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The Nature of Cloud-Like Inclusions in Two Arkansas Diamonds

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Abstract

In a recent study of occluded gas in Arkansas diamonds, two otherwise transparent crystals were crushed that contained internal translucent regions (clouds). A scanning electron microscope examination showed that the translucency was caused by numerous small (~1 to 30 μm) cavities. Many are of unusual form. Mineral inclusions were not found in the cavities nor among the crushed diamond fragments. Both diamonds yielded gas upon crushing, but composition and quantity were different.

Introduction

The Jewelers' Manual of the Gemological Institute of America (Liddicoat and Copeland, 1967) defines a cloud or cloudy texture in diamond as due to a group of tiny white inclusions that together give a cottony or clouded appearance in the otherwise transparent stone. Harris (1968) classified a cloud-like inclusion as syngenetic with the host diamond.

In this communication, scanning electron microscope (SEM) photographs are presented that show the cause of translucency in two Arkansas diamonds to be multitudes of small angular cavities. They occur in a range of sizes and shapes, and are devoid of solid matter. The cavities probably contained at least part of the gas released from the diamonds when they were crushed (Melton and Giardini, 1975).

Experimental

One of the two diamonds weighed 1.53 carats and was colorless except for the internal white translucent region. The other, pale yellow in color, weighed 2.06 carats. Both were type I. Both had a relatively smooth, rounded external shape. The two crystals were obtained from the Smithsonian Institution Roebling Collection.

Due to the defective internal regions, both diamonds crushed "easily" during earlier gas analysis experiments. Some fragments were relatively large, with cleavage surfaces through the respective translucent regions. The latter showed a fine-grained "sugary texture" under a binocular microscope to 90×. Foreign mineral matter could not be detected in the cavities at 90×, with and without crossed polarizers. Examination of the finer-grained diamond fragments by petrographic microscope (to 400×) revealed no evidence of extraneous mineral matter.

Translucent fracture surfaces were given a thin coat of gold and examined with a SEM. Photographs at 500×, 2000×, and 5000× of translucent-region surfaces in the 2.06 ct. diamond are shown in Figures 1 through 4. Figures 5 and 6 show sections of the

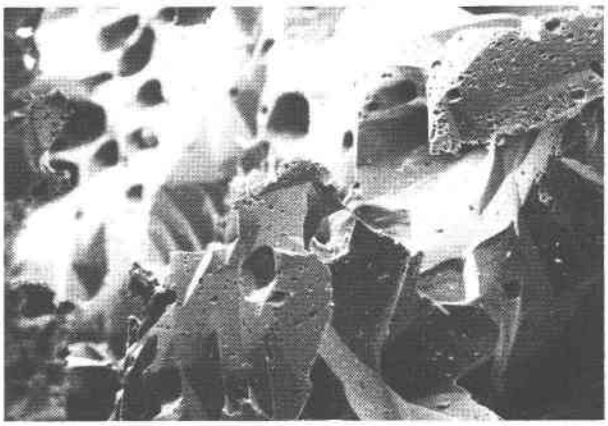

FIG. 1. SEM photo (500×). Section of the translucent region in the 2.06 ct. Arkansas diamond. Long edge of the photo = 200 μm.

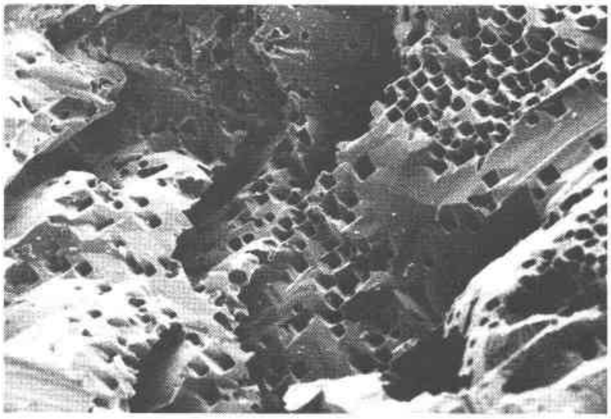

FIG. 2. SEM photo (500×). Another section of the translucent region in the 2.06 ct. diamond. Same scale as Figure 1.

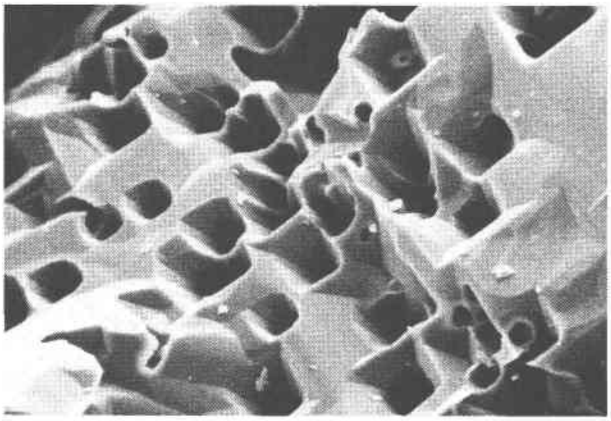

FIG. 3. SEM photo (2000×). Part of the region shown in Figure 2. Cavities with an apparent square outline at 500× are seen to actually be 8-sided. Long edge of photo = 50 μm.

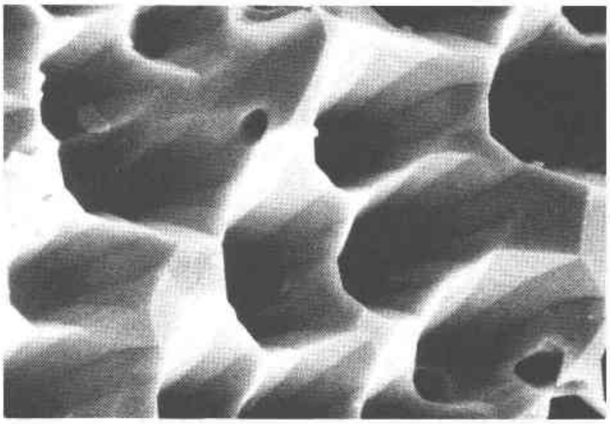

FIG. 4. SEM photo (5000×). Another section of the translucent region in the 2.06 ct. diamond. Cavities that appear to be more-or-less circular at lower magnification appear actually to be 12-sided. Long edge of photo = 20 μm.

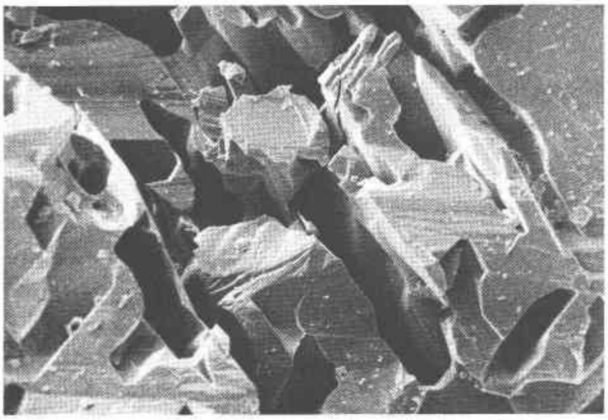

FIG. 5. SEM photo (500×). Section of the translucent region in the 1.53 ct. Arkansas diamond. Relatively large flattened cavities were common to the 2.06 and 1.53 ct. diamonds (see Fig. 2), but more abundant in the latter. Long edge of photo = 200 μm.

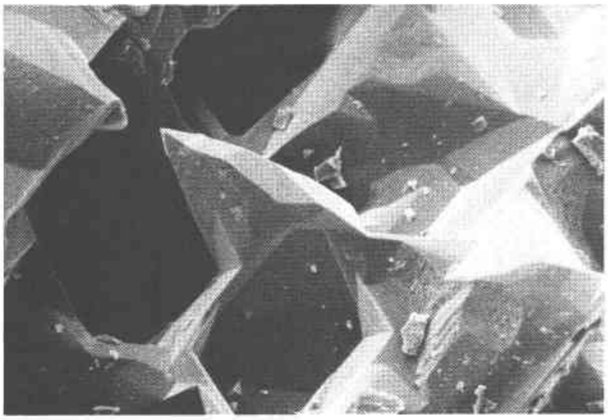

FIG. 6. SEM photo (1100×). Another section of the translucent region of the 1.53 ct. specimen. Many cavities in this region were 6-sided. Long edge of photo = 100 μm.

translucent region in the 1.53 ct. diamond. The figures are reasonably representative but do not illustrate all observed variations in cavity texture. SEM evidence of mineral inclusions was not observed.

Discussion

The texture of that part of the translucent region in the 2.06 ct. diamond shown in Figure 1 (500×) resembles that sometimes observed in hand-specimens of vesicular solidified lava. In other areas, many cavities appeared to be 4-sided at 500× (Fig. 2), but were found to be 8-sided at 2000× (Fig. 3). Other cavities appeared to be near-circular at 500×, but were found to be apparently 12-sided at 5000× (Fig. 4).

Both diamonds displayed relatively large, often interconnected, flattened cavities (Fig. 5, Fig. 2); these cavities were more abundant in the 1.53 ct. diamond. Six-sided cavities also were abundant in the 1.53 ct. stone (Fig. 6), and also existed in the 2.06 ct. specimen.

Rough comparative estimates of cavity volumes before and after crushing indicated the total volume to be larger in the 1.53 ct. diamond. Melton and Giardini (1975) obtained 5.4×10^{-4} cc of gas (STP) from the latter, and 3.4×10^{-5} cc from the 2.06 ct. crystal. This qualitative correlation suggests that most of the gas released by crushing probably came from the respective cavity volumes. The principal gas constituent from the 1.53 ct. diamond was N_2. Water, CO_2, and H_2 were principal components from the 2.06 ct. diamond. Neither yielded detectable O_2.

Conclusions

It is concluded that clouds, at least in some diamonds, reflect light scattering by a myriad of small cavities of irregular form. Both the textures of the cloud-like inclusions and the absence of mineral matter in their cavities suggest a highly fluid environment during their formation. The syngenetic classification of Harris (1968) is in agreement with the observations presented.

Acknowledgments

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