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SUGILITE, A SECOND OCCURRENCE: WESSELS MINE, KALAHARI MANGANESE FIELD, REPUBLIC OF SOUTH AFRICA

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Abstract

Sugilite, a sodium potassium ferric iron silicate, has been found in the Wessels mine, Kuruman district, Northern Cape Province, Republic of South Africa. It occurs as violet seams in manganese ore. It bears no visual resemblance to the type material. Microprobe analysis yields 69.6 SiO_2, 13.9 Fe_2O_3, 1.9 MnO, 4.7 K_2O and 6.0 Na_2O, total 96.1, by weight. The mineral is abundant and is associated with acmite and braunite in sedimentary beds.

Keywords: sugilite, alkali iron silicate, Wessels mine, Republic of South Africa, manganese ore, Kalahari.

Sommaire

On a trouvé la sugilite, silicate de sodium, potassium et fer ferrique, dans la mine Wessels, district de Kuruman, dans le Nord de la province du Cap, république de l'Afrique du Sud. En veinules violacées dans un minerai de manganèse, cette sugilite ne ressemble aucunement à son type. Une analyse à la microsonde donne 69.6 SiO_2, 13.9 Fe_2O_3, 1.9 MnO, 4.7 K_2O et 6.0 Na_2O, total 96.1 (en poids). La sugilite se trouve ici en abondance, associée à l'acmite et à la braunite dans des couches sédimentaires.

(Traduit par la Rédaction)

Mots-clés: sugilite, silicate alcalin de fer, mine Wessels, république de l'Afrique du Sud, minerai manganésifère, Kalahari.

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Introduction

Sugilite was originally described from the northeastern part of Iwagi Islet, Ehime Prefecture, Japan, by Murakami *et al.* (1976). There it occurs as isolated grains in an acmite syenite stock emplaced in biotite granite. Sugilite is associated with albite, acmite, pectolite, allanite, titanite, zircon and andradite.

This second occurrence of sugilite was originally called to the attention of the senior author by Dr. Robert Gait and Mr. Prosper Williams of Toronto. Additional samples from the same locality came to us through various individuals, to whom we are deeply indebted. This sugilite occurs at the Wessels mine, 22.5 km northwest of Hotazel in the Kuruman district, Cape Province, Republic of South Africa. The mine, owned and operated by S. A. Manganese Armcor Ltd. of Johannesburg, was opened in May, 1973. The ore bodies generally are layered, with different groups of minerals predominating in different layers. The minerals are always intimately intergrown and difficult to identify by macroscopic methods. Discussions of the geology of the surrounding Kalahari manganese field have been adequately presented by de Villiers (1967), Coetzee (1976) and Wilson & Dunn (1978). According to Dr. P. R. de Villiers (pers. comm. 1977), the sugilite was found by accident in 1973 when the roof of an inclined shaft caved in during development. Apparently no other occurrences were found, and we have no further information on this one.

Description

In the Wessels mine, sugilite occurs as bedded seams (up to 3 cm thick) of massive material interlayered with fine-grained acmite and various manganese oxides, chiefly braunite. The color of this sugilite is very dark to light violet; the color darkens with increasing abundance of acmite inclusions. The acmite can appear almost opaque with vitreous lustre and a quartzite-like texture where heavily saturated with braunite inclusions. The sugilite has a vitreous lustre with a granular texture. No single crystals were found; the mineral occurs only in a massive fine-grained state. The Mohs hardness of the Wessels-mine sugilite is 5½ to 6, slightly softer than the 6–6½ value reported for the type material from Japan. The density, determined with heavy-liquid techniques, is 2.79 g/cm^3, in good agreement with the theoretical value of 2.80 g/cm^3 calculated for the type material, which has similar composition. Optically, sugilite is uniaxial negative with refractive indices ω 1.611(3) and ϵ 1.605(3). It is very weakly pleochroic and does not respond to ultraviolet radiation.

The X-ray powder-diffraction pattern of this sugilite is identical to that of the type material from Japan. There are no discernible differences in the diffraction patterns obtained with a 114.6 mm diameter Gandolfi camera, a multicrystalline ball-mount and Cu $K\alpha$ X radiation.

We note with interest that a description of what seems to be the same mineral has been published as sogdianite by Bank *et al.* (1978). The X-ray powder patterns of sogdianite and sugilite are nearly identical, considering the strongest lines. We note the absence of zirconium in our material and suggest the possibility that the phases could have been confused.

TABLE 1. CHEMICAL DATA FOR SUGILITE

	Wessels mine	Japan
SiO_2	69.6	71.38
TiO_2	0.0	0.51
Al_2O_3	0.0	2.97
Fe_2O_3	13.9*	12.76
FeO	n.d.	0.19
MgO	0.0	n.g.
CaO	0.0	0.0
MnO	1.9	n.g.
K_2O	4.7	3.76
Na_2O	6.0	4.37
Li_2O	**	3.14
H_2O^+	0.0***	0.81
H_2O^-	0.0	0.12
Total	96.1	100.01

Accuracy of data on sugilite from Wessels mine: 3% of amount present. * Iron determined as total iron and calculated as Fe^{3+} based on known state of Fe in sugilite. ** Lithium present as a major element. *** H_2O determined by DTA/TGA. NMNH sample # 137289.

Chemical Composition

The sugilite described here was chemically analyzed with an ARL–SEMQ electron microprobe using an operating voltage of 15 kV and a beam current of 0.15 μA. The standards used were manganite for manganese, hornblende for calcium, iron, magnesium, sodium and potassium, and zektzerite for silicon. The data were corrected using Bence–Albee factors. An emission-spectrograph analysis confirmed the microprobe results and, in addition, indicated the presence of lithium in the 1–10% range, by weight. The resultant microprobe analysis is compared with the analysis of Murakami *et al.* (1976) in Table 1.

Manganese is not a major component in this sugilite. Although the material has been sold under the name of *manganese analogue of sugilite,* it is a "normal" sugilite with but minor replacement of iron by manganese. Owing to the complexities of the osumilite group, to which sugilite probably belongs, we cannot directly ascribe the available manganese to a specific valence state; therefore, we calculate it here as MnO simply for convenience. Lithium is present in significant amounts. However, this sugilite is thoroughly intergrown with microscopic crystals of acmite with a composition very near the end member and containing about 0.8% MnO. The abundant inclusions in the sugilite rendered useless an attempt to determine lithium quantitatively by flame-photometry methods and wet chemistry. However, the presence of abundant lithium was proven by ion-microprobe mass spectroscopy and further confirms the identity of this material as sugilite. DTA/TGA analysis indicates that the material has less than 0.02% H_2O and melts at approximately 895°C to a pale brown glass. The analysis refers to the darkest violet material.

The sugilite from Japan contains 3.14% Li_2O. If we calculate lithium by difference, we obtain 3.9% Li_2O for the Wessels-mine sugilite. However, if we were to use this calculated figure, the estimated error of the microprobe analysis (± 3% of the amount present) would greatly affect the number of lithium atoms in the unit cell. Hence, we cannot calculate the number of cations *per* unit cell with reliability. Given the extensive substitutions possible in the osumilite group and the undetermined oxidation state of the iron, we cannot assign the cations to specific sites without a crystal-structure determination.

Conclusions

In summary, sugilite from the Wessels mine is distinctly different from the type material in physical appearance. The mineral is no longer a rare species; it was found in kilogram quantities and in 1977 was noted in South Africa by Mr. Prosper Williams, being used for ashtrays.

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