

BARITE INCLUSIONS IN FLUORITE

By John I. Koivula and Shane Elen

Hemispherical aggregates of the mineral barite were identified as inclusions in fluorite from Illinois. One of these inclusions showed a dramatic pseudo-color change because of its position in the host. The identification of these inclusions was made nondestructively using laser Raman microspectrometry.

During the 1984 Tucson Gem and Mineral Show, one of the authors (JIK) discovered an interesting specimen while examining a large selection of Illinois fluorites for mineral and fluid inclusions. This 247.02 ct partial crystal, which measured 36 mm on its largest dimension, was transparent and had a rich, slightly brownish yellow color. What made it interesting, however, was the presence under a cube face of two prominent white, hemispherical aggregates of an unknown mineral (figure 1). Because no similar inclusions were seen in any of the other fluorite crystals, the unusual specimen was acquired for further investigation.

These inclusions resembled the fibrous white barite aggregates that had been previously observed on fluorite specimens from Illinois (Goldstein, 1997; Ross Lillie, pers. comm., 1998). Because neither inclusion reached the surface of the fluorite, however, conclusive identification at that time would

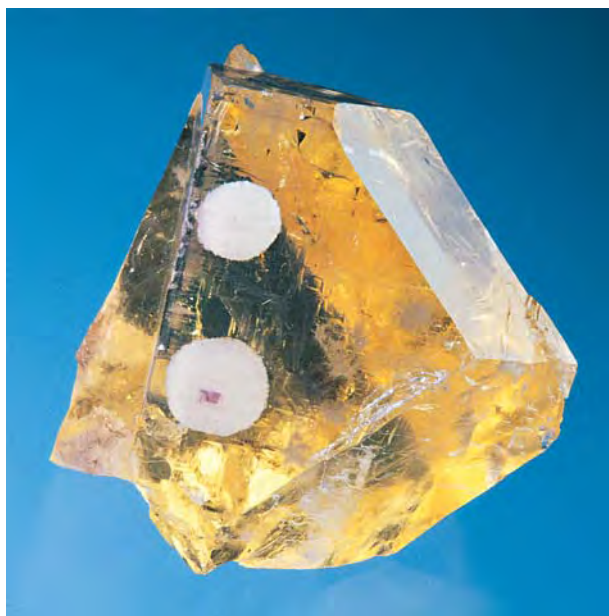


Figure 1. Two large inclusions, which Raman analysis proved to be barite, are easily seen in this 247.02 ct specimen of Illinois fluorite. Photo by Maha DeMaggio.

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have required that the host be damaged by cleaving or grinding to expose the inclusions for X-ray powder diffraction and/or chemical analysis. Given the apparent rarity of the specimen, we decided to keep the sample intact until a nondestructive means of analysis became available at GIA.



Figure 2. This 99.49 ct fluorite contains a white 7.5 mm inclusion, also identified as barite, that reflects the color of the surrounding fluorite. Photo by Maha DeMaggio.

More than a decade later, in 1995, gem cutter Michael Gray showed one of the authors (JIK) an unusual 99.49 ct faceted fluorite from Illinois (figure 2) with a white 7.5 mm inclusion that was visually identical to the two inclusions described above. This sample was even more unusual, however, because the inclusion appeared to show a color change from purple in incandescent light to blue in fluorescent illumination (figure 3).

In April of 1996, R. C. Feather described some voids in fluorite from Illinois that had the same shape as the mineral inclusions described here. In

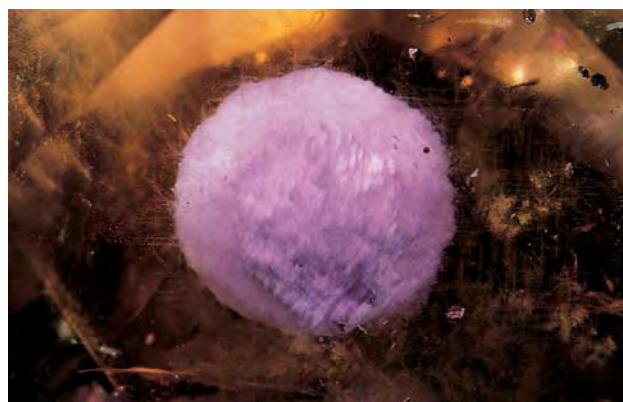
that article (p. 12), Mr. Feather speculated that the voids might once have been occupied by the mineral barite because of "the form and the fact that barite is known to occur in the area."

MATERIALS AND METHODS

The large "white" inclusions in both the original 247.02 ct partial crystal and the 99.49 ct faceted fluorite were examined with a standard gemological microscope and analyzed by laser Raman microspectrometry. In preparation for Raman analysis, both samples were first cleaned in acetone and then carefully examined with magnification to position the inclusions as close to the surface as possible and to determine the best angle from which to analyze them. This is necessary to minimize matrix effects from the fluorite host. We used a mounting clay to place the fluorite samples on glass microscope slides during analysis. Because the inclusions were so large, we were able to study them using the 20× objective lens of the Leica targeting microscope, which allowed a greater depth of focus and laser penetration into the fluorite host than the 50× lens we typically use. Further details on the Raman technique as applied to gemology can be found in Schubnel et al. (1992) and Hänni et al. (1997).

Using the continuous scan feature and the 514 nm argon laser of the Renishaw Raman system, we performed 10 complete scans of the inclusions in each of the two samples. The peak-search program employed used the Raman system's software in conjunction with the Renishaw digital spectral library. As a control, we also analyzed a crystal of barite from Colorado under the same conditions.

Figure 3. The 7.5-mm-long barite inclusion shown in figure 2 appears purple in incandescent light (left) and blue in fluorescent light (right). This pseudo-color change is imparted to the white inclusion by reflection from the fluorite host, which shows the actual color change. Photomicrographs by John I. Koivula.



RESULTS AND DISCUSSION

Standard examination with magnification revealed that the color change in the inclusion in the faceted fluorite was not a phenomenon of the inclusion itself; rather, it was caused by the position of the inclusion with respect to the color zoning of the fluorite host. The base of the inclusion rested in a zone of brownish yellow fluorite that comprised the entire pavilion of the stone, giving the fluorite a brownish yellow color face up (again, see figure 2). The upper portion of the inclusion was enclosed in a fluorite color layer that showed a strong purple-to-blue color change. The white inclusion served as an excellent background on which to display this dramatic change of color.

The Raman analysis revealed a spectral match for barite in each of the three inclusions (figure 4). All of the major peaks for barite were present in all of the analyses. Slight differences were noted between the spectra obtained for the barite inclusions and the barite control sample, but these are due to the fluorite matrix and to differences in optical and crystallographic orientation (i.e., anisotropy of Raman spectra).

As noted earlier, voids shaped like barite aggregates have been described and illustrated in fluorite (Feather, 1996). A search of the literature, however, failed to turn up any photographic documentation of actual barite inclusions in fluorite, although Goldstein (1997) briefly mentions them. No description of any association between change-of-color fluorite (Gübelin and Schmetzer, 1982) and barite as an inclusion was found. Therefore, the 99.49 ct faceted gem, which dramatically displays its color change by reflection from a white barite inclusion, may be unique.

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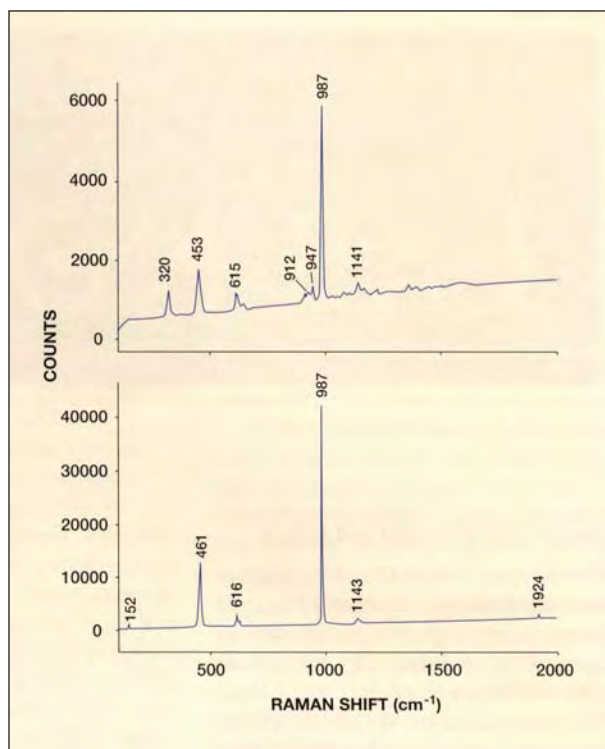


Figure 4. This representative Raman spectrum of the white inclusions in the two fluorite samples (top) is nearly identical to the spectrum for barite that was used as a reference sample (bottom). The additional peaks (e.g., at 320, 912, and 947 cm^{-1}) in the Raman spectrum of the barite inclusions are due to anisotropy of Raman spectra and matrix effects from the surrounding fluorite.

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