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IN THIS ISSUE

SCORODITE — A New Gemstone From Tsumeb, South-West Africa

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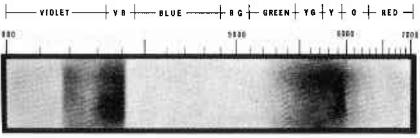
Editor's Note

In the Spring 1963 issue of *Gems & Gemology*, we described the properties of blue scorodite from Tsumeb, South West Africa, including a spectrum which is included in the excerpt below:

We usually report identifications of unusual gem materials that come into the Laboratory, either for those who might be asked to identify them by an avid collector or for collectors who wish to catalog the new items that have been cut. However, by no stretch of the imagination could the mineral scorodite be considered a potential gem material, as far as durability or availability are concerned. In its usual forms, scorodite would have no interest to anyone as a gemstone, but from the prolific rare-mineral locality at Tsumeb, South-West Africa, very attractive blue scorodite has been found. Its refractive indices have been recorded at 1.74 up to 1.92, although the birefringence is usually on the order of .03. It is a hydrated iron arsenate, usually occurring in what mineralogists describe as leek green to liver brown, but that from Tsumeb is blue with reddish overtones. It has a hardness only of approximately 4 and it is soluble in hydrochloric acid, so it is not very durable. Its particularly interesting property is its very strong pleochroism, showing violetish blue (X), greenish blue (Y) and bright red (Z). The one we tested had indices of approximately 1.78, extending to over the scale, with a specific gravity of 3.218.



Scorodite spectrum.

Approximately two years ago one of the rarest minerals – jeremejevite – was presented to gemologists in gemstone quality for the first time. The mineral has been known since February 25, 1869, when P. W. Jeremejew submitted some samples of beryl-like minerals to the Russian Mineralogical Society in Petersburg. It was not until

105 years later that the first specimens of gem quality were found at Cape Cross near Swakopmund in South West Africa (R. Liddicoat, 1974 and H. Strunz, 1974). Now an analogous event has occurred when the author recently acquired four cut samples of gem quality Scorodite which originated from Tsumeb in South West Africa. The cut gems appeared comparable to dark blue "Tanzanite" exhibiting a similarly strong dichroism and consequently at first conjectures went hitherward. Yet, detailed and careful examination revealed them to be the gem varieties of another of the rarest minerals in the world which, however, has been known since the early years of the 19th century and was named by J. F. A. Breithaupt. The name is derived from the Greek word "skórodon" = garlic, because the mineral gives off a garlic-like smell before the blowpipe.

Scorodite is a ferric arsenate hydrate ($Fe^{3+} [AsO_4] \cdot 2H_2O$) which belongs to the clinovariscite series in the hydrous group of the phosphate, arsenate and vanadate class. Chemically pure scorodite marks the iron-rich end of an isomorphous series along which the ferric iron is gradually replaced by trivalent aluminum causing scorodite to change into mansfieldite ($Al^{3+} [AsO_4] \cdot 2H_2O$). Small amounts of $[AsO_4]$ in scorodite may be substituted by $[PO_4]$, i.e., scorodite may be interspersed by molecules of strengite ($Fe^{3+} [PO_4] \cdot 2H_2O$). These manifold possibilities of substitution in varying amounts are liable to be responsible for the multiple hues and tones with which scorodite occurs.

Crystallographic Data

Scorodite crystallizes in the orthorhombic system developing prismatic $\{100\}$, dipyramidal $\{111\}$ or tabular $\{001\}$ habits. It belongs to the space group Pcab. The class designation is: 2/m 2/m 2/m and at the lattice constants are $a_0 = 10.28$, $b_0 = 10.00$, $c_0 = 8.91$ resulting in the axial ratio of a:b:c = 1.028 : 1 : 0.890, Z = 8 (H. Strunz, 1970). The crystals which rarely occur singly are usually small, yet occasionally they may reach sizes of 20 to 25 mm. The tabular samples appear often to be pseudohexagonal *(Figure 1)*.

Quite often the tiny crystals combine into forming the inner crusts of geodes, irregular clusters, botryoidal aggregates with fibrous texture or massive, cryptocrystalline, porous or sinter-like agglomerations or even earthy frostings. Cleavage is imperfect after $\{201\}$; the fracture is splintery and the toughness is quite good.

The hardness is way below practical gemstone hardness, with 3½ to 4 only.

The calculated x-ray density was found to be 3.31 while experimentally an average specific gravity of 3.29 was determined.

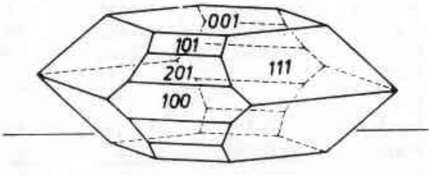


Figure 1. Tabular crystal habit of scorodite showing the forms: c = $\{001\}$, a = $\{100\}$, n = $\{101\}$, p = $\{111\}$, and d = $\{201\}$

Chemical Composition

The chemical analysis of the new material from Tsumeb was carried out on two tiny, optically pure slabs cut from a crystal of gem quality. The wet-chemical identification of the powder was considered to be the most appropriate analyzing method. When heated to temperatures between 220° and 250°C, scorodite loses its entire water content. Unfortunately, the material was not sufficient in quantity as to allow a complete analysis on one single piece and consequently it was not possible to achieve the highest degree of accuracy desired. However, the equivalent figures are exact. In *Table I* the weight percentages obtained in the present work are compared with representative chemical analyses of scorodite from other sources.

The new scorodite from Tsumeb (with only little aluminum and even less phosphorous) shows close chemical resemblance to the crystals originating from Durango (Mexico) and Bhilwara (India), that is to say they are all almost pure iron-arsenic rich end-members of the isomorphous scorodite-mansfieldite series.

X-ray Data

For the measuring of the d-values a Gandolfi-camera (Fe $K\alpha$–radiation) was used. The results agree quite well with the ASTM card-index file. The standard index file adopted the values published in a paper by Dasgupta *et al.* (1966), and the d-values are compared in *Table II.* The slight diversity of the d-values is probably based on slightly different chemical compositions (the Indian material was also not completely pure).

In spite of the minute discrepancies between the d-data of a given lattice net-plane they demonstrate unambiguously that the crystal structure of the new gem material is that of scorodite.

Optical Properties

The varigation of colors laid out on the scorodite's palette is quite remarkable and ranges from almost colorless via greyish green to leek-green, yellow and brown, as well as from bluish via

Table I. Chemical Composition of Scorodite

Source:	Analysis I 1) Durango	Analysis II 1) Idaho	Analysis III 1) Oregon	Analysis IV 2) India	Analysis V Tsumeb	Equivalents
Fe_2O_3	34.79	34.02	25.72	34.80	31.5	39.4
Al_2O_3	–	traces	5.76	0.20	1.8	3.5
As_2O_3	49.52	44.40	48.88	44.53	49.5	43.0
P_2O_5	–	4.80	1.72	0.04	0.1	
SiO_2	–	–	–	5.58	–	
S	–	–	–	0.31	–	
H_2O	15.44	17.33	17.04	13.80	14.5	
Rest	0.38	0.32	1.00			
Total	100.13	100.87	100.12	99.26	97.4	

1) Ref. 2
2) Ref. 3

Table II. Powder Data for Scorodite

Scorodite from India⁽¹⁾			Scorodite from Tsumeb⁽²⁾	
I	d-values	hkl	d-values	Int.
vs	5.654 Å	111	5.63 Å	80
vvw	* 5.210	200	—	—
m	5.050	020	5.00	50
vvs	4.495	002	4.49	100
m	4.110	211	4.10	30
m	3.821	112	3.81	30
vvw	3.353	221/022	3.36	10
vs	3.195	122	3.18	70
s	3.074	311	3.06	60
s	3.013	131	3.00	50
vvw	2.769	113	2.756	10
m	2.695	032	2.691	50
s	2.601	400	2.587	60
m	2.511	040	2.503	40
w	2.324	331	2.319	20
vvw	* 2.266	303	—	—
vvw	2.245	004	2.238	10
vvw	2.190	412	2.187	10
vvw	* 2.145	114	—	—
vvw	* 2.118	332	—	—
vvw	2.050	233	2.057	10
vvw	2.011		2.011	20
vvw	1.954	("The high angle lines were not indexed because of the large number of possible indices")	1.955	10
vvw	* 1.871		—	—
vvw	1.846		1.846	10
vvw	* 1.833		—	—
vvw	1.805		1.800	5
vvw	1.760		1.759	5
a_0 = 10.36 Å; b_0 = 10.05 Å; c_0 = 8.98 Å			a_0 = 10.35 Å; b_0 = 10.04 Å; c_0 = 8.97 Å	

(1) Dasgupta *et al.* (1966)
(2) present investigation
* lines too faint in present work for exact determination.

blue to violet whilst the pronounced trichroism must be considered according to the direction of observation. The trichroic colors with an absorption of $z > x, y$ are strongly violet–blue–blue-green (i.e., very similar to those of heated "tanzanite"). Refractive indices, birefringence and axial angles 2V change due to constitutional share in terms of quantity of the cations (Fe^{3+}) and (Al^{3+}) as well as the anions $[AsO_4]$ and $[PO_4]$ yielding differing values (see *Figure 2).*

A confrontation of the optical data in *Table III* of scorodites from the

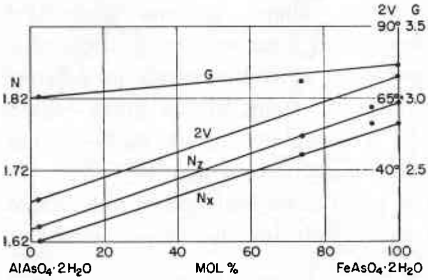


Figure 2. Diagram exhibiting the linear increase of R.I., birefringence, 2V, and density as As^{3+} in mansfieldite is gradually substituted by Fe^{3+} in scorodite (Ref. 10).

Table III. Representative Optical Data of Scorodite

Source:	Analysis I[1] (Durango)	Analysis II[1] (Idaho)	Analysis III[1] (Oregon)	Analysis IV[2] (India)	Analysis V[3] (Tsumeb)	
nα	1.784	1.738	1.741	1.784	1.785	1.785
nβ	1.795	1.742	1.744	–	1.796	1.795
nγ	1.814	1.765	1.768	1.805	1.812	1.816
Δ	+0.030	+0.027	+0.027	0.021	0.027	+0.031
2V	75°	60°	40°	65°	75°	75°

1) Ref. 2
2) Ref. 3
3) Own readings

same localities with those presented in *Table II* renders evident their dependence upon their chemical composition.

A comparison of these optical data with the chemical analyses elucidated that the refractive power, birefringence and axial angle diminish with decreasing proportion of (Fe^{3+}) and (Al^{3+}) and increasing substitution of $[AsO_4]$ by $[PO_4]$. The same observation also applies to the specific gravity. In addition, the above survey of the optical constants reveals that the optical character of scorodite is positive. The dispersion is $r > v$. The lustre may be resinous but usually it varies from vitreous to adamantine; for the medium value of its reflection coefficient $R\left(\frac{n-1}{n+1}\right)^2$ works out to be 0.079 (diamond = 0.172).

While there are no individual absorption lines present in the visible spectrum scorodite excels in a broad absorption band in the green region and a complete cut off at ∿450 nm for the section of shorter waves. On the other hand there exists remarkable transmission for the longer waves at the red end.

Microscope Examination

Viewed under the microscope all the specimens displayed a combination of inclusions very typical of crystals which experienced conspicuous growth vagaries, for they were not only interspersed by parallel arrays of hair fine fibres but also permeated by numerous liquid feathers *(Figure 3)* intersecting each other and patterned by dense concentrations of fluid droplets or hoses *(Figure 4)*. On the whole these liquid feathers were strongly reminiscent of the partially healed fractures in sapphires from Sri Lanka. Dry cracks criss-crossing one another were also abundant and added to the wispy appearance of the interior *(Figure 5)*. No discrete guest crystals could be observed but some loosely scattered tiny clods of irregular shape and of reddish to brownish black color seemed to constitute the only solid internal paragenesis. Where they happened to be flush with the surface of a polished facet they reflected a strongly metallic, silvery lustre. One such exposed spot was subjected to the electron beam of a microprobe analyzing apparatus and yielded highly informative results. First the analysis disclosed that these dark, minute lumps consisted of a multi-mineralic composition comprising at least three phases:

1) Cu and S responding for the mineral chalcocite (Cu_2S)

2) Fe indicating either hematite (α - Fe_2O_3) or goethite [α - FeO (OH)]

3) A1 corresponding with some A1-oxihydrate *(Figure 6).*

These minerals forming complex solid inclusions in the scorodite from Tsumeb fit very well into the mineral parageneses of the cementation zone of Tsumeb. By "cementation" one of the rock forming phases of the sedimentary cycle is understood and this refers to the diagenetic process by which coarse clastic sediments become lithified or consolidated into hard, compact rocks through the deposition or chemical precipitation of mineral

Figure 3. Liquid feathers interspersed with cleavage and tension cracks impairing the transparency of a facetted scorodite. 32x.

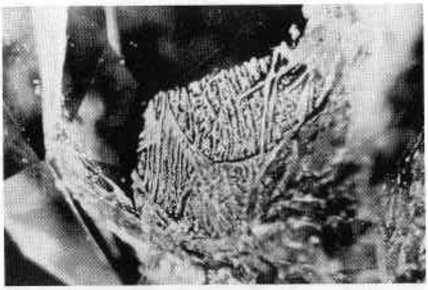


Figure 4. Section of a partially healed fracture producing a striking pattern. 32x.

Figure 5. Numerous liquid feathers in undulant arrangement betraying significant disturbances during growth. 20x.

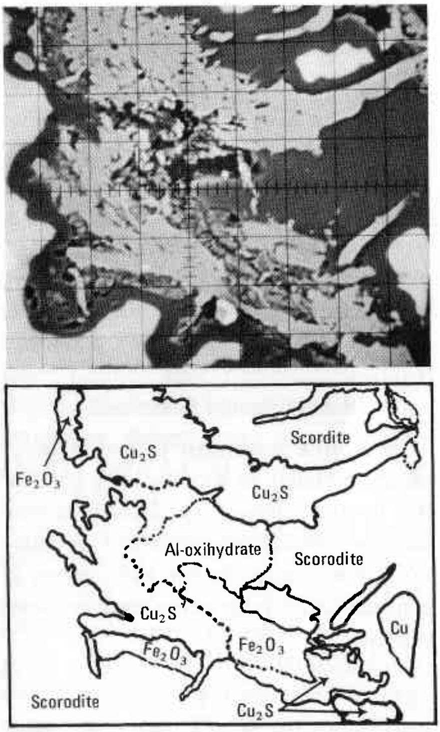


Figure 6. EMP-reflectogram of one of the reddish/brown-black clods of multimineralic ores which mark the scorodites from Tsumeb. The chemical formulae indicate the irregular distribution of the various ores.

material that occurs in voids among the individual grains of a consolidated sedimentary rock, thereby cementing the grains together as a rigid, coherent mass. The cementation zone is usually underlying the oxidation zone.

Occurrence

Scorodite is of SECONDARY origin, i.e., a characteristic product of weathering, which preferably forms in quartz due to the oxidation of arsenic-containing minerals, e.g., such as arsenopyrite, and it is found in paragenesis with beudantite, chalcedony, clay, gypsum, limonite, vivianite and others.

It occurs in numerous places all over the world. The specimens examined by the author came from Tsumeb in South West Africa, where recently a few large single crystals (up to the length of 25 mm) and some magnificent groups of smaller and larger crystals in druse-like geodes were found. These crystals originated in the second zone of oxidation or in contact with the cementation zone.

Scorodite as a Gemstone

Scorodite will most probably only be appreciated as a collector's gem in the future, because its hardness is too low for jewelry purposes and in addition, it is much too rare as to secure a commercially interesting and reliable supply.

Acknowledgement

The author wishes to express his thanks and appreciation to Pala Properties International, Inc., Fallbrook, California for supplying the scorodite described. Also, deep appreciation to Prof. M. Weibel and Dr. W. Oberholzer of the Institute of Crystallography and Petrology, Zurich, for their chemical analyses, examination with the Gandolfi camera and valuable comments. Without their generous cooperation this paper would not have been achievable.

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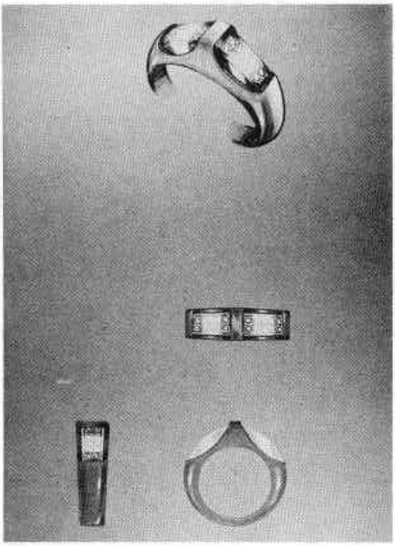
Schuetz Design Contest Winner Announced



The 1976 winner of the annual George A. Schuetz Memorial Fund Jewelry Design Contest is Miss Midori Aoshima, who is employed as a jewelry designer by J. Osawa & Co., Tokyo, Japan.

The contest, established in memory of George A. Schuetz, Sr., former president of Larter & Sons of Newark, New Jersey, is administered by the GIA. Anyone who wishes to enter may do so. Forty entries were submitted in the 1976 competition.

The annual award covers items of men's jewelry only, and entries are to be in the form of renderings or wax models (photographs or actual pieces cannot be accepted). Designs must be original and cannot have been previously exhibited publicly or offered for sale. Each entry is judged on the basis of beauty and originality of the design, feasibility of wear, manufacturability, and effective use of materials. The winner is awarded $300 to be used for any jewelry-related training at an institution of his or her choice.

Members of the 1976 Panel of Judges were Miss Lilyan Collard, jewelry designer for Donavan & Seamans Co., Los Angeles; Mrs. Mary Barr, Charles Barr Jewelers, Newport Beach, California; Gary Murray, The Hardwear Store, Ltd., Los Angeles; and Dr. Robert Gaal of the GIA Staff in Los Angeles.

Miss Aoshima's design for a man's ring, as illustrated, is an 18K yellow-gold shank cut away to reveal two 14K white-gold arcs set with twenty half-point diamonds. We congratulate her on an outstanding design and exceptional rendering. The award committee also wishes to thank all the other contestants for submitting entries.

Information on the 1977 Schuetz Design Contest will be available from GIA, Santa Monica, in the Fall.

Developments and Highlights at **GIA**'s Lab in Los Angeles

By RICHARD T. LIDDICOAT, JR.

Rarely Used Gem Materials Seen Recently

Shortly after the last *Gems & Gemology* went to press, we received our second jeremejevite, a 0.20 ct. round. We also had an occasion to identify an eosphorite weighing 3.73 cts. The jeremejevite resembled an aquamarine; eosphorite resembles topaz slightly in color. Another material which was supposed to be synthetic powellite turned out to be synthetic scheelite.

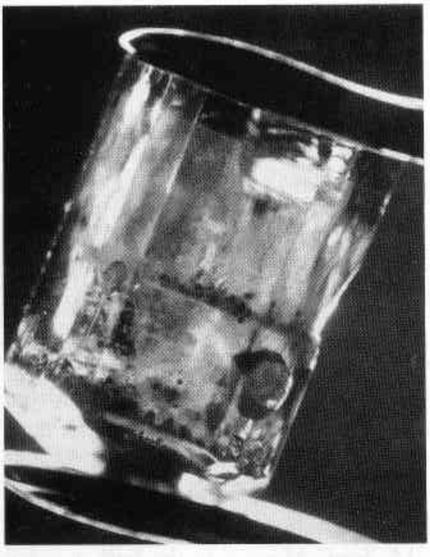


Figure 1.

We had a white cabochon in for identification. The refractive indices were taken by the spot method and although the reading appeared to be about 1.60, Chuck Fryer found that there was birefringence of about 0.03 and he determined the indices to be 1.59 - 1.62. The specific gravity was about 2.8 and the material was attacked slightly by hydrochloric acid, but did not effervesce. Mr. Fryer decided that it was probably pectolite, but scraped a tiny bit from the back of the opaque cabochon and ran an X-ray powder diffraction on it. The pattern proved that he had been right, that it was a pectolite.

We also identified a brown stone as sinhalite. It was in an old bracelet.

Another Synthetic Emerald

Recently, the Headquarters Laboratory in Los Angeles received a crystal and a cut stone of what is described as a new synthetic emerald. The attractive material had all of the characteris-

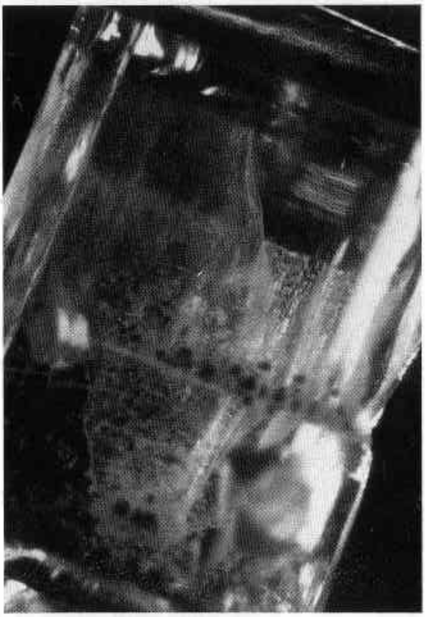


Figure 2.

tics of a flux-grown product, including veillike inclusions, many flux inclusions, medium red fluorescence and low property values; all typical of a flux-grown synthetic emerald. The refractive index was 1.560 - 1.565 ± 0.001, birefringence 0.005-0.006 and the specific gravity 2.65 - 2.66. *Figure 1* is a photomicrograph of the crystal, taken at about 10x. In *Figure 2,* we see some flux inclusions typical of the USTAN synthetic emerald. There was a layer of large phenakite crystals: a very large one extended beyond the surface of the crystal and is seen in *Figure 3.*

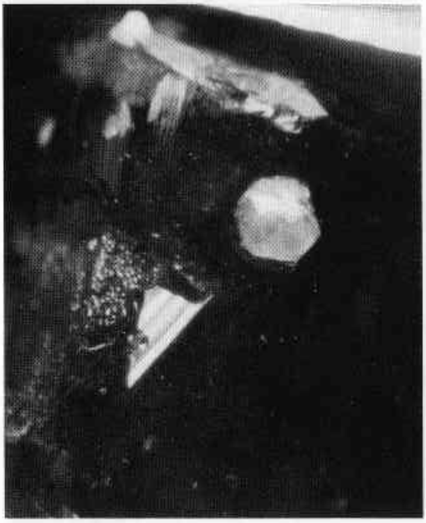


Figure 3.

Unusual Turquoise Treatment

We had a rather poor quality turquoise in for determination of whether or not it had been subjected to treatment. Its response to testing was unusual and seemed worthy of recording. When a hot point is brought next to a paraffin-treated turquoise, it causes the paraffin to melt and liquefy and come out of the pores. As soon as the hot point is removed, it resolidifies. The turquoise in question also had

Figure 4.

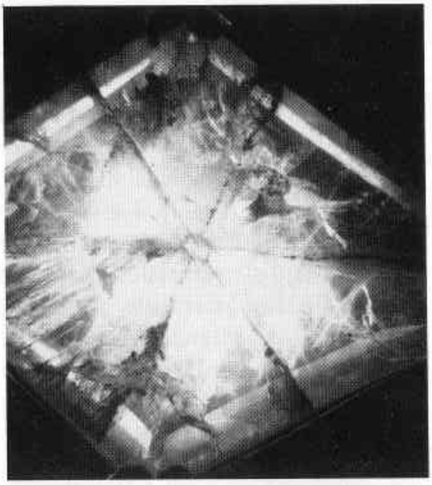


Figure 5.

been impregnated with something that melted as the hot point was brought next to it. Surprisingly, did not resolidify immediately, but remained shiny and it gave off a faint odor we associated with plastic. We had not encountered quite this reaction in an impregnated turquoise before. The shiny liquid spot is shown in *Figure 4.*

Trapiche Beryl

We received in for identification a brooch set with a rather large light green hexagon-cut stone with a green color that was not an emerald green, but rather a dull yellowish-green. There was no evidence of chromium lines in its spectrum and all of the color was confined to fractures that reached the surface. There was no question but that the stone had been dyed. It is not clear whether the stone would have had any green color without the dye. What made it particularly interesting was the pattern of black inclusions seen in *Figure 5,* radiating from a small, hexagonally outlined black zone such as that associated with trapiche emeralds. We had never encountered this in a stone that would well have been colorless or nearly so without the dye. The photograph was taken at 7x.

Plugged Hole

Often in cultured pearls that have been x-radiographed, it is obvious that the cultured pearl has been drilled eccentrically to reach dark spots of heavy conchiolin concentrations so that they may be bleached out in the bleaching process.

An exceptional example of this method is illustrated in *Figure 6,* a portion of an x-radiograph of a 10 mm. uniform necklace showing an unusual number of extra drill holes. A side drill hole shows up as a black circle on the side wall of the rather large drill hole of the cultured pearl shown in *Figures 7* and *8.* A distinct

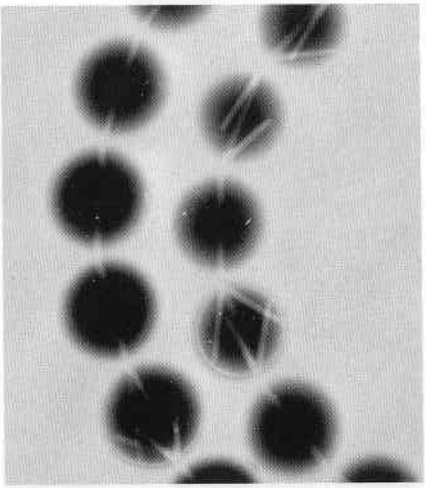


Figure 6.

Figure 7.

line to the right of the round black hole shows the dividing line between the nacre and the mother-of-pearl bead. This is shown at low magnification in *Figure 7* and at about twice the magnification in *Figure 8*.

Blue Sapphire Cluster

In recent laboratory columns both from New York and Los Angeles, reference has been made to crystal clusters that turned out to be imitation. Such a cluster simulating blue sapphire is pictured in *Figure 9*. Synthetic sapphire had been cut to simulate hexagonal prisms and then cemented together with blue cement. Bubbles are evident in the cement. The dyed cement had a typical cobalt spectrum.

Figure 9.

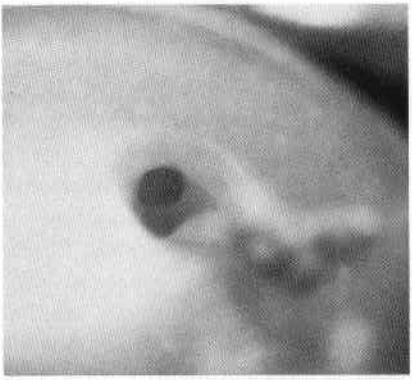


Figure 8.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To *Jacques Adler,* President, House of Adler, Honolulu, Hawaii for synthetic sapphires to be used in the Gem Identification Course.

To *J.P. Cahn,* of Brock Marten Company, San Francisco, California, for two faceted and one rough USTAN synthetic emerald for our reference collection.

To *Rock H. Currier,* G.G., Jewel Tunnel Imports, San Marino, California, for a *Makalani nut,* an ivory substitute, from Tsumeb, South-West Africa, for our reference collection.

To *Armand Duchinsky,* Pacific Gem Cutters, Los Angeles, California, for a synthetic star ruby manufactured in Hong Kong.

To *Richard Hodges,* Larkspur, California, for two strands of interesting lavender-colored coral branches for our reference collection.

To *John Clark Johnson,* G.G. of Johnson's Jewelry, Phoenix, Arizona, for an assortment of cut stones including opals, star sapphires, nephrite, quartz and glass for classroom use.

To *Juergens & Andersen,* Chicago, Illinois, for a very generous gift of natural emeralds, rubies, sapphires, opals, tourmalines and diamonds to be used in our Gem Identification classes.

To *Robert Klippel,* of Ben Ehrlich and Company, Los Angeles, California for a 0.05 carat diamond showing a peculiar natural.

To *James G. Kirwan,* of Lapstar, Inc., Beaverton, Oregon, for an assortment of rough Ceylon gem gravel to be used in spectroscopic testing in the Gem Identification program.

To *Bob Nordbye,* Gem Identification correspondence student from Largo, Florida, for three sugar-treated opals and one rough opal for our research program and display case.

To *W.N. Phillips,* President, Omega Trading Company, Santa Rosa, California for several mabe pearls for use in the Pearl Course and reference collection.

To *Bud Miller,* M & M Mining Company, Sweet Home, Oregon for a mineral specimen showing an unusual growth of quartz replacing a carbonate.

To *Bob Rogers,* of Sunstones, Quartzite, Arizona for several pieces of rough labradorite from Oregon showing unusual pleochroism.

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To *Lee Runsdorf,* New York, New York, for a large selection of natural and synthetic stones including synthetic sapphires and spinels, and quartz, lapis, chalcedony, nephrite, feldspar and malachite to be used in our Colored Stone classes.

To *James Sgro,* of Downey, California for a selection of natural opals and two quartz-topped triplets for use in the Gem Identification Course.

To *Marianne Shale,* G.G., Beverly Hills, California for a timely and generous donation of miscellaneous fresh water cultured pearls for research.

To *Sol Shalevetz,* of M & S Wholesale Jewelers, Los Angeles, California for a collection of a number of Biwa cultured pearls, two single-cut and two full-cut melee diamonds, a red coral cabochon and a small alexandrite for our reference collection and class use.

To *David Widess,* of I. Widess & Sons, Los Angeles, California for a much-needed donation of 30 cut demantoid garnets weighing a total of 6.51 carats for use in classroom and correspondence course gem identification sets.

To *Gordon Young,* Colored Stone Course correspondence student, from San Luis Obispo, California for a large jadeite cabochon weighing 44.58 carats for our reference collection.

To *Gordon J. Zerbetz,* of Westward Trading Company, Anchorage, Alaska for water worn nephrite jade rough from Kobuk River, Alaska, for class use.

A New Diamond Imitation: Cubic Zirconia

BY K. NASSAU, PH.D.
Bernardsville, N. J.

Two faceted gemstones, one 0.61 cts. (courtesy of M. S. Bancroft of New York City), the other 0.64 cts. (courtesy of R. Crowningshield) were studied as examples of a new diamond simulant. The constants were stated by the manufacturer to be: refractive index 2.15, dispersion 0.060, hardness 8-1/2, and density 5.4.

The density was found to be approximately 5.7 by hydrostatic weighing and the hardness by scratch testing was between 8 and 9. Optically, the appearance is that of an isometric crystal, but optical testing was not performed. Analysis by non-destructive X-ray fluorescence, as well as in the scanning electron microscope, showed the presence of zirconium plus a small amount of calcium. The intense X-ray beam turned the stone yellow, but the color was lost in a few days. Single crystal X-ray diffraction and precession photographs gave a cubic symmetry with $\underline{a}$ = 5.129 Å.*

Zirconia (zirconium oxide, ZrO_2) exists in several forms: monoclinic, tetragonal, cubic, and possibly hexagonal. The monoclinic form of zirconia is the mineral baddeleyite which has a refractive index of 2.13 to 2.20 but a hardness of only 6-1/2. Above 1000°C this converts to the tetragonal form[1], which, in turn, becomes cubic above about 2300°C.[2] Cubic microcrystalline zirconia can be stabilized at room temperature by the addition of small amounts of calcium, magnesium, or other oxides, and is widely used as a high temperature ceramic. It is also listed by Hey (7.10.1a) as an unnamed mineral, based on its occurrence as cubic microcrystals (with $\underline{a}$ = 5.12 Å and density 6.0) in a metamict zircon.[3]

As will be discussed in a rather timely fashion in an article to be published in the Summer issue of *Gems & Gemology*[4], the naming of such a material is best accomplished by using the chemical composition with the crystal symmetry, thus leading to the identification "cubic zirconia." Since it has also been observed in nature, it could be considered to be a "synthetic" cubic zirconia.

Under the microscope one of the stones appeared to contain many rows and clusters of gas bubbles *(Figure 1)*. At a magnification of 300x *(Figure 2)*, they were however recognizable as flux inclusions. These had formed

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*Courtesy of R. L. Barns and J. L. Bernstein; both $\underline{a}$ and the density could vary depending on the calcium content.

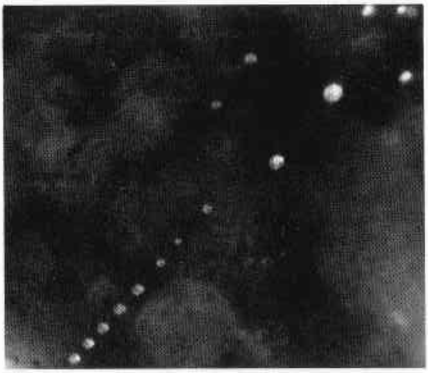

Figure 1. Rows of "bubbles" in zirconia stone.

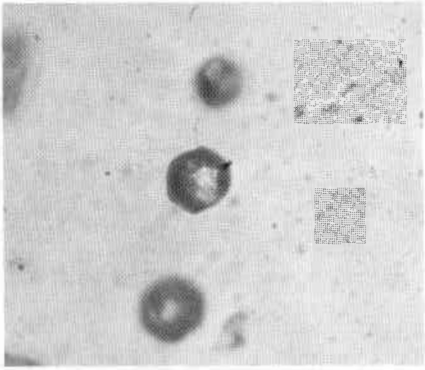

Figure 2. Close-up showing "bubbles" are flux-filled with poorly formed faces as "negative crystals" in zirconia stone.

"negative crystals" with small facets, somewhat resembling dodecahedra in form.

This material was purchased in Europe and is said to be made by the Djevahirdjian Co. of Monthey, Switzerland, under the trade name "Djevalite" by a flux technique. Many fluxes have been reported for the growth of zirconia (lead fluoride; lithium molybdate; vanadium oxide; sodium borate, carbonate, or phosphate; etc.). These generally yield monoclinic or tetragonal zirconia crystals, and it is not known what flux is being used to grow the cubic zirconia crystals.

With its unusual combination of high values for the refractive index, dispersion, and hardness, cubic zirconia appears to be an outstanding diamond simulant. In view of the difficulties associated with flux growth and the low yield to be expected (only 16% for the highly developed Gilson flux emerald process[5]), it remains to be seen if this material can compete with the somewhat less attractive but by now relatively low cost YAG and GGG.

Addendum

It appears that cubic zirconia (stabilized by about 15% yttrium oxide) is being made in the Soviet Union under the name "Phianite" by a melt technique, skull melting. This has been described by V.I. Alexandrov *et al.* (Vest. Akad. Nauk, SSSR **12**, 29, 1973).

This material is also being made by the Intermat Corp. of Acorn Park, Cambridge, Mass. (J. Wenckus, unpublished information). It is slightly softer (hardness about 8) but other constants should be similar to those of the calcium stabilized cubic zirconia described above. K.N.

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JADE —
China's Contribution to the Fine Arts

BY A. E. ALEXANDER Ph.D.

From the *Book of Rites* – Chou Dynasty 1050-256 B.C.

Benevolence lies in its gleaming surface
Knowledge in its luminous quality
Uprightness in its unyieldingness
Power in its harmlessness
Purity of soul in its purity and
spotlessness
Eternity in its durability
Moral leading in the fact that it goes
from hand to hand without
being sullied!

Can anyone have a love affair with a mineral? You can if the mineral is Jade! Not the boulder taken from a river stream or splintered pieces blasted from a cliff, but exquisite carvings fashioned by the hand of man.

Collecting jade is like collecting old, gold coins, rare snuff-bottles or 18th Century gold-enamel boxes. Fortunate is the individual who has the wealth to engage in such a rewarding pastime. A connoisseur of jade is a person possessed.

Five years ago a two strand, Imperial jadeite bead necklace was sold for $36,000. Last year at a Geneva auction, an identical necklace went for $200,000! Was $200,000 too much to pay for such a necklace? Not really. Imperial jade is as rare as a natural colored deep blue diamond and consequently warrants a high price.

In my forty years dealing with jade I realize that you can never know all there is to know about jade. You also become aware that you are not alone in your seemingly lack of comprehensive knowledge. A case in point is the reclining horse seen in *Figure 1.* It is nephrite, and its history in this instance is known.

The beautifully carved horse which

Figure 1. Medium green nephrite Ming Dynasty horse measuring 8 by 5½ inches. Royal Doulton cat figuring measures 2¾ inches in size.

measures 8 inches by 5½ inches in size was first shown to a leading expert in Chinese jade. He flatly stated that the horse was not a Ming dynasty piece, but was one carved sometime shortly after the turn of the century.

I next took the horse to another expert in Oriental art. He stated that the piece was definitely antique (meaning one over one hundred years old), but would not classify the horse as to dynasty.

Since the history of the carving is a matter of record it so happens that it is "Ming."

Dynasty jades, unlike Fabergé are not signed pieces, and therein lies the problem.

I would like to point out that inadequate lighting has created dark and light shadows on the carving which do not exist on the horse. The Royal Doulton figurine of a cat is 2¾ inches in size and is included for contrast and comparison of actual size.

Before continuing, a listing of the various Chinese dynasties should be recorded:

Shang dynasty	1766 B.C.-1050 B.C.
Chou dynasty	1050 B.C.- 256 B.C.
Ch'in dynasty	255 B.C.- 206 B.C.
Han dynasty	206 B.C.-222 A.D.
The Three Kingdoms	222 A.D.- 280 A.D.
The Six dynasties	280 A.D.- 589 A.D.
Sui dynasty	589 A.D.- 618 A.D.
T'ang dynasty	618 A.D.- 907 A.D.
The Five dynasties	907 A.D.- 960 A.D.
Sung dynasty	960 A.D.-1279 A.D.
Yuan dynasty	1279 A.D.-1388 A.D.
Ming dynasty	1388 A.D.-1644 A.D.
Ch'ing dynasty	1644 A.D.-1912 A.D.

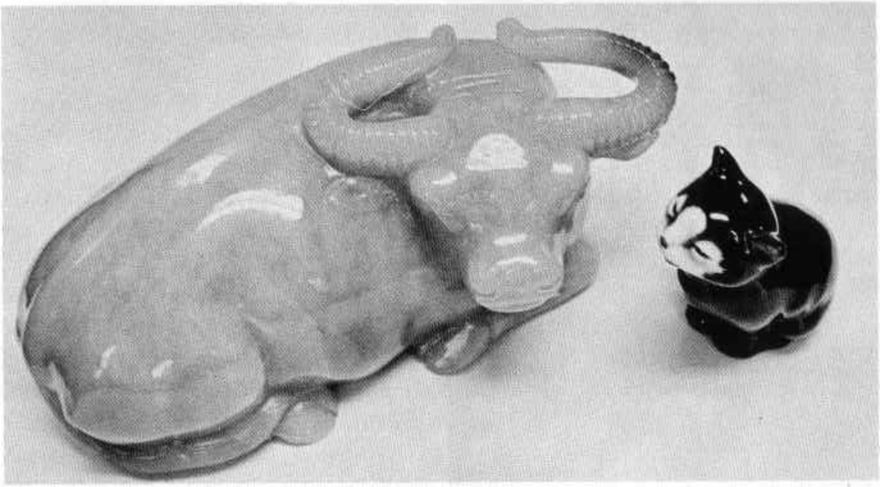

Figure 2. Mauve jadeite water buffalo measuring 7½ x 3½ inches in size. Royal Doulton cat figurine measures 2¾ inches in size.

Note: The Ch'ing dynasty is sometimes broken down as follows:

K'ang Hsi	1662-1722 A.D.
Ch'ien Lung	1736-1795 A.D.

Mention should also be made that the Chinese did *not* know jadeite, prior to 1784. In short, all the fabulous Chinese carvings of known dynasties, were nephrite!

Now, consider the photograph of the jadeite water buffalo *(Figure 2)*. This delicately hued mauve-colored

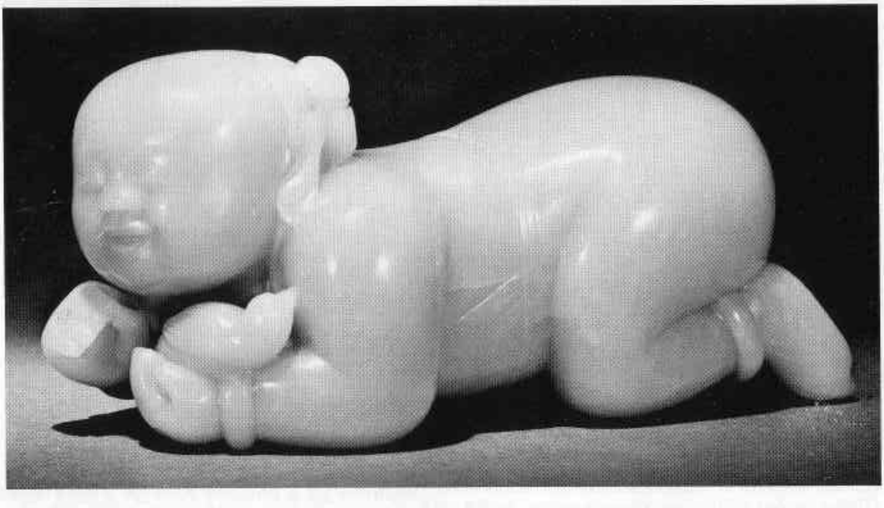

Figure 3. Eighteenth century jadeite "Pillow in the Form of a Boy," 8¾ x 4½ inches in size.

Figure 4. Greenish-white nephrite vase, with cover, K'ang Hsi-Dynasty – 1662-1922; 11 inches in height.

carving measures 7½ inches by 3½ inches high at the horns. It happens to be a flawless piece, although again improper lighting gives the impression that the carving is flawed. This buffalo is a modern piece, however, as its owner I consider it a work of art.

Richard Gump once made this observation: "I am not particularly interested in an antique jade carving versus one of modern origin. If the carved piece is superbly done, that is all that matters." In this I concur!

Figure 3 illustrates the famous jadeite carving, "Pillow in the form of a boy." It measures 8¾ inches by 4½ inches high. According to the Curator of the Walker Art Museum, Minneapolis, the beautiful carving is 18th century. Since the cut-off date for Chinese knowledge of jadeite is 1784, obviously the piece must have been fashioned after this date.

I have never ceased to wonder about the beauty of white nephrite jade. The photograph of the carved vase *(Figure 4)* believed by its present owner to be K'ang Hsi reveals in considerable detail the intricate carving.

An even whiter nephrite jade shown in *Figure 5* is that of a crested bird, with its offspring. Even though nephrite, this is a modern carving, not an antique.

However, one of the most exquisite jadeite carvings to come to my

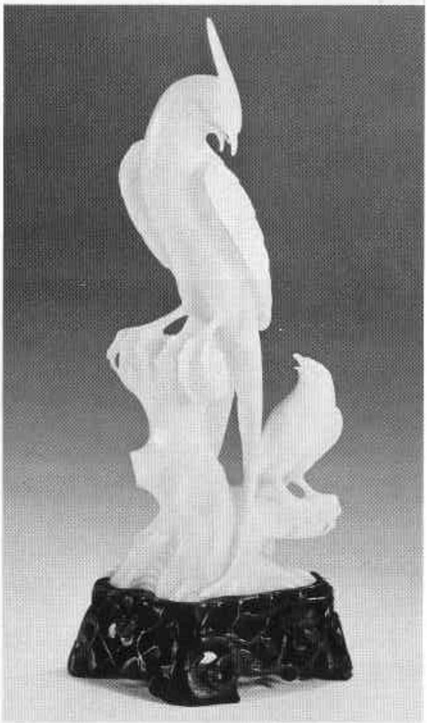

Figure 5. A modern carving in white nephrite of a Phoenix bird on a teak wood stand.

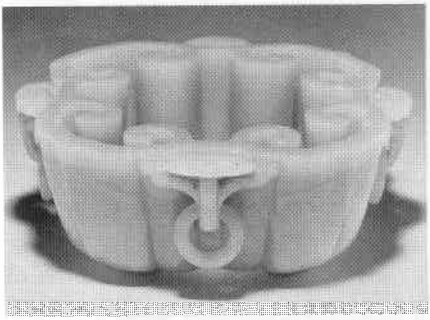

Figure 6. Modern carving of an eight-sectioned, light green jadeite bowl.

attention is the eight sectioned scroll vase seen in *Figure 6.* It is light green in color. Contemplate for a moment the symmetry of the scrolls and the care that went into their production.

Still another interesting piece is the nephrite vase with cover depicted in *Figure* 7 featuring whitish-green jade, with red-brown jade carvings on the side. The vase is 11-5/8 inches high and is representative of many Chinese carvings which reveal some shade of color other than "white."

One of the rarest of all nephrite jades is that of saffron-yellow. Such a piece of this color shown in *Figure 8* came to my attention last year. The photograph reveals an 18th century vase and cover in actual size, with double pierced scroll handles. The side carving shows in relief a bat, and near the base, a dragon with bifid tail, all supported on ling-chih fungus branches. The cover features a small dragon in relief.

Ten years ago the pair of bright green nephrite rings seen in *Figure 9* appeared in the New York market. Each ring measured 9-1/8 inches in diameter. Note the teak wood stands where every curve and every detail is an exact copy of the other. Much of the overall attractiveness of any Chinese jade carving is the teak wood stand which accompanies the piece.

In my files, I found a notation of a pair of snow-white nephrite discs. Each disc measured 18 inches in diameter and 1 inch thick. Flawlessly carved, the nephrite was completely devoid of blemishes of any kind. The discs were quickly sold at a very high price. The year was 1963.

Figure 7. An important 17th-18th century nephrite vase standing 11-5/8 inches high.

As for origin, the finest jadeite comes from the Myitkyina district of Upper Burma. Gem quality nephrite is mined (or was) in the province of Sinkiang (East Turkestan). As far as the Chinese are concerned both minerals are called simply "jade."

Chemically, nephrite is (a variety of the actinolite-tremolite series) $Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$. Jadeite is equally complex being $Na(Al,Fe)Si_2O_6$.

	Indices of Refraction	*Specific gravity*
Nephrite	1.606-1.632	2.90-3.02
Jadeite	1.660-1.680	3.30-3.36

Jade occurs in colors other than shades of green, for example, mauve, brown, red, yellow, pale blue, orange, white, and black.

Figure 8. Extremely rare 18th century yellow nephrite vase.

The ancient Chinese often created enormous carvings from nephrite. The famous jade "mountain" in the Walker Art Center, Minneapolis, weighs 640 pounds and is 38 inches long by 22¼ inches in height. This "mountain" is suitably inscribed by Emperor Ch'ien Lung and carries the date, 1784.

Some years ago, an entire series of articles entitled "Jades of the East" were written by Elsie Ruff for the British publication *The Gemmologist.* In one of her articles, she mentions that nephrite was used to create musical tones. Only the purest white nephrite was carved. The pieces perforce were flat, of varying size and highly polished. They were suspended by a thread and when struck with a *wooden* mallet a chime effect resulted. The musical jades usually numbered twelve although a few collections or series consisted of twice this many pieces.

Then there were the wonderful Four Season screens. Each measured 25 by 13½ by ½ inches in size. According to my records, the screens were transferred from Peking to Shanghai at the time of the Japanese invasion of 1937. Before they were sent to London to be auctioned (they were sold for $117,000), I almost found a buyer in New York. Did he plan to hold them intact? No, if he decided to buy he planned to have the four marvelously carved screens cut in cabochons of ring stone size.

Then there is the variety of jade we know as chloromelanite. From the name, a black color is indicated. However, under very strong illumination, the "black" is found to be in most

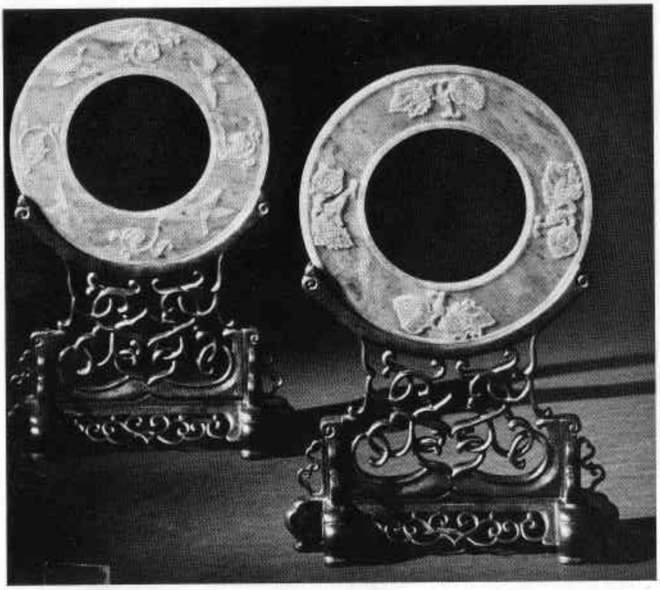

Figure 9. Bright green nephrite circles on finely carved teakwood stands from the 18th century. Circles are 9-1/8 inches in diameter.

cases a very dark green.

In 1961, a New York dealer had a pair of carved Panthers suitable for use as book ends. Each Panther measured 5 inches in length. The beautifully proportioned carvings could have been purchased at that time for a modest $200.00 the pair! Turning to jade jewelry. We have everything from a small nephrite cabochon worth a dollar, to a cabochon of Imperial jadeite quality which might wholesale for $20,000 to $30,000!

Figure 10 is a photograph of two items that appeared in an auction a year or so ago. One piece consisted of an item known as "Buddha's-hand Citron." Since the "hand" was advertised as Imperial jade, I made a special point to examine it critically. While the jadeite was an exceptional green, it was not in my opinion "Imperial" quality.

To me Imperial jadeite jade must and does rival the finest Muzo emerald in color. Had the "hand" been Imperial it may well have been worth $40,000 or more. The necklace in the photograph likewise proved to be fine jade, but not Imperial. In the beginning of this article I mentioned that $200,000 had been paid for an Imperial jade bead necklace.

Is jadeite ever found *transparent?* The answer is yes, but I must quickly add that its occurrence is exceedingly rare!

In 1964, a bi-colored jade bead necklace came to my attention. Each bead consisted of intense emerald-

Figure 10. Buddha's Hand and jadeite bead necklace. Both approach Imperial jadeite green in color.

green *crystals* evenly separated with crystals of absolutely *colorless* crystals. The mineral matter was pure jadeite.

This is akin to the 7.27 carat lozenge-shaped *transparent* faceted rhodochrosite which appeared in the New York market in early 1975. Or, like the transparent lazulite gem described in the Spring 1975 issue of *Gems & Gemology*!

Some years ago, when it was possible to visit Burma the length and breadth of the land, Dr. Eduard Gübelin made it a point to examine the jade deposits of that country. It was on this occasion that he came across the decorative green stone known by the natives as Maw-sit-sit. The rock closely resembled jadeite but was found to be slightly less hard. On his return to Lucerne he studied the mineral in detail and found it to be a mixture of albite feldspar and a small amount of chrome rich jadeite. Maw-sit-sit is used in carvings, and actually has been found to be most attractive.

Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

For the past few months in New York we have found it necessary to close the laboratory the last Friday of each month in order to catch up with office work and to have a breather. We plan to have a guest lecturer talk about his or her specialty for the benefit of the gemologists. Initiating this program was Dr. Kurt Nassau *(Figure 1)* who expanded on his discussion of the causes of color in gemstones. We all found his talk of great help in understanding articles printed in *Gems & Gemology* and *The Lapidary Journal.*

Our second speaker was Mr. Abe Nassi *(Figure 2)* who delivered an informal, highly informative talk about his travels in search of fine

Figure 1.

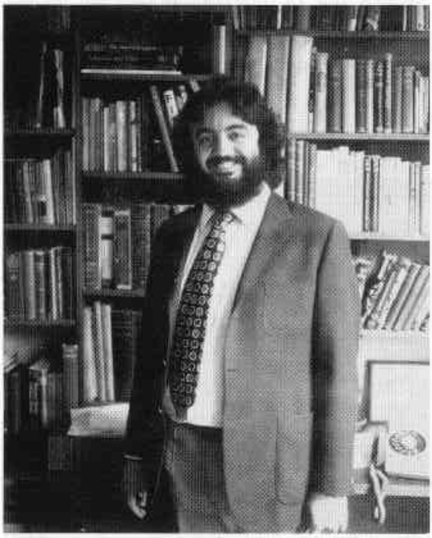

Figure 2.

Figure 3.

colored stones and the state of the market today. We look forward to having diamond cutters, jewelry designers and similar people who can help us to keep current and expand our appreciation and knowledge. In March we joined the members of the residence class in a short field trip to see some of the famous Blaschka glass flowers on loan to Steuben Glass on Fifth Avenue from the Botanical Museum at Harvard University. All felt the trip was a fantastic esthetic experience. The writer has visited the museum at Cambridge several times and comes away uplifted each time. *Figure 3* is from the Steuben catalog cover and shows part of a cluster of great laurel so meticulously and accurately done it is difficult to tell that it is not alive.

The last Friday in May all staff gemologists who were not at the official opening of the New Gem Hall at the American Museum of Natural History earlier this month joined residence class members for a memorable but quick tour of this wonderful addition to New York's cultural life. The staff hurried back to the office to join the curator and creator of the new exhibit, Dr. Vincent Manson, for lunch and an inspiring talk about the many angles from which gems may be viewed – modern prospecting and mining; identification and its increasing complications; synthetics and their usefulness in keeping interest high in the natural stones and the increasing knowledge being made available to the public.

A New Diamond Imitation

A small round brilliant, nearly colorless and estimated to weigh approximately 0.38 carats by diamond formula was found to weigh 0.63 carats. This clearly showed that it was not GGG which has almost exactly twice the specific gravity of diamond. The client stated that it was a sample from abroad and that the constants sent with the stones are: R.I. 2.15, S.G. 5.40, dispersion 0.060, and hardness 8½. We found it to be singly refractive. Consequently, we sent the stone to Dr. Kurt Nassau whose initial findings indicated the stone to be zirconium dioxide. In nature a monoclinic zirconium dioxide occurs as the mineral baddeleyite. Since the stone is cubic in structure and zirconium dioxide, it is a synthetic paramorph of baddeleyite. The initial stone contained no inclusions or other indications of the method by which it was made, thus the assumption was that it was probably a result of flux growth.

However, in the meantime another similar stone also small in size was submitted for testing. This one contained what appeared to be many gas bubbles in parallel strings indicating artificial production. A full report on these interesting imposters appears in Dr. Kurt Nassau's article in this issue. Incidentally, during the test for zirconium using intense X-ray beams, the initial stone turned an attractive brown color. Whether it fades without heat will be reported too.

Opal-Like Glass

The transparent smoky brown faceted emerald-cut stone shown in *Figure 4* was understandably mistaken for opal because of its properties. Refractive index: 1.456; S.G.: 2.25; and single refraction. However, the prominent swirl marks shown in the photograph *(Figure 5)* as well as the spherules of other glass, together with the green fluorescence under ultra-violet and opacity to X-rays, indicate a glass, probably slag.

Puzzling Sapphire

Students usually learn to associate curved inclusions in sapphire with the synthetic, and straight inclusions with natural stones. The natural sapphire shown in *Figure 6* showed a veil of needles (?) which are decidedly curved.

Recently, Mr. Carroll Chatham and his son Tom visited the New York Lab and disclosed that new flux-grown blue synthetic sapphires will soon be available to the trade. We are eagerly awaiting the opportunity to examine these new wonders from the "wizard's" laboratory.

Jade-like Quartz

Several highly styled lapis and "jade" jewelry items came into the Laboratory because the green stones were suspected of being dyed jadeite. Upon testing it was determined that the stones were quartz with evidence of chromium in the absorption spectrum. We suspect that the stones are examples of quartz from Rhodesia, locally called "mtorolite." We received

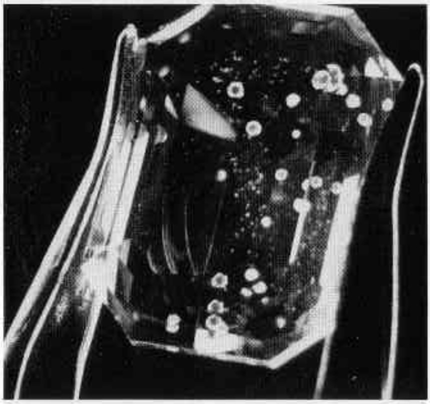

Figure 4.

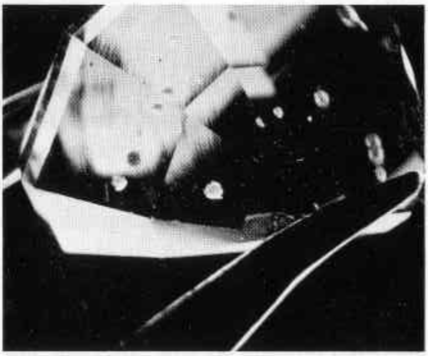

Figure 5.

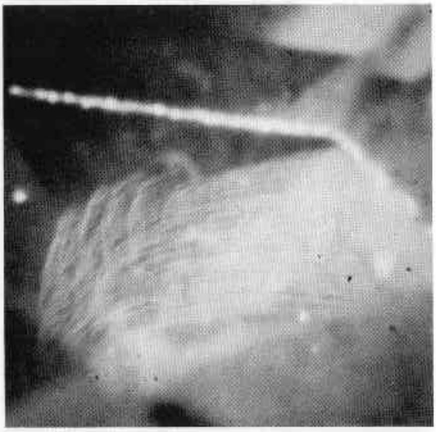

Figure 6.

from Gem Trade Laboratory member Robert C. Nelson, Jr. a slab of similar-appearing green quartz, presumably from Brazil. We are happy to add this specimen to our collection of jade simulants.

Acknowledgements

We wish to express our sincere thanks for the following gifts and courtesies:

To former staff gemologist in New York *Jerry Call* for a specimen of black opal from Piaui, Brazil.

To *Mr. Sam Goldowski,* New York, for some purple pink cut and rough scapolites from Tanzania.

To *Cy Ellenhorn,* GIA student in New York, for 12 jade-like grossularite garnet cabochons for use in classes.

To *Mr. Pierre Gilson, Jr.,* for 6 specimens each of the firm's manufactured lapis-lazuli and turquoise substitutes.

To GIA Residence graduate *Mark Hartzman,* Marcus Jewelers, New Jersey, for a large selection of natural, synthetic and imitation stones which we delight in receiving for our classes.

To *J. & S.S. deYoung,* Boston, Massachusetts, for a similar very useful collection of various stones.

To *Mr. Bill Larsen,* Fallbrook, California, for a fine small crystal of the red beryl from the new locality in Utah. Earlier this year we saw two fine bright cut stones of this material which looked like rubies.

To *Mr. Elbert McMacken* of Craftstones, Ramona, California, for his gracious hospitality to the writer and his entourage on a holiday visit in California. "Mac" gave us a tour of perhaps the largest tumbling plant there is and brought us up to date in what is new in his field. In a recent issue of *Gems & Gemology* the writer mentioned that tumbled dyed blue howlite (a relatively soft boron mineral) is Craftstones' current best seller

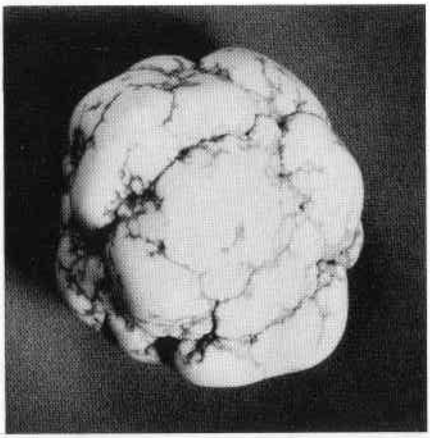

Figure 7.

Figure 8.

–given the turquoise craze only now showing signs of abating. *Figure 7* is a photograph of a large howlite nodule given the writer. It has been tumbled, but not dyed. In addition to many tumbled stones useful in gem identification classes, such as idocrase, psilomelane, dyed howlite, rhodonite, adventurine, etc., we were given a new product that poses potential problems to gem testers. It is dyed granite from the Ramona locale. With the supply of howlite definitely limited, "Mac" began experiments with local rocks and was surprised to find a light colored granite would take the dye very well. In *Figure 8* is a tumbled piece before dyeing, a dyed piece in the center, and the depth of penetration is shown in the third stone. Although the black inclusions are not exactly reminiscent of the black in turquoise, the effect is pleasing and the stone should find a place in inexpensive jewelry.

To *Mr. Irving Michaels,* New Haven, Connecticut, for a large selection of citrines and garnets, cut stones that will be valuable in residence classes.

To *Mr. W.A. Rose,* Dover, Massachusetts, for specimens of jade-like Iimori glass, North Carolina emerald in matrix and trapiche emerald crystals – all very welcome additions to our reference collection.

To *Mr. Howard Rubin,* G.G. of Ostrow Gems, Inc., New York, for two cut tourmalines which change color from a dark green to a red brown color looking very much as if they were dark alexandrites. At one time the superfluous name chameleonite was proposed for these stones.

To *Phil Thompson,* Arthur Cooley Jeweler, Springfield, Massachusetts, for a citrine cabochon with an unusual inclusion.

To *Dr. John Saul,* Paris, France, for 4 lovely purple scapolite specimens.

To *Theodore* and *Irwin Moed* for 10 variously color-treated diamonds which we will put to good use in classes.

To *Sam Stone,* New York City, for a large variety of cut synthetics and glass stones for class work.

Robert Webster

A Memorial Tribute

BY B.W. ANDERSON

The death of Robert Webster last February at the age of 76 has left an irreplaceable gap in the ranks of gemmologists. For him, to be busily occupied was life itself: inactivity, little better than death. So, while mourning his passing, we can at least be glad that by careful husbanding of his physical resources, his ability and relish for his chosen work had hardly diminished to the ending of his days.

In earning a living, Robert was perforce an early starter: as a gemmologist, a late one. His father was a pawnbroker, and on his death R.W. became an assistant in that trade in order to support his widowed mother. Whereas not until he was 34 did he take the fateful step of enrolling as an evening student in the gemmology classes at Chelsea Polytechnic, London. Here he proved an industrious and gifted student, though beaten to the Tully Medal by the brilliance of R.K. Mitchell.

Encouraged by Arthur Tremayne, editor of the recently launched monthly journal *"The Gemmologist,"* and a dynamic and influential figure in his day, Robert was soon launched on a writing career. His style, always workmanlike, was at first uncouth, but improved steadily through the years. It was thanks to Tremayne also that he was able to have published that popular student's *vade-mecum* "The Gemmologist's Pocket Compendium" and later "Practical Gemmology" – a simply explained course on the subject. Both have proved their continued usefulness in surviving to the present day in a series of revised or reprinted editions. Before long he had also become an evening lecturer in gemmology at Chelsea and at other polytechnics to which the classes were moved. Anyone who has done any teaching will agree that instructing others inevitably involves a great deal of self-instruction as an added benefit.

But it was not until immediately after the War (in which Webster had served enthusiastically as a Home Guard) when he accepted the offer of a job in the Precious Stone Laboratory of the London Chamber of Commerce in Hatton Garden, that he was able to devote all his time and talents to his chosen science. In his first year he joined in the tremendous task of testing over 100,000 stones (mostly calibré rubies) made necessary by the infiltration of synthetics into original parcels: a veritable baptism of fire. After that year the sheer quantity of stones for testing diminished, but there were problems in plenty to tackle on top of our continued bread-and-butter work of pearl testing. He now enjoyed the advantage of guidance and consultation with experienced colleagues and the availability of apparatus adequate for almost every need. In the routine work of the Laboratory he chiefly specialized in the radiography of pearls, but his powers of concentration and his general efficiency were also used to our advantage in the necessary chore of book-keeping.

Webster's talents for investigating neglected aspects of gemmology enabled him to illuminate many of the dark corners of our science, and a flow of published articles made his findings available to gemmologists the world over.

Eventually, having the Laboratory's accumulated store of first-hand data as well as the results of his own personal work at his command, he was able to compile his *magnum opus*, "Gems, their Sources, Descriptions, and Identification" which was first published by Butterworth in a two-volume format in 1962. Despite its formidable bulk and cost this work sold well, and Robert was able to complete its enlarged single-volume third edition in the year before his death.

In 1968, at the invitation of the Canadian Gemmological Association and the GIA, Webster crossed the Atlantic, where he spent some time at GIA headquarters. On another occasion he had the opportunity to visit the main diamond mining centers in South Africa by acting as gemmologist and assistant courier to a mixed group of people on a tour organized by the Illustrated London News.

Robert's frequent attendances as an expert witness in court cases involving jewelry had roused in him an increasing interest in the forensic role of gemmology. For nine years he was an honorary visiting lecturer to the Detective Training School in London. Finally he was led to apply for membership of the British Academy of Forensic Sciences, and later of the Forensic Science Society, serving on the committee of the former body after his retirement from the Laboratory in 1971.

It would be impossible in a short account to indicate the extent and scope of Webster's work for gemmology. Fortunately most of it is there for all to read in his great book "Gems."

In person he was small in stature and brisk in mien and movement. He was indeed rather fond of affecting a brusque or blunt manner. But one soon became aware of the warm heart of this very kind and generous man. In his death, the world has lost a great gemmologist, and those who knew him, a loyal and valued friend.