic coloured stones, 208, 209  
 —periclase, synthetic, 601  
 —pulse (PCL) method, 598  
 Cat's-eye and asteriated gems: East Africa, 569, properties, 572  
 'Catseyte', fibre-optic glass, 433  
 'Caymanite', 517  
 Central African Republic: carbonado chemical properties, 423  
 CERNY, P. (*see* Sherriff, B.L., *et al.*)  
 Ceylon (*see* Sri Lanka)  
 Chalcedony: (*see also* Agate and Chrysoprase)  
 —solubility causes, 201  
 —structural disparities between quartz and, 432  
 Chalcotrichite:  
 —opacified red quartz, 203  
 CHAMBERLAIN, B. (*see* Bowersox, G.W., *et al.*)  
 CHANDRASHEKHAR, H. (*see* Panjekar, J., *et al.*)  
 Chatoyancy: (*see also* Asterism:)  
 —beryllonite reported from Afghanistan, 516  
 —demantoid garnet, 594  
 —East African gems, 569  
 —fibre-optic glass beads, 404  
 —sillimanite, 433  
 CHATTERJEE, A.K., RAO, K.S., Majhgawan diamondiferous pipe, Madhya Pradesh, India - a review, 586  
 CHAVES, M.L.S.C. (*see* Karfunkel, J., *et al.*)  
 CHAYKIN, V.G., TOLUZAKOVA, A.V., Evidence of kimberlite magmatism in the eastern part of the East European craton, 188  
 Cheapside Hoard, 395, letter to editor, 513  
 CHEILLETZ, A. (*see also* Giuliani, G., *et al.*)  
 —, FÉRRAUD, G., GIULIANI, G., RUFFET, G., Emerald dating through <sup>40</sup>Ar/<sup>39</sup>Ar step heating and laser spot analysis of syngenetic phlogopite, 197  
 —, FÉRRAUD, G., GIULIANI, G., RODRIGUEZ, C.T., Time-pressure and temperature constraints on the formation of Colombian emeralds: an <sup>40</sup>Ar/<sup>39</sup>Ar laser microprobe and fluid inclusion study, 429  
 CHEN, J.H. (*see* Lee, T., *et al.*)  
 CHEN, Y.D., O'REILLY, S.Y., KINNY, P.D., GRIFFIN, W.L., Dating lower crust and upper mantle events: an ion microprobe study of xenoliths from kimberlitic pipes, South Australia, 585  
 CHERNAVTSEV, V.S., The 'Gems' Museum, 429  
 China:  
 —Altay garnets, 208  
 —corundum localities map, 468  
 —Dabie Shan: diamond and coesite-bearing terrain, 191  
 —Fujian: corundum, 470  
 —GAGTL awards ceremony, 60  
 —Hainan Island: Penglai, corundum, ruby, sapphire, 467  
 —Heilongjiang: ruby and sapphire, 471  
 —Jiansu: sapphire, 471  
 —Liaoning: Fuxian diamonds, 427  
 —Qinghai: ruby and sapphire, 471  
 —Shandong: Changle, sapphires, 201; corundum, 470  
 —Sichuan: ruby, 471  
 —Xinjiang: sapphire, 371, 471  
 —Yunnan: Ailao Mts., ruby, 471  
 CHIRNSIDE, W. (*see* Foord, E.E., *et al.*)  
 Chloromelanite:  
 —misidentification of Myanmar jade, 32  
 CHO, H., ROSSMAN, G.R., Single-crystal NMR studies of low-concentration hydrous species in minerals: grossular garnet, 198  
 CHRENKO, R.M. (*see* Bovenkerk, H.P., *et al.*)  
 Chromite: inclusions in Siberian diamonds, 113  
 CHRONIC, H., Roadside geology of Utah, 119  
 Chrysoberyl:  
 —alexandrite, 429, unusual twinning, 593  
 —Myanmar, 7

- Chrysoptase: (*see also* Chalcedony)  
 —Australia, Yerilla district, 517  
 —Myanmar, 7  
 CIMBALNIKOVA, A. (*see* Bouska, V., *et al.*)  
 Cinnabar: inclusion in baryte, Kirghisia, 46  
 Citrine: (*see also* Quartz)  
 —Myanmar, 7  
 CLARK, G., Rainbow garnet: Das Geheimnis der irisierenden Andradite in Mexico, 198  
 CLARK, T.C. (*see* Smith, C.B., *et al.*)  
 Cleaning and conservation of minerals, 54  
 Cleopatra, emerald mines of, 113  
 COATES, R., Radiolucency of diamond and its simulants, 514  
 CODELLA, P.J. (*see* Bovenkerk, H.P., *et al.*)  
 COENRAADS, R.R., VICHIT, P., SUTHERLAND, F.L., An unusual sapphire-zircon-magnetite xenolith from the Chanthaburi gem province, Thailand, 590  
 COEROLI, M., Tahiti cultured pearls, 515  
 Coesite:  
 —diamond and, bearing terrain, China, 191  
 —structure, 430  
 Cohenite-graphite-iron association in diamond, 188  
 Collecting minerals, history of, 520  
 Collections:  
 —Bloch, Mary and George, Chinese snuff bottles, 605  
 —Content cameos, 53  
 —Deutsche Edelsteinmuseum, 295  
 —Fitzwilliam Museum, intaglios and cameos, 605  
 —H.H. Pope Leo XII, Dactyliotheca, 372  
 —Johann Wilhelm von der Pfalz engraved gems, catalogue, 54  
 —Pain, A.C.D., Burmese gems, 10  
 —Perovsky, Earl, beryl, 437  
 —Tolstopiatov, 431  
 —Worrell, jade animals, 119  
 Collectors, historic, 520  
 COLLYER, T., FUZIKAWA, K., SCHWARZ, D., Das Ametrin-Verkommen von Anay, Santa Cruz, Bolivien, 515  
 Colombia:  
 —Cosquez, 429, emerald, 596  
 —Muzo hydrothermal emeralds, 435  
 —Quipama-Muzo, 429  
 Colored Stones, GIA reference guide, 520  
 Colour:  
 —cause in fluorite, 595  
 —causes in Mn-sugilite, 430  
 —diamond, yellow-green, americium-241 coloured, 514  
 —opaque minerals, 53  
 —trace elements as agents, in jade, 508  
 Columbite:  
 —inclusion in Egyptian emerald, 114  
 —inclusion in red beryl, analysis, 582  
 Commonwealth of Independent States (CIS) (*see under* USSR)  
 COMPAGNONI, R. (*see* Hirajima, T., *et al.*)  
 Composite gems, 294  
 Computer-aided image synthesis of diamonds, 112  
 Conferences and Symposia:  
 —Annual Conference, 1993, 45  
 —FM-TGMS-MSA Symposium on topaz, 600  
 —Gemmological Conference, XXIV International, Paris 1993, 50  
 —International Gemological, Los Angeles, 1991, 121  
 —New Diamond Science and Technology, Washington, 1990, 213  
 —Tucson Gem and Mineral Show, '94, 373; '95, 595, 596, 598  
 CONG, A. (*see* Dong, Z., *et al.*)  
 Congo: calcite with diopside inclusion, 46  
 COOK, F.A. (*see* Levinson, A.A., *et al.*)  
 Copal (*see* Amber)  
 Copper:  
 —inclusions in cuprian elbaite, 428  
 Coral:  
 —red, jewel of the sea, 377  
 —Taiwan, dating, 204  
 Cordierite:  
 —iolite in 'Rhodiopaz' triplets, 210  
 —Myanmar, 7  
 —special effects in, 291  
 CORREIA, J.M. (*see* Quéméneur, J., *et al.*)  
 Corundum: (*see also* Ruby, Sapphire)  
 —cathodoluminescence, 598  
 —China: localities map, 468; Fujian, 470; Hainan Island, 467, 468; Shandong, 470  
 —colour treated, review, 115  
 —diffusion treatment update, 205  
 —emerald coloured, 401  
 —gem study, Karnataka, India, 207, 436  
 —heat-treatable (Geuda) stones, 207  
 —heat treatment, 518  
 —in alkali basalt, 594  
 —pink, Kitui, Kenya, 165  
 —rose, Karelia, Finland, 431  
 —star, dyed as ruby imitation, 253  
 —Switzerland, Campolungo, pink, 374  
 —treated (*see* Treatment of gems)  
 Costa Rica: jade, 434  
 COUTO, M.S. (*see* Van Enckevort, W.J.P., *et al.*)  
 COZAR, J.S., Aplicacion de técnicas de microanálisis de rayos X al estudio de inclusiones en gemas, 198  
 —, DE VICENTE-MINGARRO, I., Alteración de las inclusiones de zircón, apatito y vidrio en el tratamiento térmico de rubie y zafiros, 591  
 CRAIG, J.R., VAUGHAN, D.J., Ore microscopy and ore petrography, 604  
 CRAM, L., Beautiful Australian opals, 212  
 Cristobalite:  
 — $\alpha$ -: specific surface area (SSA) and ultramicroporosity (UMP), 372; structure, 430  
 CROWNINGSFIELD, G.R. (*see* Fryer, C.W., *et al.*, Kammerling, R.C., *et al.*)  
 CROZAZ, G. (*see* Jerde, E.A., *et al.*)  
 Crystal field theory, mineralogical applications, 119  
 Crystal growth handbook, 444  
 Crystal pulling from the melt, 121  
 Crystallography, 296  
 CUIF, J.-P., DAUPHIN, Y., DAUPHIN, J.-P., Le periculture polynésienne, 429  
 —, DAUPHIN, Y., STOPPA, C., BEECK, S., Forme, structure et couleurs des perles de Polynésie (suite), 112  
 CULME, J. (*see* Gere, C., *et al.*)  
 Cuprite: optical anisotropy, 600  
 CURRIE, S.J.A., Notes on alexandrite chrysoberyl, 429  
 Cuts and cutting:  
 —cabochon, 590  
 —computer-aided image synthesis, 112  
 —diamond: the art of, 449; in historic jewellery, 608; wire contouring, 440  
 —radiant, diamond, 589  
 —'scissors cut' diamond, 397  
 —styles for synthetic and imitation gems, 114  
 —table-cut diamond, 397  
 CZAJA, M., MAZURAK, Z., Crystal-field analysis of Cr<sup>3+</sup> in grossular Ca<sub>3</sub>Al<sub>2</sub>(SiO<sub>4</sub>), 429  
 Czech Republic:  
 —Bohemia, fresh-water pearls, 515  
 —Bučnik landscape marble, 597  
 —Rozná yellow-green beryl, 293  
 DA CUNHA, C., Cordiérites à effets spéciaux, 291  
 Dactyliotheca of H.H. Pope Leo XII, collection, 372  
 DAI, C.F. (*see* Lee, T., *et al.*)

- DAMASCHUN, F., Budget, budget! 429
- DANAPALA, M.V. (see Pemadasa, T.G., *et al.*)
- Danburite:
- Austria, South Tirol, with milerite, 118
  - Myanmar: 7, green, 22; pale yellow, 34
  - USSR, Dal'Negorsk boron deposit, 434
- Dating:
- coral by U-disequilibrium, 204
  - emerald bearing metasomatites, Brazil, 431
  - kimberlites: India, Rb-Sr, 290; Siberia, 422; 425; South Africa, 426
  - lower crust and upper mantle events, 585
  - sphalerite by Rb-Sr, 206
  - zircon: inclusion in Zaire diamond, 424; in Thai xenolith, 590
- DAUPHIN, J.-P. (see Cuif, J.-P., *et al.*)
- DAUPHIN, Y. (see Cuif, J.-P., *et al.*)
- DAVIES, G. (ed.), Properties and growth of diamond, 520
- DAYAL, A.M. (see Kumar, A., *et al.*)
- DE BOER, H.E.R., A century-plus of opal publications, 602
- DE CERVAL, M., Mauboussin, 120
- DE GOUTIÈRE, A., Fluorescent oil inclusions in quartz, 84
- , Photogenic inclusions in moldavite, 415
- DEGTJAREVA, A.I., POSUKHOVA, T.V., GARANIN, K., Morphogenetic peculiarities of placer diamonds from Anabar River alluvial deposits and a problem of their genesis, 289
- DEINES, P., HARRIS, J.W., On the importance of fluids for diamond growth, 422
- DE JENLIS, M., Les mines de rubis de Bolai, 112
- DELOULE, E. (see Merino, E., *et al.*)
- Demantoid: (see Garnet)
- DEREPPE, J.-M., MOREAUX, C., Application gemmologique de la résonance magnétique nucléaire, 113
- DERNBACH, U., GLAS, M., HOCHLEITNER, R., JUNG, W., LANDMESSER, M., MAYR, H., SELMEIER, A., Versteinertes Holz. Aus Holz wird Stein: die Mineralogie der Holzversteinierung, 444
- Devanampiya, King, of Sri Lanka, 338
- DE VINCENTE-MINGARRO, I. (see Cózar, J.S., *et al.*)
- DEVNINA, N.N., KULKOVA, N.A., POPOVA, E.E., Mineralogical collection of the Mining Museum, St Petersburg Mining Institute, 429
- DHAMELINCOURT, P. (see Wang, A., *et al.*)
- Diamond:
- 122
  - americium-241 coloured, 514
  - analysis, 590
  - Appalachian Mts, 587
  - Argyle, microtopographic studies, 114, 189
  - Australia, Argyle mine, 514
  - Brazil, Sao Luiz mine, 291
  - Canada: kimberlite in Saskatchewan, 188, North West Territories, 424
  - carbonado chemical properties, 423
  - carbon-isotope composition, 422
  - cathodoluminescence identification, 190
  - 'The Centenary', grade, 290
  - chemical zoning of, 426
  - Chinese, 427
  - clastogenic, of Karelia, 290
  - and coesite bearing terrain, China, 191
  - colour relationship to absorption band N3, 193
  - commodity, as a, 427
  - computer-aided image synthesis, 112
  - content determination in kimberlites, 422
  - continental mantle, from old, 371
  - CO<sub>2</sub>, solid, in, 117
  - course launched in China, 126
  - 'Cross of Asia', 589
  - crystal morphology identification, 585
  - crystallisation: relation of Harzburgite to, 187; from silicate melt, 376
  - cutting, the art of, 449
  - De Beers, 426
  - Diamond Trading Co., 426
  - dislocations in large <110>-segmented, 196
  - distinction of natural from synthetic, 485
  - 'Dresden Green': mass, 421; White, 514, Yellow, 514
  - exhibition, Antwerp, 1993, 118
  - exploration, North West Territories, Canada, 425
  - famous, 192
  - fibrous, Botswana, 426
  - filled: and how to recognize them, 202; 423
  - fluids in, 426
  - formation, 425; Australia, 514
  - gases, radiogenic and noble in, 196
  - genesis, Kimberlite magma evolution and, 194
  - Ghana, Akwatia, 424
  - glass filling: 94; 183; identification and durability, 423
  - grading ABC, 213; 290
  - graphite-cohenite-iron in core, 188
  - 'Great Mogul', 427
  - growth: 422, 488, 489, 520, conditions, 491; stepped, 586
  - Guinea, W. Africa, Mandala Basin deposits, 195
  - inclusions in xenogenic, 191; in metamorphic rock minerals, 371
  - identification, basic concept for, 195
  - Indian, fluids in, 426; Majhgawan pipe, 585
  - iridescence, thin-film, 587
  - jewellery, 17th century, 123
  - lower mantle mineral associations in, 423
  - magnetic, 587
  - metamorphic rocks, Kazakhstan, 196
  - in meteorites, 421
  - modelling growth, 440
  - morphology, 493
  - Myanmar, 6; production, 33; 35
  - nano-structures on polished surfaces, 196
  - nitrogen aggregation in, 586
  - nucleation by hydrogenation of graphitic precursors, 190
  - O content determination, 115
  - octahedral: unusual, 291; growth form, <sup>15</sup>N/<sup>14</sup>N study, 422
  - origin and formation, 425, 427
  - The Peking, 608
  - phase diagram, graphite and, 489
  - polarizing microscopy, 440
  - 'Primary' deposits, 290
  - production, 424, 425
  - properties, 520
  - 'Queen Eberhardine', 514
  - radiation detectors, 290
  - radiolucency, 514
  - reactor irradiation and heat treatment, 195
  - research, 424
  - ring buying guide, 122
  - 'Rose of Saxony', 514
  - ruby inclusion in, analysis, 291
  - Russian sources, 422
  - Science and Technology Conference, Washington, 1990, 213
  - sources and production, 190
  - Tanzanian leases, 587
  - thin film growth mechanisms, 188
  - Tibet, possibly in peridotites, 187
  - trace element analysis, 426
  - treated-colour synthetic red, 190
  - trigons, 523
  - type resolution by NMR, 113
  - Unnamed Brown, grade, 290
  - USSR: 425; Anabar river deposit, peculiarities of, 289
  - Udachny kimberlite pipe, 187; and associated minerals of

- Kola Peninsula, 192; 'Mir' kimberlite pipe, 195; diamond bearing metamorphic rocks, Kazakhstan, 196; radiogenic and noble gases in, Kazakhstan, 196; Kokchetav massif, 371; sales, 1993-4 514; Siberia, formation, inclusions in, 113, Yakutian, fluids in, 426
- Venezuela, 371
- X-ray topography, 440
- Zimbabwe, 424
- Diaspore:
- colour change, 594
- in Myanmar rubies, 323, 324, 330, 331, 332, 333
- Turkey, Aydin-Mugla region, 596
- DIEN, L.I., BANCROFT, G.M., KASRAI, M., FLEET, M.E., SECCO, R.A., FENG, X.H., TAN, K.H., YANG, B.X., X-ray absorption spectroscopy of silicon dioxide (SiO<sub>2</sub>) polymorphs: the structural characterization of opal, 429
- DILLEN, H. (see Vochten, R.F., *et al.*)
- Diopside (see Pyroxenes)
- Diopseite: inclusion in calcite, Congo, 46
- Discoveries:
- Asian, recent, 118
- mineral, April 1992-1993, 116
- Dislocations, Large <110>-segmented helical, in diamond, 196
- DISSANAYAKE, C.B. (see Mendis, D.P.J., *et al.*; Rupasinghe, M.S., *et al.*)
- , RUPASINGHE, M.S., A prospector's guide map to the gem deposits of Sri Lanka, 198
- DISSANAYAKE, C.G., Origin of vein graphite in high-grade metamorphic terrains. Role of organic matter and sediment subduction, 586
- Disthene (see Kyanite)
- Dolomite:
- Canada, check-list, 439
- 'Caymanite', 517
- Grand Cayman Islands, 517
- DONG, Z., CONG, A., HAN, Z., Mineralogical criteria for determination of diamond content in kimberlites, 422
- DONINI, A. (see Superchi, M., *et al.*)
- DOUTHIT, T.R. (see Emmett, J.L., *et al.*)
- DOWLING, D.P., *et al.*, Characterisation study of diamond and diamond-like carbon, 370
- Dravite: Mikhaylovskoye mine, Chita Oblast, Russia, 375
- DREES, H.-H. (see Krappmann, M., *et al.*)
- Drill, annular, use of, 399
- DUCHAMP, M., A la recherche de la glyptique moderne, 591
- , Gravure sur pierres précieuses: les saphirs, 291
- , La gravure sur pierres précieuses: les rubis et les spinelles, 515
- , Les intailles en cristal de roche et en agates, 113
- , Les richesses du cristal de roche, 113
- DUDA, R., Die ersten Edelopale Europas. Geschichte, Gewinnung, bedeutende Steine, 430
- DUFOUR, C., HÄNNI, J.-P., Brésil, terre de pierres. Mines, cristaux et garimpeiros, 444
- Dumortierite-quartz beads, South Africa, 203
- DUNN, C.E., Diamondiferous kimberlite in Saskatchewan, Canada - a biogeochemical study, 188
- Duttha Gamiru, King of Sri Lanka, 338
- East India Companies, 344
- Eclogite:
- diamondiferous, Siberia, 423; 425; 426
- Nd and Sr isotopes from, Siberia, 194
- EDWARDS, D. (see Ramsay, R.R., *et al.*)
- Egypt:
- Marsa Alam Red Sea Hills, emerald mines, 202
- Zabara, Sikait and Umm Kabo emerald mines, 113
- Elbaite: (see Tourmaline)
- EL BAZ, M.K. (see Jennings, R.H., *et al.*)
- ELDRIDGE, C.S. (see Rudnick, R.L., *et al.*)
- Electron Spin Resonance: ruby discernment, 438
- Emerald: (see also Beryl)
- Australia, Torrington, 293, 437
- Austria, Habachtal, 521
- Colombian: inset with watch, 396; constraints on formation, 429; Muzo deposit, 435; parent brines, 591
- dating, chemical analysis, 197
- Egypt: Zabara, Sikait and Umm Kabo mines, 113; Marsa Alam mines, 202
- filters, 595
- flash effect, unusual, 593
- Fred Ward Gem Book, 54
- grape pendants, 399
- hydrothermal deposit, 435
- Madagascar mines, 118
- mineralization, Gravelotte, Transvaal, 207
- Mozambique, Morrua mines, 293
- oiling, antiquity of, 109
- Opticon treatment, 94
- parent brines evaporitic origin, 591
- petrographic and microthermometric studies, Brazilian, 117
- treated (see Treatment of gems)
- USA, N. Carolina, Big Crab Tree Mine, 204
- EMMETT, J.L., DOUTHIT, T.R., Heat treating the sapphires of Rock Creek, Montana, 198
- ENDERS, J., KEIM, T., NOHL, U., Farbwechsellnder Hackmanit aus Kanada - ein überraschender Edelstein, 113
- England:
- Crown Jewels, Myanmar gems in, 4
- Derbyshire, minerals of the Peak District, 113
- Isle of Wight amber, 435
- London: Cheapside Hoard, 395; Wakefield House, 395
- Sheffield, Renishaw Hall Blue John vase, 113
- Engraved gems:
- Glyptic art, 591
- Johann Wilhelm von der Pfalz collection, 54
- ruby, 515
- sapphires, 291
- spinel, 515
- Engraving with Monadite tool, 209
- Enhancement: (see Treatment of gems)
- Enstatite: (see Pyroxene)
- ENTREMONT, P., Chasseur de Pierre, 120
- Epidote: Myanmar, green, 7
- EPSTEIN, D.S., BRENNAN, W., MENDES, J.C., The Indaia sapphire deposits of Minas Gerais, Brazil, 291
- ERCIT, T.S. (see Groat, L.A., *et al.*)
- Eudialyte:
- Canada, check-list, 439
- Kola Peninsula, 597
- Europe, North and east. A brief review of mineral localities, 430
- EVANGELISTA, P. (see Graziani, G., *et al.*)
- Evans, Joan, 395
- EVSEEV, A.A., North and east Europe. A brief review of mineral localities, 430
- , Siberia and the Far East: a brief mineralogical guide, 430
- , Siberia's crystals and symmetry in the distribution of occurrences of minerals, 430
- , The south Urals: a brief mineralogical guide, 430
- , The Urals (from Middle to Polar): a brief mineralogical guide, 430
- Exhibitions:
- Baltic amber artefacts, Stockholm, 1992, 609
- Cheapside Hoard 1991, 397
- diamond, From the Treasury, Antwerp, 118
- Early Chinese Jade, New York, 1994, 609
- Gems and diamonds of the Kremlin, 1994, 609
- gemstones, Hessisches Landesmuseum, 1992, 609
- Jade from China, Bath, 377
- Jade in Chinese culture, 1990, 609
- Jades Impériaux, Paris, 1993, 118

- 17th century jewellery, 123  
 —Tucson '94, 373; '95, 595, 596, 598  
 Exploration:  
 —gemmology, 120, 155  
 —implications for, Western Australia, 588  
 —residual deposits in Sri Lanka, 206  
 —world-class deposits, 588
- Fa Hsien, 467  
 Fabergé, 214  
 Facetting (see Cuts)  
 FAINSTEIN, L.A. (see Kolomensky, V.D., et al.)  
 FALK, F., *Europäischer Schmuck*, 120  
 Farn, A. E., letter to editor, 287; address at awards presentation, 380  
 FARRIMOND, T., A device to facilitate the measurement of birefringence in gemstones, 105  
 —, Hydrostatic measurement of specific gravity, 161  
 —, letters to editor on measuring birefringence in gems, 184, 285  
 FEFELOV, N.N., KOSTRAVITSKIY, S.I., ZARUDNEVA, N.V., Isotopic composition of lead and its use to date Siberian kimberlites, 422  
 Feldspar:  
 —albite: moonstone, Myanmar, 6; smoky, Sri Lanka, 179  
 —amazonite: Minas Gerais, Brazil, 291; pegmatite, Ilmeny Mts, Russia, 436  
 —barium orthoclase, Minas Gerais, Brazil, 373  
 FENG, X.H. (see Dien, Li, et al.)  
 FEODOROV, V.S., Alexei V. Sverdlov: one must love and understand stone, 430  
 FERNANDES, S., SARMA, S., JOSHI, V., AGEE synthetic hydrothermal emerald, 441  
 FERRAUD, G. (see Cheillett, A., et al.)  
 Ferronyböite:  
 —in jade rock, Alps, 432  
 'Fibre Eye', 433  
 Fibre-optic:  
 —glass: chatoyant, 433; 'Catseyte', 'Cathaystone', 'Fibre Eye', 433  
 —illumination, 375  
 Fibrolite (see Sillimanite)  
 FIELD, S.W. (see Pearson, D.G., et al.)  
 Finland:  
 —Karelia, clastogenic pyropes and diamond, 290  
 —kimberlite pipes, 588  
 —Kitostrov, 431, rose corundum, 431  
 —Luomäki, a new gem beryl locality, 204  
 FINNIE, K.S., FISHER, D., GRIFFIN, W.L., HARRIS, J.W., SOBOLEV, N.V., Nitrogen aggregation in metamorphic diamonds from Kazakhstan, 586  
 FISHER, D. (see Finnie, K.S., et al.)  
 FLEET, M.E. (see Dien, Li, et al.)  
 Fluid evolution during emerald mineralization, 207  
 Fluorescence, 296  
 Fluorite:  
 —Belgium, Seiles, study, 375  
 —Blue John: vase, Renishaw Hall, 113; description and historical notes, 292  
 —cause of colour, 595  
 —green from Felix Mine, Los Angeles, 433  
 —Myanmar: 7, purplish-blue, 34  
 —pink, 437, 599  
 —Switzerland: Poncione di Manio, 437, Plaggenstock, 599  
 FOGEL, R.A. (see Mathez, E.A., et al.)  
 FOLIE, K., 150 Jahre Burgum-eine klassische Fundstelle für Zircon in Südtirol, 113  
 FOORD, E.E. (see also Taggart, J.E., et al.)  
 —, CHIRNSIDE, W., LICHTHE, F.E., BRIGGS, P.H., Pink topaz from the Thomas Range, Juab County, Utah, 591  
 FORD, T.D., Postscript to the largest Blue John vases ever made, 113  
 —, SARJEANT, W.A.S., SMITH, M.E., The minerals of the Peak District of Derbyshire, 113  
 FORSYTH, A., McELNEY, B., Jades from China, 377  
 FORT, R. (see Bustillo, M.A., et al.)  
 FRANCIS, C.A. (see Pitman, L.C., et al.)  
 FRANKLACH, M., SKOKOV, S., WEINER, B., An atomistic model for stepped diamond growth, 586  
 Frederick, Caesar, 344  
 FRIEND, C.R.L., Occurrences of boron-free and boron-poor kornorupine, 591  
 FRITSCH, E. (see also Kane, R.E., et al.; Kammerling, R.C., et al.; Koivula, J.I., et al.; Liu, Y., et al.; McClure, S.F., et al.; Moses, T.M., et al.; Muhlmeister, S., et al.; Rooney, T., et al.; Shigley, J.E., et al.)  
 —, KAMMERLING, R.C., KOIVULA, J.I., An examination of Swarovgreen: a new imitation emerald from Austria, 601  
 —, SHIGLEY, J.E., Causes of the purple and pink colours of manganooan sugilites from the Wessels Mine, South Africa, 430  
 FRITZ, M., et al., Flat pearls from biofabrication of organized composites on inorganic substrates, 431  
 FRONLICH, F., SCHUBNEL, H.-J., L'age du silicium, 120  
 FRYER, C.W. (see also Kammerling, R.C., et al.)  
 —, CROWNINGSHIELD, G.R., MOSES, T., HURWIT, K., McCLURE, S.F., Gem Trade lab notes, 189  
 —, CROWNINGSHIELD, G.R., MOSES, T., HURWIT, K., KAMMERLING, R.C., McCLURE, S.F., Gem Trade lab notes, 199, 200  
 FUZIKAWA, T. (see Collyer, T., et al.)  
 GALIBERT, O., HUGHES, R.W., Chinese ruby and sapphire - a brief history, 467  
 Galibert, O., 469  
 GALIMOV, E.M. (see also Schrauder, M., et al.)  
 —, ZAKHARCHENKO, O.D., MAL'TSEV, K.A., MALKIN, A.I., PAVIENKO, T.A., Carbon-isotope composition of diamonds from Arkhangel'sk-Region kimberlite pipes, 422  
 GAO YAN, LI JINGZHI, ZHANG BEILI, The infrared microscope and rapid identification of gemstones, 411  
 GARANIN, V.K., (see Bezborodov, A.M., et al.; Degtjarova, A.I., et al.)  
 Garnet:  
 —almandine: Canada, Labrador, 428; Myanmar, 7; in metamorphic rocks, 207; sectored birefringence, 428; Vietnam, 517  
 —aluminian, Raman spectroscopy, 436  
 —andradite, iridescent, 517; andradite in Mexico, 198  
 —asteriated, East Africa, compositions, 575  
 —Australia, 558  
 —Canada, grossular, 198  
 —chatoyant, 594  
 —chemical zoning of, 426  
 —China, Altay, 208  
 —composition, Aries kimberlite, Western Australia, 588  
 —Czechoslovakia, 599  
 —demantoid from Val Malenco, Italy, 112  
 —diamondiferous metamorphic rocks, 434  
 —Finland, Karelia, 290  
 —grossular: Altay, China, 208; crystal-field analysis, 429; Cr<sup>3+</sup> decay kinetics, 435; low-concentration hydrous, 198; Mali, Dionboko, 439  
 —grossular-andradite: Mali, 516, described, 517, 590  
 —hessonite: Orissa, India, 75; Zermatt, Switzerland, 598  
 —'Hollandine' orange spessartine, 204  
 —inclusions in Siberian diamonds, 113  
 —India, Orissa, hessonite, 75  
 —iridescent, 517  
 —Italy, 112  
 —Kazakhstan metamorphic rocks, 434  
 —Kenya, 116  
 —low RI, from Sri Lanka, 117

- Mali, 439, 516
- Mexico: gem quality, 596, rainbow, 198
- Myanmar, almandine, spessartine, 7; 34
- Namibia, spessartine, 202, 205, 374
- pyropes, clastogenic of Karelia, 290
- Rainbow, in Mexico, 198
- Siberia, 113
- spessartine: inclusion in beryl, Minas Gerais, 46; Altay, China, 208; orange, Myanmar, 7, 34; Namibia, 202, 205, 374
- Sri Lanka, 117
- Switzerland, Zermatt, 598
- Tanzania, grossular, 198
- 'tsavorite' from Kenya, 116
- vanadian-chromian, 599
- XYZ O II, 436
- Garrard: the Crown Jewellers for 150 years, 120
- GASPAR, J.C. (see Gonzaga, G.M., et al.)
- GAUTHIER, J.-P., Une mission à Takapoto, 'Île des Perles', 113
- , CASEIRO, J., LASNIER, B., Les perles rouges de Pinna nobilis, 200; (continued), 291
- GEBHARD, G. (see Milisenda, C.C., et al.)
- GEISS, H., Jade in Switzerland, 372
- Gem care, 448
- Gem hunting, 120
- Gem News, 28, 29, 190, 203, 204, 210, 370, 373, 376, 424, 433, 441, 514, 517, 519, 587, 594, 601
- Gem Trade Lab Notes, 189, 199, 200, 290, 292, 514, 516, 587, 593
- Gemmological Abstracts, 112, 187, 289, 370, 421, 514, 585
- Gemmological Association and Gem Testing Laboratory of Great Britain, Proceedings of, and Notices, 55, 125, 216, 297, 378, 451, 523, 610
- AGM, 1994, 216; 1995, 527
- Annual Conference, 45
- Annual Report 1994, 524
- Council of Management meetings, 56, 128, 225, 305, 384, 454, 527, 618
- Examinations, 221, 297, 298, 456, 612
- Gifts to, 55, 125, 216, 297, 379, 451, 524, 610
- Members' Meetings, 56, 127, 221, 297, 379, 452, 524
- Membership and Qualifications, 303
- Photographic competition, 523
- Presentation of Awards, 59, 380
- Gemmology:
  - dictionary, 446
  - physics and chemistry, 446
- Gemological Institute of America colored stones reference guide, 520
- Gemological Symposium, International, Los Angeles, 1991, 121
- Gems, R. Webster, 521
- Gems and Gemology: a retrospective of the '80's, 121
- Gemstones, Origin determination, 139; characteristic features, 141; history of, 445
- GERE, C., CULME, J., SUMMERS, W., Garrard the Crown Jewellers for 150 years, 120
- German Foundation for Gemstone Research, 518
- Germany:
  - agates, 206; Thuringia, 293
  - Bavaria: Hagendorf, zweiselite inclusion in beryl, 46; freshwater pearls, 515
  - Hunsrück, Birkenfeld Kreis agates, 428
  - Idar-Oberstein gem museum, 294
  - Pforzheim jewellery museum, 120
  - Saxony: agate in melaphyre, Hubertusberg, 117; amber in brown coal at Gute Hoffnung I, Bitterfeld, 117; aquamarine, Irfersgrun, 202; Crown of, 514; Granulitgebirge tourmalines, 118; ruby and sapphire from Seufzergundel, 208
  - Thuringia, agates, 293
- Geuda: heat-treatable corundum, classification, 207
- Ghana: Akwatia alluvial diamond, 424
- GIBBS, G.V. (see Heaney, P.J., et al.)
- Gifts to GAGTL:
  - Ariyaratna, D.H., stained ruby crystal, 611
  - Beattie, Rod, Access Asia, tourmaline crystal from Luc Yen, Vietnam, 125
  - Becker, G., Germany, book, 524
  - China University of Geosciences, Prof. Chen Zonghui and staff, Chinese gem minerals, 125
  - de Chamberlat, Marie, France, buttons in shell, bone, horn and imitation materials, 451
  - Dykhuis, Luella W., Arizona, sapphires from Montana, 452
  - Eliahoo, Mrs M.F.M., two fine beryls, 452
  - Geologisk Museum, Oslo, ruby and sunstone, 379
  - Guest, Mrs Vanessa A., rough and cut pectolite, 452
  - Hancocks and Co., synthetic ruby beads for research, 297
  - Hubrt, Ing. Ludek, Gem Servis, Prague, moldavite pieces from Czechoslovakia, 125
  - Jobin, Mark, new gem materials for research, 125
  - Kessler, John, fracture filled Brazilian emerald, 125
  - Latendresse, Gina, 'designer shaped' cultured pearls, 611
  - Lindley, G. and Co. Ltd. London, mixed diamond simulants, 524
  - Paragon Jewellery Design, 150 rough blue sapphire, 125;
    - Petre, Sarah, sapphire rough, 125
  - Ryle, Steve, Texas, Kashan synthetic rubies, 452
  - Schneider, Thomas M., California, rough blue apatites, 524
  - Scottish Branch, GAGTL, Book, The Honours of Scotland, 524
  - Sinclair, Louise, cubic zirconia, 611
  - Swarovski, Switzerland, five synthetic rubies, 524
  - Themelis, Ted, sapphire crystal, half heat treated, 125
  - Wu Chao-Ming, Taiwan, a garnet crystal and a piece of rough serpentine, 524; Taiwan nephrite, 611
- GISLASON, S.R., HEANEY, P.J., VEBLEN, D.R., LIVI, L.K.T., The difference between the solubility of quartz and chalcedony: the cause? 201
- GIULIANI, G. (see also Cheillett, A., et al.)
- , CHEILLETZ, A., ARBOLEDA, C., CARRILLO, V., RUEDA, F., BAKER, J.H., An evaporitic origin of the parent brines of Colombian emeralds: fluid inclusion and sulphur isotope evidence, 591
- , ZIMMERMAN, J.-L., MONTIGNY, R., K-Ar and <sup>40</sup>Ar/<sup>39</sup>Ar evidence for a Transamazonian age (2030-1970 Ma) for the granites and emerald-bearing K-metasomatites from the Campo Formoso and Carnaiba (Bahia, Brazil), 431
- GLAS, M. (see Dermbach, U., et al.)
- Glass:
  - fibre-optic, beads, 404
  - filling, in ruby, 42; in crackled Vernueil ruby, 43; in diamond, emerald, 94, 183
  - Lazerite, 519
  - natural, 295
  - obsidian, Peru, 516
  - optical, properties, 602
- GLASS, J.T. (see Messier, R., et al.)
- GLUSHNEV, S., Siberian sapropelic coal: a unique type of workable jet, 349
- Glyptic art, 591
- Gold:
  - content determination, 209
  - Colorado, 122
  - in exploration gemmology, 158
  - sample fingerprinting, 600
- GONZAGA, G.M., TEIXEIRA, N.A., GASPAR, J.C., The origin of diamonds in western Minas Gerais, Brazil, 423
- GOPALAN, K. (see Kumar, A., et al.)
- GOSLING, J. G., The Cheapside Hoard confusion, 395
- , Letter to Editor, 513
- GÖTZE, J., BLANKENBURG, H.-J., Zur Kathodolumineszenz



- von Achat-erste Ergebnisse, 431  
 Granite industry, worldwide, 116  
 Graphite:  
 —characterization and origin in cratonic lithosphere, 425  
 —cohenite-iron mineral association in diamond, 188  
 —in meteorites, 421  
 —vein, in high-grade metamorphics, origin of, 586  
 GRAY, M., Recent developments at the Benitoite Mine, 431  
 GRAZIANI, G. (see also Barot, N.R., et al.)  
 —, MARTINI, M., EVANGELISTA, P., A gem collection never before published. The Dactyliothea of H.H. Pope Leo XII, 372  
 Greece: 'Douros' synthetic ruby, 202; 376  
 Greenland:  
 —cancrinite, blue, 204  
 —kornerupine, boron-free, 591  
 GRIFFIN, B.J. (see Ramsay, R.R., et al.)  
 GRIFFEN, D.T., Silicate crystal chemistry, 120  
 GRIFFIN, W.L. (see also Chen, Y.D., et al.; Finnie, K.S., et al.; Guo, J., et al.)  
 —, SOBOLEV, N.V., RYAN, C.G., POKHILENKO, N.P., WIN, T.T., YEFIMOVA, E.S., Trace elements in garnets and chromites: diamond formation in the Siberian lithosphere, 113, 586  
 GROAT, L.A., HAWTHORNE, F.C., ERCIT, T.S., PUTNIS, A., The symmetry of vesuvianite, 591  
 GROMOV, A.V., On a remarkable topaz crystal with a lepidolite inclusion from the Tolstopjatov collection, 431  
 —, Rose corundum from the Khitostrov locality of north Karelia, 431  
 GROVES, G.W. (see Lu, T., et al.)  
 GRUBESSI, O. (see Aurisicchio, C., et al.)  
 GRUNDMANN, G., MORTEANI, G., 'Smaragdminen der Cleopatra': Zabara, Sikait und Umm Kabo in Ägypten, 113  
 GRUNDY, H.D. (see Sherriff, B.L., et al.)  
 Guatemala:  
 —jadeitites and albitites, 373  
 —Motagua Fault Zone, 373  
 GUBA, I., Die aussergewöhnlichen Eigenschaften von Kascholong-Opal aus einem Neuentdeckten Vorkommen im Oman, 201  
 GÜBELIN, E.J. (see also Barot, N.R., et al.; Kammerling, R.C., et al.)  
 —, An attempt to explain the instigation of the formation of the natural pearl, 539  
 Guides, mineralogical:  
 —Europe, north and east, 430  
 —Siberia: 430; and Far East, 430  
 —Urals: south, 430; middle to polar, 430  
 Guinea, West Africa: Mandala Basin diamond deposits, 195  
 GÜNTHER, B., Das Diamond Colorimeter DC 200, 518  
 GUO, J. (see also Wang, A., et al.)  
 —, GRIFFIN, W.L., O'REILLY, S.Y., A cobalt-rich spinel inclusion in a sapphire from Bo Ploi, Thailand, 201  
 —, WANG, F., YAKOUMÉLOS, G., Sapphires from Changle in Shandong Province, China, 201  
 GURNEY, J.J. (see Levinson, A.A., et al.)  
 GUTMANNBAUER, W., HÄNNI, H.A., Structural and chemical investigations on shell and pearls of nacre forming salt- and freshwater bivalve molluscs, 241  
 GUTZNER, J. (see Von Bezing, et al.)  
 Hackmanite (see Sodolite)  
 HAGGERTY, S.E. (see also Pearson, D.G., et al.)  
 —, Superkimberlites: a geodynamic diamond window to the Earth's core, 289  
 HAHN, H., Flussperlen in Bayern und Böhmen, 515  
 HALL, C., Gemstones, 212  
 HALLIDAY, A.N. (see Nakai, S., et al.; Snyder, G.A., et al.)  
 Hambergite: Pakistan, Drot, 596  
 HAMILTON, J.K. (see Woodcock, J.T., et al.)  
 HAMMER, V.M.F. (see Niedermayr, G., et al.)  
 HAN, Z. (see Dong, Z., et al.)  
 Handbook of Mineralogy, 602  
 HANNEMAN, W.W., Radioactivity revisited, 208  
 —, Glass filling of diamond, letter, 369  
 HÄNNI, H.A. (see also Gutmannsbauer, W., et al.)  
 —, Contributions à l'étude des caractéristiques distinctives des saphirs du Cachemire. Part 1, 431  
 —, Contributions à l'étude des caractéristiques distinctives des saphirs du Cachemire. Part 2, 515  
 —, Origin determination for gemstones: possibilities, restrictions and reliability, 139  
 —, SCHMETZNER, K., BERNHARDT, H., Synthetic rubies by Douros: a new challenge for gemologists, 376  
 HÄNNI, J.-P. (see Dufour, C., et al.)  
 HARDER, H., Achats als Nebenprodukt der Tonmineralbildung, 372  
 —, Edelopal: der feurig funkelnde Harlekin, 432  
 —, Smoky moonstone: a new variety, 179  
 —, Trace elements as colouring agents in jadeite, 508, corrigenda, 619  
 —, Zur Entstehung von verkiestelten Hölzern, 372  
 HARDING, R.R. (see also Barot, N.R., et al.)  
 —, A note on red beryl, 581  
 HARGRAVES, R.B. (see Miller, K.C., et al.)  
 HARLOW, G.E., Jadeitites, albitites and related rocks from Motagua Fault Zone, Guatemala, 373  
 —, VEBLEN, D.R., Potassium in clinopyroxene inclusions from diamonds, 370  
 HARRIS, J.W. (see Deines, P., et al.; Finnie, K.S., et al.; Harte, B., et al.; Lowry, D., et al.; Watt, G.R., et al.)  
 HARTE, B. (see also Watt, G.R., et al.)  
 —, HARRIS, J.W., Lower mantle mineral associations preserved in diamonds, 423  
 —, HUTCHISON, M.T., HARRIS, J.W., Trace element characteristics of the lower mantle: an ion probe study of inclusions in diamond from Sao Luiz, Brazil, 423  
 HARTMAN, J.S. (see Sherriff, B.L., et al.)  
 Harzburgite:  
 —relation to craton structure and diamond crystallization, 187  
 HAWTHORNE, F.C. (see Burns, P.C., et al.; Groat, L.A., et al.; Sherriff, B.L., et al.)  
 HAYASHI, M., Spectroscopic characteristics of yellow and green fancy colour diamond prepared by Koss, 189  
 —, HORIKAWA, Y., The weight of a round brilliant cut by calculation, 208  
 HAYS, N.K. (see Misiorowski, E.B., et al.)  
 HAYWARD, C.L., ANGEL, R.J., ROSS, N.L., The structural redetermination and crystal chemistry of sinhalite, MgAlBO<sub>4</sub>, 432  
 HAZEN, R.M., The new alchemists: breaking through the barriers of high pressure, 212  
 HEANEY, P.J. (see also Gislason, S.R., et al.)  
 —, PREWITT, C.T., GIBBS, C.V. (eds), Silica: physical behaviour, geochemistry and materials applications, 444  
 —, VEBLEN, D.R., POST, J.E., Structural disparities between chalcidony and macrocrystalline quartz, 432  
 HEDGES, L.K. (see Bailey, M.W., et al.)  
 HEINZ-JÜRGEN, B. (see Peretti, A., et al.)  
 HELMSTAEDT, H.H., 'Primary' diamond deposits. What controls their size, grade and location? Giant ore deposits, 290  
 HEMPHILL, S. (see Liu, Y., et al.)  
 HENIG, M., The Content cameos, 53  
 —, Classical gems. Ancient and modern intaglios and cameos in the Fitzwilliam Museum, Cambridge, 605  
 —, VICKERS, M., Cameos in context, 53  
 HENN, U. (see also Lind, T., et al.)  
 —, Makusanit - ein klar durchsichtiger Obsidian aus Peru, 516  
 —, ACKERMANN, L., SCHODER, K., Synthetische Opale aus

- China und Russland, 519
- , BANK, H., Gemmologische Kurzinformationen, 201
- , BANK, H., Geschliffene grünlich-braune Hornblende aus Sri Lanka, 202
- , BANK, H., Synthetic emerald overgrowths on colourless beryl, 441
- , BANK, H., Translucent nepheline from Norway, 432
- , BANK, H., Yellowish-green herderite from Brazil - a second occurrence, 432
- , BANK, H., BANK, F.H., Saphire von Indaia, Minas Gerais, Brasilien, 516
- , BANK, H., MILISENDA, C.C., Gemmologische Kurzinformationen, 202, 373, 516, 519
- , LIEBER, W., Amethyst vom Brandberg, Namibia, 114
- , MILISENDA, C.C., Synthetische Rubine aus Griechenland, 376
- , SCHNEIDER, B., Azurit-Malachit - Verwechslungsmöglichkeiten und Imitationen, 516
- HENWOOD, A.E. (see Nicholas, C.J., et al.)
- HERBERT, H.K. (see Watling, R.J., et al.)
- Herderite: Brazil, 432
- Hermann, Martin Leo, biography, 437
- Hertz, Bram, 236
- Hessonite (see Garnet)
- Hicks, Bill, 373
- HIDAKA, H. (see Kagi, H., et al.)
- Hiddenite: North Carolina, 375
- HIRAJIMA, T., COMPAGNONI, R., Petrology of a jade-quartz/coesite-almandine-phengite fels with retrograde ferronyböite from Dora-Maira Massif, Western Alps, 432
- HLAING, U.T., Hsa-Taw green tourmaline, 516
- HOCHLEITNER, R. (see Asselborn, E., et al.; Dernbach, U., et al.)
- HODGKINSON, A., Visual optics: diamond and gem identification without instruments: the Hodgkinson method, 444
- , Visual optics - the Hodgkinson method: an update, 294
- HOLDEN Jr., R.E. (see Wise, M.A., et al.)
- 'Hollandine' orange spessartine, 204
- HOLZHEY, G., Aquamarin aus Irfersgruen, Sachsen, 202
- Hope, Henry Philip, 236
- HORIKAWA, Y. (see Hayashi, M., et al.)
- Hornblende: green-brown from Sri Lanka, 202
- HUEGI, M.F., Das strahlende Blau der behandelten Topase, 202
- HUGHES, R.W., letter to editor on amber, 185
- HUGHES, R.W. (see also Galibert, O., et al.)
- , The new game, 292
- , The rubies and spinels of Afghanistan - a brief history, 256
- , U HLA WIN, Burmese sapphire giants, 551
- Humboldt, Alexander von, travels in Siberia, 447
- HURLBUT, C.S. (see also Pitman, L.C., et al.)
- , letters to editor on measurement of birefringence in gems, 184, hydrostatic measurement of SG, 285
- HURLE, D.T.J., Crystal pulling from the melt, 121
- , Handbook of crystal growth, 444
- HURWIT, K. (see Fryer, C.W., et al.; Kammerling, R.C., et al.)
- HUTCHISON, M.T. (see Harte, B., et al.)
- HUTTON, D.R., TROUP, G.J., A combined magnetic resonance and gamma-irradiation study of some green beryls, 292
- HYRSL, J., MILISENDA, C.C., Smaragdgrüne Chrom-Titanite aus dem Ural, Russland, 516
- Ibn Battuta, on lapis and spinel, 258; Sri Lankan pearls, 343
- Idocrase (see Vesuvianite)
- IIDA, K. (see Umeda, I., et al.)
- ILEPERUMA, O.A. (see Rupasinghe, M.S., et al.)
- IL'IN, O.V., On the morphology of malachite, 432
- Imitation gems (see Synthetic gems)
- Inclusions:
- in Afghanistan rubies, 264, 265
- ajoite in rock crystal, Arizona, 46
- alteration during heat treatment of corundum, 591
- in asteriated and cat's-eye gems, 577
- astrophyllite in quartz, 202
- biotite in Vietnamese peridot, 359
- bixbyite in red beryl, 582
- calcite in ruby, 42
- carbon-rich in diamond, 427
- characteristic, in Sri Lanka sapphire, 115
- characterization, in Russian synthetic emerald, 501
- chromite in Siberian diamonds, 113
- clinopyroxene in diamond, 370
- CO<sub>2</sub>, solid, in natural diamond, 117
- columbite: in Egyptian emerald, 114; in red beryl, analysis, 582
- copper in cuprian elbaite, 428
- in demantoid garnet, 594
- diamond, in metamorphic rock minerals, 371
- in diamonds: 113; Russian yellow, 363, SEM spectra, 365
- diopside in calcite, Congo, 46
- in emerald: synthetic, 403; characterization, 501
- garnet: in Siberian diamonds, 113; trace elements, 587
- in garnet, 594
- graphite in diamond, 514
- in Hawaii melts, 427
- in hessonite, Orissa, India, 80
- lechatelierite in tektite, 417, 418
- lepidolite in topaz, 431
- 'lily pad' in Vietnamese peridot, 357
- lower mantle mineral associations: in diamond, 423, ion probe study, 423
- ludwigite in peridot, 594
- in moldavite tektites, 415
- muscovite and rutile in rock crystal, Sri Lanka, 46
- Myanmar rubies and sapphire, in, distinguishing, 25
- oil, fluorescent, in quartz, New York, 85
- papagoite in rock crystal, Arizona, 46
- in peridot, 357
- in quartz, 594, 596
- in ruby, 442
- sodium fluoride and high alkali glass in diamond, 191
- spessartine in beryl, Minas Gerais, 46
- spinel: Co-rich, in sapphire, 201; Cr, in peridot, 358
- tenorite in cuprian elbaite, 428
- triangular, in diamond, 587
- veiling in Vietnamese peridot, 358
- X-ray studies, 198
- zircon in diamond, Zaire, 424
- zwieselite in beryl, Bavaria, 46
- India:
- Assam: Cretaceous-Cenozoic tectonic events, 115
- Great Mogul diamond, 427
- Jammu: beryl, 207, 292
- Karnataka: corundum gem study, 207; corundum gems, 436; Mysore district, 436
- Kashmir: beryl, 207, 292, cause of colour, 374; sapphire characteristics, 431, 515
- Kerala: gemstone mineralization, 435
- kimberlites, Rb-Sr dating of phlogopite, 290
- Madhya Pradesh: Majhgawan diamoniferous pipe, 586
- Nepal gemstones, 206
- Orissa: four hessonite occurrences, 75; gems, 204; cat's-eye sillimanite similar to fibre-optic chatoyancy, 433
- Rajasthan beryl study, 436
- Tamil Nadu, gemstone mineralization, 435
- Indo-China: (see Vietnam)
- Instruments:
- Colorimeter: Diamond, DC 200, 518; Gran, 600
- computer assisted gem identification, 375
- declinometer for refractometers, 405, addendum, 530
- diamond-wire contouring, 440
- fibre optics, miniature, 375

- Hanneman-Hodgkinson synthetic emerald filter, 595
- Infrared microscope, 411
- oil-filling apparatus for emerald, 204
- Pearlscop, 440
- Polariscopes, Gemlite, 518
- refractometer: birefringence measurement, 105; Brewster-angle, 440; declinometer, 405, 530; ROS/GEM RFA 322, evaluation, 600
- spectrophotometer, Hitachi U4001, 600
- Intaglios, 605
- International Gemological Symposium 1991, proceedings, 121
- Iolite: (see Cordierite)
- IRELAND, T.R., RUDNICK, R.L., SPETSIUS, Z., Trace elements in diamond inclusions from eclogites reveal link to Archaean granites, 587
- Iridescent garnet, 517
- Irradiation, gamma, study of green beryl, 292
- ISIK, I. (see Sariiz, K., et al.)
- Italy:
  - Aosta, vesuvianite from Bellecombe and Montjovet, 115, 173
  - Elba 'Testa Nera' tourmaline, 203
  - Val Malenco, Sandrio, demantoid, 112
- IVANOV, V.G. (see Sapozhnikov, A.N., et al.)
- IWAHASHI, Y. (see Kennedy, S.J., et al.)
  
- JACOB, D.E., JAGOUTZ, E., LOWRY, D., MATTEY, D., ROSENHAUER, M., KUDRJAVTSEVA, G.P., Diamondiferous eclogites from Udachnaya: a subducted component in the Siberian upper mantle, 423
- JACOBSON, M.L., Antero aquamarines: minerals from the Mount Antero-White Mountain region, Chaffee County, Colorado, 212
- Jade:
  - Baek Ok, 547
  - 'Black', ferrohormblende imitation, 517
  - Central American trade medium, 434
  - Chinese: animal, the Worrell collection, 119; neolithic, 438, 607
  - colour, trace elements as agents, 508
  - data, gemmological and spectroscopic, of impregnated, 478
  - exhibition, New York, 609
  - jadeite: impregnated, identification, 475; nomenclature, 317; physical characteristics, 317; trace elements as colorants, 508, corrigenda, 619; value enhanced, 112, 590; XRD data, 319
  - Juwel des Himmels, 54
  - Myanmar: deposits, 30; Maw-sit-sit variety, 32; jadeite mineral and chemical compositions, 269, 315; nephritic, 6; qualities and uses, 31; trace elements in, 510; types, 6
  - nephrite: Chuncheon, Korea, 547, properties, 548; dyed, 593; structural changes at elevated temperatures, 291; in Switzerland, 372
  - New Zealand, Maori, 447
  - nomenclature, 438
  - North America, 375
  - Switzerland: 372; Dora-Maira massif, 432
  - treated (see Treatment of gems)
  - world of, 121
- Jadeite: Guatemala, Motagua Fault Zone, 373
- Jades Impériaux, exhibition, Paris 1993, 118
- JAGOUTZ, E. (see also Jacob, D.E., et al.)
- Japan: Okinawa golden pearls, 203
- Jasper: Zebra stone, Western Australia, 433
- JASZCZAK, J.A., Quasicrystals: novel forms of solid matter, 432
- JAVERI, A., Rare stones, 202
- JAVOY, M. (see Boyd, S.R., et al.)
- JENNINGS, R.H., KAMMERLING, R.C., KOVALTCHOUK, A., CALDERON, G.P., EL BAZ, M.K., KOIVULA, J.I., Emeralds and green beryls from Upper Egypt, 202
- JERDE, E.A. (see also Snyder, G.A., et al.)
  - , TAYLOR, L.A., CROZAZ, G., SOBOLEV, N.V., SOBOLEV, V.N., Diamondiferous eclogites from Yakutia, Siberia: evidence for a diversity of protoliths, 114
- Jet:
  - fossil hydrocarbon, 438
  - USSR: sapropelitic coal, 349, characteristics, 350, chemistry and petrography, 351, factories, 351
- Jewellery:
  - arts and crafts tradition, 53
  - Cheapside Hoard, 395
  - Crown jewels, English, 313; 446
  - Crown jewels, Scottish, 603
  - Crown of Saxony, 514
  - designer, 213
  - Edwardian, 209
  - historic, 1381-1910, 608
  - 17th century jewellery, 123
- JING ZHICHUM (see Wen Guang, et al.)
- Jobbins, Alan, Editor 1986-93, 74; 397
- JOBBINS, E.A. (see also Kammerling, R.C., et al.)
  - XXIV International Gemmological Conference, Paris 1993, 50
- J.O. Crystal Co., California, 87
- JOHNSON, M.L. (see Kammerling, R.C., et al.)
- JONES, G.C., Amber, 114
- JONES, H.D. (see Nakai, S., et al.)
- JOSHI, V. (see Fernandes, S., et al.)
- JUNG, W. (see Dernbach, U., et al.)
  
- KAGI, H., TAKAHASHI, K., HIDAKA, H., MASUDA, A., Chemical properties of Central African carbonado and its genetic implications, 423
- KALACHEV, V.N., Axinite: new finds in Russia, 433
- KALINKIN, M.M. (see Polyakov, I.V., et al.)
- KAMINSKY, F.V. (see Schrauder, M., et al.)
- KAMMERLING, R.C., (see also Fryer, C.W., et al.; Fritsch, E., et al.; Jennings, R.H., et al.; Kane, et al.; Koivula, J.I., et al.; McClure, S.F., et al.; Muhlmeister, S., et al.; Shigley, J.E., et al.)
  - , CALDERON, G.P., Examination of a glass imitation of jade from Vietnam, 203
  - , FRYER, C.W., Gem Trade Lab notes, 514, 516, 587, 593
  - , FRYER, C.W., CROWNINGSHIELD, G.R., MOSES, T., HURWIT, K., McCLURE, S.F., Gem Trade Lab. Notes, 290, 292
  - , JOHNSON, M.L., An examination of 'serendipitous' synthetic zincite, 563
  - , KANE, R.E., Die Rubine-und Saphir-Abbaue von Mogok, 114
  - , KELLER, A.S., SCARRATT, K.V., REPETTO, S., Update on mining rubies and fancy sapphires in northern Vietnam, 433
  - , KOIVULA, J.I., A preliminary investigation of peridot from Vietnam, 355
  - , KOIVULA, J.I., Almandine garnets from Vietnam, 517
  - , KOIVULA, J.I., Microscopic features of synthetic rubies. Part 1: melt products, 441
  - , KOIVULA, J.I., The role of fashioning in effective gemstone substitutes, 114
  - , KOIVULA, J.I., FRITSCH, E., An examination of Chatham flux-grown synthetic pink sapphires, 149
  - , McCLURE, S.F., JOHNSON, M.L., KOIVULA, J.I., MOSES, T.M., FRITSCH, E., SHIGLEY, J.E., An update on filled diamonds: identification and durability, 423
  - , SCARRATT, K., BOSSHART, G., JOBBINS, E.A., GÜBELIN, E.J., LEVINSON, A.A., Myanmar and its gems - an update, 3
- KAMO, M., Characterization of diamond synthesized from gas phase, 189; corrigenda, 130
- KANDA, H. (see Arima, M., et al.)
- KANDA, J., Recent studies on impurities in large synthetic diamonds, 189
- KANE, R.E. (see also Kammerling, R.C., et al.)
  - , KAMMERLING, R.C., KOIVULA, J.I., SHIGLEY, J.E.,

- FRITSCH, E., Identificación de zafiros tratados por difusión, 203
- KANEKO, K., LANG, A.R., CL and microtopographic studies of Argyle diamonds, 114, 189
- KANFER, S., Das Diamanten-Imperium. Aufstieg und Macht der Dynastie Oppenheimer, 445
- KANIS, J., REDMANN, M., Four hessonite occurrences in Orissa, India, 75
- KARFUNKEL, J., CHAVES, M.L.S.C., Transparenter, schleifwuerdiger, gruener Barium-Orthoklas aus Minas Gerais, Brasilien, 373
- KARLIN, E.Z., Jewelry and metalwork in the arts and crafts tradition, 53
- KASRAL, M. (see Dien, Li, *et al.*)
- KAZACHENKO, V.T., BUTSIK, L.A., SAPIN, V.I., KITAEV, I.V., BARNOV, N.N., NARNOV, G.A., Vanadian-chromian tourmaline and vanadian muscovite in contact-metamorphosed carbonaceous rocks, Primorye, Russia, 114
- KEDDY, R.J., NAM, T.L., Diamond radiation detectors, 290
- KEIM, T. (see Enders, J., *et al.*)
- KELLER, A.S. (see also Kammerling, R.C., *et al.*; Liddicoat, R.T., *et al.*)
- , International Gemological Symposium, Los Angeles, 1991, 121
- KENNEDY, S.J., AKAMATSU, S., IWAHASHI, Y., The Hope Pearl, 235
- Kenya:
- cat's-eye, 569
- Kitui, pink corundum, 165
- Taita Hills, Voi, 'tsavorite', 116
- KESLER, S.E. (see Nakai, S., *et al.*)
- KHANLARY, M.-R. (see Rendell, H.M., *et al.*)
- Kimberlite:
- Australia, Culcutteroo, 585
- Canada: Sakatchewan, diamoniferous, 188; North West Territories, new, 424; Slave Structural Province, 425
- contrasted with lamproites, 193
- diamond content determination, 422
- Finland, 588
- generation and source rocks, 589
- Indian, palaeomagnetism, 588
- magma: evolution and diamond genesis, 194; origins, 585
- magmatism in East European craton, 188
- not primary diamond source rocks, 209
- Siberia: 113, 114; dating, 422
- South Africa: Monastery and Finsch, 115; emplacement ages, 426
- USSR: Kola Peninsula, 588; Udachnaya pipe, Yakutia, 187, 194; 'Mir' pipe, 195
- window to the Earth's core, 289
- Kimberley created emerald, 519
- Kimberley Inc., NY, 519
- KING, V.T. (see Robinson, G.W., *et al.*)
- KINNUNEN, K.A. (see Lahti, S.I., *et al.*)
- KINNY, P.D. (see also Chen, Y.D., *et al.*)
- , MEYER, H.O.A., Zircon from the mantle: a new way to date old diamonds, 424
- KIRKLEY, M.B. (see Levinson, A.A., *et al.*)
- KISSIN, A.J., Ruby and sapphire from the southern Ural Mountains, Russia, 593
- KITAEV, I.V. (see Kazachenko, V.T., *et al.*)
- KITAMURA, M. (see Minyata, T., *et al.*)
- KLAUS, D., Testa Nera: die trauernden Turmaline von Elba, 203
- KLEIN, C., HURLBUT, C.S., Jr, Manual of mineralogy 21st edition, 445
- Klein, Fritz, 439
- KLEINER, R., Chinese snuff bottles in the collection of Mary and George Bloch, 605
- KLJUNIN, S.F., ZAKHAROV, A.A., Clastogenic pyropes and diamonds of northern Karelia, 290
- KOEBERL, M. (see Schrauder, M., *et al.*)
- KOIVULA, J.I. (see also Fritsch, E., *et al.*; Jennings, R.H., *et al.*; Kammerling, R.C., *et al.*; Kane, R.E., *et al.*; Muhlmeyer, S., *et al.*; Shigley, J.B., *et al.*)
- , A photo essay dedicated to Bill Hicks, 373
- , KAMMERLING, R.C., Inclusions in garnet, 594
- , KAMMERLING, R.C., Inclusions in quartz, 594
- , KAMMERLING, R.C., The characteristics of Russian flux-grown synthetic red and blue spinels, 441
- , KAMMERLING, R.C., FRITSCH, E., Gem News, 28, 29, 190, 203, 204, 210, 370, 373, 376, 424, 433, 441, 514, 517, 519, 587, 594, 601
- KO KO (see Pow-Foon Fan, *et al.*)
- KOLOMENSKY, V.D., FAINSTEIN, L.A., The Mining Museum, St Petersburg, 433
- Komdragmet, 424
- Korea:
- Chuncheon, 547
- nephrite, 547
- Kornerupine:
- boron-free, Greenland, 591
- chatoyant, 203
- infrared spectroscopy, 413
- Myanmar, 7
- properties, 414
- KOSHIL, I.M., VASILISHIN, I.S., PANCHENKO, V.I., Bernstein aus der Ukraine, 115
- Kosmochlor: (see also Jade)
- Myanmar, surrounding chromite in jade, 32, 318; XRD data, 319
- KOSTOV, R.I. (see Petrusenko, S.I., *et al.*)
- , Amethyst: A geological-mineralogical and gemmological essay, 204
- , Mineralogical gemmology. The precious minerals through the centuries, 445
- KOSTRAVITSKIY, S.I. (see Fefelov, S.I., *et al.*)
- KOURIMSKY, J., Opal, 434
- KOVALTCHOUK, A. (see Jennings, R.H., *et al.*)
- KRAPPMANN, M., DREES, H.-H., Mineraliensuche im Süden Afrikas, 115
- KRAUS, I. (see Bouska, V., *et al.*)
- KREMKOW, C., World gem market invaded by sizeable amount of Burma ruby, 292
- KUDRJAVTSEVA, G.P. (see Jacob, D.E., *et al.*)
- KUDRYAVTSEVA, G.P. (see Bezborodov, A.M., *et al.*)
- KULIKOVA, N.A. (see Devnina, N.N., *et al.*)
- KUMAR, A., PADMA KUMARI, V.M., DAYAL, A.M., MURTHY, D.S.N., GOPALAN, K., Rb-Sr ages of Proterozoic kimberlites of India: evidence for contemporaneous emplacement, 290
- KURBATOV, V., Carcass skeletal quartz from the Indigirka river, 434
- KURCHATOV, V., PETROV, P., Opal and magnesite veins in weathered serpentinites from the western Rhodope Mts, 434
- Kyanite: Myanmar, 7
- KYLE, J.R. (see Nakai, S., *et al.*)
- KYSER, T.K. (see Ottaway, T.L., *et al.*)
- Laal Bedaschan (balas ruby), 257
- LAGACHE, M. (see Quémeuneur, J., *et al.*)
- LAHTI, S.I., KINNUNEN, K.A., A new gem beryl locality: Luumäki, Finland, 204
- LAJČAKOVA, A. (see Bouska, V., *et al.*)
- LAMBRECHT, W.R.L., LEE, C.H., SEGALL, B., ANGUS, J.C., LI, Z., SUNKARA, M., Diamond nucleation by hydrogenation of the edges of graphitic precursors, 190
- Lamproite:
- contrasted with kimberlites, 193
- generation and source rocks, 589

- Indian palaeomagnetism, 588  
 —not primary diamond source rocks, 209  
 Lamprophyre: Kola Peninsula, 588  
 LANDMESSER, M. (see Dernbach, U., *et al.*)  
 Landscape marble, 597  
 LANE, T.E. (see Nakai, S., *et al.*)  
 LANG, A.R. (see also Kancko, K., *et al.*; Walmsley, J.C., *et al.*)  
 —, Comments on 'An unusual octahedral diamond' by A. Yacout and M. Moore, 291  
 —, Penetrating diamonds with X-rays and microscope, 440  
 —, Some facets of diamond research, 424  
 LANGE, F.W., BISHOP, R.L., Abstraction and jade exchange in Precolumbian southern Mesoamerica and lower central America: Costa Rican considerations, 434  
 LANGER, K., ROBARIK, E., SOBOLEV, N.V., SHATSKY, V.S., WANG, W., Single-crystal spectra of garnets from diamondiferous high-pressure metamorphic rocks from Kazakhstan: indications for OH, H<sub>2</sub>, and FeTi charge transfer, 434  
 Lapidarium Sinicum, 467  
 Lapis Lazuli:  
 —112  
 —Afghanistan, Sar-e-Sang, 438,  
 —Myanmar, 7  
 —Pamirs, 207  
 —structural-mineralogical peculiarities, 207  
 Lapworth, P.B., letter to editor on use of name 'opalite', 64  
 LASNIER, B. (see Gauthier, J.-P., *et al.*; Pinet, M., *et al.*; Schubnel, H.-J., *et al.*)  
 LAVROVA, L.D. (see Yekimova, T.Y., *et al.*)  
 Lawrence, F.L., 400  
 Lawrence, George F., ('Stony Jack'), 395, 396, 397, 400, 513  
 Lazzerite, faceted artificial glass, 519  
 Lechatellierite: in tektites, 417  
 LEE, C.H. (see Lambrecht, W.R.L., *et al.*)  
 LEE, T., CHEN, J.H., DAI, C.F., SHEN, J.J., U-disequilibrium dating of corals in southern Taiwan by mass spectrometry, 204  
 LEGGE, P.J., Geoscience 1994 and beyond: thoughts on geology and exploration for world-class ore deposits, 588  
 Letters to the Editor: 61, 130, 183, 281, 369, 513  
 LEVINSON, A.A. (see also Kammerling, R.C., *et al.*)  
 —, COOK, F.A., Gem corundum in alkali basalt: origin and occurrence, 594  
 —, GURNEY, J.J., KIRKLEY, M.B., Diamant-vorkommen und Diamant-Produktion, 425  
 —, GURNEY, J.J., KIRKLEY, M.B., Diamond sources and production past, present and future, 190  
 LEVITSKY, V. (see Sapozhnikov, A.N., *et al.*)  
 LEWIS, R.S. (see Amari, A., *et al.*)  
 LI JINGZHI (see Gao Yan, *et al.*)  
 LI, Z. (see Lambrecht, W.R.L., *et al.*)  
 LIBOWITSKY, E., Optical anisotropy in the spinel group: a polishing effect, 440  
 —, Optical anisotropy of cuprite caused by polishing, 600  
 LICHTER, F.E. (see Foord, E.E., *et al.*)  
 LIDDICOAT, R.T., KELLER, A.S., (eds), Gems and Gemology: a retrospective of the '80's, 121  
 LIEBER, W. (see also Henn, J., *et al.*)  
 —, Amethyst: geschichte, eigenschaften, fundorte, 445  
 —, Der Blue John-Fluorit. Ein Besuch in den Flusspatgruben von Castleton, Derbyshire, England, 292  
 —, Farbenstehung und -verteilung in fluorit, 595  
 —, Lightning Ridge. Die Heimat des Schwartzopals, 434  
 Limestone:  
 —agate patterned, 599  
 —landscape, 598  
 LIND, T.H., BANK, H., HENN, U., Spessartine aus Namibia, 205  
 —, BANK, H., HENN, U., Schleifwürdige Granate (Grossulare) von einem neuen Vorkommen in Mali, 517  
 —, HENN, U., BANK, H., Leuchtend orangefarbige Spessartine aus einem neuen Vorkommen in Namibia, 374  
 LINTON, T., Miniature fibre optics, 375  
 —, NEVILLE, B., SHIELDS, A., Gemlite polariscopes, 518  
 LISITSYN, A.E., MALINKO, S.V., The Dal'Negorsk boron deposit: a unique mineralogical object, 434  
 —, SHIELDS, A., Hanneman-Hodgkinson synthetic emerald filter, 595  
 LIU, Y. (see also Wang, F., *et al.*)  
 —, SHIGLEY, J.E., FRITSCH, E., HEMPHILL, S., Relationship between the crystallographic orientation and the 'alexandrite effect' in synthetic alexandrite, 441  
 Liu Guobin, 467  
 LIVERINO, B., Red coral, jewel of the sea, 377  
 LIVI, L.K.T. (see Gislason, S.R., *et al.*)  
 LOH, F.C. (see Tan, T.L., *et al.*)  
 Lonsdaleite: crystal lattice dynamics, 196  
 LOPATO, M. (see von Habsburg, G., *et al.*)  
 LOWRY, D. (see also Jacob, D.E., *et al.*)  
 —, MATTEY, D.P., MACPHERSON, C.G., HARRIS, J.W., Evidence for stable isotope and chemical disequilibrium associated with diamond formation in the mantle, 425  
 LU, T., ZHANG, X., SUNAGAWA, I., GROVES, G.W., Nanometre scale textures in agate and Beltane opal, 434  
 Ludwigite: inclusions in peridot, 594  
 LUFF, B.J. (see Rendell, H.M., *et al.*)  
 LUKJANOVA, L.I. (see Simakov, S.K., *et al.*)  
 McCALLUM, M.E. (see Meyer, H.O.A., *et al.*)  
 McCLURE, S.F. (see also Fryer, C.W., *et al.*, Kammerling, R.C., *et al.*)  
 —, KAMMERLING, R.C., FRITSCH, E., Update on diffusion treated corundum: red and other colours, 205  
 MACDONALD, D.J. (see Burns, P.C., *et al.*)  
 McELNEY, B. (see Forsyth, A., *et al.*)  
 MACKENZIE, D. (see Tainton, K.M., *et al.*)  
 MACKENZIE, R., Fraudulent use of synthetic sapphire, 294  
 McMILLAN, P.F. (see Aasland, S., *et al.*)  
 MACPHERSON, C.G. (see Lowry, D., *et al.*)  
 Madagascar:  
 —Andranondambo, 597  
 —emerald: mines, 118; internal features, 374  
 —Mananjary Region, 374  
 —sapphire, new occurrence, 518; 597  
 MAGGIORE, C. (see Mathez, E.A., *et al.*)  
 Magnesite: veins with opal in serpentinite, 434  
 Magnetic resonance study of green beryl, 292; rotation of gem crystals, 209  
 MAGNORI, L., Brevi osservazioni sull'anfibolite zoisitica a corindone della Tanzania, 115  
 MAHROOF, M.M.M., The story of Sri Lankan pearl, 337  
 MAISSEN, F. (see Asselborn, E., *et al.*)  
 MAKAGON, V.M. (see Afonina, G.G., *et al.*)  
 Makusanite, obsidian, 516  
 Malachite:  
 —516  
 —morphology of, Russian, 432  
 MALANGO, V. (see Milisenda, C.C., *et al.*)  
 Mali:  
 —Dionboko grossular, 439  
 —grossular-andradite, 516, described, 517, 590  
 MALINKO, S.V. (see Lisitsyn, A.E., *et al.*)  
 MALINOVSKY, I.Y. (see Shigley, J.E., *et al.*)  
 MAMBWE, M.A., The mineralogy, geology and occurrence of topaz, 595  
 Mantle, Lower, mineral associations, 423  
 Marbodius, *Libellus de lapidibus*, 115  
 MARKEL, S. (ed), The world of jade, 121  
 MARTINI, M. (see Graziani, G., *et al.*)  
 'Masalik al-absar fi mamlik al-amsar', 109

- MASON, R.A. (see Brown, D., *et al.*)  
 MASUDA, A. (see Kagi, H., *et al.*)  
 MATHEZ, E.A., BLACK, J.D., MAGGIORE, C., MITCHELL, T.E., FOGEL, R.A., The determination of the O content of diamond by microactivation, 115  
 MATLINS, A.L., BONANNO, A.C., Jewelry and gems: the buying guide, 121  
 MATTEY, D. (see Jacob, D.E., *et al.*)  
 Mauboussin, jewellers, history, 120  
 MATTEY, D.P. (see Lowry, D., *et al.*)  
 Maw-sit-sit jade, 6, 32  
 MAYR, H. (see Dernbach, U., *et al.*)  
 MAZLOUM, C., Designer jewellery, 213  
 MAZURAK, Z. (see also Czaja, M., *et al.*)  
 —, Luminescence and excited state  ${}^2E_g$  decay kinetics of  $Cr^{3+}$  in grossular  $Ca_3Al_2(SiO_4)_3$ , 435  
 MEARS, K., The crown jewels, 446  
 MEDENBACH, O., (see Schmetzer, K., *et al.*; Wunder, B., *et al.*)  
 Medicinal use of pearls, 43  
 Meerschäum: (see Sepiolite)  
 Meigenburg, Konrad von, 109  
 Melaphyre, agate in, Saxony, 117  
 Members' meetings, 56, 127, 221, 297, 379, 452, 524  
 MENDE, R., Achate aus dem Geschiebe der nordischen Vereisungen, 206  
 MENDES, J.C. (see Epstein, D.S., *et al.*; Souza, J.L., *et al.*)  
 MENDIS, D.P.J., RUPASINGHE, M.S., DISSANAYAKE, C.B., Application of structural geology in the exploration for residual gem deposits of Sri Lanka, 206  
 MENON, R.D., SANTOSH, M., YOSHIDA, M., Gemstone mineralisation in southern Kerala, India, 435  
 MERCER, M.E., Methods of determining the gold content of jewelry metals, 209  
 MERIGOUX, H., (see Astric, B., *et al.*; Astric, H., *et al.*; Monat, P., *et al.*)  
 MERINO, C.J., WANG, Y., DELOULE, E., Genesis of banded, fibrous and twisted quartz by 'catalysis', unstable crystallization fronts and substitution: self-organization in agates, 435  
 MERTZMAN, A. (see Boyd, F.R., *et al.*)  
 'Mesa-lek-al-absar', 109  
 MESSIER, R., GLASS, J.T., BUTLER, J.E., ROY, R., (eds), International Conference [on] New Diamond Science and Technology, Washington DC, 1990, 213  
 Meteorites:  
 —interstellar grains in, 421  
 —moldavite, inclusions in, 415  
 MEYER, H.O.A. (see also Kinny, P.D., *et al.*; Wang, A., *et al.*)  
 —, McCALLUM, M.E., Diamonds and their sources in the Venezuelan portion of the Guyana Shield, 371  
 Mexico:  
 —Coahuila, Sierra de las Cruces, 596  
 —grossular gem, 596  
 —iridescent andradite, 517  
 —Sierra Madre Rainbow garnet, 198  
 Mica:  
 —Kazakhstan, in diamond bearing metamorphic rocks, 196  
 —lepidolite inclusion in topaz, 431  
 —muscovite inclusions in rock crystal, Sri Lanka, 46  
 —phlogopite, Indian, Rb-Sr dating, 290  
 —vanadian muscovite from Russia, 114  
 MICHELSEN, S.S. (see Watermeyer, B., *et al.*)  
 Micromounting, The complete book of, 54  
 Microscope, role in exploration gemmology, 156  
 —infrared and identification of gems, 411  
 —polarizing, diamond study, 440; crystal identification, 448  
 Microscopy, light:  
 —of pearls and naire, 244,  
 —ores, 604  
 MIKHAILOV, S.G. (see Solomonov, V.I., *et al.*)  
 Milarite:  
 —with danburite, Austria, 118  
 —Minas Gerais, Brazil, 429  
 MILISENDA, C.C. (see also Henn, J., *et al.*; Hyrs, J., *et al.*)  
 —, Gemmologische Kurzinformationen. Short notes from the gemmological laboratory of the German Foundation for Gemstone Research, 518, 519  
 —, REDMANN, M., MALANGO, V., A new occurrence of dendritic opal in south-eastern Zambia, 277  
 —, SCHLÜTER, J., GEBHARD, G., Seltene Edelstein von St. Hilaire, Quebec, Canada, 518  
 MILLER, A.M., SINKANKAS, J., Standard catalog of gem values. Second edition, 606  
 MILLER, K.C., HARGRAVES, R.B., Palaeomagnetism of some Indian kimberlites and lamproites, 588  
 MINAYATA, T., KITAMURA, M., Identification of natural and synthetic diamonds by a cathodoluminescence method, 190  
 Mineralogy: manual, 445; Handbook of, 602  
 Mines and Mining:  
 —Australasian, 449  
 —Australia: Anakie District, 599; Argyle, 424, 514; images of, 608; Lightning Ridge, 434  
 —Benitoite, 431  
 —Brazil, Sao Luiz diamond, 291; 444  
 —China, sapphire, Penglai, Hainan, 469  
 —Chivor mine, 439  
 —Colombia, Cozcuez, 596, Los Gavelines, 596  
 —Egypt: Zabara, Sikait and Umm Kabo emerald mines, 113  
 —Marsa Alam, emerald, 202  
 —Germany, amber in brown coal, Bitterfeld, 117  
 —Ghana, alluvial diamond, 424  
 —Madagascar, emerald mines of, 118  
 —Mozambique, Morrua emerald mines, 293  
 —Myanmar: gem deposits review, 3, illicit, 16; Mong Hsu ruby, 292  
 —South Africa: Jagersfontein, 589; Wessels, 430, 437  
 —Sri Lanka, 203  
 —Tanzania, Mpwapwe, 596  
 —USA: Big Crab Tree Mountain, N. Carolina, emeralds, 204; Himalaya, California, 596  
 —Vietnam, ruby and sapphire update, 433  
 —Zimbabwe, River Ranch diamond, 424  
 MISIOROWSKI, E.B., HAYS, N.K., Jewels of the Edwardians, 209  
 MITCHELL, A.H.G., Cretaceous-Cenozoic tectonic events in the western Myanmar (Burma)- Assam region, 115  
 MITCHELL, T.E. (see Mathez, E.A., *et al.*)  
 Moganite: related to solubility of chalcedony, 201  
 Moldavite (see Tektites)  
 MOLINÉ I SALA, A., The declinometer for refractometers: the latest developments. 405, addendum, 530  
 MONAT, P., MERIGOUX, H., Marbode. Poème des pierres précieuses. (Part 1), 115  
 MONTIGNY, R. (see Giuliani, G., *et al.*)  
 Moonstone: (see Feldspar)  
 MOORE, T., What's new in minerals? 206, 595, 596  
 MOREAUX, C. (see Dereppe, J.-M., *et al.*)  
 MOREL, B., Les autres grands diamants des la Couronne de Saxe, 514  
 MORSE, S.A. (see Stoiber, R.E., *et al.*)  
 MORTEANI, G. (see Grundmann, G., *et al.*; Nwe, Y.Y., *et al.*)  
 Morton, H.V., 'In search of London', 396; 397, 398  
 MOSES, T., (see Fryer, C.W., *et al.*, Kammerling, R.C., *et al.*, Shigley, J.E., *et al.*)  
 MOSES, T.M., REINITZ, I., FRITSCH, E., SHIGLEY, J.E., Two treated-colour synthetic red diamonds seen in the trade, 190  
 MOUAWAD, F. (see Peretti, A., *et al.*)  
 Mozambique: Morrua emerald mines, 293  
 MUHLMEISTER, S., KOIVULA, J.I., KAMMERLING, R.C., SMITH, C.P., FRITSCH, E., Flux grown synthetic red and

- blue spinels from Russia, 210
- MULLIS, J. (see Asselborn, E., *et al.*)
- MUNISWAMIAH, M. (see Panjekar, J., *et al.*)
- MUNTYAN, B.L., 10 interessante Mineralien-fundstellen in Colorado, USA, 115
- MURTHY, D.S.N. (see Kumar, A., *et al.*)
- Museums:
- Barbican, London, 395, 397, 398
  - British, London, 395; 605
  - Diamantmuseum, Antwerp,
  - Fitzwilliam, Cambridge, 605
  - 'Gems', USSR, 429
  - Geologisk, Oslo, 379
  - Guildhall, London, 396, 513
  - Hessisches Landes Museum, Darmstadt, 609
  - Karlsruhe, Vienna, 113
  - Kremlin, Moscow, 609
  - Muséum National d'Histoire Naturelle, Paris, 117, 120
  - Natural History, London, 10
  - Palm Springs Desert Museum, 609
  - Pforzheim, Germany, 120
  - Smithsonian, Washington, 122
  - St Petersburg, Mining Museum, 429, 433, 437
  - San Bernardino Co., California, 433
  - Statens Historiska Museum, Stockholm, 609
  - Victoria and Albert, London, 395
- 'Muthu', Sri Lankan pearl, 338
- Myanmar:
- almandine, 7
  - amber, 35
  - diamond production, 33
  - gems: an update, 3; corrigenda, 130; deposits, 14; formation of primary ruby deposits, 12; geology, 11; history of mining, 4; list of gem minerals, 6; marketing, 36
  - Hsa-Taw, 516
  - inclusions in rubies and sapphires, characteristic, 24
  - jade, wax and polymer impregnated, 476
  - jadeite, 31, 269, 315
  - MGE (Myanma Gem Enterprises), 3
  - mineral deposits, 430
  - mineral resources, 12
  - mines and mining, 4, 14, 114
  - Mogok Stone Tract: mines and mining, 14, ruby find, 201, sapphire, 551
  - Mong Hsu ruby, 292, 321, 596
  - pearl: natural, 6; cultured, production, 33;
  - peridot, 32; 375
  - Pyaung Guang peridot, 375
  - ruby, 12, 24, 201, 292, 321
  - sapphire giants, 551
  - spessartine, 7, 34
  - spinel, 33
  - tectonic events, Cretaceous-Cenozoic, 115
  - tourmaline, green, 516
- MYCHALUK, K.A., The Yogo sapphire deposit, 596
- NAKAI, S., HALLIDAY, A.N., KESLER, S.E., JONES, H.D., KYLE, J.R., LANE, T.E., Rb-Sr dating of sphalerites from Mississippi Valley-type (MVT) ore deposits, 206
- NAKAYAMA, K. (see Arima, M., *et al.*)
- NAM, T.L. (see Keddy, R.J., *et al.*)
- Namibia:
- amethyst from Brandberg, 114
  - 'Hollandine' orange spessartine, 204
  - spessartine: from near Angola border, 202; 374; characteristics, 205
- Naming gem varieties, 292
- Nano-structures on polished diamond surfaces, 196
- NARNOV, G.A. (see Kazachenko, V.T., *et al.*)
- NASSAU, K., Gemstone enhancement: history, science and state of the art. 2nd ed, 295
- , letters to editor on diamond-filling glasses, 183, 283
  - , More on the antiquity of emerald oiling, 109
  - , Synthetic forsterite and synthetic peridot, 442
- NAVON, O. (see Schrauder, M., *et al.*)
- NAVROTSKY, A., Physics and chemistry of earth materials, 446
- NEKHANENKO, I.I. (see Skobel, L.S., *et al.*)
- Nelson, Dr J., Diploma Award winner, 59
- NELSON, J.B., The glass filling of diamonds Part 2: a possible filling process, 94, 183
- , letter to editor, 281
- Nepheline: Norway, 432
- Nephrite: (see Jade)
- Neptunite: 431
- NESENZEW, V., Die Russischen Diamanten, 425
- NEUBAUER, D., Olivinkristalle aus Hawaii, 115
- NEUROTH, N. (see Bach, H., *et al.*)
- NEVILLE, B. (see Linton, T., *et al.*; Shields, A., *et al.*)
- NEWMAN, R., The diamond ring buying guide, 122
- , The emerald and tanzanite buying guide, 606
  - , The pearl buying guide, 122
  - , The ruby and sapphire buying guide, 122
- New minerals, 206
- New Zealand: Maori jade, 447
- NICHOLAS, C.J., HENWOOD, A.E., SIMPSON, M., A new discovery of early Cretaceous (Wealden) amber from the Isle of Wight, 435
- NICHOLS, M.C. (see Anthony, J.W., *et al.*)
- NIEDERMAYER, G. (see also Asselborn, E., *et al.*; Brandstätter, F., *et al.*)
- , Almandin, 207
  - , Diffusions-behandelte Korunde, 115
  - , Doubletten und Tripletten, 294
  - , Edel- und Schmucksteine aus Österreich, 292
  - , Einschlusse-Phänomene im Quarz, 596
  - , Saphir, 115
  - , Synthetische, nach dem Schmelz-diffusionsverfahren hergestellte Smaragde, 294
  - , BRANDSTAETTER, F., HAMMER, V.M.F., Edel- und Schmucksteinvorkommen in Nepal, 206
  - , STEINER, A., Ein spektakulärer Fund von Rauchquarz und Morion aus der Wiesbachrinne im Habachtal, Land Salzburg, Österreich, 435
- NIXON, P.H. (see Boyd, F.R., *et al.*; Pearson, D.G., *et al.*)
- NMR (Nuclear Magnetic Resonance), 113
- NOHL, U. (see Enders, J., *et al.*)
- Norway:
- nepheline, 432
  - Stalaker, Sandefjord, 432
  - Setesdal Mineral Park, 294
- NOVAGA, M., La vesuviana di Bellecombe e Montjovet (AO) come materiale di interesse gemmologico, 115
- , Vesuvianite from Bellecombe and Montjovet (AO Italy): a material of gemmological interest, 173
- NOVGORODOVA, M.L., TRUBKIN, N.V., AKHMEDOV, M.A., SATVALDIEV, M.Kh., Inclusions of sodium fluoride and high alkali silicate glasses within a xenogenic diamond from granitoids, 191
- NWE, Y.Y., MORTEANI, G., Fluid evolution in the H<sub>2</sub>O-CH<sub>4</sub>-CO<sub>2</sub>-NaCl system during emerald mineralization at Gravelotte, Murchison Greenstone Belt, north-east Transvaal, South Africa, 207
- Obituaries:
- Asano, Yoshio, 216
  - Baird, Donald D., 125
  - Bennett, N. P. Jameson, 216
  - Boxall, William J., 611
  - Brohier, Kenneth N., 451
  - Buhl, Robert A., 451

- Hanslip, Malcolm (Mac) James, 378
- Jerwood, John M., 286
- Jones, Claude B., 523
- Loupekin, Prof. Igor S., 297
- MacLeod, Hector M., 125
- Meakin, Peter G., 125
- Parker, Claire E., 216
- Pitkanen, Mrs Marja L.A., 523
- Shaw, John R., 523
- Shipster, Thomas R., 451
- Wilkins, David, 297, 451
- Willmott, Keith Richard, 378
- Wilson, Douglas N., 523
- Obsidian: (*see* Glass:)
- O'DONOGHUE, M., Gemmology towards the 21st century, 116
- OFFERMANN, E. (*see* Torino, a., *et al.*)
- OH groups, structural in Myanmar rubies, 326, 327
- OKAY, A.L., Petrology of a diamond and coesite-bearing metamorphic terrain, Dabie Shan, China, 191
- Olivine: (*see also* Peridot)
- Hawaii, Mauna-Lani, 115
- Zabargad, 293
- OLLIVER, J.G., TOWNSEND, I.J., Gemstones in Australia: a review of the industry and the first Australian assessment of gemstone resources, 607
- Oman: rare opal varieties in Oman Mountains, 201
- Opal:
- Aztec, 438
- Australia: 212; Andamooka, 518; Lightning Ridge, 434; Queensland, boulder, 208
- Beltane, 434
- Canada: Vernon, British Columbia, 439
- cashalong in Oman mountains, 201
- dendritic, Lake Kariba, Zambia, 202, 277, properties, 279
- Dubnik area, 430
- harlequin pattern, 432
- history and geology, 434
- imitation: Japanese 'Opalite', 64
- opal-A, specific surface area and ultramicroporosity, 372
- opal-CT, specific surface area and ultramicroporosity, 372
- Peru, 518
- prasopal in Oman Mountains, 201
- publications, 602
- structural investigation, 429
- textures, nanometre scale, 434
- veins in serpentinite, 434
- 'Opalite', objection to use for Japanese imitation opal, 64
- Opaque minerals: colour, 53
- Oppenheimer dynasty, 445
- Optics, visual, Hodgkinson method, 294, 444
- Ore microscopy, petrography, 604
- O'REILLY, S.Y. (*see* Chen, Y.D., *et al.*; Guo, J., *et al.*)
- Origin determination, gemstones, 139
- OSIPOV, V.V. (*see* Solomonov, V.I., *et al.*)
- OTT, U. (*see* VERCHOVSKY, A.B., *et al.*)
- OTTAWAY, T.L., WICKS, F.J., BRYNDZIA, L.T., KYSER, T.K., SPOONER, E.T.C., Formation of the Muzo hydrothermal emerald deposit in Colombia, 435
- Otto corundum, 518
- PACCIORINI, M. (*see* Rovetti, A., *et al.*)
- PACESOVA, M. (*see* Bouska, V., *et al.*)
- PADMA KUMARI, V.M. (*see* Kumar, A., *et al.*)
- PAGEL-THIESEN, V., Diamond grading ABC, 213
- Painite: Myanmar, 7, 10
- Pakistan:
- aquamarine, 438
- gems in pegmatites, 118
- hambergite, 596
- minerals in, 596
- Northern Areas, Drot, 596
- North West Frontier Prov., Suppatt, 596
- peridot: new occurrence, 516, locality, 596; inclusion in, 594
- Skardu, green zoisite, 203
- Palaeomagnetism of Indian kimberlites and lamproites, 588
- PALYANOV, Y.N. (*see* Shigley, J.E., *et al.*)
- PANCHENKO, V.I. (*see* Koshil, I.M., *et al.*)
- PANJIKAR, J. (*see also* Ramchandran, K.T., *et al.*)
- , Comparative study of beryl from various Indian occurrences - beryl from Jammu and Kashmir, 207
- , Comparative study of beryl from various Indian occurrences - beryl from Jammu and Kashmir [continued from vol. 4. no. 1.], 292
- , Nature and cause of colour in Indian beryls, 374
- , Comparative study of beryl from various Indian occurrences: beryl from Rajasthan, 436
- , CHANDRASHEKHAR, H., MUNISWAMIAH, M., AHMED, N., A study of gem varieties of corundum from parts of Tumkur and Mysore Districts, Karnataka, 207, 436
- , RAMCHANDRAN, K.T., New developments in synthesis of gemstones, 294
- Papagoite: inclusions in rock crystal, Ajo, Arizona, 46
- PASTERIS, J.D. (*see* Pearson, D.G., *et al.*)
- PAULITSCH, P., Mineralogische Reise nach Pakistan, 596
- Pearls and shell:
- 'Ammolite' ammonite shell, 437
- black, 517
- book, 448
- buying guide, 122
- coloured from Hanoi, 204
- conch: Myanmar, 7
- cultured: Myanmar, 6, production, 33; Polynesia, 113; Tahiti, 515
- 'demi-pearls', 44
- encystation, 543
- flat, 431
- formation, 539
- fresh-water, in Bavaria and Bohemia, 515
- The Hope, described and analysed, 235
- Horse conch, 517
- instigation of formation, 539, 542
- Japanese golden, 203
- 'Mabe', 593
- medicinal use, 43
- Mediterranean, 200
- muthu, 338, 339
- Myanmar: conch, 7, cultured, 6, natural, 7, cultured production, 33
- myrobalan, 339
- paua, 523
- Pinctada fucata*; fluorescence analysis of nacre, 237
- P. margaritifera*, 113, 235; fluorescence analysis of nacre, 236, 237; formation and colour, 429
- P. maculata*, 113; fluorescence analysis of nacre, 237
- P. maxima*; fluorescence analysis of nacre, 237
- Pinna nobilis*, red, 200, 291
- Pleuroploca gigantea*, 517
- Peria penguin*; fluorescence analysis of nacre, 236, 237
- red, of *Pinna nobilis*, 200
- Polynesian, formation and colour, 429
- Sri Lanka: 337, ancient types, 338, failure, 346, status, 338, organization of pearling, 340
- structural and chemical investigations of salt- and fresh water, 241
- structure, 400
- Tarbinella rapa* shell, 337
- Vietnam, 204
- PEARSON, D.G. (*see also* Boyd, F.R., *et al.*)
- , BOYD, F.R., HAGGERTY, S.E., PASTERIS, J.D., FIELD, S.W., NIXON, P.H., POKHILENKO, N.P., The



- characterisation and origin of graphite in cratonic lithospheric mantle: a petrological carbon isotope and Raman spectroscopic study, 425
- , SNYDER, G.A., SHIRLEY, S.B., TAYLOR, L.A., SOBOLEV, N.V., Re-Os isotope evidence for a mid-Archaean age of diamondiferous eclogite xenoliths from the Udachnaya kimberlite, Siberia: constraints on eclogite petrogenesis and Archaean tectonics, 425
- PECKETT, A., The colours of opaque minerals, 53
- Pectolite: aragonite resembling, 203
- PEKOV, I.V., Remarkable finds of minerals of beryllium: from the Kola Peninsula to Primorie, 436
- PEKOVA, N.A., Eudialyte crystals from the Kola Peninsula, 596
- PELL, J., Kimberlites and diamond exploration in the Slave Structural Province, NWT, 425
- PEMADASA, T.G., DANAPALA, M.V., Heat treated corundums of Sri Lanka; their heat treatment, 518
- Peretti, A., Smith, C.P., letter to editor, infrared spectra of synthetic rubies, 61
- PERETTI, A., SCHMETZNER, K., HEINZ-JÜRGEN, B., MOUAWAD, F., Rubies from Mong Hsu, 596
- Periclase: synthetic, cathodoluminescence, 601
- Peridot:
- Afghanistan, 438
  - Myanmar: 6, mines, occurrences, 32, 'sleepy' green, 34
  - Pakistan: 438, new occurrence, 516, 517; inclusions in, 594; locality, 596
  - 'sleepy' green: Myanmar, 34
  - Vietnam: 355, characteristics, 356, 360, inclusions, 357
- Peridotites, possibly diamond-bearing, Tibet, 187
- Perovsky, Earl, biography, 437
- Peru:
- opals, 518
  - Puno, obsidian, 516
- Petalite: pegmatite, Brasil, 436
- Petroleum inclusion in quartz, New York, 85
- Petrology of a diamond and coesite-bearing terrain, China, 191
- PETROV, P. (see Kurchatov, V., et al.)
- PETROVA, M.A. (see Yekimova, T.Y., et al.)
- PETRUSSENKO, S.L., KOSTOV, R.I., Gem and decorative minerals of Bulgaria, 122
- Phase equilibria, diaspore-corundum, 331
- Phenakite:
- Myanmar, 7
  - Russian synthetic, 519
- Phlogopite: (see Micas)
- Physical properties: hessonite from Orissa, India, 75
- Physics and chemistry of earth materials, 446
- PIACENZA, B. (see Sosso, F., et al.)
- PIAT, D., BOUQUEAU, M.-P., En direct de Madagascar, 597
- PICKER, H., Granite International, 116
- PILLINGER, C.T. (see Boyd, S.R., et al.)
- PINEAU, F. (see Boyd, S.R., et al.)
- Pinctada maculata*, 113; fluorescence analysis of nacre, 237
- Pinctada margaritifera*, 113, 235; fluorescence analysis of nacre, 237
- PINET, M. (see also Schubnel, H.-J., et al.)
- , SMITH, D.C., La microspectrométrique Raman des grenats XYZ O II. La série alumineuse naturelle pyrope-almandin-spessartite, 436
  - , SMITH, D.C., LASNIER, B., La Microsonde Raman en Gemmologie, 54
- PISKUNOVA, L.F. (see Sapozhnikov, A.N., et al.)
- Pinna nobilis* red pearls, 200, 291
- PITMAN, L.C., HURLBUT, C.S., FRANCIS, C.A., Euhedral sinhalite crystals from Sri Lanka, 597
- Pliny, 109
- POKHILENKO, N.P. (see Griffin, W.L., et al.; Pearson, D.G., et al.; Shimizu, N., et al.)
- Polishing, measurement of surface finish, 209
- Polo, Marco, on Balas rubies, 257
- POLYAKOV, I.V., KALINKIN, M.M., Diamonds and associated minerals in kimberlites and loose sediments of Tersky shore, (Kola Peninsula), 192
- POLYAKOV, V.O., Notes on history of topaz and aeschynite finds in the Ilmeny mountains, 436
- Polynesia:
- pearls, 429
  - Tahiti cultured pearls, 515
  - Takapoto, 'Île des Perles', 113
- PONAHLO, J. (see also Bezborodov, A.M., et al.)
- , Catodoluminescencia (CL) y espectros de catodoluminescencia de diamantes sintéticos experimentales De Beers, 192, 440
  - , Kathodolumineszenz (KL) und KL-Spektren von Edelstein. (Ausgewachte Beispiele) Teil II, 208
  - , The cathodoluminescence of synthetic periclase, 601
- POPOVA, E.E. (see Devnina, N.N., et al.)
- POPOVA, N.P. (see Skobel, L.S., et al.)
- Porcelanite, landscape marble, 597
- PORWAL, B. (see Ramchandran, K.T., et al.)
- POST, J.E. (see Heaney, P.J., et al.)
- POSUKHOVA, T.V. (see Degtjareva, A. I., et al.)
- POW-FOON FAN, KO KO, Accreted terranes and mineral deposits of Myanmar, 430
- Presentation of Awards, 1994: 59; 1995, 380
- PREWITT, P.J., (see Heaney, J.P., et al.)
- Prinsep, James, on Spinnelle Ruby, 258
- Problems facing gemmologists, 116
- Pseudomorphism by silica, 444
- Preria penguin*: fluorescence analysis of nacre, 237
- PUGH, S.R. (see Richardson, S.H., et al.)
- PUTNIS, A. (see also Groat, L.A., et al.)
- , Introduction to mineral science, 446
- Pyroxenes:
- diopside: pale green, 34; infrared spectroscopy, 413, properties, 414
  - enstatite, Myanmar, 7
- Qin Bingsheng, Professor, 469
- Quartz: (see also Agate, Amethyst, Chalcedony, Citrine, Jasper)
- ametrine, 293, 515
  - Austria, Wiesbachrinne, Salzburg, 435
  - Bolivia: Anahi mine, 293; Santa Cruz, 515
  - crystal growing, 118
  - inclusions in, 594
  - Myanmar: amethyst, rock crystal, citrine, agate, chrysoprase, smoky, 7
  - oil, fluorescent, inclusion, 84
  - rock crystal: artefacts, 113; muscovite and rutile inclusions, Sri Lanka, 46; papagoite, ajoite inclusions, Ajo, Arizona, 46
  - skeletal, 434
  - smoky and morion, 435
  - solubility difference between chalcedony and, 201
  - structural disparities between chalcedony and, 432
  - Tiger's-eye, 433
  - Quasicrystals, 432
- QUÉMÈNEUR, J., LAGACHE, M., CORREIA, J.M., La pegmatite Urubu, Araçuaí, Minas Gerais (Brésil), exemple de pegmatite complexe à péralite: zonalité minéralogique et géochimie des micas et tourmaline, 436
- Radiation detectors, diamond, 290
- Radioactivity, inconsistencies in US regulations, 208
- Radiolucency of diamonds, 514
- Rainbow garnet, 198
- Raman spectroscopy:
- in gemmology, illustrations of spectra of gems, 54, 214
- RAMCHANDRAN, K.T. (see also Panjikar, J., et al.)
- , PANJIKAR, J., Unusual synthetic, 442

- , PORWAL, B., Famous diamonds, 192
- RAMSAY, R.R., EDWARDS, D., TAYLOR, W.R., ROCK, N.M.S., GRIFFIN, B.J., Compositions of garnet and spinel from Aries diamondiferous kimberlite pipe, central Kimberley block, Western Australia - implications for exploration, 588
- RAO, K.S. (see Chatterjee, A.K., et al.)
- RAWSON, J., Chinese jade from the Neolithic to the Qing, 607
- READ, P., Computer assisted gem identification, 375
- , The Peking diamonds. [A tale.] 608
- READ, P.G., Diamonds and De Beers, 426
- , An experimental optical Brewster-angle refractometer, 440
- , Dictionary of gemmology, 446
- REDMANN, M., (see Kanis, J., et al.; Milisenda, C.C., et al.)
- Refractometers, the declinometer for, 405; addendum, 530
- REINITZ, I. (see also Moses, T.M., et al.; Rooney, T., et al.; Shigley, J.E., et al.)
- , De Beers near colourless-to-blue experimental gem-quality synthetic diamonds, 192
- REJL, L., TUMA, A., Porcelanite - ein neuer Landschaftsmarmor aus Tschechien, 597
- Remondite-Ce: colour change, 203
- RENDELL, H.M., KHANLARY, M.-R., TOWNSEND, P.D., CALDERON, T., LUFF, B.J., Thermoluminescence spectra of minerals, 116
- REPETTO, S. (see Kammerling, R.C., et al.)
- Replacement by silica, 444
- RETTIGHIERI, M. (see Barot, N.R., et al.)
- 'Rhodiopaz' triplets, 210
- Rhodochrosite: Colorado, Sweet Home mine crystals, 596
- Rhodolite: 'Rhodiopaz' triplet, 210
- Rhodonite:
- synthetic, infrared spectra, 61, 62
- Yukon new occurrence, 517
- RICHARDSON, S.H., CANHAM, C.D., PUGH, S.R., Three generations of diamonds from old continental mantle, 371
- RIEDRICH, G. (see Seifert, T., et al.)
- RILEY, M., Jade treasures of the Maori, 447
- RINALDI, R. (see Artioli, G., et al.)
- RIZZI, F., WEISS, S., Grösster Apatitkristall aus einer Schweizer Zerrkluft, 116
- ROBARIK, E. (see Langer, K., et al.)
- ROBBINS, M., Fluorescence: gems and minerals under ultraviolet light, 296
- ROBERT, D., Gemmes irradiées et radioactivité, 116
- , Synthèse du rubis en phase gazeuze, 293
- ROBINSON, G.W., KING, V.T., What's new in minerals? 116
- ROBINSON, P.T. (see BAI, W.-J., et al.)
- ROCK, N.M.S. (see Ramsay, R.R., et al.)
- RODRIGUEZ, C.T. (see Cheillett, et al.)
- ROONEY, T., WELBOURN, C.M., SHIGLEY, J.E., FRITSCH, E., DeBeers near-colourless to blue experimental gem-quality synthetic diamonds, 192
- ROSE, G., Humboldt's travels in Siberia (1837-1842): the gemstones. Extracts and commentaries on Gustav Rose's Reise nach dem Ural, 1837-1842, 447
- Rose, Neil, Tully medallist, 380
- ROSE, T., The Coronation ceremony of the kings and queens of England and the crown jewels, 213
- ROSE, T.R. (see Wise, M.A., et al.)
- ROSENHAUER, M. (see Jacob, D.E., et al.)
- ROSS II, C.R. (see Wunder, B., et al.)
- ROSS, N.L. (see Hayward, C.L., et al.)
- ROSSMAN, G.R. (see Cho, H., et al.; Vasconcelos, P.M., et al.)
- ROUSE, C. (see Wright, D.N., et al.)
- ROVETTI, A., ROVETTI, R., PACCIORINI, M., Campolungo, Schweiz: Neufund der grössten korund-Kristalle der Alpen, 374
- ROVETTI, R. (see Rovetti, A., et al.)
- ROY, R. (see Messier, R., et al.)
- RUBIE, D.C. (see Wunder, B., et al.)
- Ruby: (see also Corundum)
- Afghanistan: a brief history, 256, Jagdalek, properties, 265
- 'Black Princes', 4
- Brazil, inclusion in diamond, 291
- buying guide, and sapphire, 122
- Cambodia mines, 112
- China: Yunnan, Heilongjiang, Qinghai, Sichuan, Xinjiang, 471
- discernment by ESR, 438
- gas phase synthesis, 293
- Germany, Seufzergründel, 208
- inclusion in diamond, 291
- infrared spectra, 321
- Myanmar: 6, corrigenda, 130, 201; formation of primary deposits, 12; mines and mining, 14, 114; Mong Hsu mine, 292, 321, 596
- synthetic (see Synthetic and simulated gems)
- Tanzania: in zoisite-amphibolite, 115; Mahenge, 204
- 'Timur', 4
- treated (see Treatment of gems)
- USSR. southern Urals, 593
- Vietnam, 112
- XRF spectra, 143
- RUDNICK, R.L. (see also Ireland, T.R., et al.)
- , ELDRIDGE, C.S., BULANOVA, G.P., Diamond growth history from *in situ* measurement of Pb and S isotopic compositions of sulfide inclusions, 192
- RUEDA, F. (see Giuliani, G., et al.)
- RUFFET, G. (see Cheillett, A., et al.)
- RUPASINGHE, M.S. (see also Dissanayake, C.B., et al.; Mendis, D.P.J., et al.)
- , RUPASINGHE, R.A.P., DISSANAYAKE, C.B., ILEPERUMA, O.A., A tentative classification of heat-treatable corundum (Geuda) stones, 207
- RUPASINGHE, R.A.P. (see Rupasinghe, M.S., et al.)
- Russia: (see USSR)
- RYABCHIKOV, I.D. (see Brey, G.P., et al.)
- RYAN, C.G. (see Griffin, W.L., et al.)
- RYKART, R., Zur Entstehung der sternförmigen Achate in sauren Vulkaniten, 597
- Sandstone tea-pot, tea stained, 203
- SANTOSH, M. (see Menon, R.D., et al.)
- SAPALSKI, C. (see Sarmiento, L., et al.)
- SAPIN, V.I. (see Kazachenko, V.T., et al.)
- SAPOZHNIKOV, A.N., IVANOV, V.G., LEVITSKY, V., PISKUNOVA, L.F., Structural-mineralogical peculiarities of lazurite from South-Western Pamirs, 207
- Sapphire: (see also Corundum)
- absorption spectra, 142
- Australia, Anakie district, 608
- Brazil, Indaia deposit, 291, 516
- buying guide, ruby and, 122
- characteristics, Kashmir, 431, 515
- China: Changle, Shandong, 201; Xinjiang, 371; Penglai, Hainan, 467, gemmology, 469, mining, 469, Fujian, 470, Heilongjiang, 471, Qinghai, 471, Shandong, 470, Xinjiang, 472
- engraved, 291
- Germany, Saxony, 208
- green star, 593
- India, Kashmir, 431, 515
- Madagascar: new occurrence, 518; Andranondambo, 597
- Myanmar: deposits review, 3, 6, corrigenda, 130; famous stones, 555, 558
- reddish-brown, 593
- Scotland, Lewis, 594
- spinel inclusion in Thai, 201
- Sri Lanka, characteristic inclusions in, 115
- Thai, spinel inclusion in, 201
- treated (see Treatment of gems)
- Vietnam mining update, 433

- USA: Rock Creek, Montana, heat treatment, 198; Yogo Gulch, Montana, 596
- USSR: southern Urals, 593
- SARIZ, K., ISIK, I., Meerschaum from Eskisehir Province, Turkey, 597
- SARJEANT, W.A.S. (see Ford, T.D., *et al.*)
- SARMA, S. (see Fernandes, S., *et al.*)
- SARMIENTO, L., SAPALSKI, C., Relación del grado de color de los diamantes con la banda absorcion N3 (415.5nm) y con su respuesta a la luz ultravioleta, 192
- SATVALDIEV, M.Kh. (see Novgorodova, M.I., *et al.*)
- Saxony: (see Germany)
- Scapolite:
- Myanmar, 7
- Pamirs, Kukurt deposit, 208
- Tanzania, Mpwapwe mine, 596
- SCARRATT, K. (see Kammerling, R.C., *et al.*)
- SCHÄFFER, W., 'Tsavorite', der grüne Grossular aus Kenya, 116
- Scheelite:
- Canada, check-list, 439
- detection in exploration gemmology, 159
- Schehab ed-din Abul Abbas Achmed, 109
- SCHELLHORN, S., Bitterfeld: Sächsischer Bernstein aus dem Braunkohlen-Tagebau, 117
- SCHLÜTER, J. (see Milisenda, C.C., *et al.*)
- SCHMETZER, K. (see also Hänni, H.A., *et al.*; Peretti, A., *et al.*)
- , Torrington emerald update, 293
- , BERNHARDT, H.-J., Isomorphous replacement of Al and Si in tetrahedral Be and Si sites of beryl from Torrington, NSW, Australia, 436
- , SCHUPP, F.-J., Dyed natural star corundum as a ruby imitation, 253
- , SMITH, C.P., BOSSHART, G., MEDENBACH, O., Twinning in Ramaura synthetic rubies, 87, corrigenda, 226
- SCHNEIDER, B. (see Henn, U., *et al.*)
- SCHODER, K. (see Henn, U., *et al.*)
- SCHOLLER, W.L., Images of the Anakie sapphire fields, Queensland, 608
- SCHRAUDER, M., KOEBERL, M., Trace element analysis of fluid-bearing fibrous diamonds from Jwaneng (Botswana) by neutron activation analysis, 426
- , NAVON, O., Solid carbon dioxide in a natural diamond, 117, 371
- , NAVON, O., Hydrous and carbonatitic mantle fluids in fibrous diamonds from Jwaneng, Botswana, 426
- , NAVON, O., SZAFRANSEK, D., KAMINSKY, F.V., GALIMOV, E.M., Fluids in Yakutian and Indian diamonds, 426
- SCHREYER, W. (see Wunder, B., *et al.*)
- SCHUBNEL, H.-J. (see also Fronlich, F., *et al.*)
- , Les collections de synthèses anciennes du Muséum National d'Histoire Naturelle, 117
- , PINET, M., SMITH, D.C., LASNIER, B., La microsonde Raman en gemmologie, 214
- SCHUPP, F.-J. (see Schmetzer, F.-J., *et al.*)
- SCHWARZ, D. (see also Collyer, T., *et al.*)
- , Emeralds from the Mananjary Region, Madagascar: internal features, 374
- SCIUSA, E., (see Bedogné, F., *et al.*)
- SCIUTO, P.F., On the presence of OH groups in Zabargad olivine gems, 293
- Scotland:
- Lewis, 594
- sapphire, 594
- SCOTT SMITH, B.H., Contrasting kimberlites and lamproites, 193
- SCOVIL, J., WEISE, C., Tucson 1995: Neues, Neues Altes, Altes, 598
- SCOVIL, J.A., What's new in minerals? 375
- SEAL, M. (see Van Enckevort, W.J.P., *et al.*)
- SECCO, R.A. (see Dien, Li, *et al.*)
- SECHOS, B., Fracture filled diamonds, 514
- SEIFERT, F. (see Wunder, B., *et al.*)
- SEIFERT, T., RIEDRICH, G., Die Achate im Melaphyr von Gröppendorf bei Hubertusberg in Sachsen, 117
- SEGALL, B. (see Lambrecht, W.R.L., *et al.*)
- SELMEIER, A. (see Dernbach, U., *et al.*)
- SEM: nacre and pearls, 245, 246
- Sepiolite: Turkey, meerschaum, 597
- Serpentine: Bulgaria, Rhodope Mts, 434
- SHATSKIY, V.S. (see also Vavilov, M.A., *et al.*)
- , SOBOLEV, N.V., ZAYACHOVSKIY, A.A., ZORIN, Y.M., VAVILOV, M.A., A new find of microscopic diamonds in metamorphic rocks: evidence that the high-pressure metamorphism in the Kokchetav massif was regional in scope, 371
- SHATSKIY, V.S. (see Langer, K., *et al.*)
- Shell: (see Pearls and shell)
- SHEN, J.J. (see Lee, T., *et al.*)
- Sheppard, Francis, The Treasury of London's past, 396
- SHERRIFF, B.L. (see also Zhi Xu, *et al.*)
- , GRUNDY, H.D., HARTMAN, J.S., HAWTHORNE, F.C., CERNY, P., The incorporation of alkalis in beryl: multinuclear MAS NMR and crystal-structure study, 375
- SHIELDS, A. (see also Linton, T., *et al.*)
- , NEVILLE, B., ROS/GEM Optics Model RFA 322 Refractometer; an instrument evaluation, 600
- SHIGLEY, J.E., (see also Ashbough, C.E., III, *et al.*; Fritsch, E., *et al.*; Kane, R.C., *et al.*; Liu, Y., *et al.*; Moses, T.M., *et al.*; Rooney, T., *et al.*; Taggart, J.E., *et al.*)
- , FRITSCH, E., REINITZ, I., Two near-colourless General Electric type-IIA synthetic diamond crystals, 193
- , FRITSCH, E., KOIVULA, J.I., SOBOLEV, N.V., MALINOVSKY, I.Y., PALYANOV, Y.N., The gemmological properties of Russian gem-quality synthetic yellow diamonds, 193
- , KAMMERLING, R.C., MOSES, T.M., GIA evaluates progress in color detection technology, 600
- SHIMITZU, N., BOYD, F.R., SOBOLEV, N.V., POKHILENKO, N.P., Chemical zoning of garnets in peridotites and diamonds, 426
- SHING, Y.H., *et al.*, Dependence of the cathodoluminescence of diamond films on deposition temperatures, 194
- SHIRLEY, S.B. (see Pearson, D.G., *et al.*)
- SHKODZINSKII, V.S., BESKROVANOVA, V.V., Kimberlite magma evolution and diamond genesis, 194
- Shortite: Canada, check-list, 439
- SHUBENTSOVA, E.S. (see Voronkova, V.I., *et al.*)
- SiC in meteorites, 421
- Silica:
- physical behaviour, geochemistry and applications, 444
- polymorphs, specific surface area and ultramicroporosity in, 372
- pseudomorphism and replacement, 444
- structural investigation, 429
- Silicate crystal chemistry, 120
- Silicon Age, The, exhibition, Paris, 120
- Sillimanite:
- cat's-eye, Orissa, 433
- infrared: spectroscopy, 413; properties, 414
- Myanmar, 7
- SIMAKOV, S.K., BAGDASAROV, E.A., LUKJANOVA, L.I., Mineralogical and petrological features of alkali-ultramafic lamprophyres and kimberlites of Kola Peninsula, 588
- SIMPSON, M. (see Nicholas, C.J., *et al.*)
- Simulated gems: (see also Synthetic gems)
- andalusite: quartz, 601
- beryllium oxides and silicates, 210
- cat's-eye: (see Fibre-optic glass below)
- ceramic 'carving', 516
- citrine, 'Lazerite' glass, 519
- emerald: 'Swarogreen' imitation, 441, 519, examination, 601

- fibre-optic glass: 'Cathaystone', 433; 'Catseyte', 433; 'Fibre Eye', 433
- GGG, 601
- jade: Vietnam, glass imitation, 203
- Lazerite glass, 519
- 'Minkovite', 601
- opal: holographic images, 210; interesting imitation, 601; 'Opalite', objection to name for Japanese imitation opal, 64
- peridot, 'Lazerite' glass, 519
- 'Rhodiopapaz' triplet, 210
- ruby: dyed star corundum, 251
- 'Swarogreen' imitation emerald, 441, 519, examination, 601
- tanzanite, 'Lazerite' glass, 519
- tourmaline, 'Lazerite' glass, 519
- turquoise, seen in Egypt, 203
- YAG, crystallization, 294
- YAP, 601
- zirconia, cubic, 376
- Sinhalese:
  - Myanmar, 7
  - Sri Lanka, euhedral, 597
  - structure and crystal chemistry, 432
- Sinkankas, Dr J., 109
- SINKANKAS, J. (see also Miller, A.M., et al.)
- , Jades of North America, 375
- SIRAKIAN, D., Gemmes en lumière, 117
- SKOBEL, L.S., NEKHANENKO, I.I., POPOVA, N.P., Axinitfunde in der Lagerstätte Puiva, Polarural, 117
- SKOKOV, S. (see Franklach, M., et al.)
- SKTB, Smolensk, 424
- Slovakia:
  - Carpathians, Malé Karpaty Mountains, garnets, 599
- Smaragd, 109
- SMITH, B., SMITH, C., Martin Leo Hermann, 1904-1972, 437
- SMITH, C. (see Smith, B., et al.)
- SMITH, C.B., CLARK, T.C., BARTON, E.S., BRISTOW, J.W., Emplacement ages of kimberlite occurrences in the Prieska region, southwest border of the Kaapvaal craton, South Africa, 426
- SMITH, C.P., (see also Muhlmeister, S., et al.; Peretti, A., et al.; Schmetzer, K., et al.)
- , A contribution to understanding the infrared spectra of rubies from Mong Hsu, Myanmar, 321
- SMITH, D.C. (see Pinet, M., et al.; Schubnel, H.-J., et al.)
- SMITH, M.E. (see Ford, T.D., et al.)
- Smithsonite:
  - green, 596
  - USA, 79 Mine, Arizona, 596
- Snuff bottles, Chinese, 605
- SNYDER, G.A. (see also Pearson, D.G., et al.; Sobolev, V.N., et al.)
- , JERDE, E.A., TAYLOR, L.A., HALLIDAY, A.N., SOBOLEV, V.N., SOBOLEV, N.V., Nd and Sr isotopes from diamondiferous eclogites, Udachnaya Kimberlite pipe, Yakutia, Siberia: evidence of differentiation in the early Earth? 194
- SOBOLEV, N.V. (see Finnie, K.S., et al.; Griffin, W.L., et al.; Jerde, E.A., et al.; Langer, K., et al.; Pearson, D.G., et al.; Shatskiy, V.S., et al.; Shimitzu, N., et al.; Snyder, G.A., et al.; Sobolev, V.N., et al.; Vavilov, M.A., et al.)
- SOBOLEV, V.N. (see also Jerde, E.A., et al.; Shigley, J.E., et al.; Snyder, G.A., et al.)
- , TAYLOR, L.A., SNYDER, G.A., SOBOLEV, N.V., Diamondiferous eclogites from the Udachnaya kimberlite pipe, Yakutia, 426
- Sodalite:
  - Canada, check-list, 439
  - hackmanite from Canada, 113
- SOLOMONOV, V.I., MIKHAILOV, S.G., OSIPOV, V.V., AVDONIN, V.N., VASILEVSKAYA, M.F., YASHKIN, V.I., The pulse cathodoluminescence of corundums, 598
- Solubility difference between quartz and chalcedony, 201
- SOSSO, F., Some observations on gem-quality synthetic yellow diamond produced in the region of Vladimir (Russia), 363
- , PIACENZA, B., Russian hydrothermal synthetic emeralds: characterization of the inclusions, 501
- South Africa:
  - ages of emplacement of kimberlites, 426
  - Bamingui diamond project, 587
  - diamond production, 1993, 514
  - dumortierite-quartz beads, 203
  - emerald mineralisation, 207
  - Finsch and Monastery kimberlites, 115
  - Kaapvaal craton, 426
  - Kalahari minerals, 599
  - minerals, general survey, 115
  - sugilite, 430, 437
  - tiger's-eye quartz, 433
  - Transvaal, Gravelotte, Murchison Greenstone Belt, 207
  - Wessels mine, 430, 437
- Southern Africa: harzburgites and their relation to diamond crystallisation, 187
- SOUZA, J.L., MENDES, J.C., BELLO, R.M.S., SVISERO, D.P., VALARELLI, J.V., Petrographic and microthermometric studies of emeralds in the 'Garimpo' of Capoeirana, Nova Era, Minas Gerais State, Brazil, 117
- Specific gravity, hydrostatic measurement, 161, 285
- Specific surface area (SSA) in silica polymorphs, 372
- Spectrophotometry in gemmology, 439
- Spectroscopy in origin determination of gemstones, 139
- Spectroscopy, absorption: sapphire, 142
- Spectroscopy, cathodoluminescence:
  - De Beers experimental diamonds, 192
  - diamond, dependence on deposition temperature, 194
  - identification of natural and synthetic diamonds, 190
  - natural and synthetic coloured stones, 208, 209
- Spectroscopy, fluorescence emission:
  - Hope pearl, 237, 239
- Spectroscopy, infrared:
  - diamond, Russian yellow synthetic, 366
  - diopside, 413
  - jade, wax and polymer impregnated, 477, 478, 479, 480, 481
  - kornepurine, 413
  - microscope, method and applications, 411
  - nephrite, structural changes shown, 291
  - ruby, from Myanmar, 321, 323, 324, 327; synthetic: flux grown, 61; hydrothermally grown, 62
  - sillimanite, 413
- Spectroscopy, Raman:
  - garnets, aluminian, 436
  - in gemmology, illustrations of spectra of gems, 54
- Spectroscopy, reflection: Hope pearl, 237, 239
- Spectroscopy, thermoluminescence: spectra of minerals, 116
- Spessartine: (see Garnet)
- SPETSIUS, Z. (see Ireland, T.R., et al.)
- SPETSIUS, Z.V., A diamond-bearing xenolith of garnet peridotite from the 'Mir' kimberlite pipe, 195
- Sphalerite: Rb-Sr dating, 206
- Sphene:
  - Austria, Bergum, 113
  - Chrome-, green, 516
  - Myanmar, 7
  - USSR, Perm region, Saranay deposits, 516
- Spinel:
  - Afghanistan, a brief history of rubies and, 256
  - anisotropy, a polishing effect, 440
  - Australia, Aries kimberlite, compositions, 588
  - 'Black Prince's ruby', 4; 259
  - blue, Co-free, 594
  - confusion of dendritic stain with flux, 593
  - Marco Polo on Balas ruby, 257

- Myanmar, 6, 33, 34
- Russian synthetic, 210
- ‘Timur Ruby’, in English Crown Jewels, 4
- Spodumene: Myanmar, 7
- SPOONER, E.T.C. (see Ottaway, T.L., *et al.*)
- Sri Lanka:
  - Balangoda, 597
  - corundum, heat treatment, 518
  - garnet, of low RI, 117
  - gem deposits: A prospector’s guide map, 198; mining, 203; exploration for residual, 206
  - hornblende, green-brown, 202
  - Kayalpatinam, 343
  - moonstone, smoky, 179
  - pearls: 337; organization of industry, 340
  - rock crystal with muscovite inclusions, 46
  - sapphire, characteristic inclusions in, 115
  - sinhalite, 597
- STÄHL, K. (see Artioli, G., *et al.*)
- Stain, tea, in sandstone tea-pot, 203
- STALDER, H.A., AUFDENBLATTEN, M., Granatfund aus dem Täschal bei Zermatt (VS), 598
- STANEK, J., Lepidolith ind Heliodor aus Rozna’ in Westmähren/CR, 293
- STATHER, M., The origin, formation and emplacement of diamonds, 427
- STEINER, A. (see Niedermayr, G., *et al.*)
- Stishovite: structure, 430
- STOIBER, R.E., S.A. MORSE, Crystal identification with the polarizing microscope, 448
- Stone catalogue of Cloudy Forest, 467
- ‘Stony Jack’, 397, 513
- STOPPA, C. (see Cuif, J-P., *et al.*)
- STRONG, H.M. (see Bovenkerk, H.P., *et al.*)
- STRUNZ, H. (see Asselborn, E., *et al.*)
- STURMAN, N. (see Bubshait, A., *et al.*)
- Sturman, N.P.G., letter to editor, treated amber, 369
- Succinite (see Amber)
- Sugilite:
  - manganoan, South Africa, 430, chemical composition and structural formula, 437
- SUMMERS, W. (see Gere, C., *et al.*)
- SUNAGAWA, I. (see also Lu, T., *et al.*, Taijing, L., *et al.*)
  - , Basic concept for the identification of natural and synthetic diamonds, 195
  - , The distinction of natural from synthetic diamonds, 485
- SUNKARA, M. (see Lambrecht, W.R.L., *et al.*)
- Sunstone: gift to GAGT, 379
- SUPERCHI, M., DONINI, A., L’analisi merceologia del diamante, 427
- SURY, E., Mineralien richtig reinigen, 54
  - , Wie der Schein doch trügen: Edelsteine aus Glas und Klebstoff, 117
- SUTHERLAND, D.G., The diamond deposits of the Mandala Basin, SE Guinea, West Africa, 195
- SUTHERLAND, F.L. (see Coenraads, R.R., *et al.*)
- Sverdlov, Alexei V., biography, 430
- SVIRINA, E.S., Earl Perovsky (1792-1856) and his beryl collection in the Mining Museum, 437
- SVISERO, D.P. (see Souza, J.L., *et al.*)
- ‘Swarogreen’ emerald imitation, 441, 519
- Swarovski, 519
- Switzerland:
  - Alpine minerals, 119
  - apatite, 116
  - corundum, 374
  - Dora-Maira massif, 432
  - fluorite, pink, 437, 599
  - garnet, 598
  - nephrite in, 372
- Ticino: Basidino glacier beryl, 293; Campolungo corundum, 374; Naret area apatite, 116; Poncione di Maniò, 437
- Uri, Planggenstock, 599
- Valais, Zermatt, 598
- Symposia (see Conferences)
- Synthetic gemstones: (see also Simulated Gems)
  - 210
  - alexandrite, 441
  - Chatham flux-grown pink sapphires, 149
  - corundum, emerald colour, 401 (see also Ruby and Sapphire below)
  - crystal pulling from the melt, 121
  - cutting styles, 114
  - diamond: cathodoluminescence identification, 190, of De Beer’s, 192, 440, dependant on deposition temperature, 194; characterization of gas phase synthesized, 189; De Beers colourless-to-blue, 192; detection of natural from, 485; General Electric type-IIA, 193; Russian, gemmological properties, 193, 363; growth history from Pb and S isotopic measurements, 192; high pressure synthesis, 212; identification, 195; impurities in large, 189; from kimberlite melt, 376; luminescence, 365; monodite cutting tool, 209; morphology, 495; nucleation, by hydrogenation of graphitic precursors, 190, and growth, 294; radiolucency of, 514; Russian yellow, 363, colourless, 441; spectroscopic characteristics of Koss fancy diamonds, 189; synthesis, errors in, 112; thin film growth mechanisms, 188; treated-colour red diamond, 190;
  - emerald: AGEE, 441; Chinese, 519; identification by NMR, 113; flux-melt synthesis, 294; ‘Kimberley Created’, 519; overgrowth on colorless beryl, 441; Russian, characterization of inclusions, 501
  - forsterite, 442
  - Myanmar, 7
  - new developments, 294
  - oxide crystal flux growth and properties, 210
  - opal: Chinese and Russian, 518, 519; Gilson, 441
  - periclae cathodoluminescence, 601
  - peridot, 442
  - phenacite, 519 (see also Simulated gems, YAP)
  - quartz crystal growing, 118
  - radiolucency of diamonds, 514
  - Ramaura rubies, twinning in, 87, corrigenda, 226
  - review of, 117
  - ruby: (see also Corundum above, Sapphire below), Chatham, 376; Douros, 202, 376; gas phase synthesis, 293; glass in, 43, filling, 402; infrared spectra, 61, 62; lead content, 601; microscopic features, 441; Ramaura rubies, twinning in, 87; Russian, identified by dendritic flux inclusions, 202; twinning in Ramaura, 87;
  - sapphire: (see also Corundum above, Ruby above), Chatham flux-grown pink, 149; 376; colour zoned, 517; fluorescence of pink, 593; fraudulent use, 294; greenish-yellow, 441
  - spinel, Russian, 210, characteristics, 441
  - syntheses, early, 117
  - topaz, 442
  - zincite, ‘serendipitous’, 563, properties, 564
- SZAFRANSEK, D. (see Schrauder, M., *et al.*)
- SZYMANSKI, A., Story of the ‘Cross of Asia’ fancy yellow radiant cut diamond, 589
- TABRAHAM, C.J. (see Burnett, C.J., *et al.*)
- TAGGART, J.E., FOORD, E.E., SHIGLEY, J.E., Chemical composition and structural formula of manganoan sugilite from the Wessels Mine, Republic of South Africa, 437
- TAIJING, L., SUNAGAWA, I., Texture formation of agate in geode, 598
- TAINTON, K.M., MCKENZIE, D., The generation of kimberlites, lamproites and their source rocks, 589
- Taurus, synthetic gem producers, 519
- Taiwan:
  - coral dating, 204

- TAKAHASHI, K. (*see* Kagi, H., *et al.*)  
 TAN, K.H. (*see* Dien, Li, *et al.*)  
 TAN, K.L. (*see* Tan, T.L., *et al.*)  
 TAN, T.L., TAY, T.S., LOH, F.C., TAN, K.L., TANG, S.M.,  
 Identification of bleached wax- and polymer-impregnated  
 jadeite by X-ray photoelectron spectroscopy, 475  
 TANG, S.M. (*see* Tan, T.L., *et al.*)  
 Tanzania:  
 —cat's-eye, 569  
 —diamond leases, Kahama/Shinyanga, 587  
 —Lelatema Hills grossular, 198  
 —Mahenge ruby, 204  
 —Mpwapwe mine, Morogoro, 596  
 —ruby in zoisite-amphibolite, 115  
 Tanzanite: 'wagon wheel', 433  
 Tavernier, Jean Baptiste, 236  
 TAY, T.S. (*see* Tan, T.L., *et al.*)  
 TAYLOR, A., Exploration gemmology, 155  
 TAYLOR, L.A. (*see* Jerde, E.A., *et al.*; Pearson, D.G., *et al.*;  
 Snyder, G.A., *et al.*; Sobolev, V.N., *et al.*)  
 TAYLOR, W.R. (*see* Ramsay, R.R., *et al.*)  
 Tea stain in sandstone tea-pot, 203  
 Techyars Industries Ltd., 519  
 Tektite:  
 —moldavite: Czechoslovakia, inclusions in, 415; Thailand, inclu-  
 sions in, 415; refractive indices, 418  
 TEIXEIRA, N.A. (*see* Gonzaga, G.M., *et al.*)  
 Tenorite: inclusion in cuprian elbaite, 428  
 Thailand:  
 —Bo Ploi, spinel inclusion in sapphire, 201  
 —Chanthaburi gem province, unusual xenolith, 590  
 —tektite, inclusions in, 415  
 THALHAMMER, L., Achatähnlicher Kalkstein aus Nieder-  
 österreich, 599  
 Thao Tsung-I, 467  
 THEMELIS, T., Heat treating sapphires from the Anakie  
 District, Australia, 599  
 Thermoluminescence spectra of minerals, 116  
 Thermometric studies, of Brazilian emeralds, 117  
 THOMAS, A., The emerald mines of Madagascar, 118  
 —, Moçambique emerald, 293  
 —, The Luanda diamond fields [Part 1], 589  
 THOMAS, A.G. (*see* Watling, R.J., *et al.*)  
 Tibet: diamond-bearing peridotites, 187  
 Tiffany, Louis Comfort, The jewelry and enamels of, 122  
 Tillander, H., 397  
 TILLANDER, H., Diamond cuts in historic jewellery 1381-  
 1910, 608  
 Titanite: (*see* Sphene)  
 TOLUZAKOVA, A.V. (*see* Chaykin, V.G., *et al.*)  
 Topaz:  
 —colour and causes of treated, 202  
 —lepidolite inclusion in, 431  
 —mineralogy, geology and occurrence, 595  
 —Myanmar: 7, pale brownish pink, 34  
 —'Ocean Green', 197  
 —pink, Utah, 591  
 —reactor irradiated, green, 197  
 —'rhodiopaz' triplet, 210  
 —Russia, history of finds, 436  
 —symposium 1995, 600  
 —treated (*see* Treatment of gems)  
 TORINO, A., OFFERMANN, E., Cristalli di fluorite rosa dal  
 Poncione di Manio, Val Bedretto, (TI), 437  
 Tourmaline:  
 —elbaite: cuprian, Brazil, 428; California, Himalaya Mine, 596;  
 Maine, USA, 375; Mn-bearing, 428  
 —group, book, 522  
 —Myanmar: 7; Hsa-Taw, 516  
 —Saxony, 118  
 —structural changes during heating, 427  
 —'Testa Nera', Italy, Elba, 203  
 —vanadian-chromian from Russia, 114  
 TOWNSEND, I.J. (*see* Olliver, J.G., *et al.*)  
 TOWNSEND, P.D. (*see* Rendell, H.M., *et al.*)  
 Treatment of gems:  
 —corundum: diffusion, review, 115; update, 205; heat-treatable,  
 classification, 207; heat treatment, 518  
 —diamond: enhancement, 370; glass filling, 94, recognition of  
 filled, 202, identification and durability, 423, letters to editor  
 281, 283, 369; reactor irradiation and heat treatment, 195  
 —emerald: Opticon treated, 94; oiling, antiquity of, 109, appara-  
 tus, 204; fracture filling, 433, 514  
 —enhancement, science and state of art, 295  
 —irradiation, and radio-activity problems, 116; of quartz, 438  
 —jade, identification of wax and polymer impregnated, 475  
 —jadeite: value enhanced, 112; coated, 517  
 —nephrite, dyed, 593  
 —quartz, irradiated, 438  
 —ruby: glass filling, 42, 43, 402; Myanmar, 331  
 —sapphire: Australian, 599; Chinese, heat, 469; diffusion induced  
 colour, 593; Montana, heated, 198; diffusion, identification, 203;  
 fraudulent use, 294; unstable colour change in irradiated, 203  
 —topaz: reactor irradiated green, 197; review of colour and its  
 causes, 202  
 —turquoise: oiling, 109, polymer treated rough, 517  
 Tremolite: Myanmar, 7  
 Tridymite:  $\alpha$ -, specific surface area (SSA) and ultramicroporosity  
 (UMP), 372  
 Triphylite: Brazil, 202  
 Triplite: Brazil, 202  
 TROUP, G.J. (*see* Hutton, D.R., *et al.*)  
 TRUBKIN, N.V. (*see* Novgorodova, M.I., *et al.*)  
 TSCHERNICH, R.W., Zeolites of the world, 520  
 Tu Wan, Stone catalogue of Cloudy Forest, 467  
 Tugtupite: NMR study, 600  
 TUMA, A. (*see* Rejl, L., *et al.*)  
 Turkey:  
 —Aydin-Mugla region, diaspore, 596  
 —Eskischir meerschaum, 597  
 Turquoise:  
 —oiling, 109  
 —rough, polymer treated, 517  
 —treated (*see* Treatment of gems)  
 Twinning in Ramaura synthetic rubies, 87  
 UHER, P., CHOVAN, M., MAJZIAN, J., Vanadian-chromian  
 garnet in mafic pyroclastic rocks of the Malé Karpaty  
 Mountains, western Carpathians, Slovakia, 599  
 U HLA WIN (*see* Hughes, R.W., *et al.*)  
 Ultramicroporosity (UMP) in silica polymorphs, 372  
 UMEDA, I., IIDA, K., Reactor irradiation and heat treatment  
 examinations on diamonds, 195  
 USA:  
 —Appalachian Mts diamonds, 587  
 —Arizona: Ajo. rock crystal with papagoite and ajoite inclusions,  
 46; zebra stone, 594; smithsonite, 79 Mine, 596  
 —California: Beltane opal texture, 434; J.O. Crystal Co. synthetic  
 rubies, 87; green fluorite, 433; Himalaya Mine elbaite, 596; San  
 Bernardino Co. museum, 433  
 —Carolina: Big Crab Tree Mine, emeralds, 204; hiddenite, 375  
 —Colorado: aquamarines, Chaffee County, 212; 10 gem locali-  
 ties, 115; gold, 122; Sweet Home mine rhodochrosite, 596  
 —gem production, 517  
 —Hawaii: Mauna-Lani, near gem olivine, 115; Kilauea melt  
 inclusions, 427  
 —Maine: mineralogy of Bennett pegmatite, 293, elbaite, 375  
 —Mississippi Valley-type ore deposits, sphalerite dating, 206  
 —Montana, Yogo Gulch sapphires, 596  
 —New York, Herkimer, oil inclusion in quartz, 85

- Utah: roadside geology, 119; Wah Wah Mts, Beaver County, red beryl, 375, 596; Juab County, pink topaz, 591
- USSR:
- Anabar river alluvial diamonds, 289
- Caucasus jet, 349
- Chita Oblast, dravite, 375
- Crimean jet, 349
- danburite, 434
- diamond sales 1993-4, 514
- diamond sources, 422; 425
- Gems Museum, 429
- Humboldt's travels in Siberia, 447
- Ilmeny Mts, topaz, 436
- Kamchatka jet, 349
- Kazakhstan: garnet in diamondiferous metamorphic rocks, 434; Kokchetav Massif, 434; micas in diamond-bearing metamorphic rocks, 196; nitrogen aggregation in diamonds, 585; radiogenic and noble gases in crustal diamonds, 196
- Kirghisia: cinnabar inclusion in baryte, 46
- Kokchetav massif, diamonds in, 371
- Kola Peninsula: astrophyllite inclusions in quartz, 202; beryllium minerals, 436; diamonds and associated minerals, 192; eudialyte, 597; Kandalaksha graben, 588; lamprophyres and kimberlites, 588
- malachite, 432
- Pamirs, gem scapolite from Kukurt deposit, 208
- Perm region: Sarany chrome deposits, 516, green sphene, 516
- Primor'ye: vanadian-chromian tourmaline and vanadian muscovite, 114; Dal'Negorsk boron deposit, 434
- St Petersburg Mining Museum, 429, 433
- Sakhalin jet, 349
- Siberia: diamond formation, 113, 114; sapropelitic coal - jet, 349, characteristics, 350, chemistry and petrography, 351, terminology, 349; distribution of minerals, 430; Indigirka River, 434; kimberlite, dating, 422, carbon-isotope composition, 422; Udachnaya, kimberlite pipe, diamonds in 187, eclogite xenoliths, 425, diamondiferous eclogites, 426, Nd and Sr isotopes in eclogite, 194, diamondiferous, 423;
- spinel, synthetic, 210
- Twenty Third Soviet Communist Party Congress pipe, diamond, 188
- SKTB Kristall, Smolensk, 424
- Ukraine: artefacts, 115; Volodarsk beryl, 596
- Urals: axinite from Puiva, 117, 433; Kootchinskoye area, 593; mineralogical guide, southern, 430, middle to polar, 430; ruby and sapphire, 593
- Vladimir synthetic diamonds, 363
- Yakutia, kimberlite pipe, 187, 194
- U Thu Daw, interview, 553
- UYEDA, C., Magnetic field-induced rotation of diamagnetic gem crystals, 209
- VAINSHTEIN, B.K., Fundamentals of crystals, 296
- Values, gem, Standard catalog, 606
- VALVALARELLI, J.V., (see Souza, J.L., *et al.*)
- VANDERVELDE, R., Ammolite, an organic gemstone from Alberta, 437
- VAN DOORSELAER, H.D. (see Vochten, R.F., *et al.*)
- VAN ENCKEVORT, W.J.P., COUTO, M.S., SEAL, M., Nanostructures on polished diamond surfaces, 196
- VAN PRAAGH, G., Growing crystals of quartz, 118
- VASCONCELOS, P.M., WENK, H., ROSSMAN, G.R., The Anahí Ametrine Mine, Bolivia, 293
- VASILEVSKAYA, M.F. (see Solomonov, V.I., *et al.*)
- VASILISHIN, I.S. (see Koshil, I.M., *et al.*)
- VAUGHAN, D.J. (see Craig, J.R., *et al.*)
- VAVILOV, M.A. (see also Shatskiy, V.S., *et al.*)
- , SOBOLEV, N.V., SHATSKIY, V.S., Micas in diamond-bearing metamorphic rocks of northern Kazakhstan, 196
- VAVRA, N., Chemical characterization of fossil resins ('amber') - a critical review of methods, problems and possibilities: determination of mineral species, botanical sources and geographical attribution, 437
- VEBLEN, D.R. (see Gislason, S.R., *et al.*, Harlow, G.E., *et al.*; Heaney, P.J., *et al.*)
- Venezuela: diamonds and their sources, 371
- VERCHOVSKY, A.B., OTT, U., BEGEMANN, F., Implanted radiogenic and other noble gases in crustal diamonds from northern Kazakhstan, 196
- Vesuvianite:
- Austria, Bergum, 113
- Italy, Aosta, gem quality, 115, 173
- Myanmar, 7
- symmetry of, 591
- VICKERS, M. (see Henig, M., *et al.*)
- Vietnam:
- 428
- garnets, almandine, 517
- Ho Tay lake, Hanoi, coloured pearls, 204
- imitation jade examination, 203
- Luc Yen sapphire/ruby increased production, 203
- peridot, 355
- ruby: 112; myth or reality, 112; 203; and sapphire mining update, 433
- VIGASINA, M.F., Dynamics of the crystal lattice of lonsdaleite, 196
- VIKAMSEY, I., Great Mogul: the largest diamond found in India, 427
- Villiaumite: Canada, check-list, 438
- VICHIT, P. (see Coenraads, R.R., *et al.*)
- Vlasovite: Canada, check-list, 439
- VOCHTEN, R.F., VAN DOORSELAER, M.D., DILLEN, H., Fluorite from Seiles, Andenne, Belgium: coloration, fluorescence, and a remarkable crystal geometric discoloration phenomenon, 375
- VODOLASKAYA, I.V. (see Voronkova, V.I., *et al.*)
- VOILLOT, P., Der wilde Weg zu den Aquamarinern, 437
- VON ARX, F., Die grosse Kluft am Planggenstock, UR, 599
- VON BEZING, L., GUTZNER, J., Das Kalahari-Manganerzfeld und seine Mineralien. 1, 599
- VON HABSBERG, G., LOPATO, M., Fabergé: imperial jeweler, 214
- Von Humbolt, Alexander, Expedition to Russia, 429
- VORONKOVA, V.I., YANOVSKII, V.K., VODOLASKAYA, I.V., SHUBENTSOVA, E.S., Flux growth and properties of oxide crystals, 210
- VOYNICK, S., Colorado gold, 122
- Vuillet à Ciles, P., Anderson Bank Prize winner, 59
- WAGENKNECHT, F., Saphir vom Seufzergründel in Sachsen, 208
- WAKATSUKI, M., Nucleation and growth of diamond, 294
- WAKISHIMA, O., A discernment of ruby by ESR, 438
- WALMESLEY, J.C., LANG, A.R., Large <110>-segmented helical dislocations in natural diamond, 196
- WANG, A., DHAMELINCOURT, P., MEYER, H.O.A., GUO, L., ZHANG, A., A carbon-rich inclusion in a Chinese diamond and its geochemical implications, 427
- WANG, CHUNYUN, Essence and nomenclature of jade: a problem revisited, 438
- WANG, F. (see Guo, J., *et al.*)
- , LIU, Y., Garnets from Altay, China, 208
- WANG, L. (see Abdukader, P., *et al.*)
- WANG, P. (see Banerjee, A., *et al.*)
- WANG, W. (see Langer, K., *et al.*)
- WARD, F., Diamonds, 122
- , Emeralds, 54
- , Gem care, 448
- , Pearls, 448
- WATERMEYER, B., MICHELSEN, S.S., The art of diamond

- cutting, 449
- WATLING, R.J., HERBERT, H.K., BARLOW, I.S., THOMAS, A.G., Analysis of diamonds and indicator minerals for diamond exploration by laser ablation inductively coupled plasma mass spectrometry, 590
- WATT, G.R., HARRIS, J.W., HARTE, B., BOYD, S.R., A high-chromium corundum (ruby) inclusion in diamond from the Sao Luiz alluvial mine, Brazil, 291
- WEBER, I.S., *Kostbare Steine: die Gemmensammlung des Kurfürsten Johann Wilhelm von der Pfalz*, 54
- WEBSTER, R., *Gems, their sources, descriptions and identification*. 5th ed, 521
- WEERTH, A., *Lapis-Lazuli, die unendliche Geschichte*, 438
- , *Milurit und Danburit aus Südtirol*, 118
- , *Neuheiten aus Asiens Schatzkammer*, 11
- Weight of round brilliant cut by calculation, 208
- WEINER, B. (see Franklach, M., et al.)
- Weisbrod Chinese Art Ltd, A private collection of early Chinese jade carvings 28 November to 9 December 1994, 609
- WEISE, C., *Jade, Juwel des Himmels*, 54
- , *Synthetische Amethyststufen und bestrahlter 'Rauchquarz'*, 438
- WEISS, S. (see also Asselborn, E., et al., Rizzi, F., et al., Scovil, J., et al.)
- , *Schörl, Rubellit und Mohrenköpfe aus Sachsen*, 118
- , *Blauer Klufitberyll aus der Südschweiz*, 293
- WELBOURN, C.M. (see Rooney, T., et al.)
- WELLER, M., WERT, CH., *The fossil hydrocarbon jet*, 438
- WEN GUANG, JING ZHICHUM, Chinese neolithic jade: a preliminary study of archaeological geology, 438
- WENK, H. (see Vasconcelos, P.M., et al.)
- WENTORF, R.H., Jr. (see Bovenkerk, H.P., et al.)
- WERT, CH. (see Weller, M., et al.)
- West Indies: Grand Cayman Island, 517
- Wheeler, Sir Mortimer, 395, 398, 400
- WHITE, J.S., *The Smithsonian treasury: minerals and gems, 122*
- , *Der Sonnengott der Azteken. Die Opale der Neuen Welt: ein Überblick*, 438
- WICKS, F.J. (see Ottaway, T.L., et al.)
- WIGHT, Q., *The complete book of micromounting*, 54
- WIGHT, W., *Check-list for rare gemstones: carletonite*, 438
- , *Check-list for rare gemstones: dolomite*, 439
- , *Check-list for rare gemstones: eudialyte*, 439
- , *Check-list for rare gemstones: scheelite*, 439
- , *Check-list for rare gemstones: shorrite*, 439
- , *Check-list for rare gemstones: sodalite*, 439
- , *Check-list for rare gemstones: villiaumite*, 438
- , *Check-list for rare gemstones: vlasovite*, 439
- Wilson, Deborah, Anderson medallist, 380
- WILSON, W.E., *The history of mineral collecting, 1530-1799, with notes on twelve hundred early mineral collectors*, 520
- WIN HTEIN, AYE MYO NAING, *Mineral and chemical compositions of jadeite jade of Myanmar*, 269
- , *AYE MYO NAING, Studies on kosmochlor, jadeite and associated minerals in jade of Myanmar*, 315
- WIN, T.T. (see Griffin, W.L., et al.)
- WISE, M.A., ROSE, T.R., HOLDEN, R.E., Jr, *Mineralogy of the Bennett pegmatite, Oxford County, Maine*, 293
- WISE, R.W., *Queensland boulder opal*, 208
- WON-SA KIM, *Nephrite from Chuncheon, Korea*, 547
- WOOD, B.J., *Carbon in the core*, 197
- Wood, silicified, 372
- WOODCOCK, J.T., HAMILTON, J.K., eds, *Australasian mining and metallurgy: the Sir Maurice Mawby memorial volume (second edition: in two volumes)*, 449
- WOODIN, R.L. (see Butler, J.E., et al.)
- WRIGHT, D.N., ROUSE, C., *Stone polishing - measurement of surface finish*, 209
- WUNDER, B., RUBIE, D.C., ROSS II, C.R., MEDENBACH, O., SEIFERT, F., SCHREYER, W., *Synthesis, stability, and properties of Al<sub>2</sub>SiO<sub>4</sub>(OH)<sub>2</sub>: a fully hydrated analogue of topaz*, 442
- X-radiography: Hope pearl, 238
- X-ray diffraction:
- kosmochlor in jade, 319
- jadeite, 319
- olivine from Zabargad, 293
- pearls and nacre, 247
- X-ray fluorescence analysis:
- Hope pearl, 237, 238
- ruby spectra, 143
- X-ray photoelectron spectroscopy:
- jade, wax and polymer impregnated, 479, 480, 481, 482, 483
- X-ray topography: diamonds, 440
- YAGOUTS, E. (see Bezborodov, A.M., et al.)
- YAKOUMBELOS, G. (see Guo, J., et al.)
- YAMAOKA, S. (see Arima, M., et al.)
- YANG, B.X. (see Dien, Li, et al.)
- YANOVSKII, V.K. (see Voronkova, V.I., et al.)
- YASHKIN, V.I. (see Solomonov, V.I., et al.)
- YEFIMOVA, E.S. (see Griffin, W.L., et al.)
- YEKIMOVA, T.Y., LAVROVA, L.D., PETROVA, M.A., *Diamond inclusions in the rock-forming minerals of metamorphic rocks*, 371
- YORKE-HARDY, R.W., *Okanagan opal*, 439
- YOSHIDA, M. (see Menon, R.D., et al.)
- Zaire: Muji Mayi: O determination in diamonds, 115; zircon inclusion in diamond dated, 424
- Zambia: Lake Kariba dendritic opal, 202, 277
- ZANAZZI, P.F. (see Artioli, G., et al.)
- ZANG, J. J., *Neue Grossulare aus Dionboko/Mali*, 439
- ZAPATA, J., *The jewelry and enamels of Louis Comfort Tiffany*, 123
- ZARUDNEVA, N.V. (see Fefelov, S.I., et al.)
- ZAYACHOVSKIY, A.A. (see Shatskiy, V.S., et al.)
- ZAYAKINA, N.V. (see Bulonava, G.P., et al.)
- Zebra stone:
- Arizona, 594
- Australia, 433
- ZECCHINI, P. (see Astric, B., et al.; Astric, B., et al.; Aurisicchio, C., et al.)
- ZENZ, J., *Ontario - Amethyst Country*, 599
- Zeolite:
- of the world, 520
- ZHANG, A. (see Wang, A., et al.)
- ZHANG BEILI (see Gao Yan, et al.)
- Zhang Changde, 469
- ZHANG, X (see Lu, T., et al.)
- ZHI XU, SHERRIFF, B.L., <sup>23</sup>Na<sup>27</sup>Al<sup>9</sup>Be<sup>29</sup>Si solid state NMR study of tugtupite, 600
- ZHOU, M.-F. (see Bai, W.-J., et al.)
- Zimbabwe: River Ranch diamond mine, 424
- ZIMMERMAN, J.-L. (see Giuliani, G., et al.)
- Zincite: synthetic, 563
- ZINNER, E. (see Anders, E., et al.)
- Zircon:
- Austria, Bergum, 113
- aventurescent, 203
- Myanmar, 7
- Zaire, dating, 423
- Zoisite: green from Pakistan, 203
- ZOLOTAREV, A.A., *Gem scapolite from the Eastern Pamirs and some general constitutional features of scapolites*, 208
- ZORIN, Y.M. (see Shatskiy, V.S., et al.)
- Zwieselite: inclusion in beryl, Bavaria, 46
- ZYPRIAN, H., *Mikro-Achate aus Ost-Thüringen*, 293



Everything for those with an interest in  
**GEMMOLOGY**

Whether you are connected with the jewellery and allied trades  
or because the beauty and fascination of gemstones fire your imagination,  
you are invited to apply for membership

## Association activities

### Events

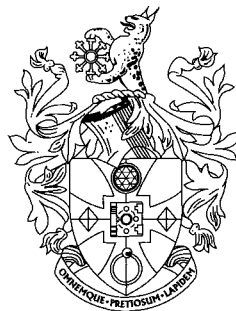
A full programme of lectures and social events is arranged for members

### Publications

Members receive quarterly *The Journal of Gemmology* and *Gem and Jewellery News*

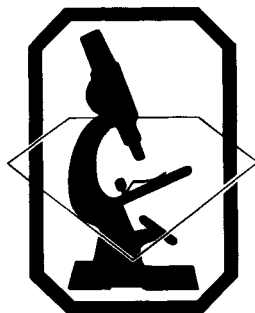
### Education

Gemmology courses - Diamond courses - workshops - travelling tutorials



## Gemmological books and instruments for sale

Members receive discounts on books and instruments



### Diamonds

We grade all sizes of diamond and issue London and CIBJO Diamond Reports

### Gems

We can identify and report on all kinds of gems – whether natural, treated or synthetic

### Pearls

Using direct radiography, X-ray diffraction and optical techniques we distinguish between natural, cultured and imitation pearls.

## Laboratory services

**Gemmological Association and Gem Testing Laboratory of Great Britain**  
27 Greville Street (Saffron Hill entrance) London EC1N 8SU

Telephone: +44 (0)171-404 3334

Fax: +44 (0)171-404 8843

Copyright © 1995  
The Gemmological Association and Gem Testing Laboratory of Great Britain  
Registered Office: Palladium House, 1-4 Argyll Street, London W1V 2LD

**ISSN: 1355-4565**

**Produced and printed by Stephen Austin, Hertford, England.**