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eye opener

By Richard W. Hughes

GQ Eye is an attempt to blend both traditional gemology and gray-area issues. In this installment, examples of the former include the articles on synthetic moissanite and surface-enhanced topaz. Such papers are crucial for the advancement of the science and we will continue in this gemological tradition.

But a large swath of the field has been ignored by conventional gemological publications – particularly those issues involving trade politics and grading. Too often the scientific community refuses to examine problems that cannot be reduced to numbers or black-and-white certainties, questions that require critical thinking. In hopes of changing this, the second installment of *GQ Eye* contains several articles that require critical thinking, including one on diamond plotting diagrams and another on diamond color grading, and future issues will continue mining this vein.

A recent bumper sticker I saw said: *"DARE – To think for yourself."* A noble goal indeed. The aim of *GQ Eye* is not simple criticism for criticism's sake. Nothing here is personal. Rather, it is about critical thinking, examination and re-examination of issues and ideas that affect our field. Let the best ideas rule. Let us all dare to think for ourselves, and allow others to do the same. ☯

Notes: The response to our first issue was terrific. We thank all of you who took the time to call or write with your comments. For the foreseeable future we will be distributing *GQ Eye* free-of-charge to all who want it. If you have not received this issue via mail, contact us to be added to our mailing list.

Errata: This issue also contains a reprint of the diamond price table from our previous issue. Typographical errors in the price table have been corrected.

DIAMOND OR SYNTHETIC MOISSANITE – CAN YOU TELL THE DIFFERENCE?

by Carlos A. Ferrer, G.G.

A well-known Los Angeles diamond cutter recently received a near-colorless, slightly greenish yellow stone with instructions to facet the girdle. While the normal weight loss for this procedure is about one point (0.01 ct.), the stone lost three points almost immediately after cutting began. Becoming suspicious, he examined the stone under the microscope and, to his surprise, found it wasn't a diamond at all. Instead, it was a synthetic moissanite, the newest diamond simulant.

This story illustrates why synthetic moissanite is making news. While many have dismissed the idea of experts misidentifying moissanite, unfortunately such mistakes have occurred more than occasionally. The following article is designed to give you the information you need to avoid such costly and embarrassing errors. It lists observations and tests that will allow easy separation of diamond from synthetic moissanite, even when mounted.

GQI LOS ANGELES • CHICAGO

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NEWS AND VIEWS FROM THE GEM QUALITY INSTITUTE

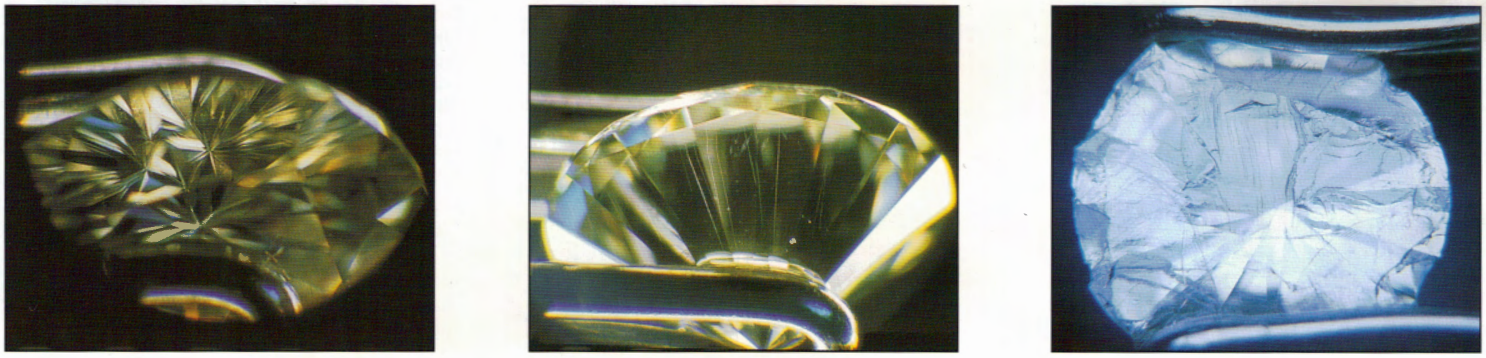


Figure 1. Characteristics of synthetic moissanite
Left: As shown above, doubling in synthetic moissanite is one of the best features to separate this simulant from diamond. (Photo: Craig Slavens)
Center: Needle-like inclusions are a common feature of synthetic moissanite. (Photo: Craig Slavens)
Right: Cleavage or parting plane in synthetic moissanite. (Photo: Richard Hughes)

TABLE 1. Synthetic moissanite and diamond compared

Property	Synthetic Moissanite	Diamond
Refractive Index	2.648–2.691	2.417
Birefringence	0.043 (DR, uniaxial)	None (SR)
Dispersion	0.104	0.044
Mohs' Hardness	9.25 (scratched by boron nitride)	10 (scratched only by diamond)
Specific Gravity	3.22 (floats in 3.32)	3.52 (sinks in 3.32)
Thermal Inertia Probe	Diamond reaction	Diamond reaction

Synthetic moissanite/diamond tester

One important feature of synthetic moissanite (silicon carbide – SiC) is that, due to its carbon-based composition, its thermal properties overlap with those of diamond. Thus it will fool standard diamond thermal testers, which are based on a diamond's thermal inertia.

A number of different testers have been developed to solve this problem. Most separate diamond from synthetic moissanite on the basis of transparency in the near-ultraviolet region (see Nassau, et al., 1997). However, with even some gemological experience and a few basic tools, one can easily separate the two materials.

Seeing double

Synthetic moissanite is a doubly refractive material with strong doubling (0.043 birefringence). This means that doubling of the rear facets is seen when the stone is viewed in certain positions. Hence the doubling of facets is a surefire diagnostic feature of synthetic moissanite. If doubling is visible, the stone is definitely not a diamond.

To see doubling, one needs a 10× loupe and a steady hand, or even better, a microscope. In order to minimize doubling, most synthetic moissanite is cut with the optic axis perpendicular to the table. Thus one must view the stone at an angle to the table. The easiest way is to rock the stone so that the reflection of the culet is visible through a bezel facet. Synthetic moissanite will display doubling in this position (see Figure 1, far left).

Inclusions

Synthetic moissanite is generally clean, but you can expect to see fine white needle- or thread-like inclusions (see Figure 1, center), as well as very fine pinpoints grouped as raindrops or stringers. Some observers report that sometimes there are clouds that appear to be crystals or gas bubbles (Nassau, et al., 1997). In addition, one stone brought to the Gem Quality Institute's Los Angeles lab consisted of a faceted stone broken into two pieces parallel to the girdle plane. Its perfect flatness and step-like appearance suggest it might be either a cleavage or parting plane (see Figure 1, far right). So far, cleavage has not been reported in synthetic moissanite, but mentions of parting do exist (Nassau, et al., 1997).

Polishing lines

With diamond, polishing lines are arranged in various orientations depending on the individual stone's hardness directions. In contrast, synthetic moissanite can be polished in a single direction, so polishing lines are often seen crossing the facet junctions in the same direction from one facet to the next. If these are present, they will be fairly easy to see with 10× magnification.

Specific gravity

When the stone is loose, testing specific gravity (SG) will easily separate synthetic moissanite from diamond. Synthetic moissanite has an SG of 3.22, while diamond measures 3.52. Thus a 3.32 heavy liquid (pure di-iodomethane, a.k.a. methylene iodide) will separate the two, with the synthetic moissanite floating and the diamond (and other major diamond simulants) sinking.

Color range

Typically, synthetic moissanite has a light, grayish yellow to grayish green cast, with colors falling between I and U on the cape diamond color grading scale. Strong greenish (or grayish) overtones suggest synthetic moissanite, especially if you see them in combination with any of the other characteristics mentioned here.

Brilliance, dispersion and hardness

Synthetic moissanite is marginally less brilliant than diamond, although it still has good brilliance. However, large differences in dispersion exist (see Table 1). These are negated somewhat on small stones, but are still visible with practice.

Synthetic moissanite is also an extremely hard material, measuring 9.25 on Mohs' scale, which is second only to diamond (10) among gem materials. This allows an excellent polish. Nonetheless, its surface can be scratched with a hardness pencil containing a boron nitride (borazon) crystal, while diamond cannot. Since a diamond hardness point can scratch both diamond and synthetic moissanite, it should not be used. Needless to say, this can be a destructive test, and so should be avoided when possible.

Conclusion

Synthetic moissanite, which currently wholesales for approximately $180/ct (Jewellery News Asia, 1998b), has properties that make it easily confused with diamond. Its brilliance, hardness and thermal inertia all display characteristics that could fool an unwary observer. As previously mentioned, the thermal inertia properties of synthetic moissanite overlap those of diamond, making this one of its trickiest characteristics. However, by using the techniques mentioned here, one can avoid these pitfalls and make the correct identification.

References

Nassau, K. et al. (1997) Synthetic moissanite: A new diamond substitute. *Gems & Gemology,* Vol. 33, No. 4, Winter, pp. 260–275.

Jewellery News Asia (1998a) Differentiating moissanite from diamonds. *Jewellery News Asia,* May, p. 146.

Jewellery News Asia (1998b) Moissanite shipments up. *Jewellery News Asia,* Nov., p. 32.

THE CRYING GAME – DIAMOND COLOR GRADING

By Richard W. Hughes

Hey there. How many of you have experienced this? You color grade a diamond with your in-house master set and it seems to you to be a solid F. Needing a document to flog the rock, you then send it off to your main laboratory ice house and it comes back one grade different. Kinda makes you wanna cry, doesn't it? If this sounds familiar, it should – arguments on diamond color grades occur with the frequency of a Bill Clinton floozie outbreak.

Weepy

Before the sobbing starts, let's look at why this is so. Probably the most important reason for color grade variations is simply the narrow size of individual grades. Let me tell you, these cubbyholes are tighter than Tom Jones' jeans, with differences being literally at the edge of human discernment. While under optimum conditions graders can generally get within a quarter grade of one another, on lab documents the best reproducibility graders can probably attain is plus or minus one full grade. Yep. One full grade. Thus today's F could be either tomorrow's righteous E or disastrous G.

Why is this so? One reason is because no major laboratory currently lists whether a stone is in the high or low part of a particular grade's range. Thus if a stone lies near a grade boundary, a quarter grade real difference can translate into a full grade printed difference on a report. For example, a high G is simply printed as a straight G. When it is regraded and becomes a low F, again it appears to the client as a pure F, even though the two internal grades are virtually identical.

Master blaster

Take the master stones themselves. Being creations of nature, no two stones are alike, and these differences are amplified by differences in cutting. De Beers continually preaches this, but all too often we ignore it. As each diamond is different, it is impossible for anyone to produce a master set totally identical to the original Gemological Institute of America-Gem Trade Laboratory (GIA-GTL) set, including GTL. And since GTL has more than one master set (reports suggest upwards of five sets in each of their two labs), variations will result. Some labs/dealers even use cubic zirconia masters, creating further problems.

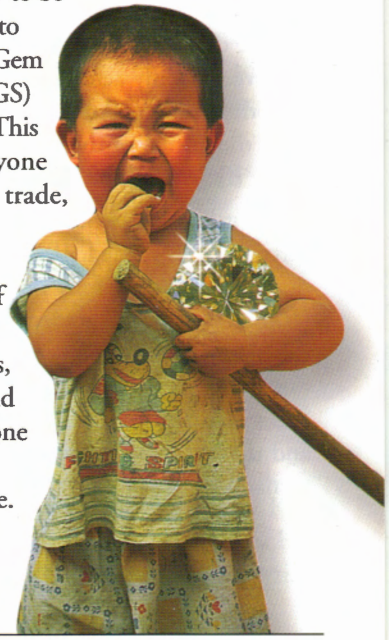
Shifty

Guess what happens when graders swap out individual master stones to improve their sets? This produces subtle shifts in the grade boundaries and can result in different grades when the same stone is regraded at a later time.

Chilly

Just how does GTL grade master sets anyway? They use something called a colorimetry scale, assigning a number to each master. This allows graders to better understand the exact position of each master stone relative to the master GTL master set. The colorimetry of a perfect master set would advance in 0.5 increments, where E is 0.5, F is 1.0, G is 1.5, etc. But not every master set is perfect. For example, a perfect F would be 1.0, but in their system an F master could be anywhere between 0.85 and 1.15. Thus if your F master is 1.15, you could have a stone that is a high F (say 1.10) that you would still grade as an E when compared to your F master.

To top it off, GTL policy allows such colorimetry to be given only to American Gem Society (AGS) members. This leaves everyone else in the trade, including the vast majority of diamond wholesalers, jewelers and labs with one extremely chilly willie.



Brownie

By definition, masters are supposed to lie only in the Cape series (yellow series, Type 1a), but again, nothing in nature is 100% perfect. So while GTL will reject stones with obvious color contaminants, subtle contaminants (such as browns, grays or greens) might still get through. Due to Australian production, many stones mined today contain a significant brown component. Stones in this brown family are particularly difficult to grade against Cape series yellow masters.

Moody

Not only do masters vary, but also the eyes of graders. Even among so-called color normal individuals, variations exist. Not all eyes show the same sensitivity to colors like yellow or brown. Furthermore, some people's moods show as many ups and downs as the presidential staff. These emotional swings, along with little molehills such as the yellowing of our corneas with age, the time of day we grade, the number of hours grading in a day, etc. can become insurmountable mountains when subtle color differences need to be discerned.

Greasy

Enjoying this? We're just getting started. Diamonds attract grease like a dirty politician, and feathers and bruted girdles provide perfect places for dirt to lodge. Bruted girdles also pick up metal from tweezers and since master stones get handled so often, this is a real problem. Simple cleaning with a cloth will not remove it – only acid boiling will do. Experienced labs generally polish or facet the girdles of their masters, but many traders do not.

So what happens when a stone with a dirty girdle is graded? If the grader does not examine it carefully in all directions (and inexperienced graders may not do this), a mistake may be made. Directional inclusions such as color zoning and graining may have a similar effect and that's something not even the white tornado can remove.

Ugly

Even graders working in the same lab with the same master set often do not standardize the viewing conditions. Some graders prefer to hold the stones within an inch or two of the light source, while others hold the stones down at the bottom of the box, more than doubling the distance from the lamp. As anyone familiar with the inverse square law knows, distance is extremely important. Doubling the distance of the stone from the lamp decreases the amount of light by a factor of four. Tripling the distance decreases the amount of light striking the stone by a factor of nine. While this may not change the color of a stone with weak fluorescence, holding a stone close to the tubes could have a dramatic effect on those with stronger blue fluorescence, masking the yellow body color.

It gets uglier still. The viewing background is not always consistent; certain labs grade against white plastic and others against cardboard cards, some of which actually fluoresce blue. Each lab believes their methods to be sound, but since labs do not necessarily use the same conditions, comparing grades between different labs can occasionally resemble an ecclesiastic house-warming party. BYOF – Bring Your Own Faith.

Slimy

Light sources themselves are a can of worms some gemologists and many dealers would just as soon not think about. While most graders use the GIA GEM Instruments DiamondLite, how many regularly change the bulbs? The spectral output of any fluorescent tube changes with time, which means the same stone may appear different at different points in time. Furthermore, the bulbs used for diamond grading all have a UV output, and this may vary from one bulb manufacturer to another.

As an added complication, the GIA GEM Instruments DiamondLite comes with two daylight bulbs, each independently controlled. As demonstrated to the author by Mike Scott and Edward Boehm of White Rose Enterprises, the light output with just one tube turned on (as opposed to both at once) reveals a significant change in color temperature, in addition to a change in the quantity of light striking the stone. The readings, using a Gossen Color Master Color-Pro 3F meter at 3000 lux sensitivity, are shown in Table 2.

TABLE 2. Color temperature readings for the GIA GEM DiamondLite

Condition	Color temperature (±50°K)
Rear tube only	6450°K
Front tube only	6280°K
Both tubes together	6410°K
Both tubes together reflected off bottom of DiamondLite	6130°K

Holy

By now, having been reduced to blubbering heaps, you're probably reaching for that old chestnut, instrumental color grading. What about getting a machine to grade the stones, right? Nice try. File that along with cold fusion and Uri Geller's mental spoon bending. It doesn't work. Ever since B.W. Anderson first suggested machine color grading of diamonds, it has remained the gemological holy grail. And to date, every instrumental color grader has had problems, insurmountable problems. This should give you some clue: reports suggest that the GIA, which sells a diamond colorimeter through their GIA GEM Instruments subsidiary, does not regularly use the instrument in their GTL.

Unfortunately, color differences between machine and eye are far too common. There are a number of reasons for this. Perhaps the biggest problem is that the machine does not "see" the stone's color in the same way as the human eye. Two stones that are visibly different to the eye may produce the same grade on the machine, while those that are identical to the eye may fall into different categories with machine grading. Since it is the human eye that is the standard, a machine eye that doesn't closely match the human equivalent is useless.

Tears for fears

Since I am not really the sadistic bastard I seem, I won't go into the other problems faced by diamond color grading systems. It is not my intention to scare readers, but rather to help those who use diamond grading reports better understand the limitations of the present techniques.

Qualified graders working under optimum conditions in the same lab with the same master set can generally attain reproducibility to within one quarter to one half grade. However, as you should now understand, such conditions are not always found today, either in dealers offices or grading labs. While many of the above problems can be minimized, none can be entirely eliminated. In combination, the result is that, even at top labs such as GTL or GQI, diamond color grades may not be reproducible to better than plus-or-minus one full grade, let alone under the conditions found in most dealers' offices. That's reality. Sad to say, but we've got to get used to it. Until the industry is ready to consider modifications to the existing grading methods and system, all we can expect is more of the same, lots more tears. Now you can start crying. ☯

Acknowledgments

The author would like to thank Thomas E. Tashey and Craig Slavens of GQI for their careful reading of the manuscript and helpful suggestions.

GIRDLE GRAFFITI – DIAMOND LASER INSCRIPTIONS

By Craig Slavens, G.G., C.G.

A recent article in *Modern Jeweler* ('Laser Tag,' August 1998, p. 16) asserted that laser inscription technology will make conventional plotting diagrams on diamond reports obsolete. Before we put the plots out to pasture, I feel a few important points need to be addressed.

First, laser inscriptions are valuable in identification only if the mounting does not obstruct the inscribed girdle area. What does one do in the case of bezel- or channel-set stones? The stone must be removed from its setting before a conclusive identification can be made.

Second, a laser inscription can be removed with minimum weight loss by repolishing the girdle. In such a situation, what would be left to conclusively identify a stolen stone? Measurements alone will not be enough.

Third, without a plot, it is impossible to prove if a stone has sustained damage since its last laboratory examination. Was that feather or chip there before? Has it extended?

A separate issue is the process patent, which guards laser inscription technology. If this is a better method of identifying a diamond, why is the licensing of the technology limited to two laboratories?

Plotting a diamond's inclusions is the most time consuming part of the grading process. By eliminating the plotting process, stones can be graded much faster. However, is this time-consuming step not in the best interest of the consumer and the laboratory? Why should a diamond under a carat forego the plot? After all, what size is the average diamond purchased in the US market? Is the removal of this information an indication that these stones are less important than diamonds over a carat?

In the age of diamond reports, where the goal is to provide more information to allow a consumer to make a confidant, educated purchase, it seems almost negligent to eliminate a plot. If other laboratories can issue "scaled down" reports and maintain market share without sacrificing the integrity of the report, why should the industry accept the removal of this vital gemological fingerprint?

In summary, let's call a spade a spade. The laser inscription of diamonds, in lieu of providing plotting diagrams, is monetarily driven. ☯

SURFACE-ENHANCED TOPAZ

By Richard W. Hughes & Thom Underwood

At the 1998 Tucson Gem Fair, a new type of enhanced topaz made its appearance (Johnson et al., 1998; Hodgekinson, 1998). This has been described by one producer, Richard Pollak of United Radiant Applications (Del Mar, CA) as a surface-diffusion enhancement, where the color is confined to a thin layer at and just below the surface.

In addition to Pollak, Charles Lawrence of CL Laboratories (Encinitas, CA; Figure 2) is producing similar material, but in a wider range of colors, including an emerald green (Figure 3, top left, lower row).

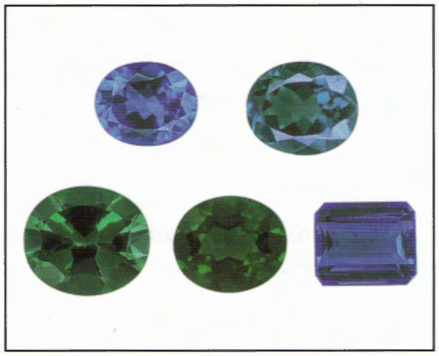
Figure 2.
Charles Lawrence of CL Laboratories shows off his surface-enhanced green topaz. (Photo: Richard Hughes)

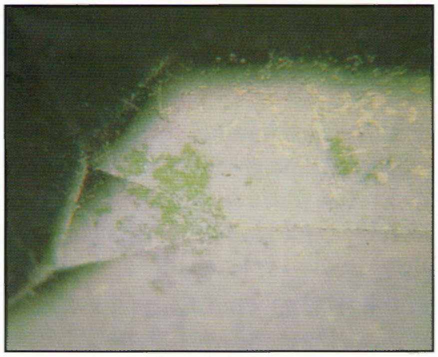
Why surface-enhanced topaz?

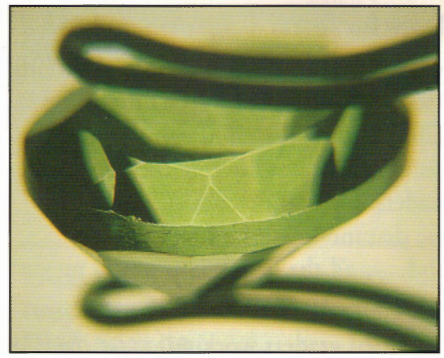
With the plethora of low-priced irradiated/heated blue topaz in the market, an obvious issue is why the world needs a new blue topaz treatment? We put that question to Richard Pollak and Charles Lawrence, who explained the advantages of the surface-treatment process. Unlike most irradiated topaz, the new treatments result in no residual radioactivity, thus requiring no costly cooling down period while stones decay to safe levels. Secondly, the new process allows for colors other than blue. As for the disadvantage of losing color if a stone is chipped or recut, the low prices of this material mean that it is a simple matter to replace the entire stone.

The Kirkendall effect

One of the classic experiments in defining diffusion was performed by A. Kirkendall (Shewmon, 1989). In this, a bar of 70–30 brass (70% copper–30% zinc)







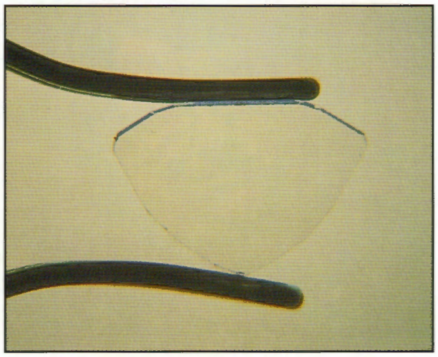


Figure 3. Surface-enhanced topaz

Top left: Color range of surface-enhanced topaz from United Radiant Applications (top row) and CL Laboratories (lower row).

Top center: Surface-color spotting of surface-enhanced topaz is clearly visible in this photo.

Top right: The white facet junctions of surface-enhanced topaz when viewed with diffused light is a key identifying feature of the CL Laboratories product.

Bottom left: Sectioning a surface-enhanced topaz shows the color layer to be so thin as to be nearly invisible with a standard gemological microscope. (Photos: Richard Hughes)

was wound with fine molybdenum wire (molybdenum is insoluble in copper and brass) and then plated with about 0.1 in. of copper. This couple was then given a series of successive anneals. After each anneal, a piece was cut from the bar and polished. This revealed, rather than the copper diffusing into the brass, more diffusion of zinc from the brass outward into the copper. This showed that the diffusion rate of zinc into copper was far greater than that of copper into zinc.

Now, on to the topaz that is the subject of this article. Microscopic examination shows the color of this material confined to a layer at and just beneath the surface. According to the manufacturers, this color layer results from heating in a cobalt- or cobalt and nickel-rich powder. So thin is this layer that the question has arisen whether this represents a surface coating or a surface-diffusion process. The Kirkendall effect suggests that this may be a moot point. When the topaz is packed in the coloring agent and heated up, an impure surface layer forms. Rather than being solely a situation of the cobalt moving into the topaz, it is possible that the topaz constituent atoms diffuse into the coloring agent, or perhaps a bit of both. Thus it appears likely that the color layer results, at least in part, from diffusion.

Johnson et al. (1998) reported that for United Radiant Applications material, the color layer could not be scratched even with a piece of quartz (Mohs' hardness = 7). Only another piece of topaz could scratch the layer. This further suggests the process involves diffusion, as opposed to a softer surface coating.

Cobalt... the culprit

At the request of CL Laboratories, research on the cause of color in surface-enhanced topaz was performed by William C. Trogler, professor of chemistry and biochemistry at University of California at San Diego.

In Trogler's preliminary conclusions he writes:

> An explanation (for cause of color) based purely on impurities does not seem reasonable, since the green stones can be turned blue on heating. The most likely explanation is that the green color represents an unstable lattice phase of topaz (probably only on the surface) where the cobalt ions occupy unfavorable lattice sites. On heating the lattice equilibrates, the cobalt ions occupy normal sites and the normal blue color is obtained. The unusual lattice could either be one significantly different from topaz (perhaps due to the fluorine loss from the surface) or else represent differing occupation of cobalt ions in tetrahedral and octahedral lattice sites.

The color is most likely caused by cobalt in the lattice, with nickel apparently playing an additional role in the green variety. When compared with unenhanced topaz, the EDAX (electron microscope data) surface composition of the enhanced topaz lattice shows that the wt% composition of cobalt is huge and suggests a heavily doped surface layer (Trogler, March 1998).

Trogler goes on to state:

> The ratios of the wt% values of the nonoxygen element is probably most meaningful. Pure topaz has an Al:Si ratio of 1.92 [1.92:1] whereas the green stones (treated topaz) have a ratio of 1.41 [1.41:1]. This suggests extensive substitution of Al by cobalt in the surface layer. The weight percentage of the silicon suggests it is perturbed the least and so the ratios relative to silicon are most useful.

Mullite formation and the RI shift

Further, Trogler suggests:

> The substitution in of [sic] significant sodium and calcium is also

TABLE 3. Properties of the new color-enhanced topaz

Property	Description – United Radiant Applications product (5 stones)	Description – CL Laboratories product (9 stones)
Color	Blue to greenish blue Munsell Hue = 7.5B–10B; Tone = 6; Saturation = 12–14	Blue: Munsell Hue = 10B; Tone = 6; Saturation = 12 Green: Munsell Hue = 3.5–10G; Tone = 5–6; Sat. = 13–15
Color distribution	Even to the naked eye; patchy surface coloration under magnification; white surface chips against a white diffusion filter	Even to the naked eye; patchy surface coloration under magnification, often with green spots; white facet junctions/surface chips against a white diffusion filter
Luster	Resinous subadamantine luster on polished surfaces	Resinous subadamantine luster on polished surfaces
Pleochroism	None to faint; generally two different shades of blue	None to faint
Transparency	Transparent	Transparent
Optic character	Doubly refractive, biaxial, positive	Doubly refractive, biaxial, sign undeterminable
Refractive index	Table facet: n_α = 1.608–1.610; n_β = 1.610–1.614; n_γ = 1.618–1.620 Birefringence = 0.009–0.010 Pavilion facet: Anomalous readings; often above 1.81	Anomalous readings; generally above 1.81 Birefringence undeterminable
Specific gravity	3.56–3.57	3.50–3.63
UV fluorescence	LW: Inert SW: Inert to faint yellowish green	LW: Very faint red flash SW: Very faint red flash
Visible spectrum	Cobalt spectrum: bands at approx. 560, 590, 640 nm.	Cobalt spectrum: bands at approx. 560, 590, 640 nm.; strongest in blue stones, weaker in green stones
Magnification	Parallel particle strings & clouds Crystals or negative crystals with tension disks	Parallel particle strings & clouds Crystals or negative crystals with tension disks
Chelsea filter	Red	Green stones: Pinkish purple Blue stones: Red
Price	Wholesale: $3/ct.	Wholesale: $16–35/ct.

suggestive of a surface coating whose composition is so far perturbed from that of topaz that there may be a different mineral form on the surface layer. In this context, it is noteworthy that the absorption spectra suggest a far heavier doping of the surface in the green stones than in the blue ones.

In experiments performed by Day et al. (1995), it was found that "Topaz [$Al_2SiO_4(F,OH)_2$] decomposes on heating above ~1100°C into mullite (nominally $3Al_2O_3{\cdot}2SiO_2$), but the composition may involve a liquid phase, a vapor phase, or both. Hampar and Zussman [Hampar et al., 1984] proposed a multistage reaction mechanism to explain the thermal decomposition of topaz to produce minor glass (liquid), cristobalite, and even corundum, as well as mullite." (Day et al., 1995).

Trogler concurs:

> There are also some interesting phase changes in topaz that yields mullite and glassy silica at 1150°C. (Day et al., 1995). The product is primarily mullite ($3Al_2O_3{\cdot}2SiO_2$) which occurs by loss of HF due to the reaction of water vapor. The oven cement may introduce water vapor that could accelerate fluoride loss. Narrow rinds of glassy silica rich in K_2O and Na_2O and with nearly no alumina present also was formed. The loss of fluoride in the green topaz surface layer suggests that some new mineral phase, whose index of refraction differs considerably from the underlying topaz may be bound to the topaz surface. The large decrease in alumina and fluoride, and large increase in cobalt and sodium would be expected to significantly influence the structure. In particular, the incorporation of sodium is more suggestive of a glass than a well defined lattice.

The green color – and a durability issue worth noting

As to the effect of nickel, Trogler has these comments:

> According to the EDAX the Co:Ni ratio is about 7:1, which is an appreciable amount of nickel. Under certain circumstances [the] nickel ion gives a broad absorption in the ultraviolet that tails into the blue spectral region (absorbs blue) and gives a yellow color. That may account for the broad absorption from 440 nm (violet-blue) to 300 nm in the green topaz. This absorption/coloration is very sensitive to the lattice according to Rossman (1981).

Charles Lawrence reported to us that his green surface-enhanced topaz will lose its color in a pickling solution, which leaves a lightly frosted surface. This is not true of his blue stones. Pollak told one of the authors (TU) that his stones do not lose color in the pickling solution. This is possibly because his stones are not a true green.

This differing reaction to an acid bath might be explained by referring to Trogler (1998), who suggests that in the green variety of surface-enhanced topaz, cobalt ions occupy "unfavorable" lattice sites that constitute an "unstable lattice phase of topaz (probably only on the surface)." We hypothesize that the pickling solution may provide the correct environment for a chemical reaction which causes the leaching of colorant(s) from the surface layer of the topaz and hence a loss of color.

Properties

The properties of this material are summarized in Table 3. By far the most important identifying feature is the color distribution at the surface. Many stones displayed surface chips where the colorless nature of the interior topaz was revealed. Placing a white glass or plastic diffusion filter over the well of the microscope reveals a spotty surface coloration, with many stones displaying a lack of color at the facet junctions. These features are shown in Figure 3, center and right.

To determine the thickness of the color layer, GQI's Martin Guptill sectioned cut stones. This revealed a color layer so thin that it could not be measured with standard gemological equipment (Figure 3, bottom left).

House of mirrors – Crazy RI readings

Perhaps the most unusual characteristic of surface-enhanced topaz is the anomalous refractive index (RI) readings. When tested on the standard gemological refractometer, enhanced topaz displays RI's ranging from normal (comparable to unenhanced topaz) to diffused (a broad vague band versus a distinct shadow edge) or none at all (above the 1.81 limit of a normal refractometer). It appears that the topaz surface might indeed be transformed into mullite, glass, and other substances. According to Phillips et al. (1981), mullite has a refractive index in the range of 1.634–1.690 ($n_\gamma - n_\alpha$ = 0.010–0.024), while glass can be higher or lower. Neither would explain the wide range of RI readings. More likely, the high concentration of cobalt near the surface is responsible for the high RI readings, while variations in the depth of post-enhancement polishing would account for the vague and varying but lower RI readings. Indeed, our testing showed a single stone can produce a variety of RI readings depending upon which facet is tested.

RI readings for CL Laboratories stones were anomalous for both the table and other facets, including many above 1.81. It is interesting to note that readings for the United Radiant Applications product were as expected for topaz on the table facet, but anomalous readings (including readings above 1.81) were encountered on pavilion facets. This suggests extra polish is applied to the table facet. Richard Pollak told one of the authors (RWH) that he does not sell material himself, but only processes material for others and suggested that the heavy polishing of the table facet was performed by one of his customers (pers. comm., 7 Dec., 1998). His customer, Kenneth Moghadan confirmed this (pers. comm., 11 Dec., 1998).

Conclusion

With gemstone enhancements being a fact of life in today's market, we can expect to see more of such novel treatments in the future. Fortunately, in the case of the surface-enhanced topaz, identification is rather simple. ☯

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CAN'T WE ALL JUST GET ALONG?

By Craig Slavens, G.G., C.G.

Considering the wacky world we live in, it may be difficult to believe that we always have motives for our behavior. But few actions occur without reason. Understanding the motivations behind each others' actions is the key to peaceful coexistence. This article discusses differences in the way traders and laboratories approach diamond grading. Its purpose is to help traders understand how laboratory grading differs from trade grading. This should help traders buy with greater confidence, for if they understand these differences, their grade estimates will more closely match the actual laboratory grades.

Trading places

Motivations of both traders and laboratories are identical in one area – a desire to make a living. However, this common road divides when it comes to consumers, who demand the best quality for the lowest price from traders, while demanding something entirely different from lab gemologists – an impartial, accurate assessment of quality. It is this contrary pull of the consumer that creates conflicts between traders and gemologists.

Due to the subjective nature of diamond grading, there will never be total agreement on grades. It has been my observation over the last eight years that, when grading clarity, traders place most of their emphasis on an inclusion's appearance. The size, nature and impact of an inclusion on the durability of a stone don't play as heavy a role as they do for the laboratory. For example, a transparent cleavage that nearly parts a stone in two is judged mainly on its appearance. Conversely, a black included crystal that is obvious with a loupe tends to be judged more severely.

Laboratory grades

While an inclusion's appearance has a large impact on a clarity decision, a laboratory's methodology also takes into account the type of inclusion, its length or size and impact on the durability of the stone. Appearance is never the sole factor in arriving at a clarity grade. For example, a trader grading a stone with a severe inclusion (such as a large cleavage) face up might call it an SI_1. However, a laboratory will examine the inclusion from all directions; the inclusion's length and severity through the pavilion might push the grade down to as low as I_1. The laboratory will try to make a fair compromise between appearance and nature, perhaps resulting in a grade of SI_2 or SI_3. Again, you cannot rely solely on appearance when estimating clarity grades.

The naked truth

Another area of differing philosophies is the grading of diamonds with eye-visible inclusions. Some traders and laboratories quickly place a stone into the *Included* (I_1, I_2, and I_3) category when a diamond has an inclusion visible to the naked eye. Again, scientific methodology must prevail in order to produce accurate and consistent grades. We must first identify what we can see with our unaided eye before we classify these stones.

Measuring the inclusion's size is a more scientific approach. Ask yourself what you see. Is it a large opaque feather or a small black spot in the table? Also take into account the size and shape of the stone. The larger a diamond, the more readily apparent an inclusion will be. A stone's shape also impacts the eye visibility of an inclusion. For example, it is generally easier to see an inclusion in an emerald cut than it is in a round brilliant.

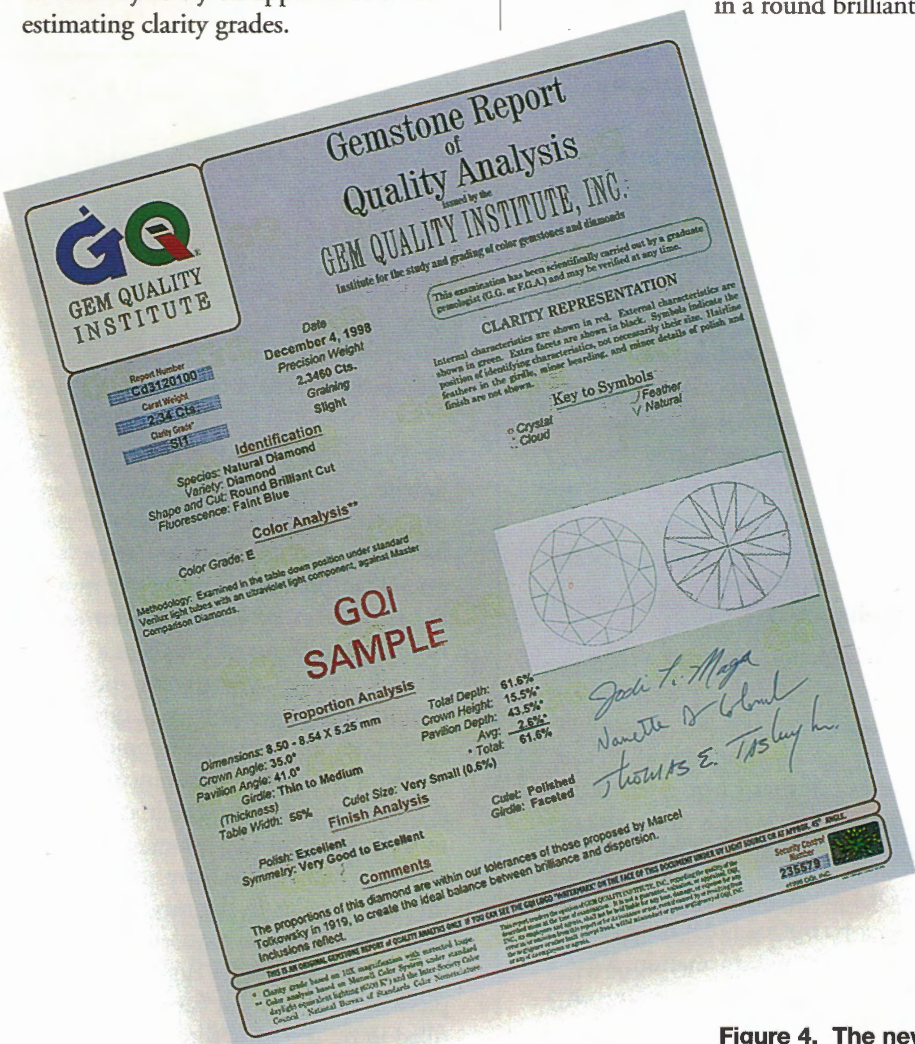

Figure 4. The new GQI Gemstone Report
(Photo: Craig Slavens)

Compare beware

In order to more accurately estimate what grade a stone will receive, traders often compare stones they are purchasing or grading with laboratory-certified stones. Since nothing in nature is identical, this can be dangerous. Therefore if you rely on this approach, make sure you compare apples to apples, i.e., stones of similar size and clarity characteristics. Don't expect a stone with a deep transparent feather to receive the same grade as one with a black crystal.

Similarly, when comparing stones for color, be aware that two stones may appear almost one full grade apart in color and receive the same color grade. Conversely, a stone may be only slightly darker than another and receive a lower letter grade. This is due to their proximity to color grade borders (see 'The Crying Game' on page 3 for more on this).

Give peace a chance

Chucking certificates in the round file and pitching profanities at labs when differences in opinions occur does little to resolve the problem. Again, nobody acts without reason. Traders and laboratories must each keep both an open mind and open lines of communication if we are all to get along.

GQI'S NEW GEMSTONE REPORT

By Thomas E. Tashey

GQI's Chicago office is now open and issuing reports for both gem identification and quality analysis. Since the format of the quality analysis reports is slightly different than that used for our EGL reports in Los Angeles, it seems appropriate to discuss these differences. The new report is shown in Figure 4. Since the same layout is used for diamonds as well as color stones, there are differences from the typical diamond trade report.

Basic information

The stone's report number, carat weight and clarity grade are listed in the top left corner. This critical information is printed in bold and is placed over several lines of security feature "micro-type" to prevent changes or forgery. Look with a loupe at these lines on an actual report and you will see why it would be difficult to duplicate.

To the right of this information is the date of issue, the stone's precision weight (to four decimal places) and any internal or surface graining (if present).

Beneath this is the identification information. We include both species and variety – this is important for color stones, and will also be useful for fancy color diamonds, enhanced diamonds and synthetic diamonds. In addition, the gem's shape, cut and long-wave ultraviolet fluorescence are included in this area.

Color analysis

The next area is color analysis. For color stones and fancy color diamonds, color is described both in words, as well as with Munsell notations. With white diamonds, we presently just list the color grade, but describe the methodology used to determine that grade. Very soon we will also begin listing the stones face-up color appearance much the same as we do for gemstones with color. Face-up grading will be discussed in detail in a future issue of *GQ Eye*.

Proportion analysis

In the proportion analysis area of the report we have added information, as well as laying it out in a more meaningful fashion. First, the stone's dimensions are listed, followed by the total depth %, determined mathematically based on those dimensions.

Next is the crown angle (a new parameter), followed by the crown height %. Beneath this line is the pavilion angle (also newly added), followed by the pavilion depth %.

Girdle thickness is then described, first in words as observed at the narrow, scalloped portion of the girdle, followed by the average girdle thickness % (a new parameter), as measured at the thicker portion of the girdle between each bezel facet and pavilion main facet. The next line to the right is listed "*total" and is a second determination of the stone's total depth %, this time calculated from the summation of the stone's crown height %, pavilion depth %, and average girdle thickness %. Because of rounding considerations, the two depth %'s may not always be exactly the same, but should be within 0.5% of one another. The final line in the proportion area lists the table width % and culet size, both as a description and as a percentage (also a new parameter).

Finish analysis

Polish and symmetry are listed under finish analysis, along with girdle and culet conditions. For girdle this means whether it is bruted (and if so, whether it is smooth, slightly rough or rough) or whether it is polished or faceted (or partially so). For culet it means whether it is pointed, abraded, nicked, chipped, polished or a natural. We are attempting to be more meaningful by stating what the specific conditions are, rather than relying on the user's knowledge of the assumptions made if not specified as is the case with most other reports. At the bottom of the report is the area for comments where additional stone information is listed, if appropriate.

Plot

On the right side of the report is the plot of the stone's external and internal characteristics and above this is another new feature – the key to the symbols used on the plotting diagram. We have long wanted to add this key to our reports and have finally done so. It certainly adds professionalism to the report. This, along with some of the other information will soon be added to our EGL reports.

The GQI Mini-Report & Consultation

GQI's Mini-Report contains all the information of the full report, but in a much smaller size. The key to symbols has also been added to the back of our Mini-Report so that when inserted into the Consultation, it folds down to complement the plotting diagram there.

The GQI Consultation is similar to the Mini-Report, but includes only the most critical stone information. We have also added a summation line on the document's spine to more easily locate individual stones. This summation line lists the stone's variety, its shape and cut, carat weight and its color and clarity grades.

Additional security features

Two final features on all of our reports are again designed to add security. One is the GQI hologram and the other is the security control number. This number will be used in the future over the internet and in other applications to ensure the confidentiality of stones to their owners. In order to access or verify information about a particular stone, both the report number and the security control number (each unique to any given stone) must be given. This means you must have possession of one of the reports to be able to access information about that particular gemstone.

We have improved the quality and quantity of the information provided about a particular gemstone, and we plan on using this information in future projects.

TALES FROM THE CRYPT – GQI LAB NEWS

By Richard W. Hughes & Craig Slavens

One of the chief benefits of lab gemology is the chance to view so many beautiful and interesting gems. Over the past several months, a number of interesting items have come in for testing, as the following illustrates.

Jadeite – Repaired, assembled, treated

Jadeite is always a tricky stone to identify, what with the great variety of treatments, assembled stones and even assembled boulders. One of the more unusual pieces we have ever seen was a thin green carving mounted in a brooch. The rich green color and high translucency suggested a fine quality jadeite carving, but microscopic examination showed tiny round inclusions on the back of the stone which appeared to move as the gem was examined from above. When viewed from the side and through the slits in the metal on the back, the truth was revealed – the gem was a composite of an egg-shell thin piece of hollowed out carved jadeite filled in on the back with a resin-like substance. The round inclusions were gas bubbles in the resin (see Figure 5).

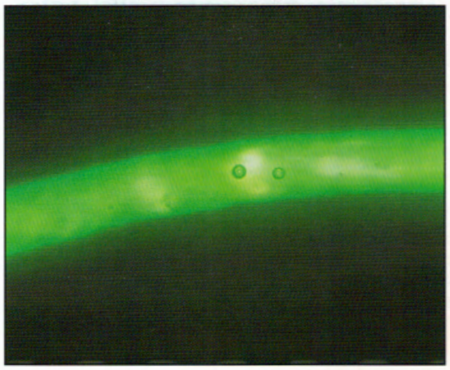

Figure 5. Resin-backed jadeite
Gas bubbles in the resin backing are clearly visible through the back of the mounting of this hollowed out carved jadeite.
(Photo: Richard Hughes)

A green jadeite bangle bracelet which came in for identification offered a different twist: microscopic examination revealed it to be broken into several pieces and carefully glued back together. The joints appeared as clear areas and also contained gas bubbles, giving the

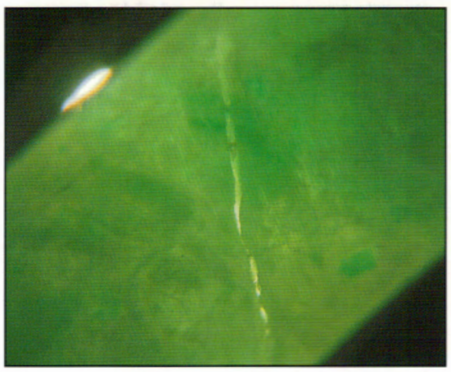

Figure 6. Repaired jadeite bangle
Gas bubbles in the clear cement layer are visible in this repaired jadeite bangle.
(Photo: Richard Hughes)

game away (see Figure 6). In addition, long-wave UV revealed a strong bluish fluorescence from the glue areas.

B-jade refers to jadeite which has been acid-bleached and then exposed to a subsequent impregnation process. The impregnation typically consists of a hardened resin (epoxy), or less frequently, paraffin (wax). If the impregnation is colored (dyed), the material is referred to as C-jade (this term also applies to ordinary dyed jade).

In many cases, B-jade cannot be positively identified with standard gemological equipment, instead requiring infrared spectroscopy. However several jadeite bangles examined by GQI recently were a snap, because the filled areas were so large that they were easily visible under magnification with overhead lighting. The filled areas display a lower luster and are visible in Figure 7.

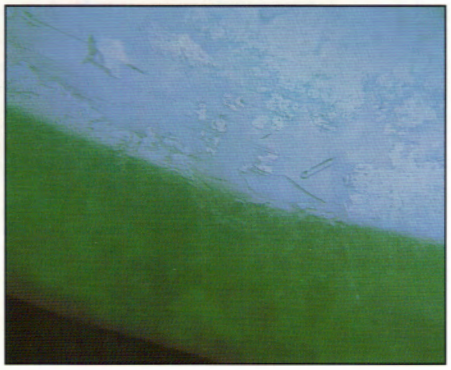

Figure 7. B-jade bangle
Large resin-filled cavities (dark areas) are easily visible in this B-jade bangle.
(Photo: Richard Hughes)

Unusual engraved diamond

In the world of diamonds, stones are produced with almost cookie-cutter regularity. Thus it was with great interest that we examined the tablet-cut diamond shown in Figure 8, which was provided to us by Samba Imports (Los Angeles).

This diamond featured laser-engraved Hebrew letters representing the ten commandments on its face. According to the Bible's Book of Deuteronomy, the ten commandments, which are the essence of Judeo-Christian-Islamic morality, were engraved on the two stone tablets given Moses on Mount Sinai. In Jewish tradition, the tablets represent both the ten commandments and the entire body of Jewish holy scriptures and law.

Traditionally, the tablets were represented by two rectangles with rounded tops. The tablets usually include the first word of each one of the ten commandments or the first ten letters of the Hebrew alphabet, which symbolize the ten commandments.

The tablets became a popular Jewish symbol in the Middle Ages. Since then, they have been frequently used to decorate synagogues and Jewish holy artifacts. And, we might add, this fascinating diamond. ☯

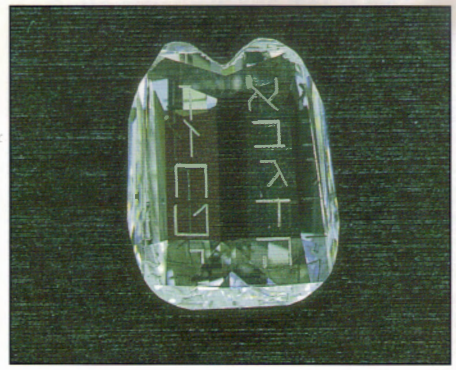

Figure 8. Engraved diamond
Diamond engraved with the ten commandments in Hebrew. (Photo: Craig Slavens)

GQI DOES TUCSON

It's Tucson time again, and GQI will be present in force. We will have an information booth set up on the mezzanine at the AGTA show, but our main booth, complete with on-site grading, will be found in the Tambo Room at the GLDA show, Holiday Inn Broadway.

In addition to our booths, GQI President, Thomas Tashey, and Color Stone Manager, Richard Hughes, will be giving lectures during the show (see Table 4). We welcome you to attend these lectures and also to stop by our booths during the show. ☯

GQI TOUR 1999

By Martin Guptill, G.G., F.G.A.

Welcome back my friends
to the show that never ends…

Many people may not yet be aware that GQI does on-site grading and identification at trade shows. We are hitting the road in January with an expanded trade show schedule (see Table 5). New additions include the Columbus Jewelry show and Professional Jeweler magazine's first ever show in Las Vegas. With a quick turnaround, trade shows are the perfect place to have your goods graded. So drop by for a visit. We offer on-site grading at all locations. ☯