THE OCCURRENCE AND GEMOLOGICAL PROPERTIES OF WESSELS MINE SUGILITE

By James E. Shigley, John I. Koivula, and C. W. Fryer

Examination of jewelry-quality sugilite shows that it consists of manganese-bearing sugilite and other minerals in a polycrystalline aggregate. The material occurs in a large stratiform manganese orebody at the Wessels mine near Kuruman, South Africa. Some 12 to 15 tons of sugilite of varying quality are estimated to occur at the mine. The attractive purple color is due to the presence of about 1–3 wt.% manganese oxide. The research reported here revealed that there are actually two types of gem materials that have heretofore been called sugilite: one that is predominantly manganoan sugilite with minor impurity minerals, and the other that is chalcedony mixed with (and colored by) sugilite.

ABOUT THE AUTHORS

Dr. Shigley is director of research, and Mr. Koivula is chief gemologist, in the Research Department of the Gemological Institute of America, Santa Monica, California. Mr. Fryer is director of gem identification at the GIA Gem Trade Laboratory, Inc.

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In 1979, a new gem material with a striking purple color began appearing on the gem market (figure 1). Its source is the Wessels mine in the northern part of Cape Province, Republic of South Africa. Initially there was some question as to the identity of this material, and in the gemological literature it was first referred to as sogdianite (Dusmatov et al., 1968; Forbes et al., 1972; Bank et al., 1978; Dillman, 1978). Subsequently, Dunn et al. (1980) showed that this new gem material is actually a compositional variety of the uncommon mineral sugilite (which is closely related to sogdianite) that contains minor amounts of manganese. The manganese is responsible for the distinctive purple color.

The mineral sugilite was first described by Murakami et al. (1976) from a locality in southwest Japan. There it occurs in limited amounts as small brownish yellow grains in an aegirine syenite host rock. Clark et al. (1980) reported an occurrence of the mineral as a few tiny pink crystals in manganese ore from the state of Madhya Pradesh in India. These two and the Wessels mine are the only known occurrences of sugilite. The appearance of the massive purple material from the Wessels mine bears no resemblance to the "type" material from Japan.

Manganoan sugilite from the Wessels mine has been marketed under several trade names, including Royal Lavulite and Royal Azel. Within the trade, however, there has been some confusion as to the exact nature of this gem material. In contrast to single-crystal gem materials with gemological properties that generally fall within well-defined limits, this sugilite is both polycrystalline and polymineralic (i.e., it consists of an aggregate of tiny individual grains of sugilite and other minerals). The polycrystalline character and often variable mineral content of manganoan sugilite results in a wide variety of material that might be considered gem quality, as well as in a broad range of gemological properties. The lack of

Figure 1. The jewelry shown here combines fine sugilite in a variety of applications. The necklace incorporates 166.4 ct of translucent sugilite beads; the S-shaped center pendant consists of sugilite inlaid in gold with pavé-set diamonds from which is suspended a 4.6-ct pear-shaped faceted translucent sugilite. The bracelet illustrates various shades of sugilite, here inlaid with gold. The ring features a 6-ct cabochon-cut center stone set in gold. Jewelry by Randy Polk. Photo © Harold & Erica Van Pelt.

definitive gemological data on the nature of manganoan sugilite prompted the investigation reported in this article. Our research showed that material from the Wessels mine can range from samples that are predominantly manganoan sugilite to those that contain major amounts of chalcedony mixed with manganoan sugilite. Although standard gemological tests can indicate that both minerals are present in a single sample, they cannot determine the relative proportions.

Using information from a recently published field study of the Wessels mine (Dixon, 1985), and also from written communications with a mine geologist, we will provide a brief description of the occurrence of manganoan sugilite. This is followed by a gemological characterization of this material (and of the chalcedony mixed with sugilite) and a summary of the diagnostic features by which it can be identified. Although the correct varietal name for the sugilite from the Wessels mine is purple manganoan sugilite, to be consistent with trade use we will refer to this material simply as sugilite throughout the balance of this article.

GEOLOGY

Location and Access. The Wessels mine is located some 80 km northwest of Kuruman, and is accessible by automobile (figure 2). This area of South Africa is part of the Kalahari Desert. Within this region, the relatively flat topography is interrupted by a few gently rolling hills and by occasional stream or river channels. Most of the terrain is covered by sand. Mean elevations are approx-

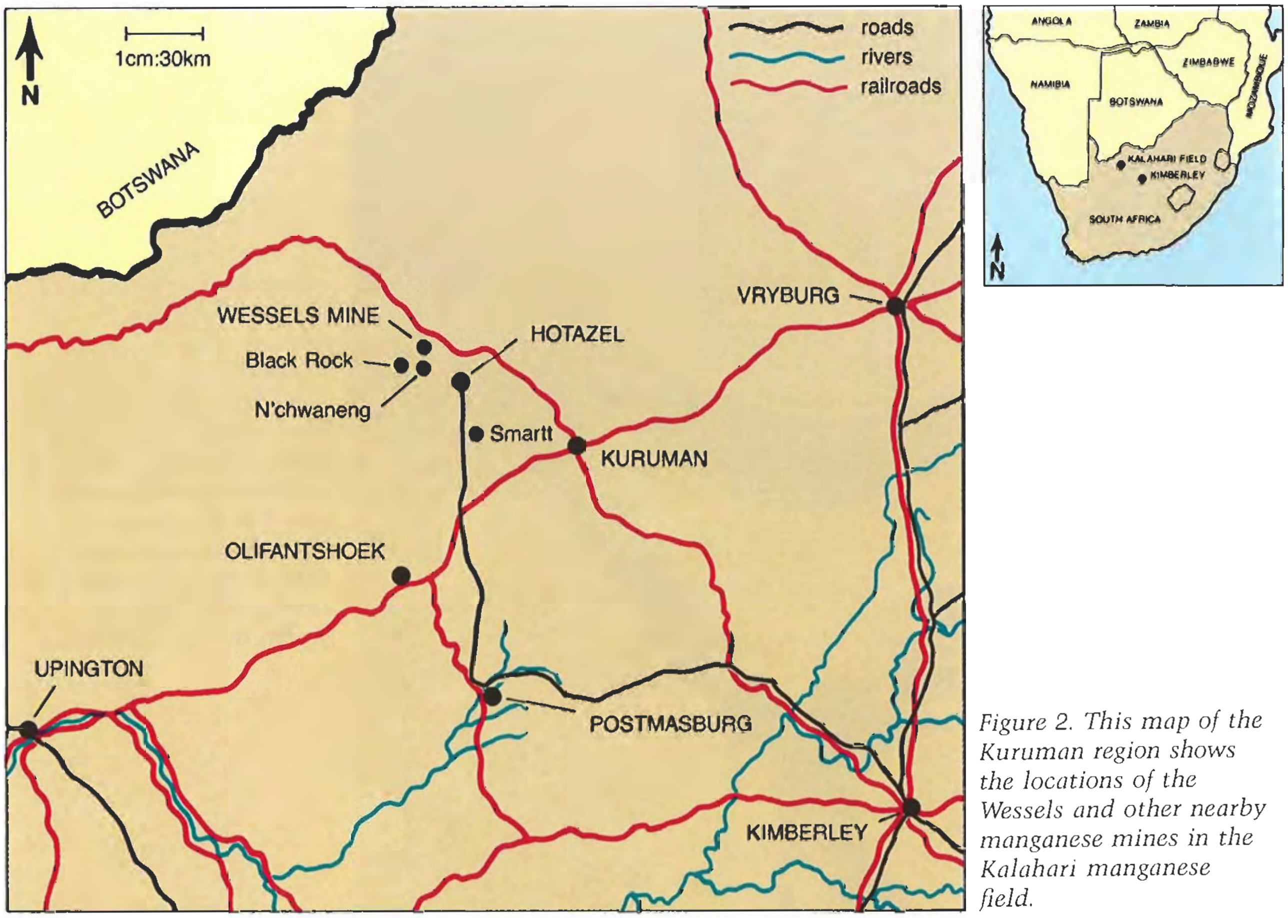


Figure 2. This map of the Kuruman region shows the locations of the Wessels and other nearby manganese mines in the Kalahari manganese field.

imately 1000 m above sea level, with isolated rock outcrops rising an additional 20 to 30 m above the land surface. Annual rainfall averages 20 to 25 cm. The local climate is characterized by distinct seasonal temperatures—from below 0°C (32°F) during winter to above 38°C (100°F) in summer—and by large daily temperature variations. Vegetation, typical of the elevated topography and semiarid climate, consists of small trees, low scrub bushes, and various grasses.

Nature of the Manganese Deposit. Manganoan sugilite occurs in small quantities with other manganese minerals at the Wessels mine, one of a number of surface and underground mines that exploits a series of important manganese deposits in the northern Cape Province. These deposits, known collectively as the Kalahari manganese field, extend over a distance of some 140 km from Black Rock to Postmasburg. With estimated reserves of eight billion tons of ore, these are among the largest and richest manganese deposits in the world (Roy, 1976; Button, 1976).

The manganese fields near Kuruman were discovered early in this century (see details in Boardman, 1964). By the late 1920s, geologists had located a series of major manganese orebodies along two parallel, north-south trending belts beginning at Postmasburg. Some of these deposits, such as at Hotazel, are mined at the surface by open-pit methods. In most places, however, the manganese ore occurs below the desert sand, and is only seen in channels cut by streams or in rock samples brought up during well excavation or subsurface drilling. The Wessels mine, owned and operated by South African Manganese Mines Ltd. (SAMANCOR) of Johannesburg, is one of the largest underground mines in the Kuruman area and has been in operation since 1973.

Regional Geology of the Kalahari Manganese Field. At the Wessels mine, the manganese ore occurs in a stratiform orebody (for further information, see Roy, 1976, and Hutchinson, 1983). Such stratiform manganese deposits are found in India, Brazil, Ghana, and the Soviet Union, but the ones in South Africa are among the largest and economically most important.

The regional geology of the area around the Wessels mine has been described by J. E. de Villiers (1960, 1983), Boardman (1964), Button (1976), and P. R. de Villiers (1967, 1970). The manganese ore occurs at several horizons within a sequence of sedimentary rocks that is over 10,000 m thick. The ore layers are quite rich, some with a manganese content in excess of 50% (Wilson and Dunn, 1978). The ore consists of braunite, hausmannite, manganite, pyrolusite, rhodochrosite, and other manganese-bearing minerals (Frankel, 1958). It is dark brown to black and occurs in massive layers. Although not especially thick (5–25 m), some individual layers of ore are remarkably continuous and have been traced more than 50 km.

According to Söhnge (1977), the layers of manganese ore and the enclosing sediments were deposited in a sedimentary basin between 2.6 and 2 billion years ago. The manganese was derived either from weathering of the surrounding land or from hydrothermal solutions that moved through the sediments during local episodes of volcanic activity. Favorable conditions led to the deposition of various manganese minerals at certain layers in the sequence of sedimentary rocks.

Figure 3. At the Wessels mine, sugilite can occur in massive or layered form. This representative sample (6 × 5 × 1 cm) shows the layered appearance often seen in the material. The thickness of individual sugilite layers varies greatly, and can reach up to several centimeters across. The thin layers in this sample are almost pure manganoan sugilite. The sugilite occurs with black braunite and a light gray rock containing pectolite and possibly acmite. Photo © Tino Hammid.

The Occurrence of Sugilite at the Wessels Mine. Compared to the production of manganese, only small amounts of sugilite are found at the Wessels mine. Because of its minor economic importance relative to the manganese ore, sugilite has not received great attention from mine officials. The few reports published on sugilite since its discovery in 1973 lack specific information on the occurrence; the best description is by Dixon (1985). The information presented below is taken from that article as well as from written communications with Dr. D. N. Bird, a SAMANCOR geologist.

Sugilite is found in massive form in layers or seams within certain zones in the manganese ore (figure 3). When several sugilite layers occur together, the group can reach 15 cm thick. The layers of sugilite mineralization are not continuous, but rather they extend laterally as far as 15 m. The sugilite is also found as irregular-shaped patches or as massive material that fills the spaces between brecciated blocks of manganese ore. In the original description, Dunn et al. (1980) mentioned that the sugilite and its associated minerals—chiefly braunite and acmite pyroxene—are intimately intergrown on a fine scale. According to Dixon (1985), associated minerals also include andradite, wollastonite, pectolite, vesuvianite, glaucochroite, and quartz. Dixon describes this group of minerals as forming a skarn within the layered manganese ore. A skarn is a mineralized ore deposit that results from the chemical interaction of circulating hydrothermal solutions with the sedimentary host rocks through which they pass. Original minerals in the host rock are metasomatically replaced by new minerals, which then often form a sequence of mineralized zones related to the direction of flow of the hydrothermal solutions. At the Wessels mine, sugilite apparently formed by such a process at some point following the original deposition of the manganese-bearing sediments.

Manganoan sugilite has been mined intermit-

Figure 4. In the underground workings of the Wessels mine, miners probe with metal poles for layers of sugilite within the massive manganese ore. Photo by John Pittorino.

Figure 5. A miner working underground in the Wessels mine displays a chunk of sugilite that has just been taken from the mine well. Photo by John Pittorino.

tently. The original discovery resulted from an accidental encounter with a sugilite-rich area during normal mining operations. When sugilite is found (figures 4 and 5), the miners remove it from the host rock using hand tools, haul it to the surface, separate it from the more abundant manganese ore, and stockpile it for eventual sale. At the mine, the quality of the sugilite varies greatly, with no particular quality being restricted to certain parts of the underground workings. Dr. Bird (pers. comm., 1985) reported that sugilite has not been observed in any of the other manganese mines operated by SAMANCOR, and has not been identified in any of the neighboring mines in the Kalahari manganese field. No exact figures are available on the total reserves of sugilite at the Wessels mine, but R. D. Dixon (pers. comm., 1985) has unofficially estimated that there are 12 to 15 tons of sugilite of varying quality present. He based this estimate on his field studies and on the occurrence and production of the sugilite mined thus far. Of the projected reserves, no estimate is available as to how much is gemologically important or actually recoverable. However, blocks of massive jewelry-quality sugilite weighing up to several kilograms have been found.

CHARACTERIZATION OF WESSELS MINE SUGILITE

For our study we examined a number of massive samples as well as 25 cabochon-cut and faceted pieces of varying quality. It was during our examination that we discovered that two types of material actually come from the Wessels mine: (1)

samples that are predominantly sugilite; and (2) samples that are less pure, and that contain varying amounts of chalcedony mixed with (and colored by) sugilite. Samples from the latter group exhibit gemological properties of both minerals, and should be identified as a rock composed of both; standard gemological testing of these samples will only indicate if some significant amount of chalcedony is present. The following paragraphs summarize the properties of relatively pure manganoan sugilite (see box). The properties of the samples composed of chalcedony mixed with sugilite are also reported in the text when they differ significantly from those of manganoan sugilite. In the discussion that follows, samples containing both chalcedony and sugilite are identified as such; the term *sugilite* is used only to refer to samples that are predominantly manganoan sugilite.

PROPERTIES OF WESSELS MINE SUGILITE

Color: bluish purple to purple to reddish purple
Textural appearance: uniform color to veined or mottled
Toughness: good to excellent
Cleavage: none observed
Transparency: opaque to translucent
Luster: vitreous to resinous
Refractive index: about 1.607
Specific gravity: 2.74 to 2.80, average 2.76
Hardness: $5^1/_2$ to $6^1/_2$
Absorption spectrum: bands at 411, 419, 445 and 495 nm; 419-nm band most intense; band strength related to the intensity of the purple color; broad regions of absorption below 430 and from 500 to 600 nm
Color stability: stable to normal heat and light conditions of wear
Ultraviolet fluorescence: inert to long-wave and short-wave ultraviolet radiation
Chemical composition: $(K,Na)(Na,Fe^{3+},Mn^{3+})_2(Li_2Fe^{3+})Si_{12}O_{30}$
Crystal system: hexagonal

Appearance. The most striking feature of the purer samples of sugilite is the purple color. As described using GIA's color terminology, the material generally has a purple or bluish purple hue with a variable tone (6–8) and saturation (2–4). A representative ColorMaster reading for the best-quality material is C-04/00/66. In incandescent light, the material takes on a more reddish appearance. Samples containing chalcedony that are lower in sugilite content retain the same purple hue but are less saturated in color and are lighter in tone.

A small amount of sugilite from the Wessels mine has a distinct reddish purple or dark pink color that corresponds to a ColorMaster reading of C-43/35/100 (figure 6). We found this material to differ in chemistry and in absorption spectrum from the more common purple sugilite, as described later in this article. This reddish purple color variety of sugilite is reported to be quite rare at the mine and, to our knowledge, has not appeared on the gem market.

The textural appearance and coloration of both sugilite and those samples intermixed with chalcedony can range from quite uniform to mottled, veined, or layered depending on the homogeneity of the material (figures 7 and 8). When observed with a microscope, all samples (even those with a uniform color) were found to consist of interlocking grains of sugilite and other impurity minerals of differing size, shape, and optical orientation (figure 9). This polycrystalline nature can become so pronounced as to give some pieces a polygonal appearance. Others, with a relatively uniform color, have an orbicular texture in which faint, grayish purple, 1–2 mm round areas can be seen. Narrow reddish brown veinlets up to 2 mm across cut through some samples in random directions.

Sugilite can fracture along irregular surfaces, but the material used for jewelry is generally quite tough and durable. Cleavage was not apparent in the samples we examined. The material varies from opaque to translucent. There apparently is no relationship between the degree of transparency and the sugilite and chalcedony content. The luster on a broken surface is vitreous or resinous.

Refractive Index. Dunn et al. (1980) reported the refractive indices of manganoan sugilite from the Wessels mine to be $\epsilon = 1.605$ and $\omega = 1.611$. It was during R.I. testing that we first noted the two distinct types of gem material. Sixteen of the 25 samples gave a nonvarying spot or flat-facet reading of 1.607, as expected for sugilite (Fryer et al., 1981). One of the faceted stones, however, gave a distinct reading of 1.544 that corresponds to the refractive index of quartz or chalcedony. The remaining eight samples showed two separate readings of 1.544 and 1.607. When the magnifying lens was removed from the refractometer, and flat-facet readings were taken at various locations on one of these eight samples, a number of locations on different mineral grains easily gave either or sometimes both of these refractive indices.

These results indicate that the gem material commonly called "sugilite" in the trade actually ranges from relatively pure manganoan sugilite to samples that contain progressively greater amounts of chalcedony. Samples exhibiting the two refractive indices should not be described as sugilite but rather as a rock consisting of a mixture of sugilite and chalcedony. There is no way to determine if chalcedony is the major constituent of a particular sample by standard gemological testing procedures.

Birefringence. As is common with other massive, polycrystalline gem materials used for lapidary purposes, none of the samples tested on the refractometer displayed discernible birefringence. The double readings of 1.544 and 1.607 are distinct and separate refractive indices for the two different minerals found intermixed in some samples, and they should not be mistaken for birefringence.

Pleochroism. The samples examined are polycrystalline, and display no pleochroism because of the random orientation of their microscopic constituents.

Specific Gravity. To test for specific gravity, we selected six samples from the group of 25. This set covered the range of colors of sugilite and included a lighter-colored sample that also contained chalcedony (as indicated by the 1.544 refractive index). Testing of this group should demonstrate a simple means of distinguishing material that is predominantly sugilite from pieces that are chalcedony mixed with sugilite because of the lower specific gravity of chalcedony (2.58–2.62, as compared to 2.79 for sugilite).

The samples were tested first in a methylene iodide–benzyl benzoate solution of known 2.67 specific gravity. The sugilite samples sank readily in the liquid; their specific gravity was estimated to be approximately 2.75 to 2.80. The single lighter-colored sample containing chalcedony sank slowly in the liquid; its specific gravity was estimated to be approximately 2.70.

Using a Voland double-pan balance and three repeated measurements, we obtained a hydrostatic

Figure 6. Comparison of purple and reddish purple samples of massive sugilite from the Wessels mine. The specimens are 2 cm high. Photo © Tino Hammid.

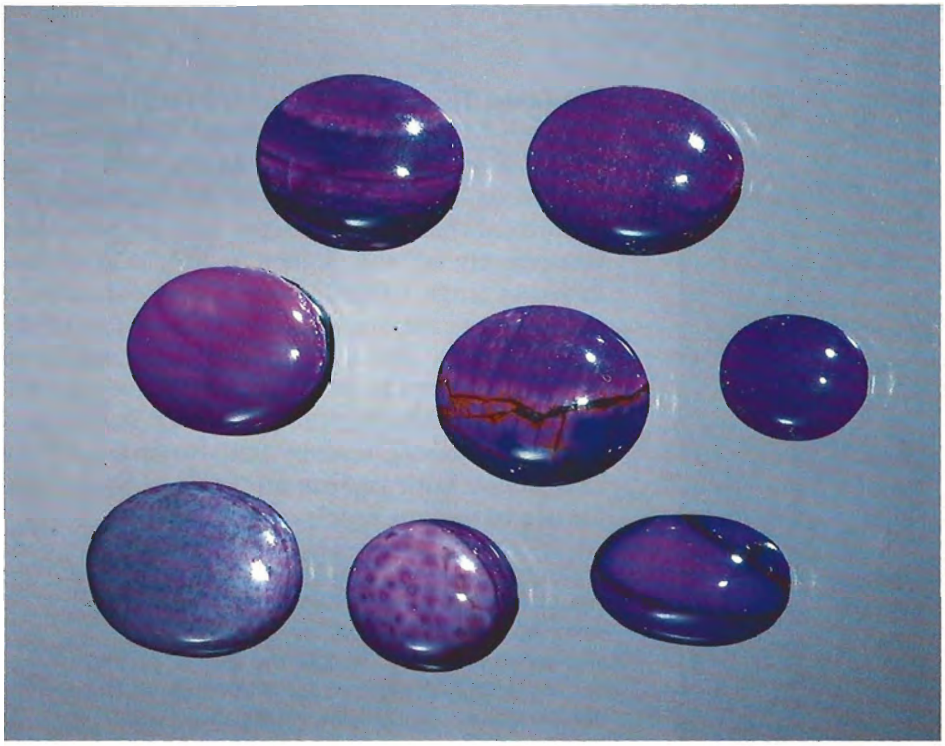


Figure 7. This selection of cabochons of manganoan sugilite, ranging from 2.53 to 9.08 ct, illustrates the range of color and textural appearance of the material. Photo © Harold & Erica Van Pelt.

value of 2.69 for the lighter-colored sample, and values of 2.74–2.78 (2.76 average) for the remaining five samples. It appears, then, that measurement of specific gravity does indeed provide a rough indication of how much chalcedony a sample of this material might contain, with samples with lower specific gravities containing more chalcedony.

Absorption Spectra. When examined with a "handheld" type of spectroscope and reflected light, the sugilite samples were found to exhibit one or more of the following features: a weak band at about 411 nm, a strong band at about 419 nm, a weak band at about 445 nm, and a weak band at approximately 495 nm. The strong band at 419 nm could be seen in all samples, but the weaker ones were not always visible. In addition, broad regions of absorption below 430 nm and from 500 to 600 nm were noted (see spectrum illustrated in Fryer et al., 1981). The strength of these spectral features increases in intensity as the color of the sugilite becomes darker. The narrow bands were much less obvious in the reddish purple color variety of sugilite, but the broad absorption region from 500 to 600 nm was still visible. In a sample of the chalcedony mixed with sugilite, no narrow bands were observed, but, again, a broad region of absorption from 500 to 600 nm was weakly visible.

Figure 8. Although this material was originally thought to be sugilite, gemological tests indicated that it is actually a mixture of chalcedony and sugilite. The carving is 4 cm in diameter and weighs 51 ct. Photo by Scott Briggs.

Absorption curves on this material were obtained with a Pye-Unicam UV/VIS spectrophotometer, and compared with the absorption spectra of other manganese- and iron-bearing min-

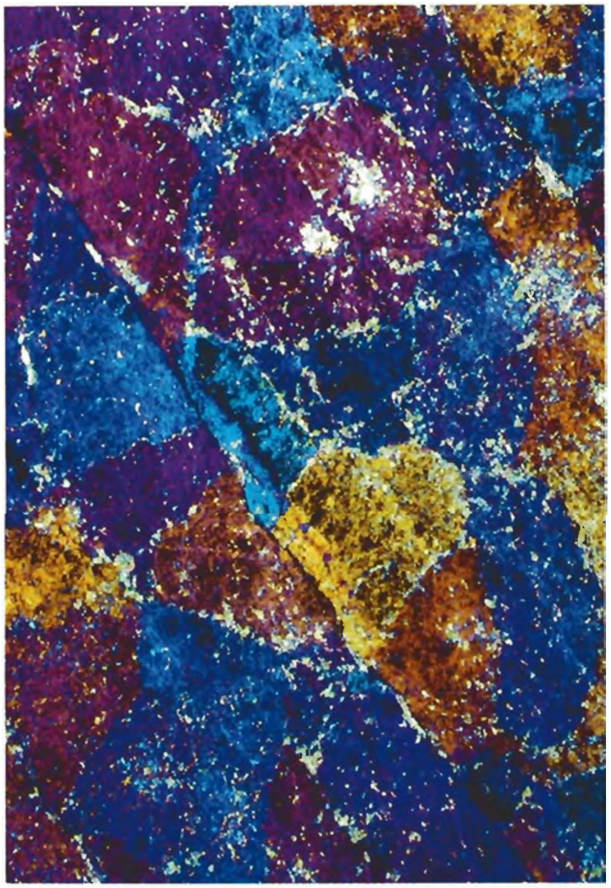
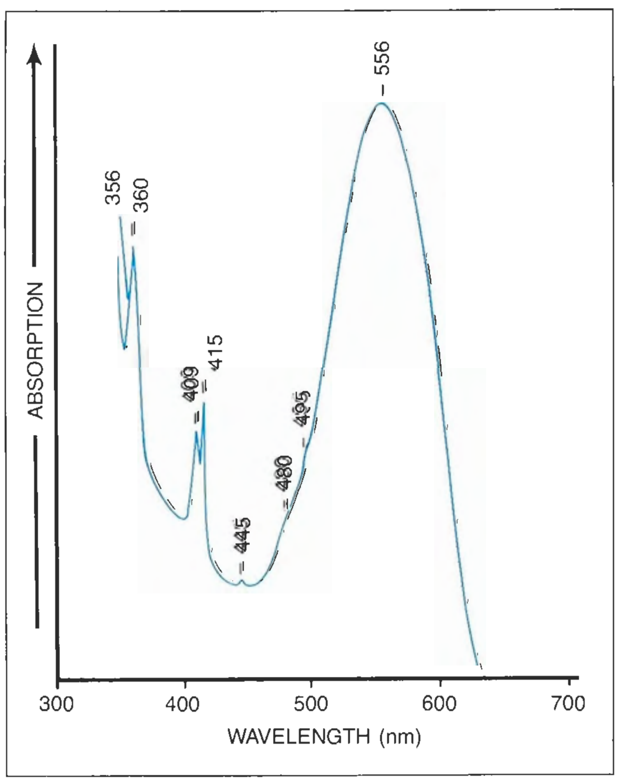


Figure 9. In this thin section viewed with polarized light, individual grains of sugilite, each exhibiting a different interference color, are seen in a polygonal arrangement that relates to the polycrystalline character of the material. The grains are approximately 0.1 mm in diameter. The tiny black inclusions are impurities. The presence of sugilite and other minerals in such a granular aggregate leads to the polymineralic nature of this material; magnified 50×. Photomicrograph by John Koivula.

erals. The results (see figure 10) indicate that the color of the purple sugilite can be attributed to both manganese (as Mn^{3+}) and iron (as Fe^{3+}). The color of the material proved to be stable when subjected to heat (100°C) and light (exposure to direct sunlight for several hours) conditions that might be experienced during routine jewelry use. In addition, none of the samples was found to have been treated with any color-enhancing dyes. The same remarks on color stability can be made for the samples containing both chalcedony and sugilite.

Hardness. The samples we tested vary in hardness between $5^1/_2$ and $6^1/_2$, and most commonly between 6 and $6^1/_2$, on the Mohs scale. Those specimens that gave a 1.544 R.I., indicating a significant chalcedony content, also tended to test consistently at the higher, $6–6^1/_2$, end of the hardness range. Other factors that appear to affect the hardness are texture and the thickness of the sugilite layers. These hardness values correspond to those reported by Dunn et al. (1980) for manganoan sugilite. No directional variation in hardness was noted during testing. Both sugilite and the chalcedony with sugilite are sufficiently durable for use in various jewelry applications.

Figure 10. The spectrophotometer absorption curve of a polycrystalline sample of purple manganoan sugilite. Within the visible region, the absorption peaks indicated correspond to the narrow absorption lines seen in a "hand-held" type of spectroscope. The large peak centered at about 556 nm corresponds to the broad region of absorption from 500 to 600 nm seen in the hand spectroscope. The curve was obtained with a Pye Unicam PU8800 UV/VIS spectrophotometer with a 1-nm bandwidth and a 1-nm/sec scan speed. The path length through the sample was approximately 1.56 mm.



Ultraviolet Fluorescence. All of the 25 samples were inert to long-wave (366 nm) ultraviolet radiation. When exposed to short-wave ultraviolet radiation, six of the samples showed a slight reaction while the remaining 19 were inert. Of the six, four fluoresced an extremely weak, dull, chalky orange. The remaining two exhibited weak to moderate orange fluorescence on a few tiny randomly arranged spots. Some of these spots were pinpointed and then examined with the microscope, but no distinct mineral grains responsible for the fluorescence could be resolved. It was noted, however, that those samples that reacted to short-wave ultraviolet radiation were also among those that had both the 1.607 and 1.544 refractive indices. Thus, such a fluorescence reaction seems likely to be due to the presence of chalcedony in the sample. Manganoan sugilite is inert to ultraviolet radiation.

Chemical and X-ray Diffraction Data. Chemical composition data on manganoan sugilite have been published by Dunn et al. (1980), Clark et al. (1980), Olivier et al. (1983), and Dixon (1985). They reported that the material contains about 1–3 wt.% manganese oxide. The chemical formula of manganoan sugilite can be written as follows:

$$(K,Na)(Na,Fe^{3+},Mn^{3+})_2(Li_2Fe^{3+})Si_{12}O_{30}$$

The X-ray diffraction pattern we obtained for a sample of manganoan sugilite from the Wessels mine (GIA 14561) is consistent with X-ray data reported for the type sugilite from Japan (1986 JCPDS Mineral Powder Diffraction File 29-824). Least-squares refinement of 68 measured reflections obtained from this specimen yielded unit-cell dimensions of $\underline{a} = 10.020(3)$ Å and $\underline{c} = 14.085(11)$ Å. The close correspondence of these values to those of the type sugilite from Japan ($\underline{a}$ = 10.007 Å, $\underline{c}$ = 14.000 Å) suggests that the presence of manganese has little influence on the crystal structure. The reddish purple color variety of sugilite gave a similar X-ray diffraction pattern.

X-ray diffraction patterns obtained from some of the more grayish purple material confirmed the presence of important amounts of quartz (in the form of the cryptocrystalline variety chalcedony). Patterns for some of the other minerals in those pieces of rock containing sugilite with prominent gray layers revealed (black) braunite, (grayish) pectolite and, to a lesser extent, (white) barite. The reddish brown veinlets cutting some samples were found to be a color variety of sugilite of presumably different chemical composition.

Gemological Uses. Since its discovery, sugilite (and the samples now known to contain chalcedony as well) has been used in an increasing variety of jewelry and decorative applications. The material can be categorized into various quality grades on the basis of color (hue and saturation), texture (uniformity or zonation of color, presence of veining, banding, or fractures), hardness, translucency, and size (thickness of the sugilite layers). Most of the sugilite is cut in cabochon form (figure 7). Commonly, thin layers are used for inlay in both jewelry and decorative objects (see, e.g., Elliott, 1986; see also figure 1). Larger massive pieces make excellent carving material (figures 11 and 12). A few translucent pieces of manganoan sugilite have been faceted (again, see figure 1). Individuals who have worked with this material report that good samples, selected to be free of fractures and other defects, cut and polish in a manner

Figure 11. Sugilite has become a popular carving material, as this blue heron illustrates. The bird, 19 cm high, was carved by Herbert D. Klein Co., Idar-Oberstein. The beak is jasper and the legs are 14K gold. Photo © Harold & Erica Van Pelt.

Figure 12. This piece of sugilite was carved in a dragon motif by Hing Wa Lee, Los Angeles, CA. The carving measures 52 × 35 × 7.5 mm. Courtesy of Sylvia and Ralph Coello; photo © Tino Hammid.

normal for a gem material of this hardness. In many ways, during cutting, carving, and polishing, sugilite behaves similar to jade (both jadeite and nephrite) and, to a lesser extent, to lapis-lazuli (although sugilite is reported to be slightly harder on the saw and polishing wheel). The fact that sugilite does not fracture or cleave easily, and is not heat sensitive, is important when considering its potential usefulness as a gem material.

SEPARATION FROM OTHER MATERIALS

Only a few other opaque or translucent purple gem materials could be confused by sight alone with sugilite (figure 13). However, they are easily separated by standard gemological testing.

Whether dyed or naturally colored, purple or lavender jadeite has a distinctive 1.66 spot refractive index reading. Massive violet to purple dumortierite, though rarely encountered as a gem material, also has a refractive index range that is much higher (1.678 to 1.689) than that of sugilite.

Charoite is easily separated from sugilite on the basis of sight alone because of its distinctive interlocking, fibrous texture. Additionally, charoite's 1.55 refractive index is much lower than that of sugilite (although it is close to that of the chalcedony-sugilite mixture).

The refractive indices of chalcedony and massive amethyst are so low in comparison to sugilite's 1.607 reading that no misidentification should result. As noted earlier, though, the grayish purple material from the Wessels mine that we found to be chalcedony mixed with sugilite will give the refractive indices of both minerals. This material, which should be identified as a rock composed of chalcedony and sugilite, is also weakly fluorescent to short-wave ultraviolet radiation. In contrast to the absorption spectrum of sugilite, there are no sharp lines in the absorption spectrum of either the sugilite-colored chalcedony or amethystine chalcedony (Shigley and Koivula, 1985). However, both can have spectra with a region of absorption from 500 to 600 nm.

Although the above-mentioned gem materials

Figure 13. A cabochon of manganoan sugilite (14.12 ct) is surrounded by cabochons of possibly similar-appearing gem materials. Clockwise from the top, these are lavender jadeite (25.07 ct), charoite (10.26 ct), two pieces of amethystine chalcedony (9.51, 8.34 ct), dyed jadeite (8.60 ct), and amethyst (9.69 ct). Photo by Robert Weldon.

also differ dramatically from sugilite in their specific gravities, this testing method is not always practical because the gems must be removed from their mountings for testing. In virtually all cases, the refractive index, together with sugilite's unique absorption spectrum, should be sufficient to separate it from any other known violet-to-purple, opaque-to-translucent gem material.

CONCLUSIONS

Purple manganoan sugilite has been found in commercial quantities at only one location, the Wessels mine near Kuruman in South Africa. With a hardness of $5^1/_2$ to $6^1/_2$, the finest qualities of manganoan sugilite are ideally suited for use in all forms of jewelry. As a polycrystalline gem material, it is generally tough and resistant to fracturing. Sugilite is also color stable to both light and heat in normal wearing conditions. We know of no sugilite that has been treated in any way to improve its appearance. Sugilite can be readily separated from similar-appearing materials.

Some material from the Wessels mine was found to contain important amounts of chalcedony. These differ from the purer manganoan sugilite in their gemological properties. Although the chalcedony-bearing samples have a slightly greater hardness (6 to $6^1/_2$), they are less saturated in color. We do not know how much of this latter material may appear in the market, but few samples of it relative to those of sugilite have been submitted for identification to the GIA Gem Trade Laboratory (R. Kane, pers. comm., 1987). Nonetheless, samples containing chalcedony can easily be distinguished from sugilite on the basis of the gemological properties summarized here.

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