Opalite triplets – new imitations of opal

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Abstract

Significant quantities of a reportedly new production of the imitation opal known as 'Opalite' or 'Opal Essence' which was on display at the 1993 Tucson Gem Shows, is described. The refractive index and SG were found to be 1.50 and 1.17 respectively. Also on display at the shows were triplets and mosaic triplets made with central layers of Opalite under a clear dome and a wax-like base. A key non-destructive method of identification for the unassembled Opalite is the recognition of the clear plastic coating, whilst observations made on a microscopic level, both in terms of internal structures and phosphorescence effects are important in the identification of the triplets and mosaic triplets.

Key words: Mosaic, Opal, Opal Essence, Opalite, Plastic, Triplet

Introduction

In the late 1970s and early 80s reports were published (Horiuchi, 1978 and 1982) concerning the introduction of a new opal simulant. This simulant, which has in latter years been marketed as 'Opalite' (Koivula and Kammerling, 1989), may be described as a plastic imitation of opal in which the play-of-colour is caused by the same mechanism as that which causes the visual effect in natural opal (*see for example* Nassau, 1980).

The 1993 AGTA Tucson Gem Show saw the introduction of a new production of 'Opalite' made in Japan (Koivula and Kammerling, 1989, report a US marketing effort at that time and state that it was also being promoted as 'Opal Essence'). Further, the company displaying the new production, Universal Canal Jewelry, also produced doublets, triplets and mosaic triplets made by making use of thin layers of the same material.

Whilst there are no difficulties in terms of differentiating between the 'Opalite triplet' (or indeed any other triplet) and natural solid opal, problems are forecast for the separation of the new composite with plastic imitation opal from the natural opal triplets. The following report outlines in a brief format (for comparison with the triplet material) the properties of two samples of the new Opalite production obtained at the 1993 AGTA show and in a more detailed format, the properties of six Opalite triplets and four Opalite mosaic triplets provided for research by Universal Canal Jewelry.

Working methods

During the examination of the new production of 'Opalite', as well as the triplets and mosaic triplets assembled from this material, priority was given to basic gemmological testing techniques that might produce simple identification criteria. The instrumentation used was limited to the GemoLite microscope, standard refractometer, ultraviolet lamps, plus sectility and thermal reaction testing equipment.

Standard microscopic observations were made using a GemoLite microscope at magnifications of between 10 and 60x. A variety of illumination techniques were used including darkfield, brightfield (diffused and transmitted) and variable incident lighting through an optical fibre.

A GIA GEM Instruments Duplex II refractometer was used to obtain both 'distant vision' refractive indices (from curved surfaces) and normal flat surface readings from the bases of cabochons. The GIA GEM Instruments Thermal Reaction Tester was used on setting '90' and the reactions observed under magnification with the microscope.

A non-standard variation in the use of the equipment was employed in the observation of the *'detail'* of the luminescence effects. A GIA GEM dual long-wave/short-wave ultraviolet lamp was placed in the position normally occupied on the GemoLite by the standard double tube overhead fluorescent light. Observations were made in a 'darkroom' at magnifications of between 10 to 30x, after the observers eyes had become dark adapted (1 to 2 minutes). The effects were otherwise observed in the standard 1:1 at approximately 12 inches distance, but again in a darkroom with dark adapted eyes.

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Fig. 1. Two Opalite samples, illustrating the different sizes/appearances the colour patches may show. *Photo by Maha DeMaggio.*

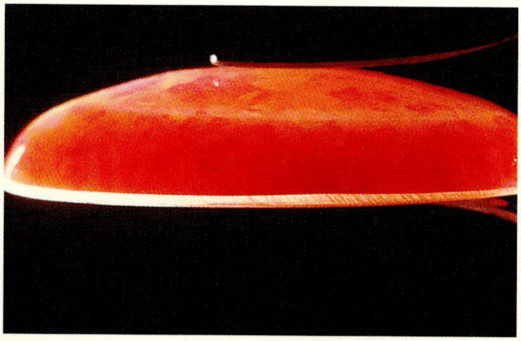


Fig. 2. This edge-on view of a solid Opalite cabochon in transmitted light clearly reveals the transparent colourless coating on the base. Note also the material's salmon pink body coloration when so illuminated with islands of deeper colour. 7x. *Photo by John I. Koivula.*

Opalite

Since the CSIRO concluded their investigations in 1964 (Jones *et al.*, 1964) and the true cause of the play-of-colour in opal became known, several attempts have been made to synthesize or imitate the 'opal effect'. By the mid 1970s Pierre Gilson had produced his 'synthetic opal' (Liddicoat, 1974; Jobbins *et al.*, 1976; Scarratt, 1986) and by the end of the decade an all-plastic 'play-of-colour' material, 'Opalite', had been produced (Horiuchi, 1978).

The two examples of the latest production of Opalite obtained at the 1993 Tucson Gem Show, and described here, are similar in their characteristic features to those described for the 1988 production by Koivula and Kammerling (1989).

The two samples, which closely resemble natural white opal, or more particularly the Gilson synthetic white opal, in general appearance, are of similar size, 3.70ct (19.22 x 14.12 x 3.93mm) and 3.84ct (19.2 x 14.35 x 4.21mm),but were chosen for their slightly differing structural appearance. The 3.70ct example displays mostly small pin-point colour segments whilst the 3.84ct example displays broader colour segments (Figure 1).

Both samples are perfectly oval with good proportions and, contrary to the appearance of natural opal which is cut with weight as an important consideration, the backs are flat and free from any indentations, cavities, etc.

Both display irregular columnar structures when viewed in profile (Figure 2) and, as previously reported, show what appears to be a clear layer 0.4mm in depth on their bases (see also Figure 2). Upon closer examination the clear coating on the 'base' is revealed to be one that covers the entire surface of the 'opal effect' layer. Figure 3 shows that when the examples are viewed 'base on' a clear rim, similar in proportions to the layer seen across the base in profile, is seen (cf Figure 2). Also, when viewed from the top,there appears to be a significant clear portion which has to be 'focused through' before the play-of-colour portion is reached.

Under magnification and in reflected light (directly overhead and at approximately 90° to the

Fig. 3. When viewed base-on and illuminated with horizontal fibre-optic illumination, this Opalite cabochon reveals the thickness of the clear coating covering its upper surface. 7x *Photo by John I. Koivula.*

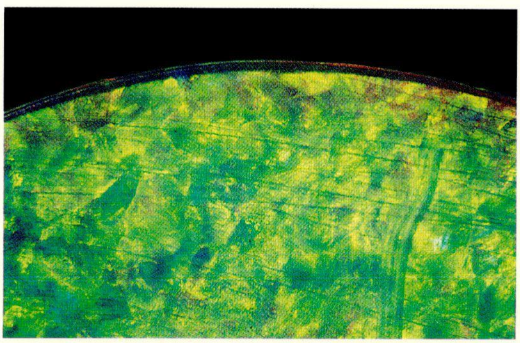


Fig. 4. The cracked or 'dried mud' structure - also referred to as the 'honeycomb' appearance - of the Opalite is seen here when examined in transmitted light down the length of the columnar structure. 20x. *Photo by John I. Koivula.*

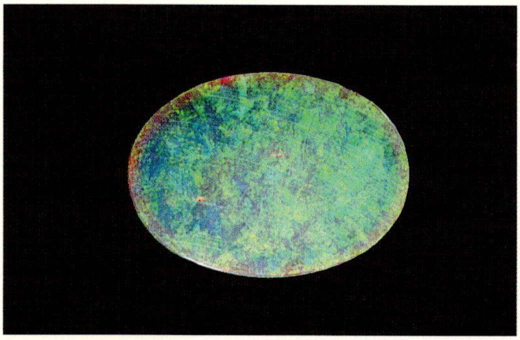


Fig. 5. A brightly reflecting, green metallic 'foil-like' effect is noted here when viewing the flat base of this Opalite cabochon using overhead illumination. *Photo by Maha DeMaggio.*

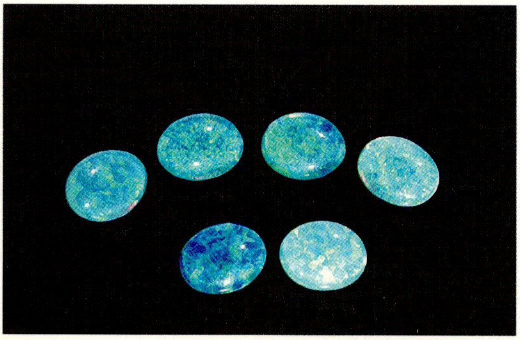


Fig. 6. The six Opalite triplets examined in this investigation. *Photo by Maha DeMaggio.*

surface of the specimen), the colour segments appear to change through blue, green and orange. The blue and green colours have a dull two-dimensional appearance whilst the orange, which may be mixed with yellow, has a bright three-dimensional appearance. In brightfield illumination and viewing directly through the top of the cabochon, the basic overall colour is an orange-yellow with islands of pink contained within structures that may be described alternatively as having the appearance of 'cracked and dried mud' or a 'honeycomb structure' (Figure 4). When viewed through the side, again in transmitted light, the overall colour is of a salmon pink that contains deeper pink islands.

An unusual feature is seen principally when the flat back of the cabochon is viewed. As the cabochon is moved slowly in reflected light, a brightly reflecting green layer with a metallic foil-like appearance becomes evident (Figure 5). To some extent, this 'foil-like' effect may be observed in the top of the cabochon as a stripe moving across the top as the specimen is rocked.

Whilst the overall face-up colour-effect in these plastic imitations is blue in either incandescent or fluorescent overhead light, when the cabochons are rocked so that the view becomes close to 'edge-on', the colour effect is predominately orange. Thus far, the authors have not noted a similar effect in natural white opal.

The refractive index, determined both by the distant vision and flat contact techniques, was found to be 1.50. The SG was determined by hydrostatic weighing as 1.17 . Under long-wave ultraviolet light the specimens fluoresced a strong bluish-white, with the acrylic on the base (where it is most distinctive) reacting more strongly than the remainder of the cabochon. No phosphorescence was observed. The specimens were also found to be easily sectile and melted in contact with a 'hot point'.

In order to make the comparison with previous productions complete, the infrared spectrum of the latest production was taken. The resulting curve was found to be similar to those previously published (see Koivula and Kammerling, 1989, Figure 5).

Fig. 7. Examined with horizontal fibre-optic illumination, the bright edges of bubbles both above and below the Opalite layer are noted. 10x. *Photo by John I. Koivula.*

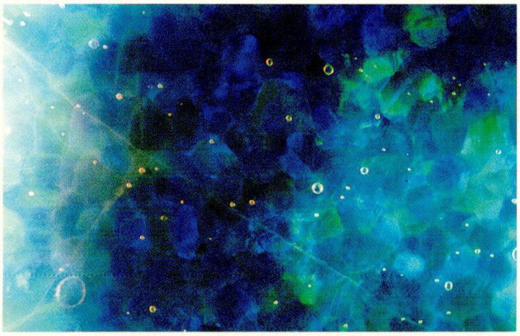
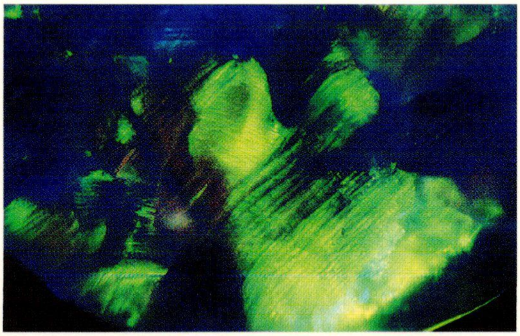


Fig. 8. The three-dimensional pinpoint (or pinfire) colour segments of the Opalite layer in this triplet display a characteristic 'brush stroke' or 'ploughed field' effect. 10x. *Photo by John I. Koivula.*



Opalite triplets

Six Opalite triplets (Figure 6) were examined for general appearance, microscopic clues to identification, refractive index, UV fluorescence, hot point reaction and sectility. The specimens ranged from 1.77 to 2.03 ct.

Appearance

When viewed from the top and without magnification the Opalite triplets have a similar appearance to natural or synthetic opal triplets in that one appears to be looking through a 'lens' at the 'opal' layer below. The phenomenal colours seen are mainly blue to green and these change as the stone is moved ('roll over') as might be expected for natural or synthetic opal. A side view reveals an unusually thick (compared with what might be expected for a natural opal triplet) layer of Opalite (0.40 to 0.80mm) under a colourless dome of a slightly greater circumference and above a black base of lesser proportions. It should be noted that not all the Opalite layers were of a uniform thickness; rather, in several specimens these were wedge shaped.

Microscope

The specimens were chosen for their variation in colour segment size and type (see Figure 6). Observed under low magnification (15x) and in reflected light, the basic appearance is again similar to that which is expected for a natural or synthetic opal triplet. However, because of the high nature (2.4 to 2.5mm) and lens-like rounding of the dome as well as its somewhat greater circumference than the Opalite layer, the play-of-colour towards the edges appears 'blurred' by internal reflections (see Figure 6). Bubbles are clearly visible in the junction layers and these stand out with 'bright' edges in horizontal fibre-optic illumination (Figure 7).

As with the whole Opalite specimens, the colour of each segment changes through blue, green and orange, but unlike the whole Opalite each of the colours and segments in the 'pinpoint segment' type have a three dimensional appearance. Some colour segments in the 'pinpoint' type revealed the 'ploughed field' or 'brush stroke' effect (Figure 8) seen in some natural opal, but this was not generally the case. On the other hand this effect was very evident in the Opalite triplets with the larger colour segments.

Upon focusing through the Opalite layer to the junction below, a metallic 'foil effect' similar to that described for the whole Opalite, seemed to be present in small areas, but with generally a mauve colour. The base, whilst appearing black, is translucent and grey with a multitude of included black spots. As with the whole Opalite the slice present in the triplet appears as an overall 'salmon pink' with deeper pink islands when viewed side-on in transmitted light (Figure 9). The junction adhesive layers above and below the Opalite layer have a similar appearance to each other and are probably the same substance.

Refractive Index

Distant vision readings for the dome of the triplet produced a reading in the region of 1.50, which is the same as that recorded for the Opalite itself, whilst the readings from the flat backs revealed readings of 1.49. In the authors' experience these are within the ranges of the glass and plastic substances sometimes used to produce colourless caps and black backs for natural opal triplets. However, conclusive identification of these materials was not carried out.

UV Fluorescence

The six triplets were examined under both long-wave and short-wave ultraviolet light for possible fluorescence and phosphorescence reactions. Under long-wave, the only part of the triplet that could be said to fluoresce is the adhesive in the upper and lower junctions. Here the adhesive layers have a bright blue fluorescence which is followed by a distinctive mottled yellow-green phosphorescence when the ultraviolet light is turned off. This effect is best seen under magnification as misinterpretation may result from 1:1 observation (i.e. when viewed through the dome, as will be the case when the stone is set), the same bright blue fluorescence will be seen as well as the continuing mottled phosphorescence, as appearing (incorrectly) to come from the 'opal' or 'Opalite' layer. Note: to obtain the phosphorescence reaction, this material must be held close to the UV lamp (25-50mm) for a minimum of 30 seconds.

Under short-wave ultraviolet light the adhesive layers fluoresce similarly to the long-wave effect, but of a lesser intensity. Under this wavelength there is no perceptible phosphorescence. The colourless dome fluoresced with a yellow/chalky effect of a moderate strength under this wavelength.

Thermal reaction/sectility

With the prior knowledge that we were dealing with a plastic opal-like material, it was decided to carry out two potentially destructive testing procedures under controlled conditions. These were the point reaction to heat of the various components of the triplets and also the ability of the various parts to 'peel' when a sharp blade is applied.

Both the base and the Opalite layers were found to be easily sectile - the base slightly more so. When the probe of the thermal reaction tester was placed lightly on a small portion of the exposed area of the Opalite layer, the part touched was found to melt very quickly. The same test on the black base layer revealed that this portion of the triplet melted extremely quickly and on a par with what might be expected if the material were a wax candle. The transparent colourless dome was found to be neither sectile nor did it react to the thermal reaction tester.

Opalite Mosaic Triplets

Two oval Opalite mosaic triplets (Figure 10) were examined and compared with a single natural opal mosaic triplet also obtained at the 1993 Tucson Gem Show. The sizes of all three samples were similar: the natural mosaic measuring 17.99 x 13.05 x 3.8mm and weighing 6.63ct, and the Opalite mosaics measuring 16.5 x 12.49 x 5.15 and 16.45 x 12.3 x 4.91mm and weighing 6.79 and 6.13ct respectively. Each specimen was examined for general appearance, microscopic clues to identification, refractive index, UV fluorescence, hot point reaction and sectility.

Appearance

When viewed from the top and without magnification the Opalite mosaic triplets were similar in appearance to the natural opal mosaic triplet. The sectional nature of the opal or Opalite mosaics can be seen clearly, and without magnification, through the transparent colourless domes. Also clearly visible without magnification are the shapes of the various sections of the mosaics. In the case of the Opalite these could be seen as being triangular whilst in the case of the natural opal the shapes are more irregular, i.e. truncated triangular and trapezoid generally with chipped and rounded points.

As with the Opalite triplets discussed earlier, the colours seen in the Opalite mosaics are mostly blue to green and the 'roll-over' effect is similar to that which occurs in the natural opal mosaic specimen. However, the colours of the natural specimen, whilst tending to have a greater presence of orange/red, were a little duller in appearance.

When viewed side-on the Opalite mosaics revealed a somewhat thinner section of Opalite than is used in the Opalite triplet and the thickness is also variable as the cabochon is turned (from 0.3 to 0.4mm), but is of a similar thickness to the opal used in the natural opal mosaic triplet (the latter varying from 0.3 to 0.4mm). However, the curvature of the clear dome on the natural mosaic triplet begins more closely to the opal layer than it does for the Opalite mosaic triplet, which has a steep rise before the curvature begins (Figure 11). Both the natural opal and the Opalite mosaic triplets have black material bases but the base of the natural is somewhat thinner than in the Opalite assemblage.

Microscope

Observed under low power (15x) magnification, and in reflected light, both the natural opal and the Opalite versions of the mosaic triplets reveal substantial gaps between the mosaic sections in which can be seen the clear adhesive and bubbles therein. It is also confirmed that the mosaic sections in the natural version vary more in their shape than do those in the Opalite version, all of which are triangular with truncation only occurring at the edges of the triplet.

The mosaic sections used in the Opalite version appear to have been selected from the type of Opalite in which the colour segments are wide rather than the pinpoint type and, as a result, the 'ploughed field' or 'brush stroke' effect is evident in most of the sections (Figure 12).

The blurring of the edges observed in the Opalite triplets does not seem to be as great a factor in the Opalite mosaic version. This is probably due to the differing profiles of the domes of each type. The triplet being more rounded and having a greater 'overhang' beyond the outer edge of the Opalite layer, in comparison with the mosaic version.

The sections in the natural opal mosaic, as might be expected, are made from a variety of types (from the pinpoint play-of-colour to wider colour patch versions (Figure 13)), and many individual sections may also contain included matrix material.

In transmitted light the natural opal version loses virtually all of its play-of-colour effect and the near transparent and grey (rather than black) nature of the base is revealed (Figure 14). In this situation the bubbles in the adhesive layers stand out with black rims. Due to the greater opacity of the backing, in contrast the Opalite version appears much darker and still exhibits much of its play-of-colour.

Refractive Index

Distant vision refractive index measurements were recorded for the domes and direct refractive

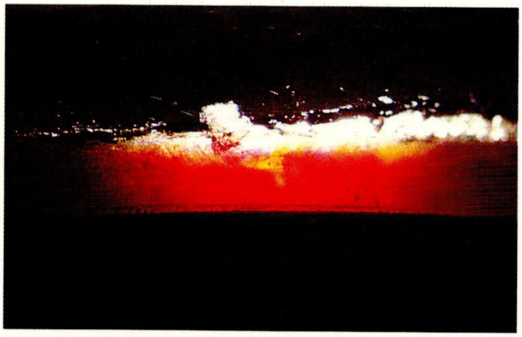


Fig. 9. The salmon pink transmitted-light appearance of Opalite is clearly seen in the triplets as well when viewed slde-on. 7x. *Photo by John I. Koivula.*

Fig. 10. The two Opalite mosaic triplets examined in this investigation. *Photo by Maha DeMaggio.*

index readings were taken from the bases of both the natural opal and Opalite versions of the mosaic triplets. For the Opalite version the RI of the dome was found to be 1.51 and the base 1.49, whilst for the opal version the dome was found to have a refractive index of 1.52 and the base 1.53.

Fluorescence

The two Opalite mosaic triplets and the natural opal mosaic triplet were all examined for their reactions to ultraviolet light.

In common with the Opalite triplets, under long-wave ultraviolet light the adhesive layers of the Opalite mosaic triplets were found to have a bright blue fluorescence which was followed by a distinct phosphorescence. This effect is best seen under magnification when the true nature of the fluorescence and the phosphorescence, i.e. coming from the adhesive rather than the Opalite, can be seen. When viewed through the clear dome with the unaided eye (1:1), the fluorescence effect of one of the Opalite versions appeared to be coming from between the Opalite mosaic sections, i.e. from the adhesive, but the other sample appeared to show an overall effect, probably due to the fact that its upper adhesive layer is thicker.

Under short-wave ultraviolet light the transparent domes of the Opalite versions fluoresced with a 'chalky' appearance which interfered with any effect the adhesive or Opalite might have. However, the sample with the thicker upper adhesive layer phosphoresced (from the adhesive) whilst for the sample with the thinner layer no phosphorescence was seen.

The reaction of the natural opal mosaic triplet was as could be expected from a material made with a natural 'white' opal component (see Jobbins *et al.*, 1976). Under long-wave ultraviolet light, viewed from the side, the upper adhesive layer fluoresced as with the Opalite version. This was also confirmed when the triplet was viewed through the clear dome, when the fluorescence of the adhesive could be seen in between the opal sections (Figure 15). However, and as can be

Fig. 11. When examined from the side, the two Opalite mosaic triplets on the right are seen to have thicker colourless caps than does the typical natural opal mosaic triplet, as illustrated by the one assemblage on the left. *Photo by Maha DeMaggio.*

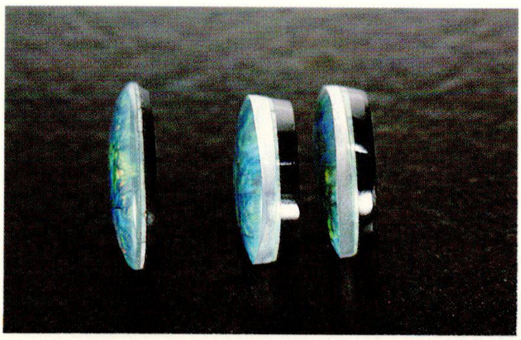
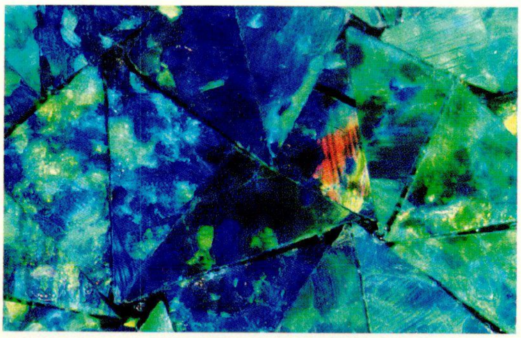


Fig. 12. As seen here, magnification reveals the typical 'brush stroke' or 'ploughed field' appearance of some of the chips in this Opalite mosaic triplet. Note also the very sharp edges of the individual chips as compared with those of the natural opal mosaic triplet shown in Figure 13. 7x. *Photo by John I. Koivula.*



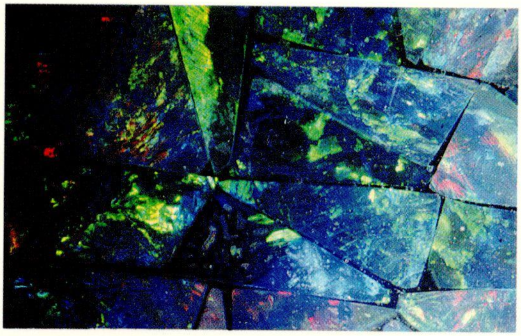


Fig. 13. Careful observation reveals the varying phenomenal colour types in the opal typically used to produce natural opal mosaics. Note also the blunted and other irregular terminations to the individual opal fragments. 7x. *Photo by John I. Koivula.*

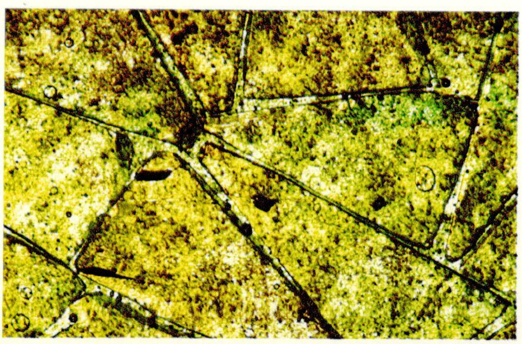
expected with white opal, it was noted that the opal sections also fluoresced and when examined under magnification the distinct phosphorescence effect, which could be seen at 1:1, was found to come from the opal sections rather than the adhesive between them.

Thermal reaction/sectility

Only the adhesive layer of the natural opal mosaic triplet reacted to the thermal reaction tester in that it melted at the point of contact. In the case of the Opalite assemblage, however, both the base and the Opalite layer melted at the point of contact - the base extremely fast and on a par with a wax-like substance.

The transparent domes of the Opalite assemblages were found to have no reaction to the thermal reaction tester and nor were they sectile. However, both the Opalite layer and the base were found to be sectile, the base more so that the Opalite. The natural opal version was found to be non-sectile apart from the adhesive layer.

Fig. 14. The same natural opal mosaic triplet illustrated in Figure 13, seen here in transmitted light. 10x. *Photo by John I. Koivula.*



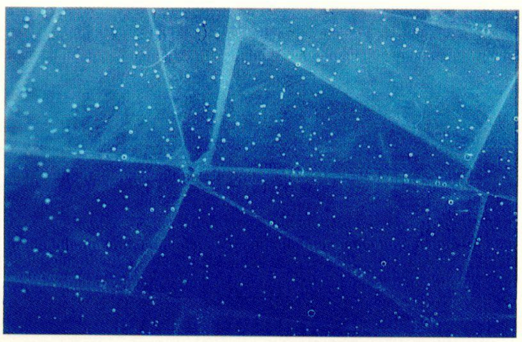
Discussion

The authors hope that the foregoing report assists, first in warning gemmologists of the presence of Opalite triplets and mosaic triplets on the market and, secondly, in giving some basis for their identification. However, in the discussion below it should be remembered that it is the nature of 'composite' stones and particularly those composed of natural opal, that the components may and do vary (differing types of opal, adhesive, backing and domes) from those discussed here (see Anderson/Jobbins, 1990; Nassau, 1980).

The reportedly new production of Opalite is similar to, if not the same as, previous productions and reference should be made to Koivula and Kammerling (1989) for useful identification features. However, the observation of the clear plastic/acrylic layer which covers the entire surface of the Opalite cabochon, together with the refractive index of 1.50 (cf. natural opal - at 1.44) and lack of phosphorescence (white opal usually phosphoreses strongly) should be sufficient to identify the material, particularly when set in jewellery. If the flat back of the Opalite is visible through a setting, observation of the green foil-like flash should also indicate that the substance is not natural opal, although similar effects have been noted with synthetic opal. Any damage marks on a suspect stone, such as chips and sharp edged scratches, would tend to indicate a natural or synthetic stone rather than the plastic imitation, where damage would have a much softer or smoother appearance.

The Opalite triplets and mosaic triplets create a number of problems for the unwary. The clear domes are made of a material (most likely clear glass) sometimes used for natural opal triplets and the Opalite structures seen through the dome are

Fig. 15. A natural opal mosaic triplet under long-wave ultraviolet radiation. Note the fluorescence of the adhesive between the opal sections. Under this magnification phosphorescence is seen to come from the opal sections and not the adhesive - the reverse was the case for the Opalite mosaic triplets. *Photo by John I. Koivula.*



similar to those observed in natural opal. However, such natural opal layers may contain matrix material which should not be present in Opalite or mosaic Opalite layers. The Opalite layers in the Opalite triplets were also noted to be somewhat thicker than might be expected for the opal in a natural opal triplet, an observation that would be particularly useful when examining loose stones.

The natural opal mosaic triplet examined for comparison purposes was produced from irregularly-shaped pieces of opal whilst the Opalite version was made from essentially all triangular pieces. A useful identification technique is the observation of fluorescence and phosphorescence effects under magnification. During this investigation it was found that the adhesive used in the Opalite mosaic type phosphoresced whilst the Opalite did not, whereas in the natural opal version the opal phosphoresced whilst the adhesive did not or was not perceptible positioned next to the opal sections. This observation would also apply in the case of the triplets if white opal were used in the natural version.

Whilst destructive testing is not recommended, the observation of the surface area of the wax-like base of the Opalite triplets as a 'hot point' is brought close, will undoubtedly reveal a movement of the surface even before contact is made.

Undoubtedly, gemmologists must now be far more critical in their examination of assembled stones which appear to include opal as one of their components. Those which are set in closed back/bezel settings will be particularly difficult to identify.

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