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See Inside Cover

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On the Cover

A diamond-and-emerald creation by Erwin Pearl of New York City. The necklace is formed by trails of marquise diamonds that form a garland of leaves, each held by double ribbons of baguettes. Larger marquise leaves sprout from the base of a pear-shape emerald. A 100-carat cabochon-cut emerald pendant is framed by marquises of varying size.

Photo courtesy
N. W. Ayer & Son, Inc.
New York City

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Developments in the Synthetic-Emerald Field

by
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Within a relatively short period, several new synthetic emeralds have become available. This issue of *GEMS & GEMOLOGY* carries an article by Edward J. Gubelin, C.G., Ph.D., the prominent Swiss gemologist, describing a product made by Zerfass, in West Germany, and a second one being made in France. Dr. Gubelin's report was received while this article was nearing completion; this one discusses products not covered by Dr. Gubelin and expands on his remarks with respect to the French product.

Johann Lechleitner, of Austria, already well known for his success in adding an overgrowth of synthetic emerald on natural beryl, is also presently making whole synthetic emeralds. There have been at least three other successful experiments in synthetic-emerald growth of commercial size reported to us recently; in two cases, we believe it is the intent of the scientist to market synthetic emeralds at a later date.

The developer of the new French synthetic emerald, Pierre Gilson, of the ceramic firm Etablissement Pierre Gilson, Pas de Calais, France, very kindly furnished us with a faceted stone weighing .75 carat and a large crystal weighing over 47 carats. The crystal shown in *Figure 1* measures approximately 26 x 25 x 5½ millimeters. One of the remarkable facts about the Gilson success is the large sizes he has been able to grow in the relatively very short time he has worked. Johann Lechleitner also generously supplied us with a solid synthetic-emerald wafer; layered faceted stones; and overgrowths on crystals, as well as on faceted stones.

The first step in the study of a new synthetic gemstone is to determine whether it is indeed a counterpart of a

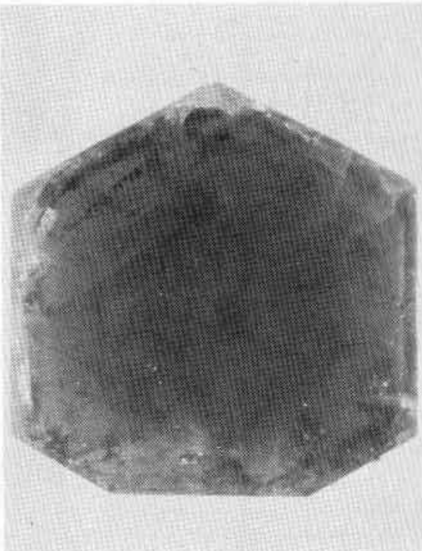


Figure 1

natural stone. To prove this beyond question, X-ray diffraction was employed. The powder-diffraction patterns, taken with copper radiation, are placed to demonstrate their essential agreement, proving them to be structurally identical *(Figure 2)*.

The Gilson synthetic emerald has been on the market for only a short time. We had the opportunity to see samples of crystals and cut stones last summer, but it was not until a few months ago that faceted stones reached the market. The Gilson product seems likely to prove popular, because it resembles attractive grades of natural emerald. Its color is often a distinctly yellowish green, rather than the bluish green usually seen in the Chatham product. When Mr. Pierre Gilson was in the United States in the summer of 1963, he carried with him a number of samples of rough and cut synthetic emeralds. The rough crystals were flat tablets with metallic wires attached *(Figures 3 and 4)*. The crystal furnished in 1964 is larger and clearer than those seen in 1963.

A recent examination of fifteen stones, said to have been cut from one crystal, displayed a distinct variety of appearances. They ranged in size from a few points to over eight carats. All were cut with the optic axis at right angles to the table; nine displayed a yellowish color unlike any Chatham material we have seen, four were a more nearly pure green, and two had a bluish-green color similar to Chatham's. We were told by the cutter that, before cutting, the crystal had had a distinct dividing line between the yellowish- and bluish-green material. Both the cut stone and the crystal examined more recently showed a distinct color banding *(Figure 5)*; however, this is much less prominent than in the Lechleitner-overgrowth material that will be described later.

Our measurements of refractive indices, using monochromatic sodium light and a number of different refractometers, averaged 1.559-1.562. Gubelin reports indices of 1.558-1.562. As with the Chatham, the birefringence seems to be between .003 and .004. The specific gravity taken on the large crystal approximates 2.661; this means that the S.G. of the new French synthetic is also appreciably under natural emerald.

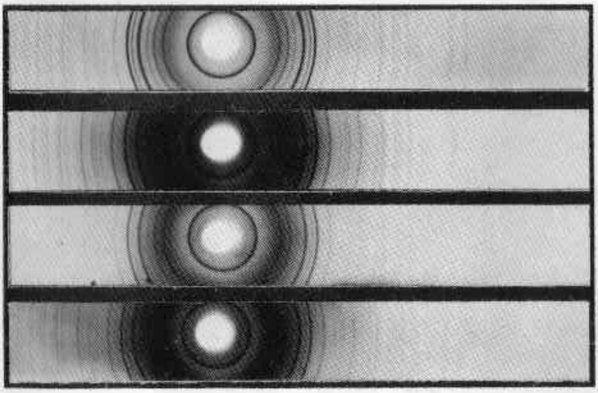


Figure 2 **Powder X-ray diffraction patterns, taken with Cu radiation, of natural and synthetic beryls.**

A. Natural beryl

B. Chatham synthetic emerald

C. Lechleitner synthetic emerald

D. Gilson synthetic emerald

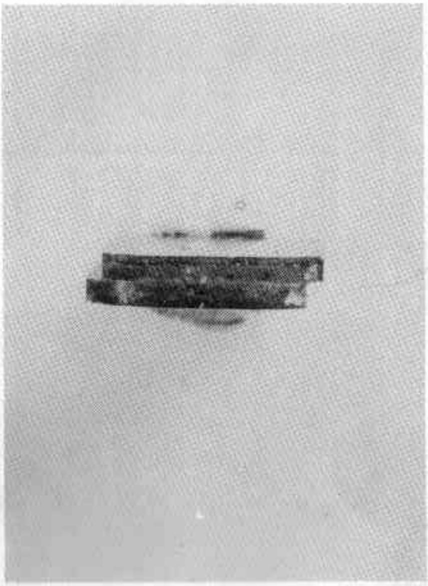


Figure 3

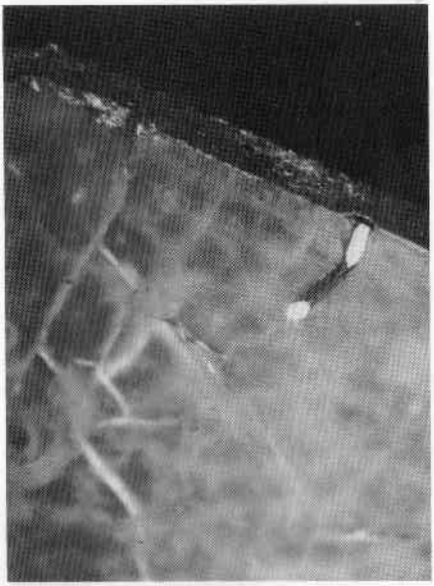


Figure 4

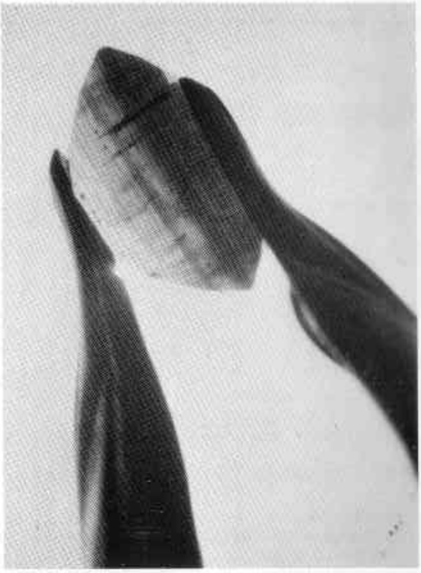


Figure 5

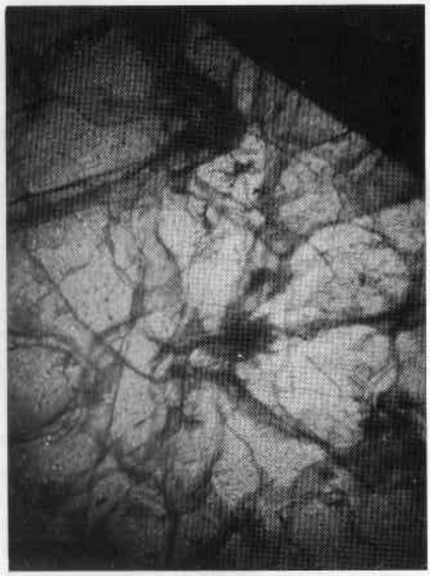


Figure 6

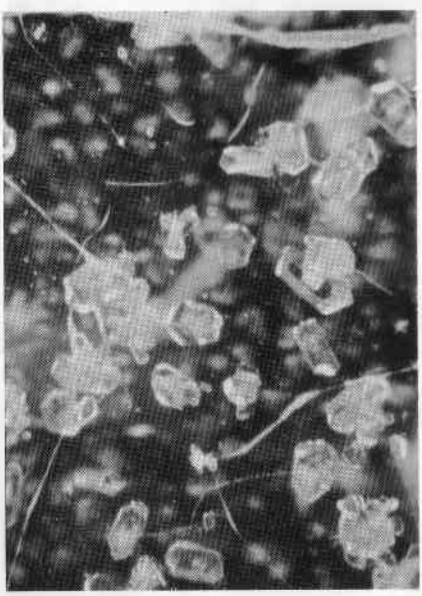


Figure 7

Figure 8

Figure 9

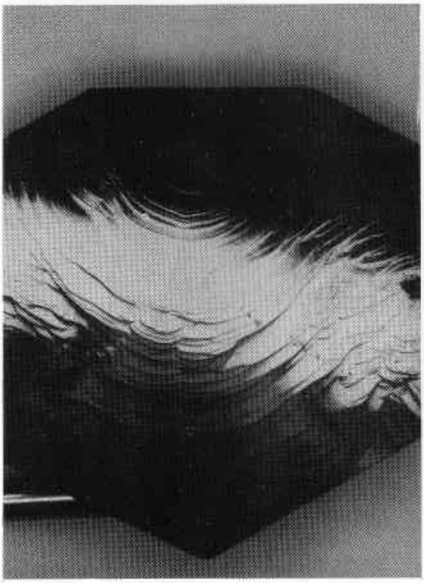


Figure 10

The inclusions in the Gilson product are basically similar to those in Chatham's product, but there are some zones of liquid and gas inclusions that appear to be yellowish. For the most part, the wisplike inclusions are very similar in appearance and veillike distribution to those long considered typical for synthetic emerald *(Figure 6)*. As in Chatham's product, there is a slight tendency for the liquid and gas wisps to have a preferred orientation parallel to prism faces. There are also a number of colorless crystals that are probably phenakite *(Figure 7)*; sometimes, they have little satellite inclusions that are reminiscent of those Gubelin called "breadcrumb" inclusions when he encountered them in aquamarine *(Figure 8)*. One of the major differences from the Chatham product is the yellow fluorescence that is particularly noticeable under long-wave ultraviolet and slightly less obvious under short wave. The yellow fluorescence superimposed over the usual red fluorescence of synthetic emerald imparts a slightly orangy appearance to the Gilson product under ultraviolet. Probably, it is this yellowish fluorescence, added to the faint yellowish cast of some liquid inclusions, that tends to give a yellowish-green color in daylight. Faceted stones showed strong dichroism in deep blue-green and a lighter yellowish green. The Gilson material, unlike Chatham and Lechleitner, failed to transmit far enough into the ultraviolet for scheelite to be activated by 2537 Å radiation directed through the Gilson crystal.

Apparently, the crystal is made up of a mosaic of tiny individuals, because

Figure 11

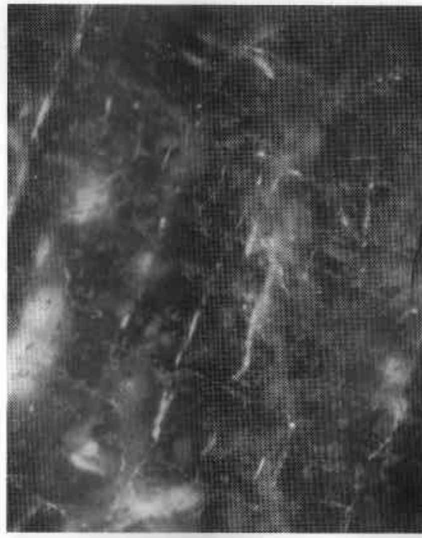


Figure 12

Figure 13

under crossed Polaroid plates there is a patchwork pattern of interference colors resembling the appearance of pinfire opal under normal reflected light *(Figure 9)*. The growth structure on the basal pinacoid of the crystal shows in *Figure 10*.

Our first knowledge of the efforts of Johann Lechleitner came when his synthetic-emerald overgrowth on natural beryl was introduced in America as *Emerita*. Later, the marketing for this product was taken over by Linde Products, first under the name of *Linde Synthetic Emerald* and later under a more fully descriptive name. Since that time, Mr. Lechleitner has obviously continued with developmental work. He recently sent us some faceted stones in which emerald occurs as layers alternating with white beryl, plus a tablet of uniform synthetic emerald over two

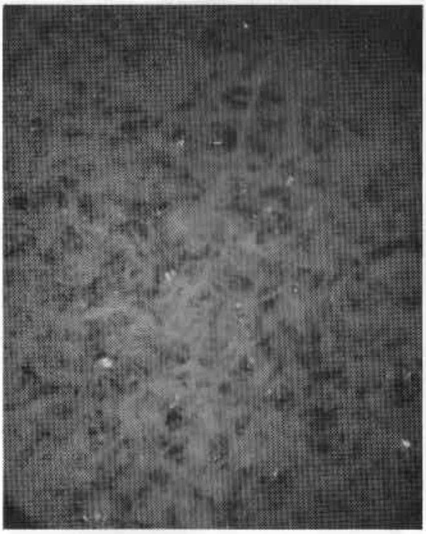


Figure 14

Figure 15

millimeters thick and about fifteen millimeters in diameter. Both the overgrowth and the interlayered type of synthetic emerald are characterized by the two sets of strain cracks that trend at right angles to one another *(Figure 11 and 12)*. Strain cracks in synthetic emerald overgrowths are described in Dr. Gubelin's article "More Light on Beryls and Rubies with Synthetic Overgrowth," Winter, 1960-61, *Gems & Gemology*. The new wafer type is apparently grown in such a way that several very thin layers of identically oriented (presumably natural) white beryl are placed in the growth chamber. Synthetic emerald then grows between them, filling the space and making considerably thicker tablets than could be grown ordinarily in the same length of time. This has a distinct advantage over the earlier method; it produces the depth of color desired. The major fault with the early Lechleitner effort was that the result was too pale to resemble fine emerald. Cut stones given to us for study had a much greater intensity of color than we had seen in the overgrowth on the prefaceted beryl. The layered structure is clearly evident in *Figure 13*.

The tablet of solid synthetic emerald showed all of the characteristics of the Chatham material under magnification. The distribution of wisplike inclusions was also very similar *(Figure 14)*. The color both in daylight and under short- and long-wave ultraviolet was essentially identical to Chatham's product.

There were distinct differences in characteristics between the early overgrowth of synthetic emerald on beryl and the findings made on each of the new Lechleitner products. Holmes and

Crowningshield reported refractive indices of 1.575-1.581 for the initial *Emerita (Gems & Gemology,* Spring, 1960). The layered cut stones showed 1.564-1.569 on the colorless layer, and the uniform synthetic-emerald plate gave readings of approximately 1.560-1.563.

The specific gravity of *Emerita* was given as 2.649-2.707, and the two recently received crystals were .008 above and below 2.70. The average of the two faceted interlayered types was 2.678 and the uniform synthetic emerald was only 2.647; this is within the range of Chatham material.

As might be expected, the red fluorescence of the three types varies with the amount of synthetic emerald contained. The overgrowth type is usually weakest, because the thickness of the synthetic is usually small in relation to the colorless beryl. Layered material is stronger, but the uniform synthetic emerald is markedly stronger than either. In all cases, a dark room and a dark, dull background are essential to an accurate assessment of the strength of fluorescence. Fluorescence to long-wave ultraviolet is similar to that of other synthetic emeralds, in that it is appreciably stronger than under short wave.

Under crossed Polaroids, both the overgrowth and the layered types give single-crystal reactions. The wafer of synthetic emerald shows the same mosaic pattern as that encountered in the Gilson crystal perpendicular to the optic-axis direction *(Figure 15)*. There are several distinct prismatic crystals protruding from the main pinacoidal surface.

There should be little difficulty in distinguishing these new products from natural emeralds, because the properties of the solid types are so close to figures published for Chatham and the old German synthetic emeralds.

It is interesting to speculate about the impact of these new synthetic emeralds on the synthetic market.

Two New Synthetic Emeralds

by
Dr. E. J. Gubelin

About one year ago, Professor Karl Schlossmacher announced the advent of a new synthetic emerald on the market and informed the reader that the product was being made by Mr. Walter Zerfass, at Idar-Oberstein[1]. His detailed description of the physical properties revealed that they were very similar to those of the synthetic emeralds produced by Chatham and by the German Dye Trust. The R.I. values have been found to be 1.555 for ε and 1.561 for ω, which result in an unusually high birefringence of .006; whereas the double refraction for synthetic emeralds of other makers is about .003 to .004, thus serving as a reliable means of identification. The well-known "bright-line" effect in benzylbenzoate, which was discovered by Professor Schlossmacher and recently described by R. K. Mitchell[2], is also very conspicuous, since the refractive indices are even lower than those in Chatham's synthetic emeralds. The specific gravity has been determined at an average of 2.66, which coincides very well with the constants of other synthetic emeralds. The newcomer among synthetic stones also displays distinct fluorescence under both long- and short-wave ultraviolet light and thus makes no exception to the synthetic emeralds hitherto known. The general appearance of the endogenetic structure is determined by the characteristically irregular distribution of the wisplike "feathers" that immediately betrays the manmade origin, even when observed through a pocket lens. Careful examination showed, however, that the seemingly random arrangement of the liquid feathers actually results in a honeycomb pattern. Examining the stones at a right angle to the optic axis, the walls of the honeycomb cells appear to be shaped by the liquid feathers; these, in turn, are formed by parallel, elongated liquid-filled tubes. The feathers, however, do not extend uniformly from the top down into the depth of the stones but are interrupted, forming ribbons, or tapes, that run more or less parallel to the basal plane, thus producing the appearance of parallel banding. Two photomicrographs illustrated these new features of the endogenesis in what was, at the time Professor Schlossmacher wrote, the latest synthetic emerald.

Meanwhile, more synthetic emeralds of Zerfass' production have appeared in the trade, and I recently received a small number of samples that granted me the welcome opportunity of investigating them more closely. In the accompanying letter, Mr. Zerfass stated that for the time being he could only turn out small stones in good quality; larger pieces (above ½ carat) could not yet satisfy the jeweler. I was surprised at the fine quality of the stones sent me, since they were an intense bluish-green hue of medium tone and resembled very closely genuine emeralds from the Chivor and the Gachala mines, in Colombia. I was able to confirm Professor Schlossmacher's statements mentioned above, and the figures I obtained concur very closely with his. The refractive indices, measured on the Rayner refractometer, resulted in the average value of 1.558 for ε and 1.562 for ω, with a birefringence of .003 to .004.

The bright-line effect in benzylbenzoate appeared very distinctly and the difference in the dichroic colors was also most remarkable. The specific gravity was 2.66, thus coinciding with all other synthetic emeralds and rendering it easy enough to identify them in a diluted solution of bromoform. In short- and long-wave ultraviolet light, Zerfass's emeralds are readily excited to glow with red fluorescence. Although the ordinary jeweler might be satisfied with this information and be content that he will encounter no difficulty in recognizing these new synthetics and distinguishing them from genuine emeralds, a keen gemologist may be interested in differentiating this new man-made product from other synthetics already familiar to him.

Professor Schlossmacher has already pointed out some telltale characteristics of the inclusions, but the question arose as to whether the honeycomb pattern was of accidental occurrence or a constant feature. In all the specimens I observed, this particular arrangement of wisplike feathers formed hexagonal cells, but in most cases they were distorted hexagons. It is interesting to note that the honeycombs occurred especially around the center, where occasionally the hexagonal cell takes up the central area as if it had grown as the first-born, followed by the surrounding prisms. Thus, the seemingly irregular arrangement of the veillike liquid feathers is governed by certain directional forces that play their role during the crystal growth *(Figure 1)*. When I turned the stones and looked into them in a direction parallel to the basal plane, there appeared the banded liquid feathers exactly as Professor Schlossmacher described them[1] *(Figure 2)*. The strong impression of parallelism was empha-

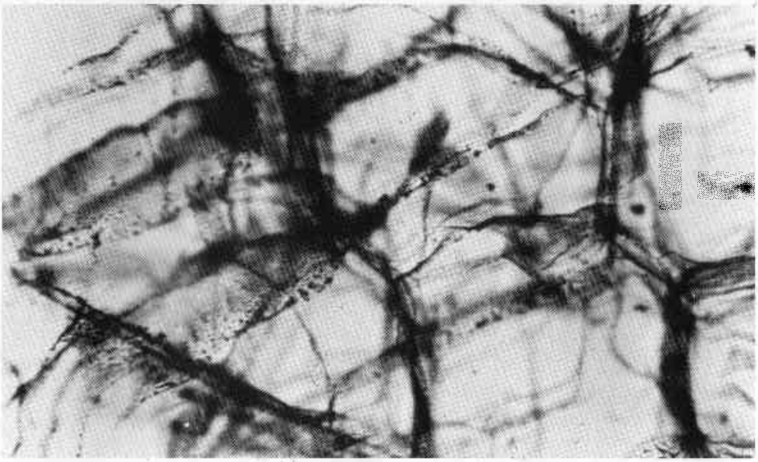


Figure 1 **Honeycomb pattern of wisplike feathers, as observed through the table facet (120x).**

Figure 2 **Banded lateral appearance caused by horizontal fluid ribbons and zonal structure (75x).**

sized by a striking zonal structure that was well marked by straight, black lines between which the intervening matter appeared in various shades of green, with some even being colorless. Most of these parallel layers contained liquid feathers, but a few were substantially devoid of any inclusions. It seems, thus, that the synthetic crystal did not develop in one continuous growth action but rather in interrupted periods, owing to changes in temperature and the con-

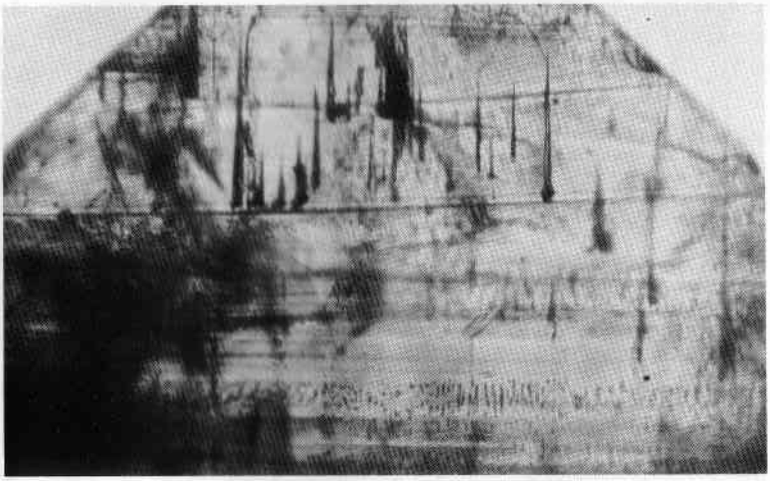


Figure 3 Group of cuneate growth funnels (75x).

centration of the feeding material. This periodically intermittent growth resulted in a zonal structure. It is during just such intervals of interruptions that individual seed crystals may develop; these are either emeralds, if the concentration of the solution remains unchanged, or phenakites, if the feeding material becomes deficient of alumina. Most of the layers suffered from strong stresses, which, when released, formed cracks. The nutrient solution immediately penetrated these cracks and caused them to heal partly, thus forming the well-known wisplike fluid feathers. Within the ribbons, the single-liquid droplets form mainly small tubes, that are parallel to the c-axis, giving the feathers a striped texture. The general appearance and arrangement of these feathers, together with the highly evident strict parallelism, produces a much more orderly impression than in other synthetic emeralds.

While investigating these internal details, I was surprised at the presence of yet another kind of inclusion that yields conclusive evidence as to the method of production employed by Zerfass. Cuneate growth-funnels of exactly the same type that have been described before as being typical endogenetic features of the synthetic emeralds made by Professor R. Nacken[3,4], and that also occur in the synthetic mantle of Lechleitner's *Emerita,* appeared in the synthetic emeralds made by Zerfass *(Figure 3).* With their broader end, they "stood" on a tiny microlite (probably a phenakite) whereas the tapering tube running parallel to the c-axis ended in a point. The cuneiform cavity is a two-phase inclusion that contains both liquid and a gas bubble *(Figure 4).* The existence of these growth funnels permits the assumption that Zerfass obtains his synthetic product by the hydrothermal

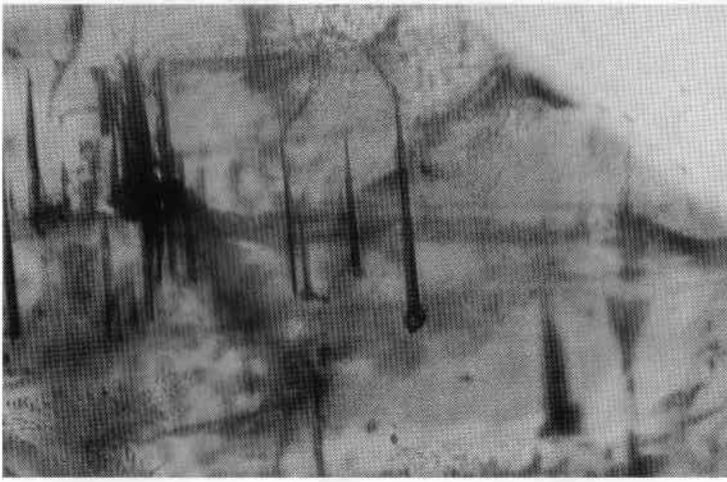


Figure 4 **Cuneiform growth funnels standing on a tiny microlite of phenakite (125x).**

method, as opposed to Chatham, who proceeds by the method of the diffusion melt[4,5,6]. The refractive index of the microlites from which the growth funnels start is higher than that of the host; also, the interference colors are remarkably more vivid in polarized light. It is well known from investigations carried out with other synthetic emeralds that phenakite may develop as an undesired mineral of the internal paragenesis[4]; therefore, it is not inappropriate to assume that these tiny guests are also phenakites. This accessory mineral is limited in size to minute grains, whereas in the synthetic emeralds made by the German Dye Trust and Chatham the microlites develop relatively large aggregates of euhedral crystals. In the synthetics by Zerfass, they may occur singly or in great quantities, according to the local importance of the phenakite components. The cause of their formation lies in a local and temporary deficiency of alumina in the "mother solution," which seems to occur at the beginning of a new phase when a fresh layer is built up *(Figure 5)* or, more rarely, during the development of individual layers. This fall of the concentration of alumina is due to periodical changes in the nutrient or the temperature of the alkaline solution. These alterations may also be responsible for the intermittent growth that results in the formation of layers. The crystal growth stops when the appropriate amount of alumina becomes deficient and when seed crystals of phenakite spring into eixstence; when the content of alumina increases again, crystal growth is resumed and the next layer is formed. In recapitulation, it may be claimed that the process used by Zerfass is the *hydrothermal method,* resembling the procedure employed by Professor R. Nacken. The synthetic crystals are marked by parallel layers

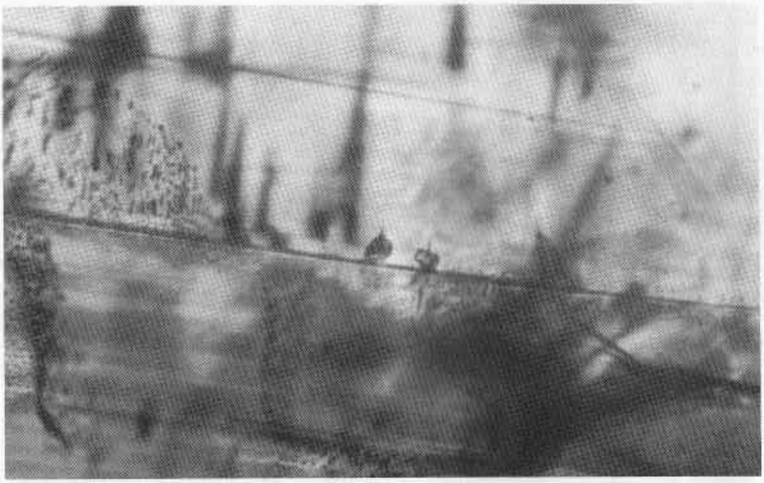


Figure 5 **Minute seed crystals of phenakite, formed on the surface of the last layer when alumina concentration was low. Tiny growth funnels had just started to grow on the microlites.**

that result from intermittent crystallization. The layers themselves either develop as an assemblage of individual cells separated by liquid films of mother liquor that fostered their coalescence or, more probably, the liquid feathers are healing fissures that first formed as cracks (often embracing hexagonal blocks) that resulted from the sudden release of internal strain.

Another new synthetic emerald of even more recent production made its appearance towards the end of 1963. This latest newcomer on the gem market displays a warmer, more pleasing look, in that its green color is enhanced by a yellowish tint that causes it to be in remarkable harmony with Muzo and Sandawana emeralds of outstanding quality. After stubborn investigations, the name of the firm in Paris where the French synthetic emeralds were being made was traced. It is Messrs. Pierre Gilson, at Champagne-lez-Wardrecques, Pas de Calais, which is north of Paris. Consequently, the latest synthetic emeralds appeared on the market as Synthetic Emeralds by Gilson.

To the unaided eye, these new synthetics appear relatively pure and, indeed, under the microscope it becomes immediately evident that they are less densely permeated with inclusions. The predominant kind of inclusion, however, is formed by the analogous wisplike feathers that are characteristic of all previously manufactured synthetic emeralds. In surprising distinction to the products of the German Dye Trust and Zerfass, however, the French synthetics contain very few single veils that cross each other in irregular curves at only one or two points below the table facet *(Figure 6)*. The lateral view discloses the feathers to

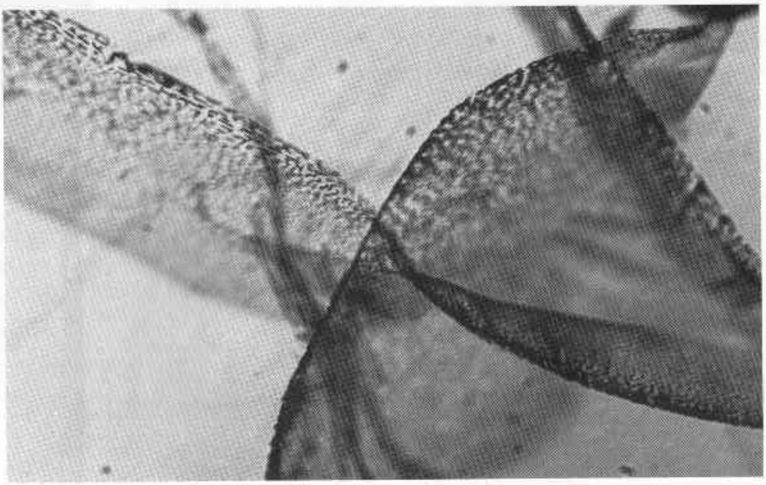


Figure 6 Softly curved wisplike feathers, as seen through the table facet of the new French synthetic emerald (75x).

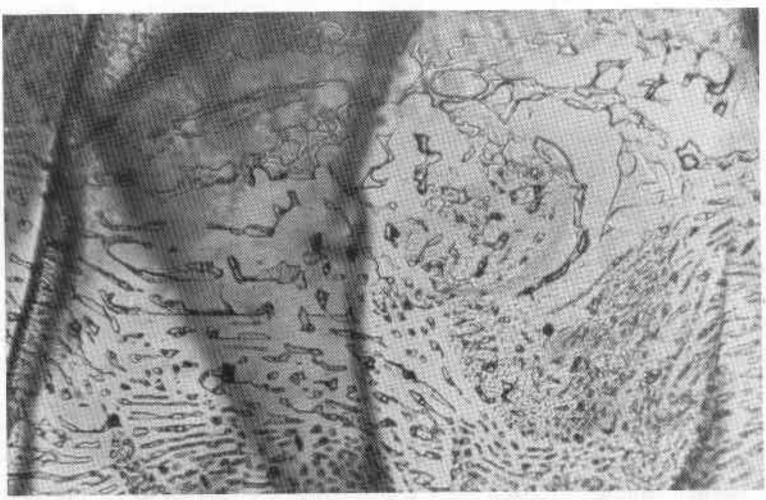


Figure 7 Lateral aspect of wisplike feather, consisting of irregularly shaped fluid droplets, some of them being two-phase inclusions (125x).

consist of irregularly shaped and disorderly disseminated fluid drops. In some places, the droplets assemble into curved hosts, as if they had been subjected to a flowing or whirling action *(Figure 7)*. Some of the feathers are also traversed by narrow sections within which the individual droplets are oriented in a different direction, thus creating the impression of folds. This peculiarity of many liquid feathers is also quite characteristic of synthetic

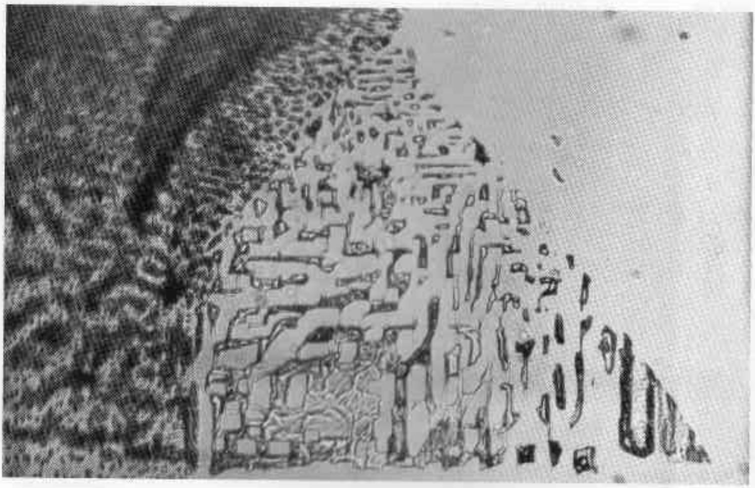


Figure 8 Flat, fluid films, exhibiting the characteristic appearance of the "undigested" liquid drops in healing fissures (125x).

emeralds by Chatham. Many of the larger fluid drops are two-phase inclusions, in which the gas vesicle is conspicuously tiny. On the whole, it may be stated that the general appearance of the texture of the liquid feathers and the irregular shapes of their fluid drops closely resemble those in "Igmeralds" and Chatham's synthetic emeralds, with which gemologists have become familiar through their own observations and through the numerous publications on the subject. There are the liquid-filled canals, single or assembled ones, running parallel to the direction of the c-axis; the irregular fluid hoses; the recticulated nets, formed by intercommunicating droplets; the curved tubes; and the flat, thin films in disoriented distribution, which, in their totality, characterise the unique inclusion picture of synthetic emeralds *(Figure 8)*. Considering the pronounced correspondence among the endogenetic-fluid formations of "Igmeralds," Chatham's products and the new French synthetic emeralds, it may consequently be inferred that all three products have been or are being made by the same process; i.e., the *diffusion melt*. This course of reasoning does not, however, postulate that the temperature gradient, the concentration of the feeding material, the catalyst and accessory constituents may not differ slightly. The new French production supplies a distinct corroboration for this assertion, in that all specimens so far examined appear to be devoid of phenakite crystals of any size, implying that the phenakite phase is being excluded from the manufacturing process.* The investi-

*Editor's note: Apparently this condition is not true of all Gilson material in that some examined in Los Angeles and New York contained an abundance of phenakite.

gation of the physical properties revealed a remarkable concurrence with the constants of the other synthetic emeralds. The average figures for the refractive indices are $\varepsilon = 1.558$ and $\omega = 1.562$, resulting in the typically low birefringence of .003. The dichroism displayed a more strongly pronounced yellow component for the twin color of the ordinary ray, whereas the bluish green of the extraordinary ray is somewhat more subdued. In the absorption spectrum, which exhibits the normal absorption lines of emerald, I was not able to detect any lines that might be ascribed to iron; however, I suspect them to be present in very small traces. The specific gravity also did not differ from the ordinarily low value and was found to be 2.655.

When the specimens were subjected to long- and short-wave ultraviolet light, a surprising reaction emerged: they did not emit the expected red fluorescence of other synthetic emeralds but emanated an olive-green color, which appeared to be weaker in the short waves of 2537 Å. Under crossed filters, on the other hand, they developed a brilliant-red fluorescence that was very similar to that of samples from the other producers. The following table may serve as a means of comparison and distinction.

Comparison of Physical Constants

Product from:	*Refractive Index* ε	*Refractive Index* ω	Δ	*Specific Gravity*
German Dye Trust "Igmerald"	1.559	1.562	.003	2.65
Chatham	1.560	1.563	.003	2.65
Zerfass	1.558	1.562	.003 .004	2.66
France	1.558	1.562	.003 .004	2.65

Comparison of Fluorescence Colors

Product from:	*3650 Å*	*2537 Å*	*Crossed Filters*
German Dye Trust "Igmerald"	Strong red	Strong brick red	Glowing red
Chatham	Strong red	Dull bluish red	Glowing red
Zerfass	Strong red	Dull bluish red	Glowing red
France	Olive green	Weak olive green	Glowing red

From this different behavior of the new French synthetic emeralds under ultraviolet light, we may suspect that some new ingredient, most probably iron, is being added to the nutrient material. This ingredient may not only be responsible for the green fluorescence, but also for the improved and more pleasant color of these newcomers. Iron is well known to act as an inhibitor to luminescence. The presence of iron is clearly corroborated by tiny metal inclusions of brownish color, which I assume to be ilmenite; they are arranged in planes parallel to the basal pinacoid.

Summary. Two new synthetic emeralds are now on the market. They are true emeralds, as far as their chemical composition, physical properties and color are concerned. Their quality, which is quite good, may be compared with genuine emeralds of second grade from certain localities. There is no basis for any alarm, however, since they can be identified easily by their typically low physical constants and by the same general endogenetic formations; i.e., wisplike feathers, as all the synthetic emeralds hitherto made possess. Small differing details of the internal paragenesis and the fluorescence in ultraviolet light enable the interested gemologist to distinguish the products of the various makers from each other.

Literature

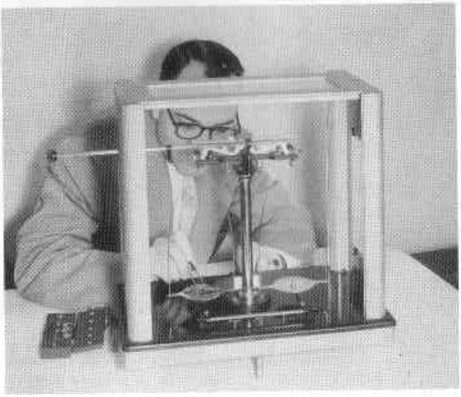
1. K. Schlossmacher, "Eine neue Smaragdsynthese." Zeitschrift der Deutschen Gesellschaft für Edelsteinkunde, Heft 43, Frühjahr, 1963.
2. R. K. Mitchell, "A Variation of the Becke-Line Effect." The Journal of Gemmology, Vol. VIII, No. 2, p. 280.
3. G. van Praagh, "Synthetic Emeralds." Science News, 3, 1947.
4. W. F. Eppler, "Synthetischer Smaragd." Deutsche Goldschmiede Zeitung, Nr. 4, 1958.
5. W. F. Eppler, "The Herbert Smith Memorial Lecture." The Journal of Gemmology, Vol. VIII. No. 3, p. 88.
6. W. F. Eppler, "Synthetic Emerald." The Gemmologist, Vol. XXX, No. 358, p. 81.

Developments and Highlights

at the

GEM TRADE LAB

in Los Angeles



by

Richard T. Liddicoat, Jr.

Since the Winter, 1963-64, issue of *Gems & Gemology* went to press, the Los Angeles Laboratory has encountered an unusual number of interesting problems, conditions or materials. Many of these were photographed.

The Effect of Excess Heat on a Diamond's Surface

There is nothing particularly unusual about a diamond being subjected to excess heat in a fire. The appearance of the surface at the stage before it becomes frosted is characteristic. We were able to take a photograph of this appearance that should aid in its recognition by those unfamiliar with it. *Figure 1* shows a magnified portion of one bezel and star facet on the crown of a diamond that had been rather severely affected at the surface but that was not otherwise harmed. The stone was sent in for identification, probably because it did not have diamond's characteristic brilliancy to the eye. The surface was shiny and gave the impression of having been covered with a hardened, clear glue or lacquer. It gave the impression that it could be cleaned off readily, but even boiling in acid would not remove what resembled a coating. The only successful corrective action would be to repolish the stone. The appearance in *Figure 1* is typical of a "fire-coated" diamond.

Figure 1

Unusual Refractometer Readings

Two stones were submitted to the Laboratory by a former student in what we assumed to be a routine identification. When a small colorless stone was placed on the refractometer, we expected from the luster either a reading for synthetic spinel or perhaps for corundum; therefore, when readings of 1.72 and 1.735 appeared, we were startled. When a Polaroid plate rotated in front of the eyepiece confirmed the double refraction, we were faced with confirmation that we had an unusual material. Examination under magnification disclosed that we were examining a hexagonal bipyramid, hemimorphic in nature. The uniaxial-positive optic character, in addition to other properties, led to the mineral bromellite (beryllium oxide) as the only likely possibility. The rounded gas-vesicle inclusions suggested that it was synthetic; the man who brought it in confirmed the fact that the material was indeed manmade. As yet, he is not ready to disclose details of the process used or, indeed, anything regarding its origin. The properties are as follows: it is uniaxial-positive with an ordinary ray of 1.720 or 1.719 and an extraordinary ray of approximately 1.735; the specific gravity for the small crystal was determined to be 3.00 ($\pm$.02); its fluorescence under long-wave ultraviolet was a faint orange, but no fluorescence was detected under short-wave ultraviolet or X-ray; nine scratched the material with difficulty, but eight did not; and, it was transparent and colorless. The stone examined is pictured in *Figures 2 and 3.*

Another Hollowback

When the piece of jewelry pictured in *Figure 4* was first examined, the un-

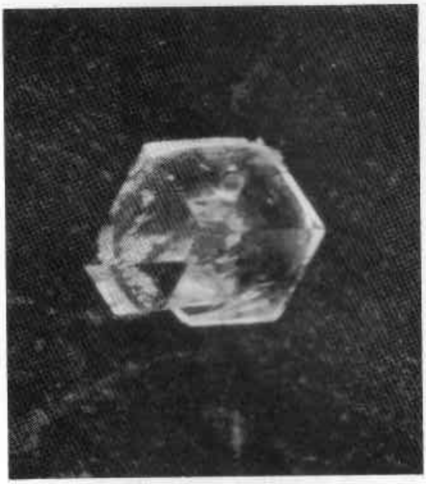


Figure 2

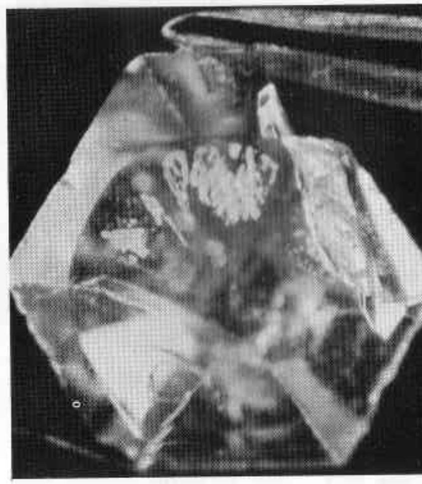


Figure 3

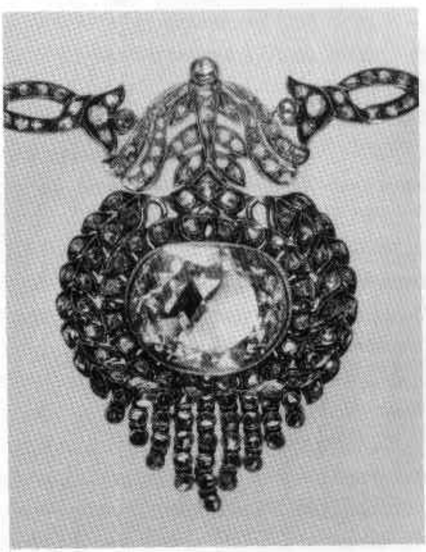


Figure 4

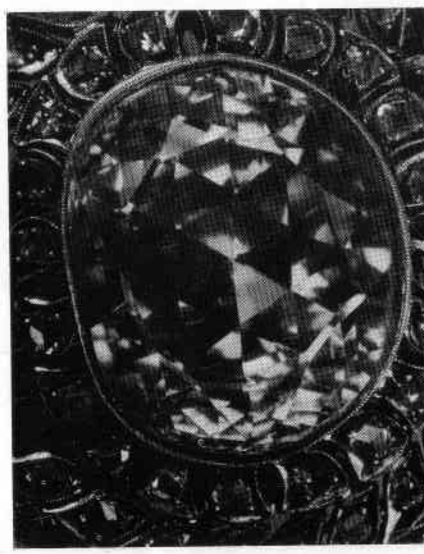


Figure 5

usual appearance and the covered back led us to suspect that we had a thin flat piece of diamond, cut as a crown with no pavilion. An impression of the presence of a pavilion is conveyed by cutting facets into the metal beneath the diamond crown. Inspection under magnification usually discloses the nature of this kind of fraud. One clue is seen under the table edge, where reflection

Figure 6

of crown facets from the flat back of the thin cap gives a double line of facet edges that seems to outline the table. This double line shows up clearly in *Figure 5*. In addition, nicks or dust on the base of the thin cap are usually seen under magnification. Such stones, which are cut from thin macles or flats, have the spread of a many-carat stone, but actually have only the depth of a crown of such a diamond. In *Figure 5*, the reflection appears as a double edge to facets around the table; this is particularly noticeable on the right-hand side of the table.

Huge Natural

Recently, we examined and graded a large pear-shaped diamond with a huge natural. The length of the natural (several millimeters) was so great in relation to the total length of the stone that we made a photograph of it *(Figure 6)*. Note that it extends from well to the left of the corner prong and considerably to the right. A natural of this size is very readily visible to the unaided eye, and in this case it distorted the symmetry of the pear shape. It actually was a shield shape, with nearly flat sides and high shoulders.

An Interesting "Pedigree"

Sometimes the stories that come with the stone to be identified are as interesting or more so than the identification. A large white ovoid mass of approximately 30 millimeters in the long direction and slightly over 20 in the circular cross section was brought in with a written "pedigree" signed by a professor at an Indonesian university. It was reported to contain a coconut pearl of great beauty and value. The ovoid mass covered it, much as the shell of a coconut covers the fruit beneath. The object had a specific gravity that was near 2.4 and a very interesting and odd appearance in certain lights looking down on either narrow end. The bull's eye pictured in *Figure 7* was photographed to illustrate this appearance. The object turned out to be glass, made up in concentric cylindrical layers covering the initial thin rod, and then rounded off at the ends.

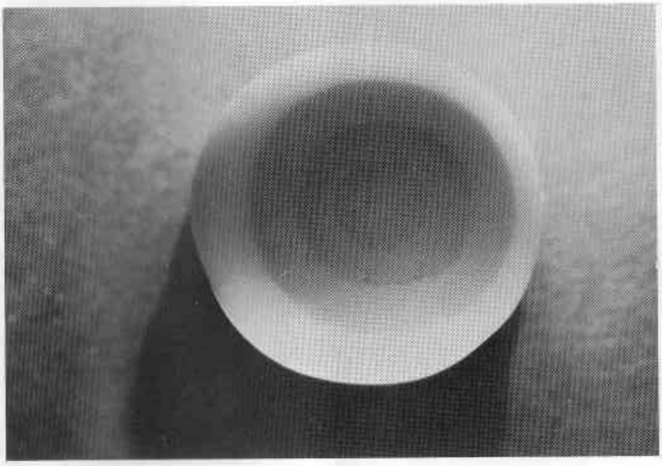


Figure 7

Diamonds Lacking in Brilliancy

Two diamonds of equal size and with comparable proportions and finish may differ greatly in brilliancy; this may be true even when both are clear to the unaided eye. Occasionally, diamonds with no obvious inclusions under 10x have almost no brilliance. In a sense, it is to this type of diamond that grading for purity is much more meaningful when called *clarity grading* than *imperfection grading*. The older term, *imperfection grade,* never seemed to be truly applicable. If a diamond has cloudy inclusions that reduce its transparency materially, even though no individual inclusion is visible under a loupe, there is no question but that its value is reduced tremendously, because it does not have the beauty we associate with a fine diamond. Two large diamonds brought to the Lab for grading showed this characteristic to vastly different degrees. One showed cloudy areas readily under 10x and was noticeably lacking in brilliancy; it also had several important cleavages, so that the clarity grade was never in question. However, without the cleavages the clarity grade would have had to be almost the same, since the transparency was so seriously reduced by the cloudy inclusions. The other stone presented a more serious problem, because the inclusions were so minute that only under certain lighting conditions could they be seen at all under 10x and then only with great difficulty. Despite the fact that the proportions were nearly ideal, it was lifeless, and merited, in our opinion, a distinct downgrading in clarity to compensate for or explain its appreciable reduction in value based on this dullness. Each of the stones showed a peculiar surface appearance under magnification; it could best be likened to a

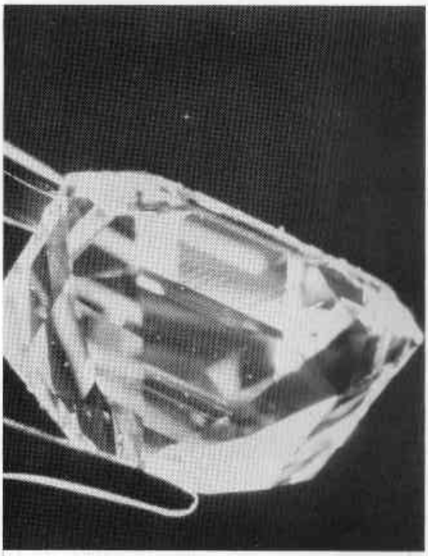


Figure 8

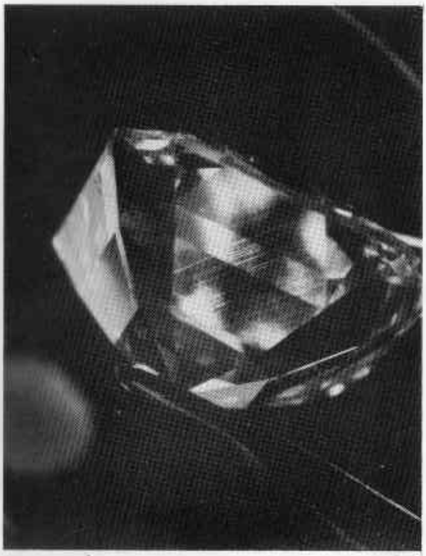


Figure 9

very fine-grained version of the "orange-peel" effect seen on some polished jadeite. In other words, this dimpled appearance could be seen only faintly under 10x. It is probable that each of the stones contained millions of minute gas inclusions, very tightly spaced, and that the polishing left a very finely pitted surface that contributed to this faint orange-peel effect. How far down the clarity scale the second stone should be graded is surely a matter of opinion; we believe that its lack of brilliance suggests a material downgrading. There is no question but that this would cause violent objections on the part of the owner, because of the lack of obvious inclusions under 10x. However, anything that materially reduces the transparency and thus the brilliancy of a diamond must reduce its value in proportion to the reduction in brilliancy.

Growth Lines

Usually, growth lines in a diamond are visible only with difficulty, and then only in certain positions and under ideal lighting in a large stone. Recently, we received an emerald-cut stone in which the growth lines were accentuated by tiny cloudy inclusions, giving the stone a streaked appearance, as shown in *Figure 8*. To accentuate this banding, we took the photograph a second time between crossed Polaroid plates. In *Figure 9*, the strained condition of the diamond is readily evident from the shredded pattern and the light areas, as seen in the end facets of the pavilion. The streaks are also emphasized and now are readily visible, not

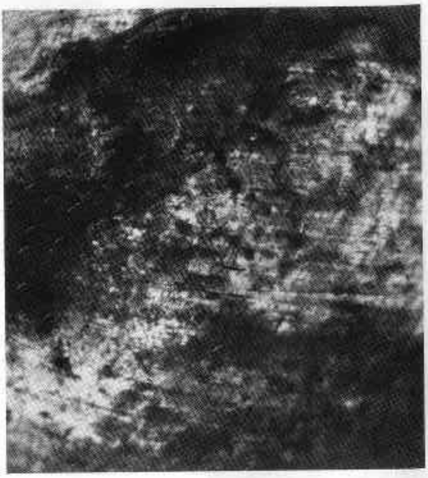


Figure 10

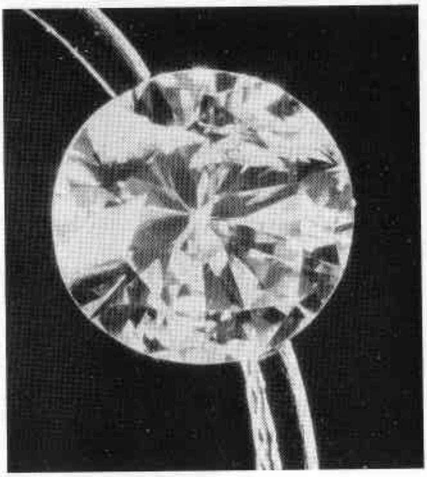


Figure 11

just in the upper facet but in the next two as well. This is a condition very similar to that described in the last paragraph and one that also affects brilliancy, but in this case to an appreciably lesser degree.

Star Labradorite

A blue-gray cabochon showing a distinct four-rayed star was identified as labradorite feldspar. The inclusions were rather coarse and sufficiently dense to be rather difficult to photograph. However, *Figure 10* shows the appearance of the stone under magnification, to give an idea of the nature of the inclusions causing the star.

Twinning in Pink Diamond

Most pink diamonds are characterized by very strong twinning and quite often by narrow zones of deeper color. *Figure 11* was taken to illustrate this typical banded twinning structure and color zoning. In a bezel facet at 2:30, parallel bands of color may be seen extending from the girdle toward the culet. Twinning lines appear as a series of parallel lines running from the corner of the table at 2:30 toward the culet. Several distinct parallel lines are visible. Tightly spaced twinning may be seen in a direction from about 11 o'clock toward the culet.

Cyclotron-Treated Diamonds

It is rare today to see green or yellow diamonds that were given their irradiation initially in a cyclotron, rather than in a nuclear reactor. However, a group of three green diamonds examined in the Laboratory showed the characteristics of cyclotron treatment. Of these, only one had the so-called cloverleaf, or umbrella effect, at the culet. One with a huge culet showed the very in-

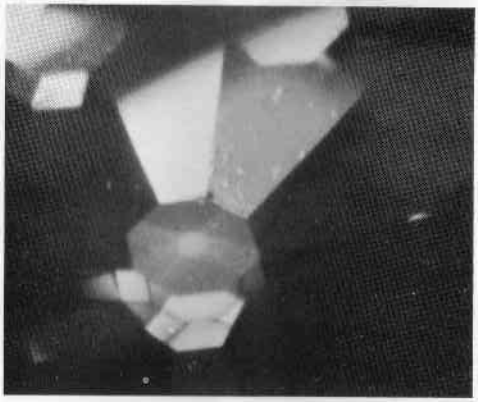


Figure 12

teresting pattern that is pictured in *Figure 12*. There is a lighter spot in the center of the large culet and vague outlines of the near-culet portions of the pavilion main facets. Traces of the lines of intense color representing the maximum depth of penetration of the bombarding particles, are seen on adjoining facets. Such lines are most readily seen by looking through the crown toward the culet, especially if the stone was bombarded with the culet side toward the beam.

We Appreciate

The gift of 50 demantoid garnets from Los Angeles jeweler, **Dave Widess.** These stones fill a great need in our practice-stone sets.

From **Martin Ehrmann,** Beverly Hills gemstone dealer, we received a rough specimen of scheelite plus faceted quartz, synthetic rutile and white sapphires.

We are grateful to **Joseph Uram Jewelers,** Miami, Fla., for the synthetic sapphire ("Thrilliant").

A selection of stones that consisted of glass, carved ivory, plastic and lapis-lazuli imitations donated by **J. J. O'Brien**, Midas Diamond Brokers, Goleta, Calif., were gratefully received.

Any natural, synthetic, assembled or imitation is always gratefully received by the GIA. The better ones are considered for our display cases; others are used to meet the tremendous demand for practice sets that accompany our Identification-Course Assignments or those mailed to other students for practice.

Black-Treated Opals

by
Dr. E. J. Gubelin

News has recently been leaking out of Australia that white opals are being blackened artificially, and several parcels have been offered on the market in Europe. Through the ever-helpful cooperation of Mr. Arthur W. Wirth, whose keen interest in gemology is well known to members of the trade, I was able to acquire and investigate various qualities of these treated opals.

To the uninformed jeweler and to the unaided eye, these stones do not have a suspicious appearance; therefore, it seems appropriate to publish a word of warning and to describe their distinguishing features.

The most reliable means of detection is the microscope. Although in white and black opals of natural color the gelatinous body material appears rather homogenous, the treated samples teem with granular black dots that resemble black dust, which are formed by the dried residue of the artificial coloring agent. This dust is very easy to perceive, even under weak magnification, and its appearance is so characteristic that distinction from undyed opals becomes quite simple *(Figure 1)*.

The dyestuff does not seem to penetrate the stone deeply but is concentrated in the cutaneous layer, which becomes apparent in translucent specimens at a depth of about two millimeters, where the untreated white opal is visible. This confinement of the color concentration to a thin portion at the surface may lead to a complete loss of color if the stone is repolished. The texture of the surface, as well as the distribution of the black dots, leads to the conviction that a rather porous material with many cracks is being subjected to dying. In some parts of the

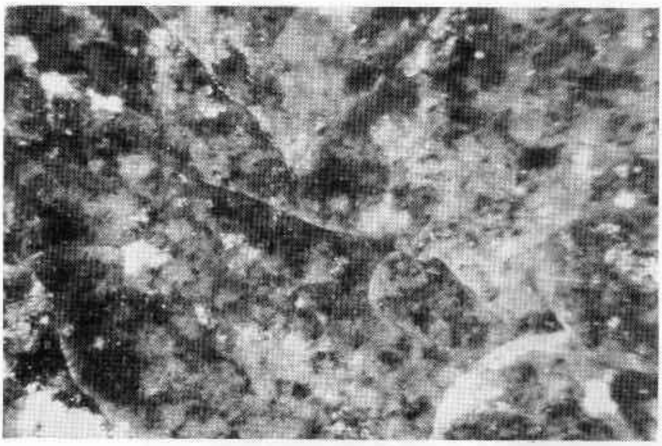
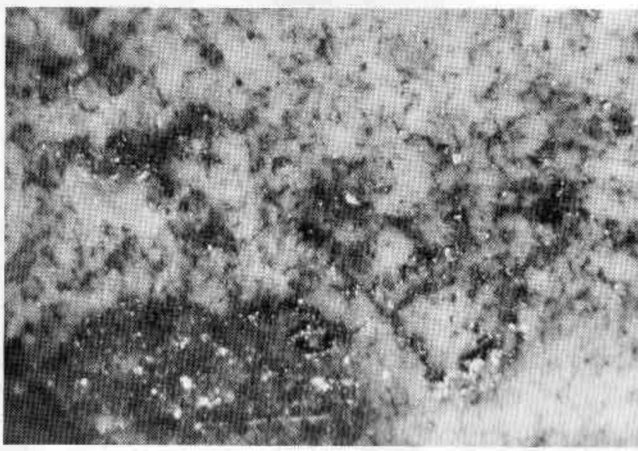


Figure 1

Figure 2



stone the black dust is densely accumulated; in other less-porous areas it is much less evident, producing a cloudy appearance *(Figure 2)*. The gray and cloudy white patches thus form the sparse dissemination in which the coloring residue is especially conspicuous. In some opals of inferior quality, there exist, along certain cracks, veins and patches of a dense-white material (possibly agate) that remains clean and free from the dying agent, since it is impossible for the dye to penetrate these dense areas.

The accompanying photomicrographs illustrate more adequately than words the resulting appearance of this method of treatment, and I trust that no reader will hereafter find it difficult to identify an artificially dyed opal.

The black coloration proved to be resistent to acetone, hydrochloric and nitric acid, sulphuric acid and aqua regia, as well as to benzene, carbontetrachloride and ethylenedibromide. The Gem Trade Laboratory in New York reported*, however, that it could be removed easily by *warm* sulphuric acid. The possibility of removing the coloration either by chemical reaction or by recutting makes it imperative to mark these stones with the clear and unmistakable designation: artificially-treated opal.

*Robert Crowningshield, "Black-Treated Opal." *Gems & Gemology,* Fall, 1962, page 336.

New York RJA Supports GIA program

The faculty and administration staff of the Gemological Institute were highly gratified by a recent communication from the New York State Retail Jewelers' Association.

A letter over the signature of Herschel M. Graubart, the then president of NYSRJA, contained an unsolicited gift of $100. The letter said in part:

> *The Board of Directors of the Association meeting in Schenectady, N.Y., January 26, voted this contribution in appreciation of, and to help further, your valuable work for our Industry.*

This money will be used to further the Gemological Institute's expanded research program that is aimed at keeping abreast of developments in the form of new synthetics and imitations. Sustaining-membership dues are also used specifically for research purposes. Support of this nature has enabled the Laboratory to purchase recently over $6000 of X-ray-diffraction equipment to further our research effort.

We are indeed appreciative to the New York State Retail Jewelers' Association for their generous recognition of GIA's efforts in behalf of the jewelry industry.