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ALEXANDRITE, With a Fish-Eye Effect

The West Coast Gem Trade Laboratory recently examined an oval mixed cut that proved to be somewhat unusual. We identified the 2.93 ct stone as a natural alexandrite chrysoberyl; it appeared red-brown in incandescent light, with a slight change of color toward green in fluorescent light.

The identification as chrysoberyl was a relatively routine gemological matter. However, while looking for a biaxial interference figure using a small glass ball as a condensing lens and cross-polarized light, we noted a fish-eye type of optical effect (figure 1). Further examination of the stone at different levels of magnification revealed a slightly milky cloud that appeared to be composed of extremely fine, submicroscopic particles.

The "fish-eye" could only be resolved in one particular direction

through the stone. Since this did not coincide with an optic axis in the chrysoberyl, we did not suspect that it was an odd interference phenomenon.

A similar optical effect—although not as well defined—can be seen when cat's-eye imitations made from fiber-optic glass are examined with a condensing lens down the length of their fibers. If the submicroscopic inclusions in the natural chrysoberyl are aligned in the same manner as the glass fibers in the imitation cat's-eyes, the effect shown might be due to a tunneling of light through the lens. If this is indeed the cause of the optical effect shown in figure 1, then an important question remains unanswered: Why is cross-polarized light necessary to resolve the "fish-eye"? This is the first time that we have seen such an optical effect in any natural gemstone, and we have many questions. More detailed optical examination, probably including the study of a thin section under high magnification, would be required to find a more complete answer.

John I. Koivula

DIAMOND, with a Stellate Cloud

During the course of diamond quality grading, graders occasionally encounter unusual internal features. Even though such features can reduce the overall clarity of their host, and consequently the assigned clarity grade, they can be interesting from a scientific standpoint. Such was the case with the stellate "cloud" in a near-colorless round-brilliant-cut diamond shown in figure 2.

Because of the extent and translucency of this cloud, together with its prominent position centered under the table facet, the assigned clarity grade was understandably low. Nevertheless, the exotic hexagonal, star-like appearance of this cloud gave the interior of the diamond an attractive geometric character. While geometric clouds are occasionally seen in diamonds, most of these are cubic or octahedral in shape; a hexagonal form is considerably rarer.

The cloud shown here appears to be a phantom of either a hextetrahedron or hexoctahedron diamond crystal. In these two crystal forms, the triangular faces are divided into six sections each. As shown in figure 3, this division changes a four-sided tetrahedron to a 24-sided hextetrahedron, or an eight-sided octahedron to a 48-sided hexoctahedron.

When one looks perpendicular to a hextetrahedral or hexoctahedral crystal face, one sees a form composed of six pie-shaped faces divided by six interfacial ridges. This gives the appearance of a six-rayed star. A phantom formed in a diamond crystal with this habit might show a stellate cloud in a cut stone. If the cutter oriented the rough so that a hextetrahedral or hexoctahedral face was nearly parallel to the plane of the table facet, then the star-shaped cloud would be readily visible through the table facet.

Editors' note: The initials at the end of each item identify the editor(s) or contributing editor(s) who provided that item.

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Figure 1. This unusual fish-eye effect was noted in a 2.93 ct alexandrite when it was observed in one particular direction through a condensing lens with cross-polarized light.





Figure 2. The hexagonal star-shaped cloud in this diamond appears to represent a phantom with a rare crystal form. The riblike extensions possibly follow previous growth steps. Magnified 10 $\times$.

The view of this cloud was distorted by reflection and refraction from the facets, so no firm conclusion could be drawn as to which crystal form it represented. Suffice it to say that this is a most unusual inclusion in a diamond, and in this writer's opinion it is also quite beautiful.

John I. Koivula

EMERALD, The Case of the Invisible Filler

The use of organic compounds to fill surface-reaching fractures and fracture systems in emeralds has been a standard practice for many years. It is often said that virtually all emeralds today are "oiled," and this generalization has been borne out by our experience in the laboratory. The visibility of surface-reaching fractures is reduced by replacing the air that normally fills those openings with an organic compound that has a refractive index similar to that of the host emerald. The treatment effectively reduces the mirror-like reflective quality of any cracks and, in the process, improves the apparent color intensity of the emerald. This method of emerald enhancement was thoroughly addressed by R. Ringsrud in the Fall 1983 issue of *Gems & Gemology* ("The oil treatment of emeralds in Bogotá, Colombia," pp. 149–156), and by R. Kammerling et al.

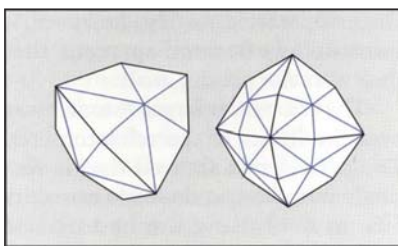


Figure 3. These line drawings illustrate two rare forms found among isometric crystals such as diamond. The hextetrahedron at left has 24 faces, formed by dividing each of the four triangular faces of a tetrahedron into six parts. The hexoctahedron at right exhibits 48 faces.

in the Summer 1991 issue ("Fracture filling of emeralds: Opticon and traditional 'oils,'" pp. 70–85).

Occasionally, a surface-reaching fracture will intersect an included crystal or a larger primary fluid-inclusion chamber (a negative crystal), thereby exposing the inclusion to the surface. Some of these mineral inclusions are very vulnerable to attack by acidic solutions. Most notable are carbonates, such as calcite and dolomite. If exposed to the surface, these inclusions are often dissolved away, sometimes during the cleaning processes used on rough crystals to remove iron oxide and hydroxide stains and other undesirable debris. This leaves a comparatively large void, with the shape of the original mineral inclusion, in the emerald. Fluid inclusions simply drain out once they have been intersected by a fracture, also leaving a void.

When such voids are filled with an organic compound, the result is never perfect. The refractive indices of the fillers we have encountered to date do not exactly match that of the surrounding emerald. (In particular, they cannot match *both* refractive indices of an emerald.) The relief caused by this difference in refractive indices makes the filled voids visible. Gas bubbles trapped in the filler within these relatively large voids often make the treatment even more obvious (see, e.g., figure 4). As a result,

such voids often provide the first indications of treatment when the emerald is examined with magnification.

Therefore, staff members in the West Coast lab were somewhat surprised to encounter a treated natural emerald with a filled void that was essentially invisible. This lack of relief indicated that the R.I. of the filling agent was nearly identical to those of the emerald—more so than any other filler we had previously examined. The only reason this void was recognized at all was because it contained three gas bubbles. As can be seen in figure 5, the bubbles appear to be enclosed within the emerald itself; the chamber surrounding them is virtually invisible. No form of microscopic manipulation or creative illumination, including an attempt at the Becke line test, adequately resolved the complete outline of the void. Nor did we see any flash-effect colors in the "invisible" fractures that must have been intersecting it. The refractive index of the emerald was 1.576–1.581, so the filler must have had an R.I. between those two readings.

Although there is no doubt that a filler was present, the combined limitations of nondestructive testing and the short time available for examination prevented us from determining

Figure 4. Note the prominent gas bubble and yellowish liquid filling in this rhombohedral void. As is typical of most large voids in such treated emeralds, the chamber is readily visible because the refractive index of the filler is sufficiently different from one or both of those of the surrounding emerald. Magnified 15 $\times$.



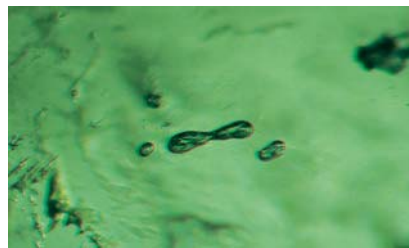


Figure 5. These three trapped gas bubbles provide the only evidence of a filled void in this emerald; the filler itself is virtually invisible, probably because its refractive index is very close to both those of the host emerald. Magnified 30 $\times$.

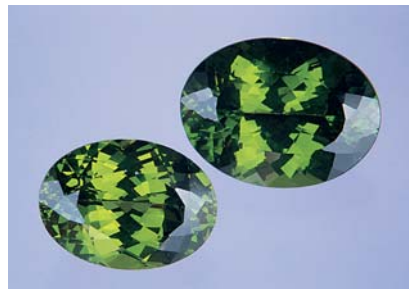
its precise nature. We did observe that the filling material was either solid or highly viscous. It is possible that a mixture of substances yielded the very close match in optical properties that made this filling invisible. However, because natural emeralds exhibit a range of refractive indices, we think it unlikely that such "invisible" treatment will become the norm.

John I. Koivula

GLASS Imitation of Peridot

Two green oval faceted gems were recently sent to the West Coast laboratory (figure 6). An identification was requested for the larger of the two (26.28 ct). When they were examined face up, both looked very much like the peridot that has been coming out of Pakistan for the last several years.

Figure 6. These green ovals look like peridot, but they were identified as glass. The sample on the right weighs 26.82 ct.



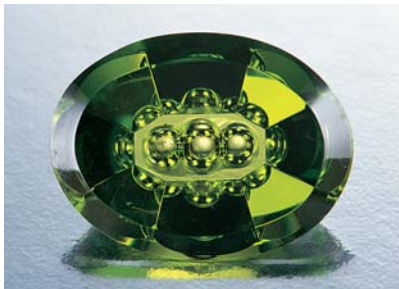
Once we started testing, however, it immediately became apparent that they were not peridot at all.

The R.I. of the larger "stone" was over the limits of the refractometer. The polariscope showed that it was singly refractive, and we measured its S.G. at 4.43 using the hydrostatic method. These properties indicate a high-property glass. Microscopic examination revealed parallel flow lines, confirming this conclusion.

We subsequently learned that these two samples had been purchased at the 1998 Tucson gem show as Chinese peridot by renowned American gem cutter Arthur Anderson. He acquired a few of these pieces in their faceted shape, intending to recut them into some of his own designs. As he started to cut the first one (figure 7), he noticed that the material did not react to the cutting wheel like peridot, at which point he sent the two pieces to the GIA Gem Trade Laboratory for identification.

Glass has been used to imitate a multitude of gemstones for centuries. In recent years, it has been found in salted parcels of amethyst, aquamarine, and Mexican fire opal, to name just a few examples. Careful manipulation of the color makes it impossible to distinguish these glasses from the stones they imitate by visual appearance alone. Of course, any number of gemological tests (e.g., optic character) can separate these

Figure 7. The behavior during carving of a third sample, similar to those shown in figure 6, made the cutter suspicious that the material was not peridot. This glass imitation weighs 18.81 ct.



imitations quickly in most instances, but it is easy to forget that any stone could potentially be glass.

This is the first instance we have encountered of material sold as Chinese peridot turning out to be glass. This should, however, serve as a warning for anyone in the market for such peridot to be wary of this imitation.

SFM and IR

JADEITE with Unusual Evidence of Enhancement

The identification of treated jadeite has been a persistent problem for gemologists and jewelers for many years. The methods of treatment most commonly used historically, such as dyeing and waxing, are intended to enhance the outward appearance of lower-quality, or poorly polished, material. More recently, there has been a proliferation of jadeite objects treated throughout by a multi-step process that involves heating, acid "bleaching," and impregnation with an organic polymer (see, e.g., E. Fritsch et al., "Identification of bleached and polymer-impregnated jadeite," *Gems & Gemology*, Fall 1992, pp. 176–187). The jadeite gems, jewelry, and carvings enhanced by this process are widely known as "bleached jade" or "B-jade."

Because the vast majority of the surface-reaching fissures filled by this process are extremely fine, there is usually no visible evidence of treatment even with a microscope. Today, most laboratory gemologists rely primarily on Fourier-transform infrared spectrometry (FTIR) to detect B-jade. So, while it is relatively easy for a gemologist to identify a material as jadeite, detection of bleaching and impregnation almost always requires advanced testing with FTIR.

On rare occasions, however, a large surface pit or wider fissure will contain visual evidence of this treatment in the form of polymer residue and/or trapped gas bubbles. Such was the case for a mottled bright green-and-white jadeite bangle that was recently submitted to the West

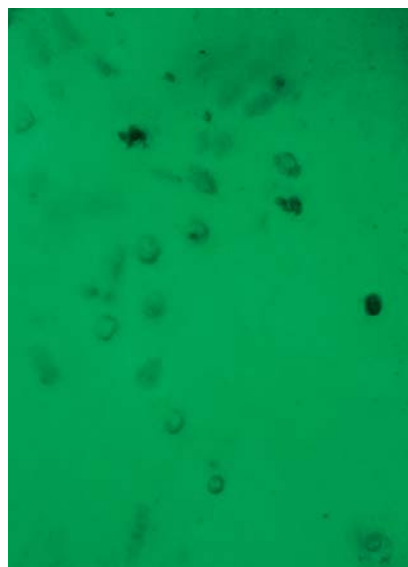


Figure 8. Subsurface bubbles provide evidence of enhancement in a bangle bracelet of "B-jade." Some of the bubbles are badly distorted, while others are nearly spherical. Their reduced visibility is caused by the translucency of the overlying jadeite. Magnified 40x.

Coast laboratory for identification and testing for possible enhancement. Without magnification, this bracelet looked like many other jadeite objects we receive in the laboratory. When we examined it with a microscope at even 10x magnification, however, numerous small gas bubbles (figure 8) were easily seen. Some of the bubbles were almost per-

fectly spherical, while others were quite distorted. They were individually contained in small voids in the jadeite that we speculated must have been formed during the acid bleaching.

It is possible that acid-dissolvable inclusions of some mineral, such as a carbonate, may have been removed from the jadeite by the acid treatment. The resulting voids were then only partially filled with the polymer during the impregnation step, leaving a gas bubble as proof of enhancement.

John I. Koivula

CULTURED PEARLS

Black, Surface Enhanced

Suspecting that a strand of 11 mm black circled pearls had been treated to enhance their appearance, a client submitted them to our West Coast lab for identification. All the pearls had an extremely high luster and showed pronounced purplish pink and green overtones. While handling them, the client had noticed a peculiar smoothness on the pearls' surface and that they were somewhat sticky to the touch.

Gemological tests verified that they were indeed cultured pearls of natural color, and microscopic examination with reflected overhead illumination showed a highly reflective surface, with a top nacre layer that was very transparent. Pearls (both natural and cultured) normally show a pattern of fine lines (figure 9), called suture lines, that are a characteristic growth feature in the nacre. However,

the suture lines in these black cultured pearls were barely visible (figure 10). We did see some fine polishing lines, but they appeared to be located slightly underneath the surface rather than on it. The needle probe left a smooth indentation, similar to that left on plastic-coated materials, which raised more doubts regarding the surface condition. Without using destructive testing methods, though, we could not verify the type of treatment. Therefore, we obtained the client's permission to remove one cultured pearl (figure 11) for further testing.

We checked this sample with a thermal reaction tester. The hot needle initially left only a chalked groove, as would be expected for a soft carbonate. However, with continued application of heat, the chalked material began to coagulate. This change proved that some foreign material was present on the surface. We sent the cultured pearl to a laboratory that specializes in polymer analysis to identify the surface material. The laboratory reported that this foreign material was a poly-dimethyl siloxane, a form of silicone that is occasionally applied to pearls to enhance their appearance. *KH*

Imitation Tahitian Pearls

The occurrence of gray-to-black natural pearls is rare (see, e.g., M. Goebel and D. M. Dirlam, "Polynesian black pearls," *Gems & Gemology*, Fall 1989, pp. 130-148). Throughout the trade, dark-colored pearls are presumed to be cultured, but a laboratory

Figure 9. The suture lines in this natural-color black cultured pearl are readily visible with magnification and reflected light. Magnified 30x.



Figure 10. Suture lines are much more difficult to resolve in this coated black cultured pearl. Magnified 30x.

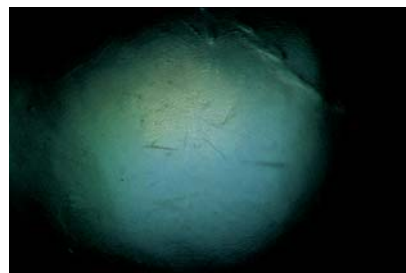


Figure 11. The coating on this black cultured pearl greatly enhances all aspects of its appearance.





Figure 12. The grayish green spheres (10.15–10.25 mm in diameter) in these ear studs make convincing imitations of Tahitian black pearls.

report is often desired to determine whether the color is natural or the result of treatment. Less frequent is the need to determine whether the material itself is genuine (that is, natural/cultured or imitation). A recent example of such a submission, examined in the West Coast lab, are the ear studs shown in figure 12.

To the unaided eye, these grayish green spheres (which measured 10.15–10.25 mm in diameter) have the appearance of “pistachio” colored Tahitian cultured pearls. However, magnification revealed several sub-surface features that were typical for glass or plastic, but unlike any we have ever seen in a pearl: swirl marks, flow lines, and gas bubbles beneath a smooth, transparent coating (figure 13). We obtained a refractive index of



Figure 13. With 10× magnification, the imitation pearls shown in figure 12 exhibit gas bubbles and swirl marks below a smooth coating.

1.50 by the spot method, and determined that the optic character was isotropic. We saw no lines with a desk-model spectroscope, and we observed weak, chalky green fluorescence to both long- and short-wave UV radiation. These properties proved these items to be imitation pearls.

A strand of silvery gray to black imitation pearls was seen in the West Coast lab a few years ago (Fall 1995 Gem Trade Lab Notes, pp. 202–203). Those beads had an odd, rubbery surface texture, and a layered construction was visible at the drill holes. We determined that one of the layers was bismoclite (a bismuth oxide chloride used as a coating material), which gave those imitation pearls their color. Unfortunately, the mounting of each of the recently examined ear studs

Figure 14. This 1.44 ct chatoyant purplish brown cabochon was identified as the rare mineral taaffeite.



Figure 15. A group of parallel reflective planar inclusions with striations was responsible for the cat's-eye effect in this taaffeite. Magnified 30×.



prevented observation of a drill hole or determination of their composition.

CYW and IR

Cat's-Eye TAAFFEITE

Some gems commonly exhibit phenomena, such as change of color (alexandrite), chatoyancy (chrysoberyl), and asterism (sapphire). Occasionally we are reminded that any gem material potentially can show a phenomenon, even if such a phenomenon was not seen in that material before.

Such was the case with a 1.44 ct chatoyant cabochon recently submitted to the West Coast lab for identification. The purplish brown stone had a fairly well developed “eye” (figure 14). We determined an R.I. of 1.72 by the spot method, and an S.G. of 3.68 by the hydrostatic method. The stone showed a uniaxial optic figure, weak pleochroism, and was inert to both long- and short-wave ultraviolet radiation. These properties all pointed to the rare gem mineral taaffeite as the identity of the cabochon. However, we had never seen a cat's-eye taaffeite before. Since we could only get a spot R.I., and thus no estimate of the birefringence, we decided to analyze the stone on the Raman spectrometer. The Raman spectrum confirmed that the stone was indeed taaffeite.

Microscopic examination did not reveal the parallel needles or growth tubes normally found in a chatoyant stone. Instead, there were parallel reflective planar inclusions with striations (figure 15). These striations, along with the reflectivity of the inclusions, caused the chatoyancy. We have seen similar reflective inclusions as a cause of chatoyancy on at least one other occasion (see “Cat's-eye sapphire,” Summer 1995 Gem Trade Lab Notes, pp. 126–127). *SFM*

PHOTO CREDITS

Maha DeMaggio photographed figures 6, 7, 11, 12, and 14. John Koivula was the photographer for figures 1, 2, 4, 5, 8, 9, 10, and 13. Shane McClure provided figure 15.