Observations on the Slocum Stone

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Introduction

During the last two years, a new imitation opal gem material has appeared on the gem market in the U.S.A. This material is an opal simulant which is a sodium calcium magnesium silicate glass. When viewed from a distance of three feet, the material has a striking similarity to gem opal. This material is called THE SLOCUM STONE after its creator, J.L. Slocum. This imitation opal is sold by MDI Corporation, 3417 Rochester Road, Royal Oak, Michigan 48073, U.S.A. It is manufactured in at least five colors which are termed "white, crystal, amber, semi-black, and black" according to a brochure from the manufacturer. An initial report on the material was published by Crowningshield (1974).

Physical Description

The author examined two of the simulated gems; one with black body color and one with no body color. The clear material is the one described herein. It is quite attractive and might pass for opal in the eye of an untrained casual observer.

The material is quite transparent in transmitted light and one could easily read this printed page through the gemstone, were it not for the opalescent effect which returns much light to the eye and cuts down the effective transparency. To an experienced gemologist, some of the Slocum stones, particularly the black colored material, exhibit a vague resemblance to crinkled cellophane under crown-glass. However, a careful observation indicates that the color-causing medium is indeed distributed through the material in a rather uniform manner.

The opal simulant studied herein was about 20 x 12 mm and cut *en cabochon.* Upon examining the imitation opal from directly above the crown, one sees an "opalescence" of violetish blue, orangish red, and yellowish green. As the stone is moved, the character of the light changes in a manner similar to opal, and the individual color-spots, sheets, and veils change from one color to another and back again. There are no localized color-concentrations or patchy effects.

Two salient features aid the gemologist in visually recognizing the Slocum stone. *First,* there is a preferred orientation for the "opalescence" and when the stone is viewed from the side, there is a marked reduction in the opalescent effect. The *second* noteworthy feature is that when the material is viewed with transmitted light passing normal to the plane of the orientation, a patchwork of very small green splotches is very obvious. The splotches do change color upon tilting the stone, but in a peculiar manner not identical to the effect seen under reflected illumination. This effect, quite unlike opal, is rather peculiar.

The examined Slocum Stone has a density of 2.47 g/cm^3 (±0.03) compared with the manufacturer's range of 2.41 – 2.50. The refractive index is nD = 1.514 (±0.003) compared with the range of 1.49 – 1.51 offered by the manufacturer. The material is isotropic and the effect seen in crossed polars is kaleidoscopic. It is not fluorescent in either long- or short-wave length ultraviolet radiation. The material does not diffract X-rays coherently, is amorphous, and is not affected by heating to 200°F. The *Slocum Stone* is a *glass.*

A notable feature of this material among other simulants is its extreme toughness. Its resistance to chipping and breaking is quite high. The author spent about 15 minutes bouncing this imitation gem on floors with no effect to the stone whatsoever. It might be added in passing that this very tenacious material has a rather lively bounce; greater than that of normal glass gems. Breaking the material for analysis using a device comprised of opposing chisels was quite difficult and confirmed the toughness of the material.

The Mohs hardness is about 5-5½. Several measurements were made with a Vickers micro-hardness tester. Eight impressions with a 100-gram load gave an average hardness number of 509 (±38). Five impressions made with a 50-gram load gave an average hardness number of 465 (±50). This Vickers hardness confirms the Mohs hardness value. The observed variation in micro-hardness of the material (not of concern in evaluating its gem potential) is also seen as a differential resistance to polishing. A careful examination of a polished surface *(Figure 1)* reveals a subtle, irregular, "suturing" between adjacent grains of the glass. The presence of these grains suggests a gross granular or lamellar texture with

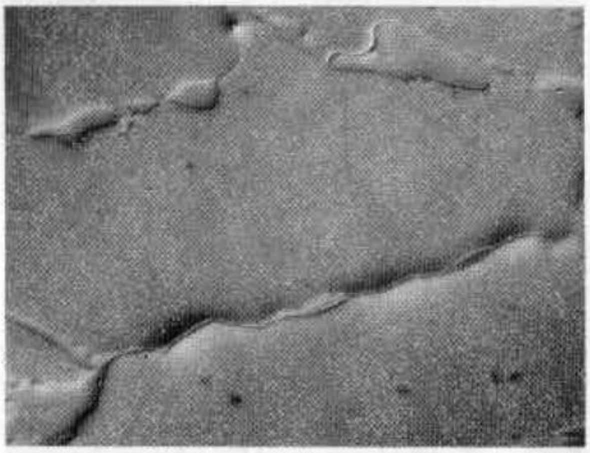

Figure 1. Irregular suturing between grains of the Slocum stone. (Photo taken with Nomarski phase-contrast technique at 44x.)

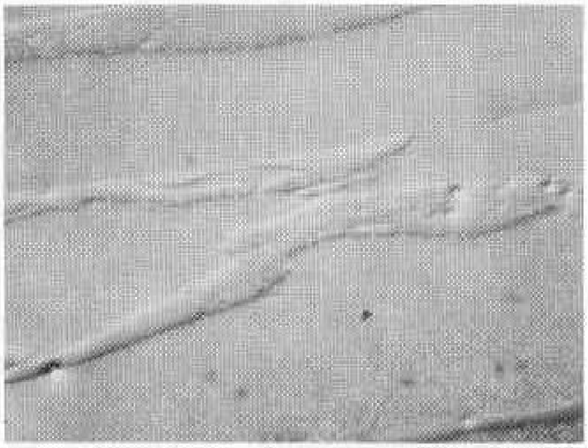

Figure 2. Lenticular-aggregate texture of the Slocum stone. (Photo taken with Nomarski phase-contrast technique at 44x.)

a grain size varying up to 1.5 mm. The highly polished surface of a thin section of the material was coated with carbon and then coated with platinum and photographed in reflected light. Photographs of this section are shown in *Figure 2*. The section is cut normal to the base of the cabochon and shows the irregularity of the texture very well. The preferred orientation of the grains is obvious and the grains are lying with their tabular direction parallel to the normal line of sight of the viewer, assuming the stone

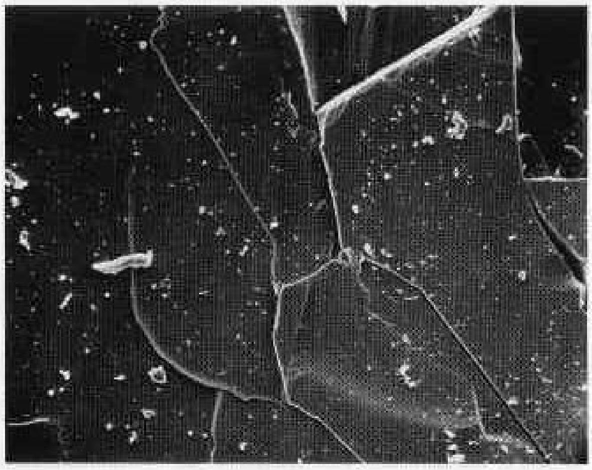

Figure 3. Photograph showing the irregular fracture of the Slocum stone. (Photo taken with the Scanning Electron Microscope (SEM) at 130x.)

was cut in the manner suggested by the manufacturer's pre-orienting of the material. This irregularity of the grains is also likely the cause of the extreme toughness of this material. The fracture of the glass is irregular and random *(Figure 3)*, with no diagnostic features.

High Magnification Observations

In an effort to attempt to explain the "opalescent" effect seen in the

Figure 4. Photograph of a large fracture surface of the Slocum stone. (Photo taken with the Scanning Electron Microscope (SEM) at 53x.)

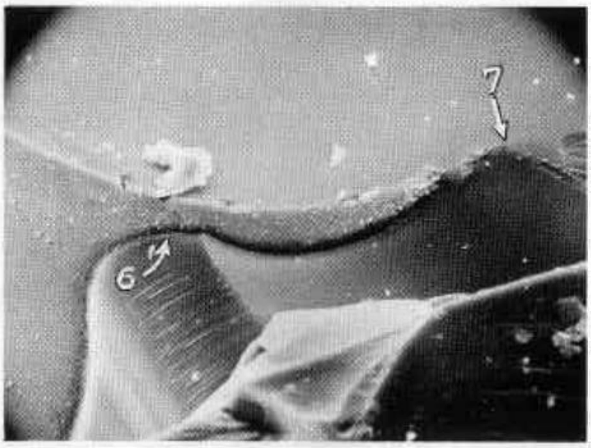

Figure 5. High magnification photo of the lenticular texture of the Slocum stone. (Photo taken with the Scanning Electron Microscope (SEM) at 680x.)

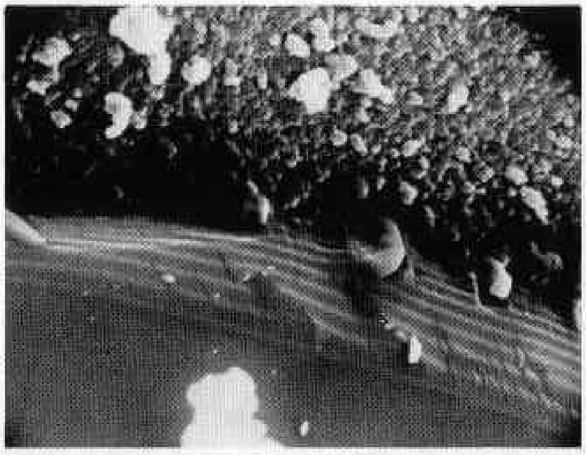

Figure 6. High magnification photograph of the border between the two different textures in the Slocum stone. (Photo taken with the Scanning Electron Microscope (SEM) at 10,500x.)

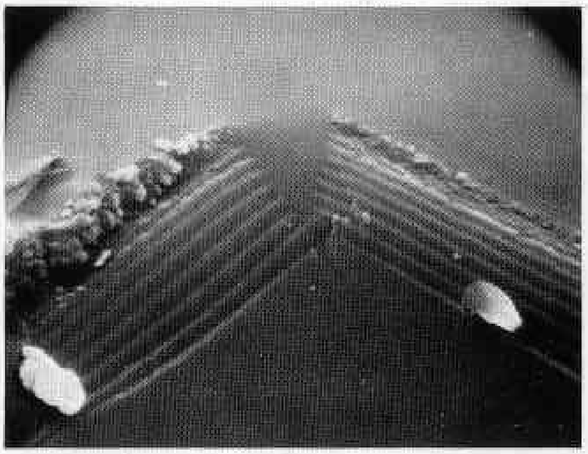

Figure 7. High magnification photograph of the border between two grains of similar smooth texture. (Photo taken with the Scanning Electron Microscope (SEM) at 10,500x.)

material, small fragments were examined by means of a Scanning Electron Microscope (SEM). It was thought that the effect might be due to a thin film of organic material lying between the individual lamellae. No film was observed, however, even at magnifications of 10,500 x, nor was any other intergranular material noted.

Figure 4 illustrates a very small section of a fractured surface magnified 53 times. Scattered bits of particulate matter are dust and glass fragments and should be ignored. A small portion of *Figure 4* (designated by arrow 5) was examined at 680 magnifications and is shown as *Figure 5*. The lamellar texture seen in *Figure 2* is also quite obvious here, although here it is seen on a very small scale. In this photograph the material is seen to consist of two separate textures; one extremely fine-grained, and the other of a micro-granular nature. It is possible that the "opalescent" effect is generated at the juncture of these two texturally inhomogeneous materials. Two small sections of *Figure 5* (designated by arrows 6 and 7) were photographed at a magnification of 10,500 x to generate *Figures 6* and *7*. It is readily apparent from *Figure 6* that there is quite a variation in the texture of individual lamellae in the material. Here the border between the truly homogeneous glassy and micro-granular portions is clearly seen. This textural difference is also likely responsible for the differential microhardness of the Slocum stone, as noted earlier in this paper. *Figure 7* is a photograph (at 10,500 x) of the "sutured" junctures where two glassy portions appear (see *Figure 1)* to join without any intervening lamellae of the coarser-grained material. Here a chevron-like banding occurs which may be due to a compositional variation below the limits of detection of the microprobe or, more likely, due to a gradual change in grain size between the two textures. This banded effect is also seen in *Figure 6,* but is less pronounced.

TABLE I

Microprobe analyses of the Slocum Stone

	#1	#2
SiO_2	71.85	73.20
TiO_2	0.00	0.00
Al_2O_3	1.95	0.07
FeO	0.00	0.00
MgO	4.37	4.28
MnO	0.00	0.00
CaO	7.59	8.98
K_2O	0.60	0.02
Na_2O	13.22	14.08
TOTAL	99.58*	100.63*

accuracy of data ± 2% relative

* plus 0.29 % H_2O by the Penfield method.

Chemistry

This imitation opal material is a sodium calcium magnesium potassium aluminum silicate glass. The manufacturer states that it is composed of "SiO_2, Al_2O_3, and alkalies, and is anhydrous."

The sample was analyzed with an ARL-SEMQ electron microprobe using an operating voltage of 15 kV and a beam current of 0.15 μA. Standards used were SiO_2 for silicon, hornblende for aluminum, iron, calcium, potassium, magnesium, and titanium. Manganite was used for manganese and anorthoclase for sodium. Separate analyses with different standards have verified the composition. A microprobe scan indicated the absence of other elements. The data were corrected by computer using Bence-Albee correction factors.

Two analyses of the material are presented in *Table I.* Analysis #1 is representative of the bulk of the glass examined. The material is very rich in silicon, sodium, calcium, and magnesium. During the course of analyzing the material, it was noted that the base of the imitation opal was deficient in aluminum and enriched in calcium and sodium relative to the bulk of the material. Analysis #2 is representative of the composition of the base. Water was determined by the Penfield method and found to be a miniscule 0.29% by weight. When compared to the water content of gem opal, this water is negligible. The Slocum stone is also, aside from the aluminum-deficient base noted above, quite homogeneous in composition.

In summary, the Slocum stone is a sodium calcium magnesium glass of extremely high tenacity. The cause of the "opalescence" is not known with certainty since the observations herein are subject to several interpretations.

Acknowledgements

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References

Crowningshield, R. (1974). Developments and highlights at GIA's Lab in New York. *Gems & Gemology* **14,** #12, 362-363.