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HYDROTHERMAL RUBIES AND EMERALD-COATED BERYL

By E. GÜBELIN

TWO new forms of substitutes for gems have appeared on the gem market in the course of the last 15 months and only a few samples have as yet been submitted for investigation. These few, however, have offered ample possibilities for thorough examination and especially for the finding of characteristic means of distinction.

HYDROTHERMAL RUBY

In the autumn of 1958 two American scientists, R. A. Laudise and A. A. Ballman,(1) of the Bell Telephone Laboratories, succeeded in producing synthetic ruby by the same hydrothermal process as was used for making synthetic quartz. At first this achievement was considered to be of mere scientific or technical interest, until Carroll Chatham announced similar progress in his laboratory in San Francisco and declared that he would soon develop the experimental stage into commercial production. He also claimed that the new production would provide stones that were more reminiscent of natural rubies. It is to be anticipated that these new synthetic rubies may be placed onto the market and one can but hope that they will not be sold with misleading names.

The apparatus used by Laudise and Ballman corresponds with that which Bell Telephone Laboratories are using for the synthesis of quartz—which has its ancestry in the method invented by Professor R. Nacken. However, the task is much more complex because the nutrient in the form of aluminium oxide complicates the problem on account of the various modifications (gibbsite [$Al(OH)_3$], boehmite [Al OOH], diaspore [Al OOH] and corundum [Al_2O_3]) in which it occurs. Many experiments were necessary in order to ascertain optimum conditions of the techniques. Solvent, nutrient, temperature, pressure and the additional foreign reagents, are only a few of the variable factors which may render the hydrothermal synthesis a hazardous gamble.

The autoclave consists of a welded steel cylinder closed with a threaded cap which could support pressures in excess of 30,000 pounds per square inch. In the cavity of this vessel a cylindrical silver tube is placed, within which the reaction takes place. The nutrient, consisting of poorly crystallized gibbsite [$Al(OH)_3$] or corundum [Al_2O_3] is concentrated at the bottom of the silver tube and the tube is filled with sodium carbonate. The seed crystals, which might be either natural or synthetic ruby, of desired orientation, are suspended from a silver frame in the upper part of the apparatus. This assembly is heated up to 400°C. from below by means of an electric heating plate. The top region remains cooler, thus leading to temperature conditions which cause circulating currents in the interior of the saturated alkaline solution. This is very similar to the water central heating system, raising the warmer solution from the area of the nutrient to the top of the bomb, while the cooler solution sinks to the bottom, where it is heated and made to ascend again. The precipitation of the reagent, that is to say the crystallization of alumina (corundum), takes place on these seed crystals, which grow analogous to any natural or synthetic crystals, forming in a solution in accordance with their typical crystal habit and developing all the faces characteristic of their particular species. Thus the nutrient, which is first an aluminium-hydroxide, transforms into alumina crystals during this process. One single run may take one or two months. It is interesting to learn that Verneuil synthetic rubies of the rod shape made by Linde Air Products may be used as seed crystals, if slabs are cut whose main face is oriented at right angles to the main crystal axis.

The crystals grow extremely slowly. Under favourable conditions the growth rate may vary from 2/1000 to 1/100 inch per day. The fastest-growing face is the basal plane, whereas flat plates seem to be the prevalent forms on which the prism faces are strongly reduced. Occasionally rhombohedral forms are also developed. The sizes of these hydrothermal rubies vary from ¾ to 1¼ inches. The colour depends upon the percentage content of chromium oxide. The best hue is obtained through the addition of one per cent of chromium, i.e., in that 1/10 g. sodium-chromate is added to one quarter gallon of solvent. The colour is also affected by the material of the interior wall of the autoclave, which makes the corundum crystals green if it is made of iron. Silver gives the best results.

I have recently had the opportunity of examining a few hydrothermal rubies claimed to be produced by Chatham, and since I believe that my observations are able to yield some clue as to an easy and reliable identification, I shall describe them hereafter. Determination of the physical data offers no diagnostic distinction, as all specimens tested revealed physical properties identical to those of natural rubies. The refractive indices were within the normal limits of 1·76–1·77 and the birefringence was constant with a value of −·008. In some instances these constants were difficult to identify, because the film-like artificial coating caused the shadow edges to be rather indistinct. The dichroism showed the well known twin colours of purple-red and yellowish-red, while the absorption spectrum displayed its characteristic sequence of four lines in the red (6942, 6928, 6680 and 6595 Å) and three lines in the blue region (4765, 4750 and 4685 Å) with a broad band between 6100 and 5500 Å. Short-wave radiation excited strong red fluorescence, whose hue was toned slightly differently depending upon the light source. The specific gravity varied between 3·9840 and 3·9882 only. Phosphorescence under x-rays was not distinct enough to serve as a criterion, but it might be evident if the seed consisted of synthetic ruby.

Under the microscope the stones were deceptive owing to the natural inclusions in the core. The latter formed the integral and main part of the stones' volume, for the former seed crystals of natural origin had been covered with a relatively thin synthetic

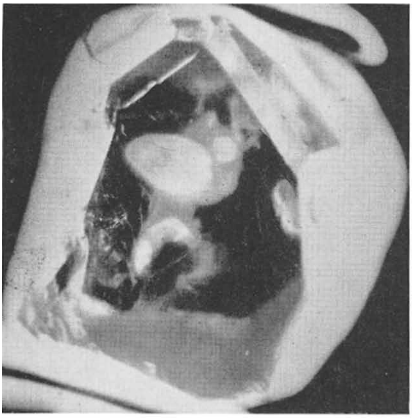

FIG. 1. *Ruby crystal with synthetic overgrowth displays typical habit and crystal faces of seed-crystal. Dark ground illumination. 20 ×.*

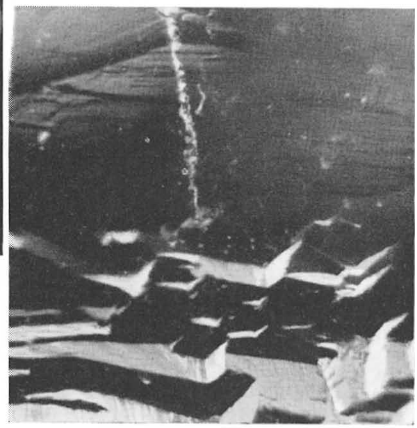

FIG. 2. *Rough surface markings of synthetic mantle indicating prism faces. Dark ground illumination. 80 ×.*

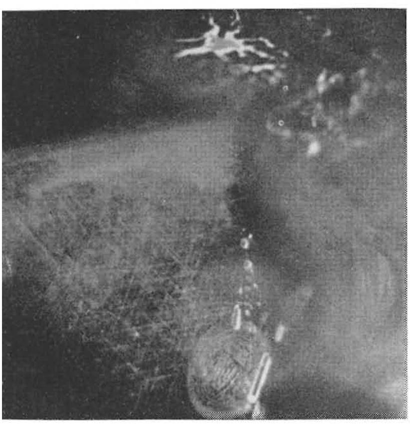

FIG. 3. *Typical " silk " consisting of acicular rutile inclusions, a circular liquid feather and a group of prismatic microlites in the natural ruby " seed ". Dark ground illumination. 7 ×.*

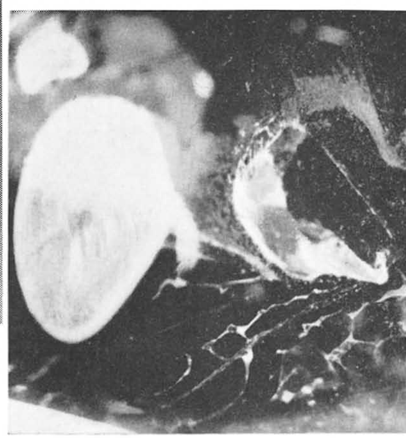

FIG. 4. *Natural inclusions in the ruby core. Dark ground illumination. 40 ×.*

coat. The specimens were rough crystals, and had they been or were they ever to be cut, then most or all of the coat would be abraded in the cutting process. The man-made surface layer had in all cases simulated the habit, shape, crystal faces, growth marks and external irregularities of the seed crystals. In distinct contrast from the hydrothermal rubies produced by Bell Telephone Laboratories, Chatham's samples were not flat, tabular crystals, but exhibited the typical truncated hexagonal prisms ending with rather small basal planes (Fig. 1). All specimens were strongly marked by typical growth features such as incipient development of the prism and the rhombohedron faces (Fig. 2).

Within the genuine core, various types of natural inclusions could be observed: for instance, rutile needles forming plane-like " silk " (Fig. 2) or whitish clouds or zones and solid mineral inclusions of the kind typical of Burma rubies, as well as liquid feathers and any other natural inhomogeneities (Fig. 4). The synthetic coating, however, could be discerned under very intense scrutinization because it teemed with minute gas-bubbles. These were either distributed singly or more often accumulated into lines, planes, clouds, or other odd shapes (Fig. 5 and Fig. 6). It was possible to notice that the formations were abruptly terminated

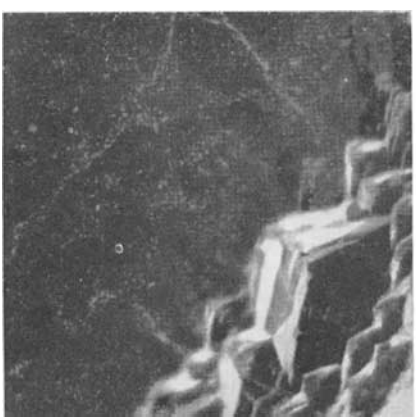

FIG. 5. *Lines and tiny clouds consisting of myriads of minute gas bubbles in the synthetic surface layer. Dark ground illumination. 80 ×.*

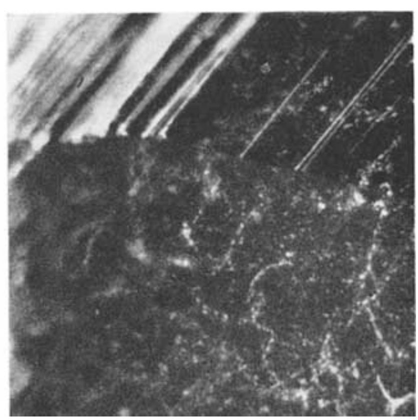

FIG. 6. *Characteristic shape of short curved lines of submicroscopic gas bubbles in the hydrothermal coating. Dark ground illumination. 80 ×.*

along the junction planes between seed crystal and unnatural layer. In one sample it could be seen how a natural feather of liquid inclusions ran across the core and was sharply cut off by the previous natural crystal face. This face was, however, overlaid and traversed by a loose cloud of gas bubbles in the artificial overgrowth. These features are extremely delicate, and it takes a sharp eye and a keen microscopist to discover them, but they offer sufficient proof to pronounce a decisive verdict.

Emerald-coated Beryl

The latest surprise in the field of gem substitutes is a product made at Innsbruck in Austria, the process of manufacture having been devised by Johann Lechleitner. The name of " Emerita " has been given to the material, based on the words " emerald " and " merit ". The idea of giving this new synthetic material a fancy name is, though debatable, not altogether out of the question: it would rank in the same category as other coined names for gem substitutes such as Simili, Strass, Igmerald and Fabulite. These have become known and accepted by the public as names for gem substitutes.

This new substitute is also composed of two parts, a genuine colourless or slightly coloured beryl functioning as a nucleus upon which a thin layer of synthetic emerald is deposited by a special process, the technical details of which have not yet been completely released. In a personal communication J. Lechleitner confirmed that his method of production is purely hydrothermal and completely different from C. Chatham's process, which depends upon the principle of the diffusion flux (similar to the method used by the German Dye Trust.)(7). He claimed his procedure to be an entirely new method which he had developed and which has proved to involve innumerable possibilities for alterations, which would allow the synthesis of a great number of minerals. The formation of emerald, however, is limited to the exact combination of very precise conditions, such as the mixture of the nutrient, composition of solvent, chemical component in the very zone of formation, temperature and temperature gradient as well as pressure. Unfortunately, J. Lechleitner would not disclose any further details.

The unusual feature of this process is that these synthetics are grown from a seed or core which is either cut as cabochon or faceted, and synthetic emerald in the form of a very thin coat is deposited on the cut beryl nucleus. Thus the synthetic stones, as they result from the production run, are either unpolished cabochon or faceted samples with a rough crystal surface. Both these parts, beryl nucleus and emerald mantle, are wholly crystalline and completely homogeneous, because the beryl core continues to grow synthetically as emerald. Consequently, both parts form one homogeneous monocrystal, absolutely analogous to those natural crystals, such as tourmaline, which consist of variously coloured growth states, and they exhibit all the properties characteristic of beryl and emerald respectively. This speeded-up method of producing a surface layer on beryl cores will obviously result in very thin overgrowths only. The unpolished specimens display all the external features and growth marks of genuine beryls, but they evidently differ considerably on the various facets owing to crystallographic orientation (Fig. 7). Needless to say all these emerald-coated specimens are

FIG. 7. *Growth markings in the hydrothermal emerald mantle on one of the pavilion facets. Dark ground illumination. 80 ×.*

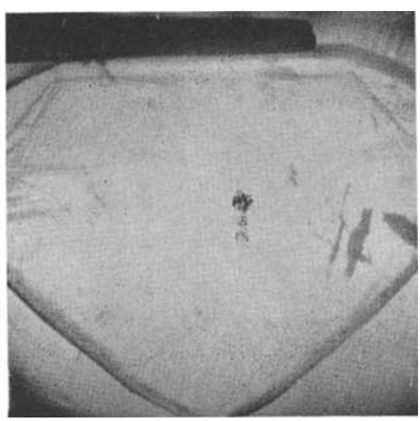

FIG. 8. *Lateral view manifests the dark "relief" of the synthetic emerald coating which envelops a colourless beryl seed. Bright field illumination. 10 ×.*

polished before they are offered to the trade. Lechleitner, with a sincere tendency to follow ethical sales principles, proposes to leave the pavilion facets unpolished so that these may serve as a mark of his product.

Also, due to varying growth speeds in accordance with crystallographic directions, the thickness of the synthetic overgrowth varies in different directions and therefore on different facets (Fig. 8). The intensity of the colour also depends upon the depth of the overgrown emerald layer, which usually gives the stone a cold bluish-green hue. In electric light the appearance is at its best, when the stone has an additional warm yellow tinge and vivid fire. As a tentative test I had a strongly coloured yellow heliodor and a well coloured aquamarine coated with synthetic emerald layer, but to my surprise no appreciable colour-difference resulted, although their transparency was slightly inferior to those specimens which embraced a pure and colourless beryl core.

Because of the excellent homogeneity of the product there is some difficulty in distinguishing it from a genuine gem. The refractometer would always only measure the refractive indices of the synthetic overgrowth, which correspond with those of the natural counterpart.

With specimens whose hydrothermal emerald film is very thin the shadow edges may appear rather blurred and render R.I. readings very difficult and inaccurate. In such stones interference colours can be observed if the stone be swivelled.

In contrast to " Igmerald " and Chatham's synthetic emeralds, this new material has no lower values, so that the very reliable immersion test in benzylbenzoate ($n_D = 1{\cdot}57$) cannot be applied here. On my specimens I measured 1·578 to 1·590 for ω and 1·571 to 1·583 for ε, with a constant value of ·007 for the birefringence. It will be interesting to learn what factor accounts for these surprisingly high figures, as other features of these substitutes seem to indicate that there is no interstitial content of trace elements in the lattice. On the other hand I found the specific gravity to yield normal figures between 2·676 and 2·713, while the beryl core of one sample, from which the synthetic layer had been polished off, gave a specific gravity of 2·672 only and R.I. of 1·564–1·570.

The dichroism is weak but equal to that of genuine and other synthetic emeralds, being yellowish-green for the ordinary and blue-green for the extraordinary ray, but the intensity of the twin colours changes with the depth of the coating. When I received the first specimens in March, 1960, I was astonished by the strong and very clear absorption spectrum, which showed all the typical chromium lines in the red region (6835, 6806, 6620, 6460 and 6370 Å). The luminescence, excited by short-wave irradiation, is of red colour, which is, however, less intensive than in synthetic emeralds of other productions.

The best and most reliable means of identification is secured by microscopic examination. Here again, exactly as with the hydrothermal ruby, one might be seriously confused by natural inclusions in the seed. These might consist of any of the usually occurring endogenetic formations, such as solid mineral inclusions, liquid feathers, two-phase and even three-phase inclusions of primary or secondary origin (Fig. 9). If any of these happened to reach the previous surface, these will show because of their sharply linear termination a little below the present surface. Errors might

FIG. 9. *Three-phase inclusions in natural nucleus superimposed by tell-tale straight lines and dust-like particles in the synthetic overgrowth. Dark ground illumination. 40 ×.*

FIG. 10. *Cracks (dark specks) in genuine beryl nucleus are mirrored in synthetic overgrowth if specimen is inclined and looked at through its body. Dark ground illumination. 40 ×.*

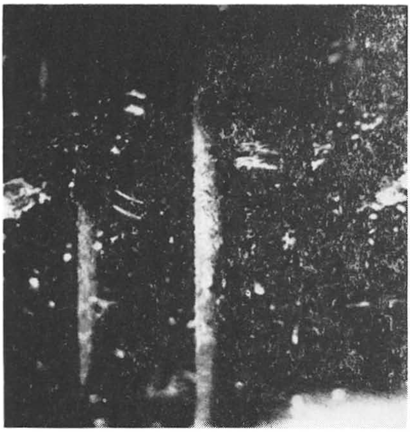

FIG. 11. *Mirror effect of impurities in the synthetic emerald layer if stone be appropriately tilted. Dark ground illumination. 40 ×.*

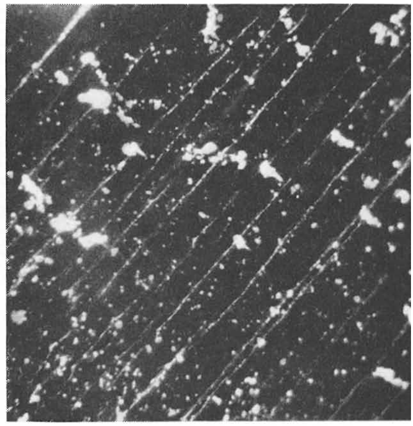

FIG. 12. *Straight lines and dust-like particles form a typical feature in the internal structure of the hydrothermal coating. Dark ground illumination. 40 ×.*

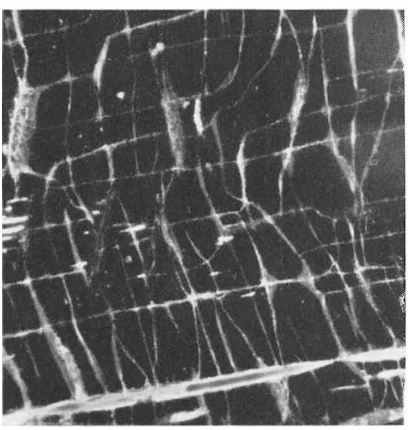

FIG. 13. *Net pattern produced by systems of parallel cracks running along the direction of the prism and parallel to the base. Dark ground illumination. 40 ×.*

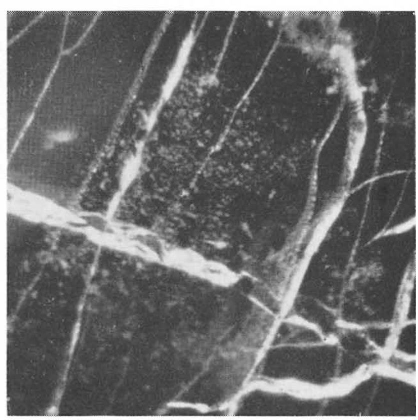

FIG. 14. *Looked at sideways the straight " lines " disclose themselves to be tension cracks. Dark ground illumination. 80 ×.*

easily occur if one had to discriminate between these emerald-coated beryls and emeralds from the new Gachala Mine in Colombia, whose bluish-green colour the new substitutes simulate rather well. If submersed in a suitable immersion liquid such as benzylbenzoate and examined sideways, it is usually possible to distinguish between the core and the dark green seam formed by the man-made mantle, which appears as a dark narrow border line (Fig. 8). In dark-field illumination, and if turned into an appropriate position, the junction plane often behaves like a mirror and it becomes possible to discern the beryl-nucleus from the surface layer. This occurs if the refractive indices between beryl body and hydrothermal mantle happen to differ slightly. Genuine inclusions in contact with the former surface of the seed may appear reflected in the synthetic mantle, or foreign particles and inclusions in the overgrowth are mirrored in the core (Figs. 10 and 11). In some specimens the junction plane seems to be covered with a " dusty powder ", which betrays the overgrown layer most conspicuously by its expansion over the flat surface of the nucleus. A most striking means of identification is provided by a system of straight parallel lines or by nets of crossing streaks in the mantle (Figs. 12 and 13). When the stone is tilted and examined obliquely these lines reveal

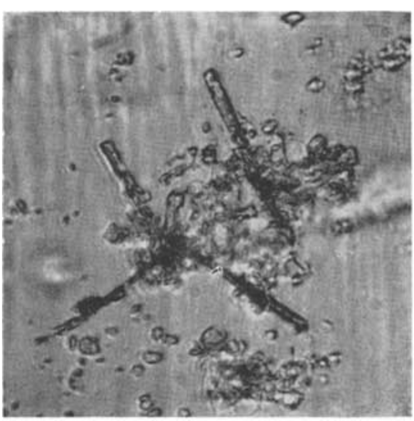

FIG. 15. *Radial arrangement of euclase or phenacite crystals surrounded by numerous tiny microlites of this alien crystal phase on the surface of the beryl seed. Bright field illumination. 500 ×.*

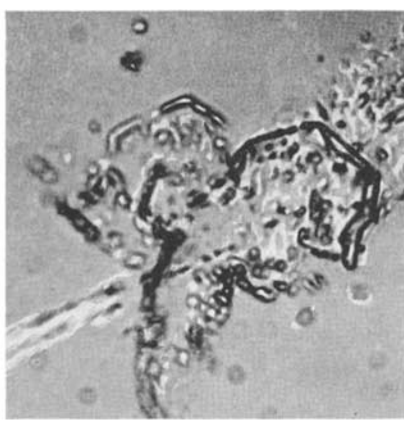

FIG. 16. *Skeleton of alien crystal depicting hexagonal outline and developed on surface of beryl core. Bright field illumination. 250 ×.*

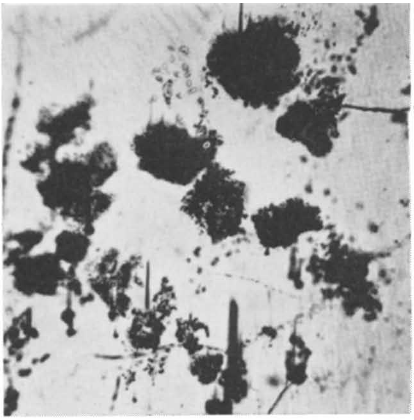

FIG. 17. *Ball-like aggregates of "foreign" crystals formed on junction plane between beryl nucleus and synthetic emerald overgrowth. Bright field illumination. 100 ×.*

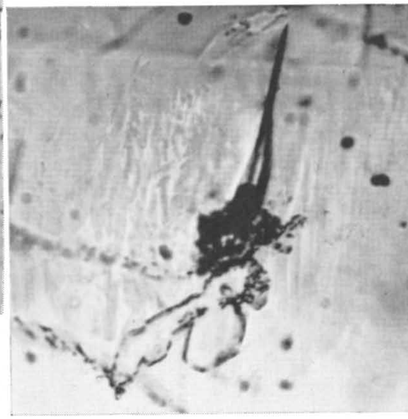

FIG. 18. *Growth funnel forming a two-phase inclusion above an agglomeration and a skeleton of alien crystal phase which acted as obstacle in the growth flux. Bright field illumination. 250 ×.*

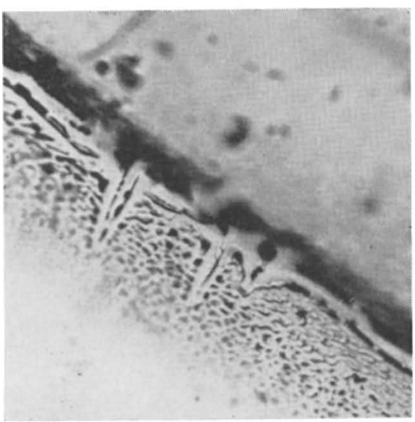

FIG. 19. *Partly healed fissure in the synthetic emerald coating being clearly marked by the "undigested" residual liquid drops. Phase contrast 250 ×.*

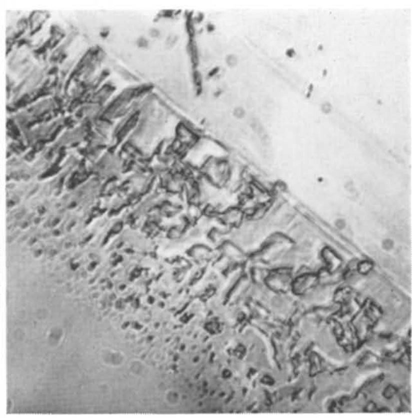

FIG. 20. *Liquid drops being the "undigested" residue of the hydrothermal solvent and being trapped in a healed fissure of the synthetic emerald layer. Phase contrast 500 ×.*

themselves to be cracks in the synthetic emerald-coating. Their breadth usually corresponds with the depth of the hydrothermal overgrowth (Fig. 14).

These are the impressions one may gain under a low-power lens. Strong magnification, however, may reveal the hydrothermal emerald coat to contain an abundance of most informative inclusions. What seemed to be dusty particles are in reality single crystals, crystal skeletons or tiny agglomerations of some alien phase (e.g. phenakite [Be_2 SiO_4] or euclase [Be (AL, OH) SiO_4]) or other related minerals, which may grow on the junction surface at the beginning of the operation before the favourable conditions for the formation of the emerald layer are reached (Figs. 15, 16, 17). They may be deliberately caused to develop or not, through a low temperature, a different temperature gradient or other reasons. In many cases larger individuals or aggregations of these foreign particles may act as obstacles in the growth flow of the nutrient and thus give rise to a lattice vacancy in the shape of a spike-like tube. This corresponds with a general tendency of the emerald structure to develop "growth-funnels" parallel to the c-axis. These acicular cavities form two-phase inclusions containing a

FIG. 21. *Characteristic appearance and distribution of residual liquid drops in one of these tell-tale healing fissures in the hydrothermal overgrowth. Phase contrast 100 ×.*

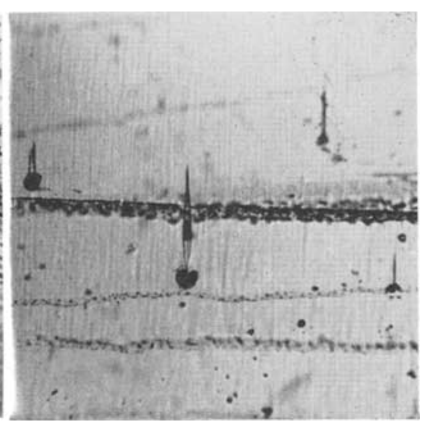

FIG. 22. *Straight healing fissure running parallel to the basal plane (0001) and several growth funnels lying in the direction of the c-axis. Phase contrast 100 ×.*

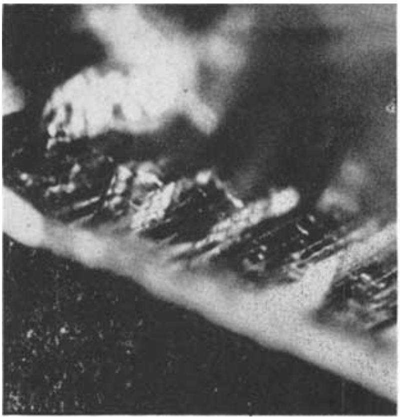

FIG. 23. *Some of the parallel straight fissures clearly manifest the thickness of the hydrothermal emerald mantle. Dark ground illumination. 40 ×.*

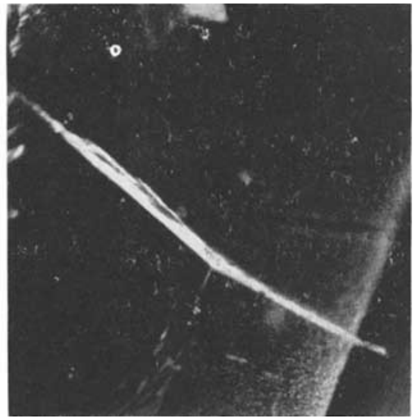

FIG. 24. *Dry crack running through synthetic emerald layer along undetermined direction. Dark ground illumination. 40 ×.*

watery fluid of the hydrothermal solvent and a bubble. The pointed end of their tapering shape indicates the direction of growth (Fig. 18). Likewise the lines mentioned above, which proved to be fractures in the synthetic emerald mantle, exhibit the characteristic appearance of healing cracks, which substantiate that they occurred while the stone was still suspended in the saturated hydrothermal solvent and the emerald layer still in its *statu nascendi*, so that the fissures could fill with mother-liquor and eventually heal (Fig. 19). The spotted pattern, which may be observed under small magnification, is caused by the " undigested " residual drops of the liquid which soaked into these cracks (Figs. 20 and 21). The fractures are likely to be caused by a slight atomic disarrangement between the surface lattice plane of the beryl-body and the superimposed emerald layer, which contains a small content of chromium-oxide. One set of these healing fissures developed along the growth directions and hence runs parallel to the two-phase inclusions formed by the dwindling growth-funnels, while the other system of cracks lies more or less perpendicular to the direction of principal growth, that is to say, in the basal plane (Fig. 12, 13 and 22). Such an arrangement of cracks causes a net-like pattern of streaks and lines in the artificial overgrowth, whose thickness can readily be recognized by the breadth of these fissures, if the stone is properly inclined and the cracks examined sideways (Fig. 23). In many respects the endogenetic features of the synthetic emerald overgrowth resemble the internal structure of the synthetic emerald produced by R. Nacken[6] and therefore indicate an analogous mode of synthesis.

Knowing these tell-tale characteristics, the gemmologist should encounter no particular difficulty in identifying this new substitute, if the hydrothermal overgrowth displays any of the features described above. But here again, as in the case of the hydrothermal ruby, the microscopic examination must be carried out with the utmost care, otherwise one might easily be deceived by genuine inclusions and readily overlook the much more delicate, yet definitely conclusive, structural features in the man-made overgrowth.

Moreover one must remain aware of the fact that the hydrothermal process of producing crystalline material can easily be governed by deliberately altering the growth conditions. Thus the synthetic emerald mantle may develop absolutely pure and clear of any markings, and indeed Lechleitner has produced specimens whose hydrothermal emerald mantle was completely flawless while others were merely marked by a few irregular " dry " (not healed) cracks (Fig. 24). In these cases the lateral examination, displaying a dark green rim round a pale or colourless body, may yield the sole verdict.

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Gemmological Notes

JEWELLERY AND GEMMOLOGY

J. ROACH.

Nigel W. Kennedy's article, "How rare are Chatoyants and Asterias", which appeared in the Journal for October, 1960, raises two points of interest which prompt me to write about the difficulties facing gemmologists employed in the trade. On the one hand Mr. Kennedy feels that his not being employed in the trade limits the number of specimens coming to his notice; on the other hand he criticizes jewellers for their bias towards " trade " stones.

Regarding the first point, I have found, along with many other gemmologists, that there is no advantage in being a jeweller when it comes to handling the lesser known specimens, although one can become very proficient in handling the so-called " trade " stones. Despite the fact that these latter stones are the life-blood of gemmology, they play but a small part in our scientific studies.

Indeed, learning gemmology in the trade is fraught with trials and tribulations. Most employers, in these enlightened days, encourage their staffs to study the subject; but it is still far from easy for the young newcomer. The youngster finds he is speaking a different language—what to him are Citrines, Demantoids and Spinels are to others Topazes, Olivines and Balas Rubies. At the same time he is more than likely to meet opposition from senior personnel who themselves have never bothered to learn and are determined to prevent others from so doing.

It is no new experience for jewellers to be accused of bias towards certain stones and of not caring about the rest. I do not think, however, that our critics really appreciate the difficulties besetting the jewellery trade in this respect. Without the commerce of jewellery, gemmology would perish, as was pointed out by A. E. Farn (*Journ. Gemmology*, 1960, VII, No. 7).

Most gemmologists are keen; but if not kept in check keenness can run away with itself. After all, selling jewellery is a commercial enterprise, gemmology a science. On the whole most jewellers make money, while by common conception most scientists do not.

One must realize that as far as the jeweller is concerned, gemmology is a means to an end not an end in itself. The keen gemmologist will find that 90% or more of his gemmology is practised outside his place of business.

If any proof is required of the relatively small part played by gemmology in a jeweller's business, a reference to the Retail Jewellers' Handbook elicits the suggestion that one third of a jeweller's total sales should consist of gem-set and gold jewellery. When one realizes that probably 95% of public demand for gem jewellery consists of diamonds alone, one gets a realistic picture of the very small proportion left for the sale of other stones. Is it surprising that both manufacturers and retailers do not venture into the realms of star beryls, etc. ?

No, I am afraid that life in the jewellery trade does not consist of hours spent in testing and studying gemstones. Indeed, were it not for hours spent at home doing such things, many a gemmologist would not use an instrument for weeks on end, and when something unusual does turn up the day is truly an eventful one. Such a stone, incidentally, was the chatoyant topaz I was fortunate enough to come across some two years ago in an assorted parcel. This, sad to relate, was my last " big find ".

SOME NOMENCLATURE PROBLEMS

O. Dragsted.

Some time ago I was shown a necklace bought in the East as " Tibetan Jade ". It consisted of aventurine quartz beads. I looked up various dictionaries and textbooks on gemmology to find out whether aventurine quartz was known under this misleading trade-name, but in vain.

My next thought was, must this misnomer now necessarily be translated into many languages and included in all future dictionaries, mentioned in lists of improper names as a warning, and included in the tuition of students.

Would not this procedure mean that a rather isolated case of misrepresentation is vigorously spread out to a large number of people. Perhaps the result would be that some dealer after consulting a textbook on gemstones would tell his customer: " Strictly speaking this is a so-called aventurine quartz but it is much better known as ' Tibetan Jade '." And the lucky customer will show her friends the fine " jade " from Tibet. In this way we might involuntarily set ablaze a misguiding torch which ought to be quenched.

How many gemmologists are not thinking of the forbidden words " Korean Jade " when encountering a serpentine figurine ? Because they are taught not to use this false name, they will always remember it.

The other day a woman showed me some Jutland amber which she had stained. There were several colours, and she remarked that the green dyed amber had now attained a jade-like appearance. I visualized a brand new trade name " Jutland Jade ", so I retorted " No jade ever had that poisonous hue " !

A jewellery manufacturer showed me a few years ago some gold ornaments set with what he termed " blue topazes ". They were small milky cabochons, and it demanded a great deal of imagination to see any tint of blue in them. They turned out to be quartz, and I must admire the logic of his suppliers:

" Burnt amethyst which has attained a yellow hue is marketed as ' topaz ', so burnt amethyst which has been burnt milky white (somehow resembling a poor quality of the otherwise bluish moonstone) must be marketed as ' blue topaz '." In Sweden this product has been called " månkristall ", a name which indicates that it belongs to the same family as rock crystal having at the same time some resemblance with moonstone.

I may mention a queer example showing how literature keeps alive a false name which might otherwise have been forgotten long ago. Revising a commercial vademecum I found under kyanite (disthene) a note that this stone had been known earlier as "simple sapphire ". It is perhaps now 200 years since kyanite was determined, so I chose to omit that it had ever been sold as sapphire. This information was new and interesting when published in 1808 by C. Prosper Brard in his " Traité des Pierres précieuses " as follows: " On avoit voulu les faire passer pour des saphirs . . . Ce fut M. Haüy qui s'apercut le premier que ces prétendus saphirs n'etoient que des disthènes ".

We are constantly teaching students that they must doubt the identity of any stone they get in their hands, because so many stones are sold under false names. Some misleading gemstone names are so widespread that we cannot omit them. But many others could doubtlessly be excluded, especially those which correspond to mineralogical definitions.

So this tends to be an appeal towards our common aim of a clean nomenclature: Let us subdue the misnomers through our silence. Let us eliminate them from our gemmological books. Let us leave them to oblivion.

One might accuse us that through our silence we give consent to the falsities. *Qui tacet consentit.* I would rather say that our literature should contain nothing but the truth, so if a stone-name cannot be found there, it is suspect, and our silence would be an accusation. Said Cicero versus Catiline, " *Cum tacent clamant* ".

FASHION, TREND OR VOGUE

A. E. FARN.

Just after the war there was a great scarcity of everything—except demob suits. Suddenly there seemed to be a demand and very ready sale for cameos in jewellery. Every teenager, middleager, old ager and dowager had to have one. At first they were scarce and consequently high in price in comparison to the quality of workmanship. As time passed however there came a glut of cameos carved in stone, shell, plastics, china, plaster and coral, every conceivable medium was fully exploited to saturation point. Now that popular demand has ceased, the true level of merit and worth has caused fine pieces to assert themselves in a mediocre market. Most jewellers can remember the pre-war days when one steadily smashed up all old gold and silver objects which were bought for melting, especially all those (then) hideous Victorian bracelets, pendants and brooches which now have assumed considerable merit and there has been searching of trinket boxes to find these (now) sought after pieces. If one could foresee a trend, of course, one could make money. If one could really afford to sit on present day outmoded stock it would in time turn a full circle to sudden demand.

The change in demand for certain styles of jewellery is often sparked off by newspaper items, giving details of royalty, film stars and ballerinas, attending some function or other, wearing this and that garment with, for example (hopefully) a huge row of ivory beads, matching bangle and ear studs. A little later the fashion page of the dailies gives a write up on the new fashion which Miss someone or other (top model or near celebrity) features in so and so's dress collection and a small blurb on recent well-to-do personages who also export this new fashion. The daily diary talking on events in town also lends a hand in this touch of Society news. Very soon the fashion descends to the lower ranks, which causes the local jeweller to gnash his teeth when he thinks of all those lovely ivory beads he so often refused to buy or was so pleased to sell at a give-away price, "Sic transit black Monday", but soon to his rescue come the fashion (imitation) jewellery sales; if the local girl cannot get ivory she is just as happy with (spare the term) simulated plastic ivory.

Speaking of the local girl, one of course realizes the tremendous potential the teenager exerts in spending power. They must be recognized and treated as to-morrow's mainstay.

To-morrow's mainstay or yesterday's white elephant, neither is of much financial solace unless one can turn it to account; this does not happen to the man who cannot afford to sit and wait.

For a short while jet seemed to enjoy a comeback, but once again the plastic imitation killed its real appreciation, since plastics are so easily moulded and are a much more malleable material and so cheap to produce.

Amber, too, has this plastic rival, though I find it hard to understand why so many huge necklaces of bakelite beads of perfect match, colour, transparency and beautiful graduation should cause any jeweller to ponder—are they amber ? Once again his teenage customer buys for colour and not for authenticity and his " contemporary " (a word meaning modern) jewellery sales increase and in fact to-day form a steady part of his regular trade. It is strange how even the word contemporary adds a hint of glamour to fashion, whereas " modern " doesn't sound half so genteel—a question of U and non-U in mundane eyes or ears.

Certain types of jewellery, which are rather specially created such as stone-set crosses, are a particular case in point. Since they originally had a particular denomination or type of person as their ultimate wearer they prove to be a very hard seller indeed upon the secondhand market. As time goes by, however, and the steady drop in the purchasing power of the pound continues, the break up value rises until, regrettable aesthetically but to the utmost satisfaction of the jeweller, the cross becomes an economic " breaker ".

One fashion which is slowly re-asserting itself is that of wearing a stick-pin. This in itself is a very welcome change especially as a slight relief to the somewhat sombre garb of the more conservatively dressed male. Apart from dress relief it also allows the use of the drop-shape and slightly baroque pearl, the yellow diamond or pear-shaped ruby or sapphire, all of which lend their shape so well to stick-pin usage. Although it needs sales promotion, national press-coverage and snob-appeal to get people stick-pin minded, it would certainly help trade and would be a good idea to get the fashion launched. When one considers some of the audiences and committees of jewellery functions—the very heart of the gem trade—one is struck by the low sartorial standard of the assembled males and their lack of any normal items of jewellery—some in button cuffs and soft collars, some no cuff links at all—perhaps one stick-pin per 100 jewellers or jewellery-trade workers present. These people could, if they tried, help their own trade enormously by creating a fashion and thus a demand. A man need not be terribly well off to sport a slim silver cigarette case, plain or engine-turned cuff links and a stick-pin costing (if carefully purchased) not more than ten pounds. The stick-pin might, if carefully chosen, even advance in value as time goes by, which could thus become a good buy and a form of investment, whereas contemporary jewellery is merely a goodbye to one's money with an immediate heavy depreciation somewhat like leasehold property—a declining asset.

Coral, amber, jet, tortoiseshell, ivory, mother-of-pearl, scent bottles, chatelaines, card cases, fans, lorgnettes—all will have their turn—well not all.

LIGHTING SPECTROSCOPE

S. Buzalewiez.

The lighting spectroscope consists of two joined tubes: the spectroscope proper and an electrical battery lamp emitting focused light.

The cutting of stones is devised for the purpose of totally reflecting most rays of light falling onto, and passing into, the gem, and of returning them to the eye when viewing the gem from above, i.e., vertically to the table facet. Practically all the rays of light falling on the gem at right angles to the plane of the table facet, or slightly oblique from such direction, are totally reflected and the majority of all other rays falling on the gem (increasing as the refractive index of the stone decreases), not being totally internally reflected, pass through the gem and do not return to the viewing eye.

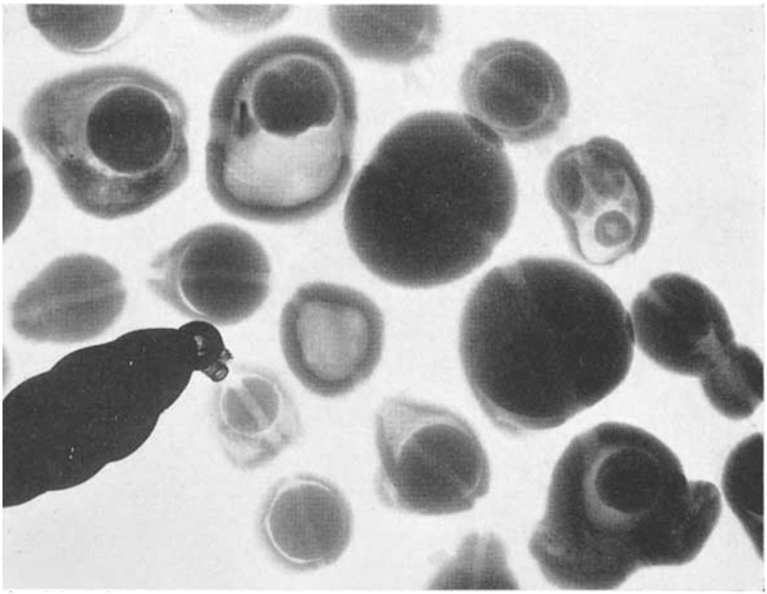
There are therefore two conditions of optimum observation of the light passed into a gem:—

1. Observation of the gem from above, perpendicularly to the table facet.
2. The lighting of the gem from above also as nearly as possible at right angles to the plane of its table facet.

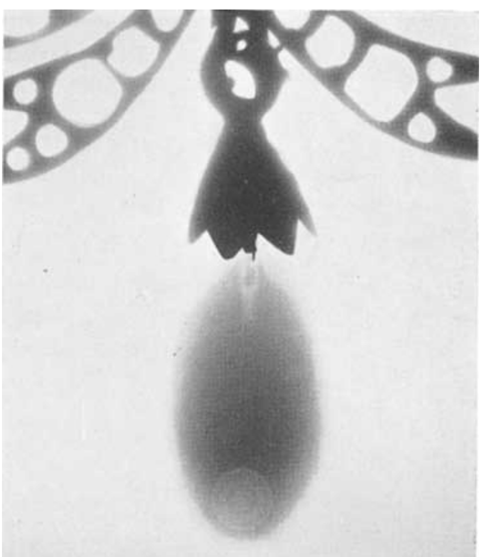
These conditions are fulfilled by observation of a gem in the light passing from the spectroscope itself.

Spectroscope and electric battery lamp emitting focused light joined together to form the lighting spectroscope.

Being a pocket apparatus adapted to the observation of gems, both unset and set, by both transmitted and scattered light, the lighting spectroscope, in conjunction with a pocket atlas of absorption spectrum bands, can become a main gemmological instrument in commercial practice.



A striking photograph of part of a very baroque cultured pearl necklet showing two pearls with unusual structures. One pearl has three peculiar nuclei, and the other appears to be non-nucleated. The presence of such pearls in a cultured pearl necklet may be due, it is suggested, to the mother-of-pearl bead nuclei having been aborted, but the pieces of mantle tissue remained in the animal and had formed non-nucleated pearls. *Robert Webster.*



An agate-like nucleus in an unusual position at the extreme end of a natural elongated drop pearl.

B. W. Anderson.

GROWTH MARKS IN EMERALD

By W. F. Eppler

THE intermittent growing of beryl has already been demonstrated on a Brazilian emerald[1]. Emeralds from other localities exhibit similar features, an example of which is shown in Fig. 1. The striae of growth are parallel to the basal plane, and they are bordered by " steps ", which indicate the direction of steep hexagonal bipyramids. The layers indicate a fluctuation in the composition of the mother-solution. While this part of the stone is colourless, it is covered by a good emerald-green upper part (dark in Fig. 1), which has been grown later. The system exhibits an intermittent growth of the emerald, which has been caused by a considerable change of the components of the mother-liquor as well as their concentration.

In another emerald, a similar striation parallel to the basal plane can be observed (Fig. 2 and 3). The layers represent a

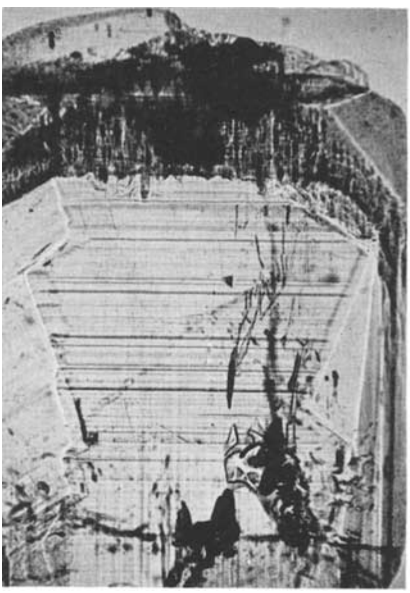


FIG. 1. *Emerald with a striation parallel to the basal plane. This part is colourless. Upper part (dark) exhibits a good emerald-green. View perpendicular to the c-axis. 22 ×.*

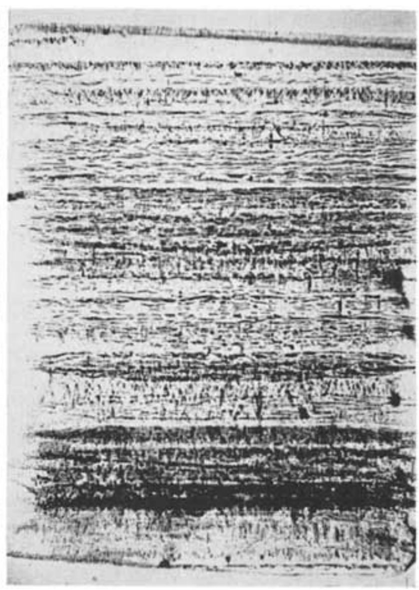


FIG. 2. *Emerald with a marked striation parallel to the basal plane. Dark green layers alternate with brighter or colourless ones. 22 ×.*

former frontier of growth, which has been advanced by a nutrient of an alternating composition. Thereby, darker green layers are followed by brighter ones, which sometimes appear to be nearly colourless. By using a higher magnification, traces of steep growth-pyramids can be observed, indicating differences in the former conditions of growth likewise (Fig. 3).

The marks of growth in emerald can best be observed by immersing the stone in benzylbenzoate, a liquid the refractive index of which ($n = 1{\cdot}570$) approaches very closely to that of genuine emeralds. Additionally it is useful to close the aperture nearly completely when observing the stone under the microscope. In realizing these conditions, very little differences in the refractive index can be detected, so that with this technique minute variations in the chemical composition of different parts of the same emerald can be revealed.

Other peculiarities of crystal growth in emerald are chips or splinters of beryl, or emerald respectively, which have been entrapped at random orientation (Fig. 4). They are easily overlooked as they have the same refractive index as the host crystal, but they are clearly seen when using polarized light (Fig. 5). Without any doubt, the splinter has been pre-existent with regard to the embedding emerald.

Sometimes, the splinters caused a disturbance at the growing emerald by which liquid-filled tubes have been originated. In

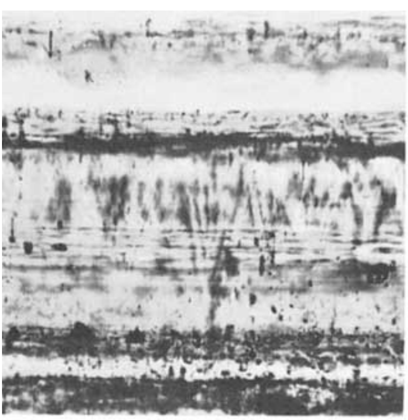


FIG. 3. *Emerald with steep growth-pyramids; part of Fig. 2. 65×.*

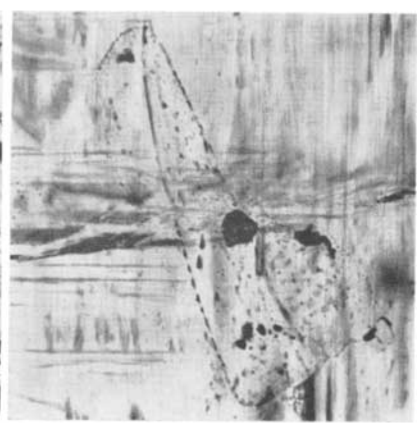


FIG. 4. *Emerald with an unorientated chip of another emerald. 65×.*

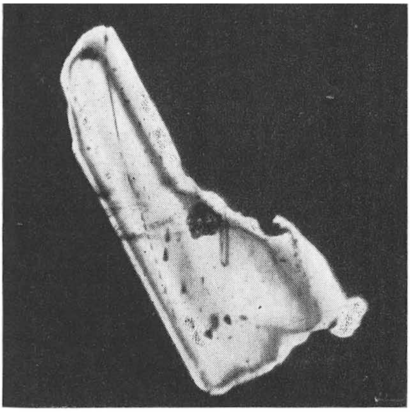


FIG. 5. *Emerald, same as Fig. 5, crossed polarizers.* 65 ×.

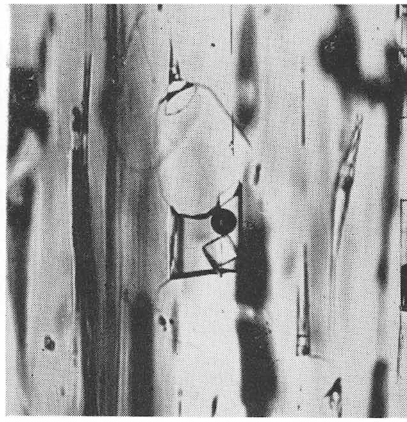


FIG. 6. *Emerald from Colombia. Two unorientated chips of a pre-existing emerald caused a liquid-filled tube with a libella and a cubic crystal. View perpendicular to the c-axis of the host crystal.* 120 ×.

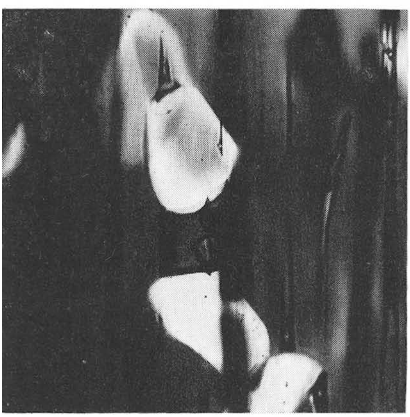


FIG. 7. *Emerald from Colombia; same as Fig. 6; polarized light.* 120 ×.

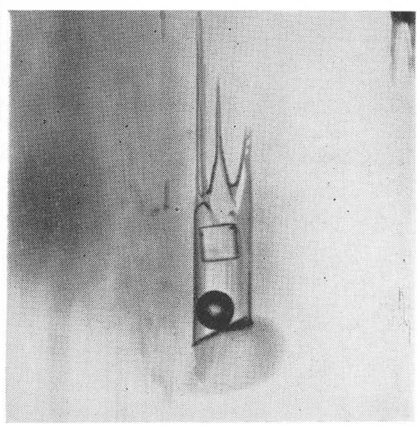


FIG. 8. *Emerald from Colombia. A heterogeneous splinter of emerald caused a three-phase inclusion with a pronged end. View perpendicular to the c-axis of the hosting crystal.* 120 ×.

Fig. 6 and 7, two chips are connected by a short tube representing a typical three-phase inclusion. It is evident that the chips were present while the emerald was still growing. When it reached with its surface the first chip (below), it not only surrounded the foreign particle but deposited behind it some of the material unsuitable for its own growing process. The same happened after having reached the second (upper) chip, as can be concluded from the tip-like little tube on its top, which is a smaller repetition of the three-phase inclusion. With regard to Fig. 6 and 7, such an explanation supposes a growth of the emerald crystal from below in an upward direction.

A similar case is shown in Fig. 8, where a pronged three-phase inclusion seems to bear a (shadow-like) splinter of a former emerald. In reality, the phenomenon originated during the growth of the crystal which took place (in Fig. 8) from above downwards. Such tubes caused by growth seem to be typical for emeralds from Colombia. They are characterized by sharp ends, indicating at the same time the direction of growth and the c-axis of the emerald. Mostly, they represent three-phase inclusions, the solid components of which are cubic crystals. In Fig. 9, the enclosed crystals exhibit other forms than the cube only, by which the speculations of their nature are multiplied.

These particular tubes, originated by the growth of the emerald from Colombia, have a counterpart in the three-phase inclusions which have been originated by the healing of fissures (Fig. 10). In most of the cases, they follow approximately the direction of the basal plane of the host crystal, and they are characterized by irregular forms. Occasionally, the inclusions contain several isotropic crystals, as is shown in the picture.

Among the marks of crystal growth, inclusions of calcite have been reported (E. J. Gübelin[2]). Fig. 11, taken from a Colombian emerald, exhibits a flattened three-phase inclusion. Its contours are not clearly visible as they are out of focus. In spite of this, the typical components of a three-phase inclusion are well illustrated: a rounded libella with a broad dark rim, indicating the presence of a liquid; very near to its right side a cubic crystal, partly covered by overlying other inclusions, and, which seems to happen very rarely, a well-developed rhombohedron of calcite (above the libella). It seems unusual that a calcite crystal forms a constituent of a three-phase inclusion in an emerald.

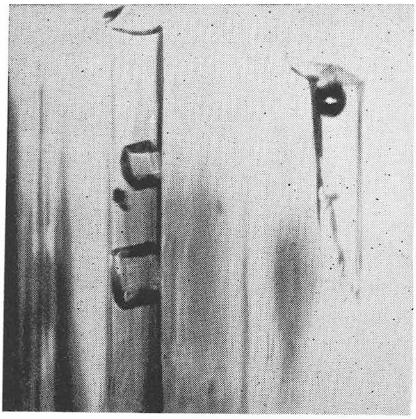


FIG. 9. *Emerald from Colombia. A tube parallel to the c-axis with two colourless crystal inclusions, exhibiting additional faces. 120 ×.*

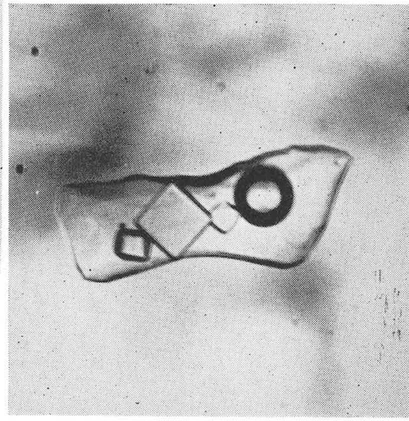


FIG. 10. *Emerald from Colombia. A three-phase inclusion of a healing fissure with several isotropic crystals. View approximately in the direction of the c-axis of the emerald. 220 ×.*

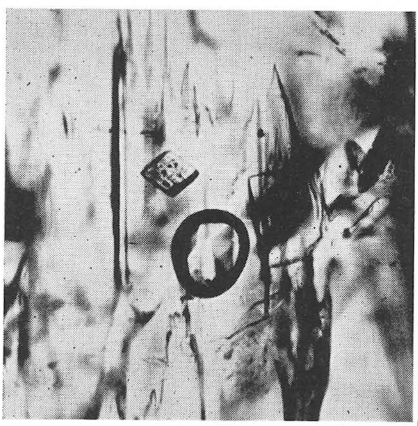


FIG. 11. *Emerald from Colombia. A calcite crystal (rhombohedron) as an unusual constituent of a three-phase inclusion. View perpendicular to the c-axis of the emerald. 120 ×.*

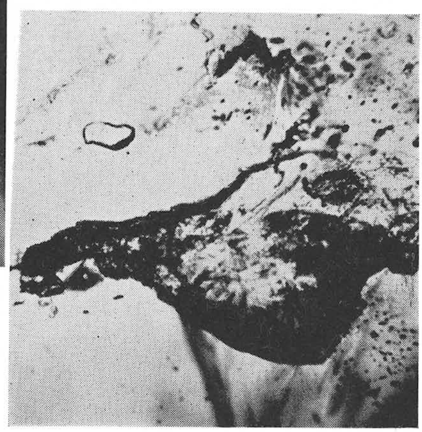


FIG. 12. *Emerald with rounded inclusions of petalite at random orientation. 65 ×.*

Crystal inclusions of petalite have been found in an emerald (Fig. 12). This mineral has been described recently as an inclusion in Brazilian aquamarine,[3] from which it could be separated and determined. The chemical composition of the monoclinic crystal ($Li_2O . Al_2O_3 . 8SiO_2$) is very similar to that of spodumene, from which it differs only by a higher content of silica. Larsen-Berman[4] quote the values for it as follows: $n_\alpha = 1{\cdot}504$; $n_\beta = 1{\cdot}510$; $n_\gamma = 1{\cdot}516$; $n_\gamma - n_\alpha = +0{\cdot}012$; inclined extinction $= -8°$; specific gravity $= 2{\cdot}4$; perfect cleavage parallel (001), less perfect parallel (201). It seems likely that the presence of petalite in a beryl or emerald is due to an excess of lithium and a shortage of beryllium in the mother-solution. If these conditions have only been temporary, the newly crystallized petalite could partly be dissolved by the growing emerald. For such reasons, the inclusions of petalite both in aquamarine and emerald have the appearance of remainders with rounded surfaces rather than of well-developed crystals.

Summarizing, significant marks of growth, detectable in emerald, are: straight layers of growth following preferred crystal planes; splinters or chips of pre-existing emerald which have been, for some reason or other, broken and embedded in newly grown emerald crystals as heterogeneous inclusions; three-phase inclusions in the form of tubes parallel to the c-axis caused directly by the process of growth; other three-phase inclusions characterizing healing fissures and being regarded as the " undigestable remainders " of the mother liquor; crystals of calcite; and partly dissolved crystals of petalite.

The emerald, without any doubt one of the most desired gem stones, reveals to the interested observer a multitude of pecularities, the evaluation of which imparts a comprehensive knowledge of crystal growth.

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3. Eppler, W. F. *Ungewöhnliche Kristall-Einschlüsse, Deutsche Goldschmiede-Zeitung, 1961, 1,13-15.*
4. Larsen, E. S. and Berman, H. *The Microscopic Determination of the Nonopaque Minerals,* Washington 1934.

ASSOCIATION NOTICES

GIFTS TO THE ASSOCIATION

The Council of the Association is grateful for a copy of *Kamienie Szlachetne* (Precious stones) by K. Maslankiewicz, from S. Buzalewicz of Warsaw.

A donation of £25 to the Sir James Walton Memorial Library from Lady Walton is also gratefully acknowledged.

MIDLANDS BRANCH

A meeting of the Midlands Branch of the Association was held at the Imperial Hotel, Birmingham, on 24th January, 1961. Mr. E. Shipton presided and the guest speaker was Mr. M. Bowen who gave a most interesting talk on personal adornment from the Roman era to the present day. Mr. Trevor Solomon warmly thanked Mr. Bowen for his erudite and fascinating talk.

MEMBERSHIP

At a meeting of the Council held on 29th November, 1960, Mr. Geoffrey Hyman, Blackpool, D.1960, was transferred from Probationary to Fellowship membership.

OBITUARY

The death has occurred of Mr. Leonard Nathan, Birmingham, an Ordinary member of the Association since 1953.

TALKS BY MEMBERS

BLYTHE, G. : " Gemstones," Priory Round Table, Southend, 16th January ; " Diamonds and their substitutes," South Essex Natural History Society, 19th January, 1961.

TODD, G. E. (Miss): " Gemstones ", Housewives' Club, Purley, 10th January, 1961.

JONES, T. G.: " Gemstones ", Institute of Physics, Bristol University, 9th December, 1960; Physical Society and The Institute of Physics, London, 13th January; Nuclear Research Centre, Harwell, 8th February, 1961.

WELL, G. T.: " Introduction to gemmology ", Eighteen plus Club, Sevenoaks, January, 1961.

GILLOUGLEY, J.: " Diamonds ", Scottish Women's Rural Institute (Brookfield Branch), 20th February, 1961.

PARRY, G. (Mrs.): " Gemstones ", Women's Institute, Llanbarry, Glamorgan, 7th March, 1961.

THOMAS-FERRAND, J. (Mrs.): " Birthstones of the month ", East Anglian Television. One talk each month until August.

CAIRNCROSS, A. "Gemstones", Letham Kirk Women's Guild, 23rd January; Perth Young Unionist Branch, 9th March; Laggan W.R.I., 14th March; Mortloch Church Women's Guild, 13th March, 1961.

COUNCIL MEETING

A meeting of the Council was held at Saint Dunstan's House, Carey Lane, London, E.C.2, on Wednesday, 15th March, 1961. Dr. W. Stern presided.

The following were elected:—

FELLOWSHIP

Havem, Unni, Blindern, Norway
Levan, Augustus S., Richmond
Pidduck, Arthur A., Loughborough
Sharp, Charles S., Scarborough, Ont.

ORDINARY MEMBERS

Auger, Brian J. E., Woking
Burke, Frieda J., Philadelphia, U.S.A.
Clifford, Christopher A., Maidstone
Coop, Norah M. N., London
Cooper, William E., Stockport
Cuadrado, Pelayo, Buenos Aires, S. America
Houston, David F., El Cerrito, U.S.A.
Inglis, Andrew I., Edinburgh
Micinski, Czeslaw Z., Manchester
Montgomery, William E., Philadelphia, U.S.A.
Nadort, Edward A., New Westminster, Canada
Quartermaine, Helen L., Selangor, Malaya
Rogers, William T., Tunbridge Wells
Sampson, Esme, Gerrards Cross
Tivol, Harold E., Kansas City, U.S.A.
Watts, Pete, Lincoln

PROBATIONARY MEMBERS

Harber, David A., Crawley
Hewson, Robin J., Egham
Penner, Ernest W., Islington, Canada
Grumser, Pierre, London

The Council gave approval to a revised syllabus of examinations, to be introduced for the 1962 examinations.

BELGIAN GEMMOLOGICAL SOCIETY

A Belgian Gemmological Society has recently been formed and the first President is Mr. F. Duyk and the Secretary is Mr. H. Mornard both of Brussels. Mr. van de Walle, of Bruges, is Treasurer. The Society has arranged courses in gemmology and holds examinations, and students are also encouraged to take the gemmological courses held in Idar-Oberstein. Arrangements have been made to exchange information with the Belgian Society.

WAVERLEY GOLD MEDAL ESSAY

The Journal *Research* is this year sponsoring The Waverley Gold Medal Essay Competition for the ninth year in succession. The Competition is designed to encourage the scientist in the laboratory and the engineer in the production plant to express his views and translate his work into an essay that will be readily understood by other scientists, directors of industrial firms and others interested in science and technology.

The **Waverley Gold Medal,** named after and bearing the coat of arms of the late Lord Waverley, together with **£100** will be awarded for the best essay of about 3,000 words describing a new project or practical development in pure or applied science, giving an outline of the scientific background, the experimental basis and the potential or actual application of the idea to industry or their importance to society.

A second prize of **£50** will be awarded and also a special prize of **£50** for the best entry from a competitor under the age of thirty on 31st July 1961.

The last date of entry is 31st July 1961

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No. 2
April, 1961

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