

Maria KULIG *

CHALCOPHANITE FROM THE SILESIAN-CRACOVIAN Zn-Pb DEPOSITS

UKD 549.748.31:553.44(438.232)

A b s t r a c t. Chalcophanite was identified in museum samples of Mn oxide minerals derived from the weathering zone of the Silesian—Cracovian Zn-Pb deposits and labelled in the collection as psilomelane, wad and pyrolusite. This mineral was also found in a chocolate-brown substance, occurring in dolomite and galmei fissures in the mines of Dąbrówka Wielka and Olkusz. Hydrohetaerolite and an accompanying Mn-Pb oxide mineral had been identified earlier in a similar substance from these deposits. The identification of chalcophanite was based on X-ray powder patterns (the strongest lines: 6.91, 3.46, 2.556, 2.455, 2.228 Å) and microscopic examinations in reflected light. Reflectance (R %) of chalcophanite in air is: for white light $R = 30.0-10.5$, for green light $R = 28.1-9.6$. The results of thermal and infra-red spectrophotometric analyses of all the samples containing chalcophanite are presented. It has been found that upon heating, chalcophanite is gradually transformed into hydrohetaerolite and then into hetaerolite.

On examination of museum specimens (collections of the Wrocław University) of psilomelane, wad and pyrolusite derived from the weathering zone of the Silesian-Cracovian Zn-Pb deposits (the region of Tarnowskie Góry and Bytom), the author has found that they are mixtures of Mn oxide minerals, their dominant crystalline phase being chalcophanite. Until now the occurrence of chalcophanite in the Silesian-Cracovian Zn-Pb deposits has not been recorded, though Nienadkiewicz (1911) noticed the presence of complex Mn-Zn oxides with a considerable Pb content in the mines of Olkusz. It was a chocolate-brown or black, earthy substance. Basing his investigation only on a chemical analysis, Nienadkiewicz described it under the name of „zincdibraunite” as a new mineral of the chalcophanite group with the formula $ZnO \cdot 2MnO_2 \cdot H_2O$, containing Pb and Ca oxides. The present author has examined a substance similar to that described by Nienadkiewicz, but found in the Orzeł Biały mine near Bytom. It has been demonstrated that the substance in

* Institute of Mineralogy and Mineral Deposits, Academy of Mining and Metallurgy, Cracow (Kraków, al. Mickiewicza 30).

question is a mixture of Mn oxide minerals, the two principal ones being hydrohetaerolite and an accompanying Mn-Pb mineral (Kulig 1973). Recently, chalcophanite has also been noticed in such a substance from the mines of Dąbrówka Wielka and Olkusz.

In Table 1 the samples examined and their localities are listed together with minerals accompanying chalcophanite. Since the microcrystalline form of the samples (except chalcophanite MK-6 and MK-7) makes mechanical separation of their mineral components impossible, investigations were performed on mixtures.

Table 1
List of samples from the Silesian-Cracovian Zn-Pb deposits containing chalcophanite

Sample	Locality	Mineral composition	Miscellaneous
The region of Tarnowskie Góry:			
MK-6	Nakło	chalcophanite, psylomelane	
MK-7	Radzionków	chalcophanite, psylomelane	Specimens from the collection of the Wrocław University
The region of Bytom:			
MK-3	Scharley	chalcophanite, Mn-Pb phase	
MK-8	Scharley	chalcophanite, woodruffite (?), cerussite	
MK-9	Scharley	chalcophanite, hydrohetaerolite, Mn-Pb phase	
MK-97	Dąbrówka Wielka mine	chalcophanite, Mn-Pb phase	Samples collected from the fissures of triassic dolomite and galmei in the mines of the Bytom and Olkusz region
The region of Olkusz:			
MK-29	Olkusz mine	chalcophanite	

Chalcophanite is a hydrated Zn and Mn oxide with the formula $ZnMn_3O_7 \cdot 3H_2O$ (Wadsley 1955a). It crystallizes pseudotrigonally in the triclinic system, $C_1^1 - P\bar{1}$, and reveals a layered structure, the arrangement of which being Mn-O-Zn-H₂O-Zn-O-Mn. There are weak hydrogen bonds between the H₂O molecules and the atoms of O, which are interlaid between the layers of Mn and Zn atoms (Wadsley 1955a). Chalcophanite is a supergene mineral occurring, generally, in paragenesis with hydrohetaerolite, hetaerolite, woodruffite, hydrohausmannite, cesarolite, rancieite, and others (Hewett and Fleischer 1960, Frondel 1953).

It was first described by Moor (1875 *fide* Frondell, Heinrich 1942) in the Sterling Hill N.J. deposit as a product of the alteration of franklinite under supergene conditions. Later, this mineral was recorded in several other deposits, e.g. in Leadville, Colorado, in paragenesis with hetaerolite, in Janjevo near Pristin (Yugoslavia), in South-African deposits in paragenesis with psilomelane, in Bachani deposit (Victoria, Australia), in Tridiv in India, etc. Deshpande 1959, Villiers 1945, Vujanović 1954.

Chalcophanite from the weathering zone of the Silesian-Cracovian Zn-Pb deposits occurs, together with psilomelane, in the form of small tabular crystals, which have a strong lustre and are black-grey in colour. The crystals either form globular aggregates or are scattered in the cryptocrystalline, compact mass of psilomelane (museum samples MK-6 and MK-7 from the Tarnowskie Góry region) (Photos. 1, 2, 3). Chalcophanite has also been found in the form of fine crystals within the black, porous granular aggregates of Mn oxide minerals that occur together with cerussite on dolomite (museum samples MK-3, MK-8 and MK-9 from the region of Bytom) (Photos. 4, 5). Moreover, the detection of chalcophanite was permitted by X-ray examination of a black-brown, earthy substance that occurs in dolomite and galmei cavities in the mines of Dąbrówka Wielka (MK-97) and Olkusz (MK-29). Despite its small cohesion, this substance also reveals granular structure.

In reflected light, grey-white, well-crystallized chalcophanite aggregates having a tabular or lancet-like structure have been noticed in samples MK-6 and MK-7 from the Tarnowskie Góry region. They reveal strong anisotropy (close to that of graphite) in white, cream-yellow or blue colours and characteristically a very strong bireflectance (Photos. 1, 2). In some crystals perfect cleavage and frequent twinnings may be observed. Reflectance measurements were performed on well-developed chalcophanite crystals (MK-6 and MK-7) on the section || c axis, using an MPV photometer, with an attachment for reflected light, with a Leitz-Wetzlar ORTHOLUX-POL microscope. The data obtained are listed in Table 2 together with those of Pavlovich (v. Ramdohr 1960) and Uytenbogaardt and Burke (1972). The reflectance (R %) of chalcophanite was measured in air. In the museum samples, from the region of Bytom (MK-3, MK-8, MK-9), chalcophanite forms fine tabular and microcrystalline aggregates. It reveals strong anisotropy and characteristically a very strong bireflectance. The aggregates of chalcophanite are „cement” for

Table 2
Reflectance (R %) of chalcophanite in air

Wavelength in μm	Pavlovich (v. Ramdohr 1960)	Uytenbogaardt, Burke (1972)	Chalcophanite MK-6 and MK-7
550	$R_{max} = 30.0$ $R_{min} = 10.5$	$R_{max} = 27.3$ $R_{min} = 10.0$	$R_{max} = 29.5$ $R_{min} = 10.0$

the collomorphic concentrations of other Mn oxide minerals. In several cases the crystallization of chalcophanite also took place within these aggregates (Photos. 4, 5).

X-ray powder patterns (VEM apparatus, GDR) were taken for eight samples in 114.6 and 57.3 mm cammeras, using CoK α radiation ($\lambda =$

Table 3
X-ray data of chalcophanite from the Tarnowskie Góry region

Chalcophanite Sterling Hill ASTM, 7-174		Sample MK-6		Sample MK-7	
I	d (Å)	I	d (Å)	I	d (Å)
100	6,88	10	6,91	10	6,81
9	6,25	—	—	1	6,25
38	4,06	4	4,07	2	4,00
42	3,50	9	3,46	10	3,49
10	3,30	1	3,30	2	3,25
2	3,21	1	3,21	2	3,20
5	3,09	—	—	2	3,11
21	3,03	1	3,02	—	—
7	2,985	—	—	1	2,839
30	2,760	1	2,779	1	2,772
32	2,697	1	2,700	—	—
42	2,550	5	2,556	4	2,558
53	2,451	2	2,455	1	2,475
23	2,391	3	2,398	3	2,406
70	2,224	4	2,228	3	2,246
18	2,115	2	2,109	—	—
6	2,008	1	2,044	—	—
6	1,966	1	1,972	—	—
28	1,894	2	1,901	1	1,914
7	1,836	1	1,823	1	1,884
18	1,783	1	1,789	2	1,778
5	1,749	1	1,728	2	1,722
4	1,705	1	1,706	—	—
4	1,676	—	—	—	—
9	1,655	—	—	3	1,652
33	1,586	8	1,594	3	1,586
12	1,557	1	1,558	2	1,541
20	1,513	1	1,520	3	1,507
13	1,497	2	1,500	1	1,449
33	1,421	4	1,430	3	1,417
11	1,391	1	1,397	—	—
5	1,316	—	—	3	1,324
8	1,270	5	1,279	1	1,297
5	1,258	—	—	2	1,253
5	1,228	—	—	1	1,237

= 1.788896 Å) with an Fe filter, a voltage of 35 kV, a current of 10 μ A. In Table 3, d values of chalcophanite are listed. In the samples MK-6 and MK-7 psilomelane was also identified, but its reflections were omitted. X-ray patterns of some other samples (MK-8 and MK-9) indicate the presence of chalcophanite, hydrohetaerolite and the suspected presence of woodruffite (reflection 4.74 Å).

Chemical analyses of samples containing chalcophanite were performed by the method of atomic absorption spectroscopy, using a UNICAM SP-90 spectrophotometer. The H₂O content was calculated from a loss on ignition and checked by Penfield's method. The chemical composition of the examined samples are presented in Tables 4 and 5.

Table 4
Chemical composition of chalcophanite and the samples MK-6 and MK-7 from the Tarnowskie Góry region

Component	Chalcophanite Tabacimbi (Villiers 1945)	Chalcophanite Buchan (Wadsley 1950)	Chalcophanite Janjevo (Vujanović 1954)	Tarnowskie Góry region	
				MK-6 *	MK-7 **
MnO ₂	61,30	65,39	67,64	67,23	77,54
MnO	6,10	0,22	—	—	—
ZnO	17,10	18,19	18,60	18,43	11,88
PbO	—	—	—	—	0,11
BaO	—	—	—	0,45	0,47
FeO	—	—	0,60	—	—
Fe ₂ O ₃	1,90	0,32	—	0,28	0,05
SiO ₂	—	1,88	—	—	—
Al ₂ O ₃	0,30	0,39	—	—	—
H ₂ O	13,00	13,09	12,50	—	9,63
0,50					
Total	100,20	99,48	99,34	—	99,68

* Analysed by use of the electron microprobe X-ray analyser.

** Analysed by use of the AAS-method (psilomelane admixture).

In Table 4 the chemical composition of chalcophanite MK-7 from the Tarnowskie Góry region is compared with that of chalcophanite from Tabacimbi (Villiers 1945), Buchan (Wadsley 1950) and Janjevo (Vujanović 1954). Zn deficiency in sample MK-7 is probably due to the presence of psilomelane. The chemical composition of chalcophanite MK-6 from the Tarnowskie Góry region was also estimated by use of electron microprobe X-ray analyser. The analysis were performed on MS-46 CAMECA apparatus using MnO₂ and metallic Zn as standards. The obtained results are listed in Table 4 and Plate II.

Samples MK-3, MK-8, MK-9 and MK-97 from the region of Bytom in comparison with the samples from the Tarnowskie Góry region, are

Table 5

Chemical composition of the samples from the Bytom region containing chalcophanite

Component	MK-3	MK-8	MK-9	MK-97
MnO_2	68,36	49,53	53,65	59,50
ZnO	11,30	7,72	29,88	14,19
PbO	14,00	33,28	6,89	16,10
BaO	2,01	2,50	1,91	N.D.
Fe_2O_3	0,09	0,08	0,17	1,16
SiO_2	0,63	0,10	0,80	N.D.

Sample MK-8 contains cerussite and 0.20% As. Sample MK-9 contains 1.57% As

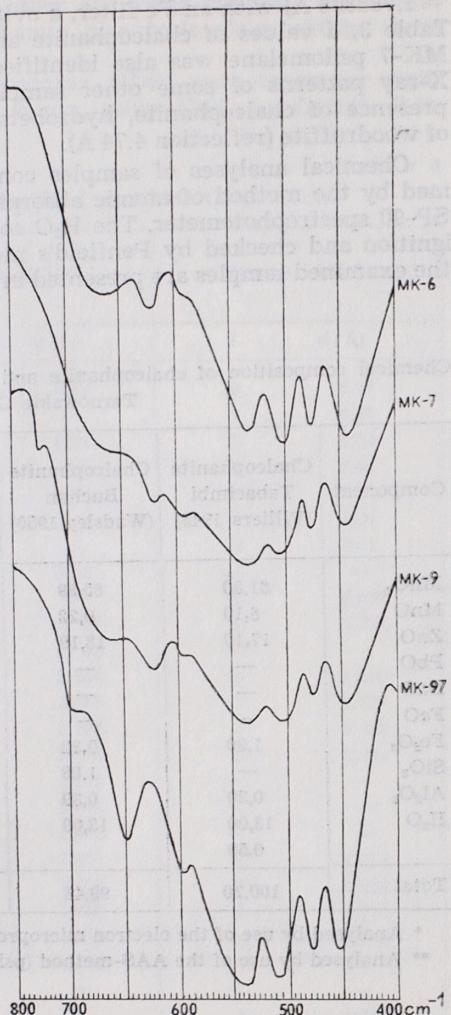


Fig. 1. Infra-red absorption of chalcophanite MK-6, MK-7 from the Tarnowskie Góry region, MK-9, MK-97 from the Bytom region

characterized by the content of Pb (Table 5). The presence of Pb in samples MK-8 is connected with cerussite and with the Mn—Pb oxide phase, the latter having been observed in reflected light. The content of Ba is connected with the presence of psilomelane (Phot. 3). Zn in the samples analysed is a component of chalcophanite, but it may also be partly connected with hydrohetaerolite (MK-9) and probably with woodruffite (MK-8).

The samples discussed were also subjected to infra-red spectrophotometric examinations using Zeiss UR-10 apparatus. The samples were prepared in the form of KBr disks (0.7—0.8 µg of substance + 300 µg of KBr).

Absorption spectra of chalcophanite MK-6 and a sample MK-7 containing chalcophanite and psilomelane are compared in Figure 1. In the range of wave numbers 400—700 cm⁻¹, six distinct bands may be distinguished on the absorption spectra. The position of their maxima is identical for both samples: 445, 475, 500, 530, 595 and 620 cm⁻¹. They are probably due to vibrations within the metal-oxygen groups in the chalcophanite network. The absorption maximum 1640 cm⁻¹, visible on the spectra, is caused by the bending vibrations of H_2O molecules.

Figure 1 shows also the absorption spectra of samples MK-9 and MK-97 from the region of Bytom, containing chalcophanite, besides other Mn oxide minerals. In the range of wave numbers 400—700 cm⁻¹ they show absorption bands similar to those of chalcophanite MK-6 from the Tarnowskie Góry region.

Two samples containing chalcophanite were subjected to thermal analyses (Fig. 2). On DTA curves some endothermic effects may be observed, the strongest one appearing in the range 120—260° with its maximum at 190° (sample MK-7). According to Wadsley (1950), this effect corresponds to the complete dehydration of chalcophanite. In this temperature range a 9.63% loss of weight was registered on the TG curve of sample MK-7. The other endothermic effects are connected with the presence of other minerals.

Upon heating, chalcophanite is transformed first into hydrohetaerolite and then into hetaerolite (Wadsley 1950). An X-ray patterns of the sample MK-7 heated to 1000° has shown the presence of hetaerolite (Tab. 6). The infrared absorption spectrum of the heated sample MK-7 is compared, in Figure 3, with the hetaerolite spectrum obtained after heating hydrohetaerolite MK-72 (Kulig 1973) from the Orzeł Biały mine, to 1000°, and with the spectrum of hausmannite, which is isostructural with hetaerolite. The positions of the absorption maxima of the two heated substances are similar, and correspond to the following wave numbers:

MK-72/1000°: 425, 495, 540, 610, 635, 665

MK-7/1000°: 430, 495, 535, 610, 635, 665 cm⁻¹,

which indicates the similar structure of their co-ordinating polyhedra. Compared with hausmannite, these substances seem to have a somewhat different structure.

Both the mode of chalcophanite occurrence in the weathering zone of the Silesian-Cracovian Zn—Pb deposits and the paragenesis of Mn oxide minerals, such as hydrohetaerolite, woodruffite (?), Mn—Pb mineral, psilomelane and cerussite, point to the supergene origin of chalcophanite (Hewett, Fleischer 1960). The analysed samples of Mn oxide minerals from the Silesian-Cracovian deposits represent the same type of dendrite-like granules with collomorphic inner structure but the degree of crystallinity of the individual minerals within the granules is different.

Acknowledgements: The author is indebted to the Management of Mineralogical Museum of the Wrocław University for the kind loan of specimens for study. Mgr M. Świercz from the Chemical Laboratory of the Bolesław mine the author wishes to thank for carrying out the chemical analyses (AAS) and Mrs. Dr. St. Jasieńska for

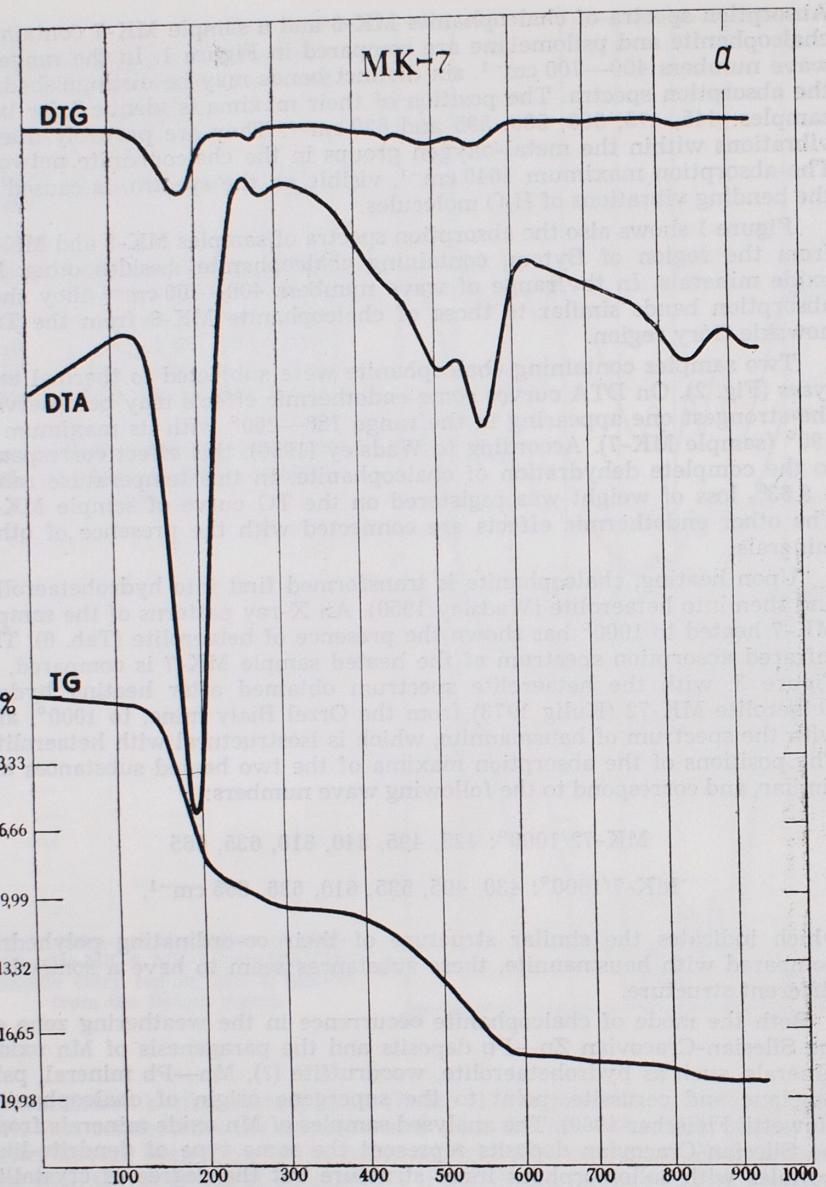


Fig. 2. Thermal curves of samples containing chalcophanite
a — sample MK-7 from the region of Tarnowskie Góry, b — sample MK-3 from the region
of Bytom

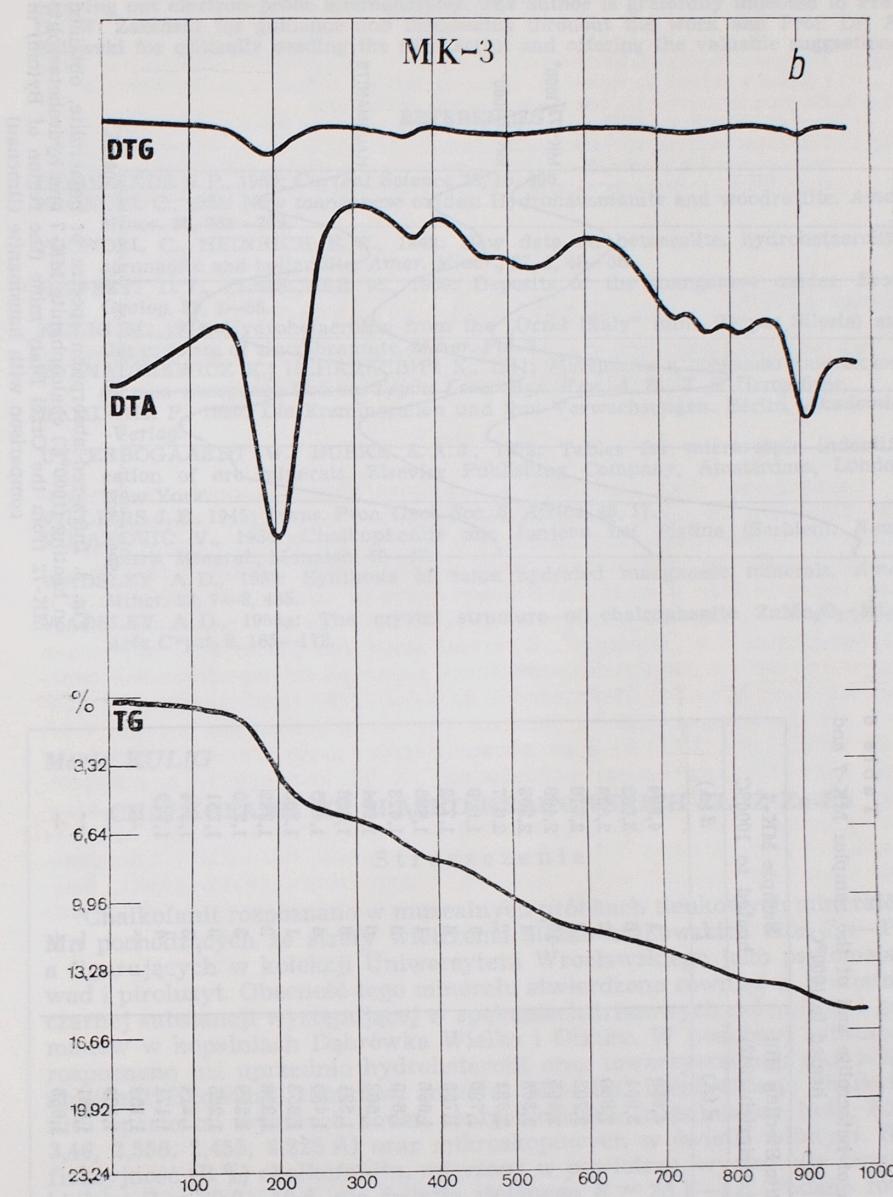


Fig. 2 (b)

Table 6
X-ray data of hetaerolite and of the samples MK-7 and
heated to 1000°C

Hetaerolite, Sterling Hill (Frondel, Heinrich 1942)		Sample MK-7 heated to 1000°C	
<i>I</i>	<i>d</i> (Å)	<i>I</i>	<i>d</i> (Å)
1	4,880	1	4,884
7	3,051	6	3,053
4	2,860	2	2,854
9	2,703	9	2,716
10	2,465	10	2,469
3	2,305	1	2,303
3	2,021	2	2,027
3	1,796	1	1,809
5	1,755	4	1,772
4	1,686	1	1,685
3	1,619	3	1,623
5	1,563	6	1,564
8	1,521	8	1,528
4	1,433	4	1,435
1	1,353	1	1,365
3	1,326	2	1,332
2	1,279	3	1,270
3	1,265	3	1,261
1	1,214	3	1,214
5	1,171	4	1,179
4	1,153	—	—
3	1,109	—	—
3	1,091	—	—
2	1,055	—	—

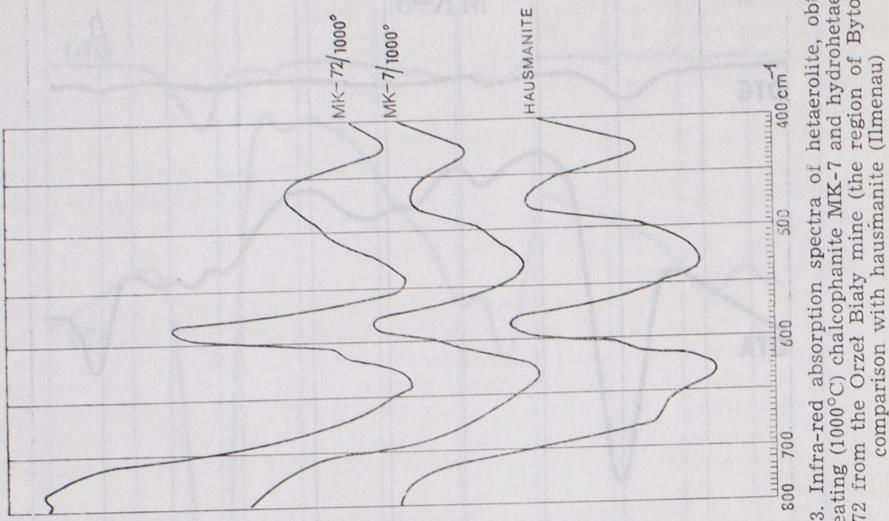


Fig. 3. Infrared absorption spectra of hetaerolite, obtained on heating (1000°C) chalcophanite MK-7 and hydrohetaerolite MK-72 from the Orzeł Biały mine (the region of Bytom) in comparison with hausmanite (Ilmenau)

carrying out electron-probe microanalyses. The author is gratefully indebted to Prof. Dr. W. Zabiński for guidance and discussions throughout the work and Prof. Dr. A. Bolewski for critically reading the manuscript and offering the valuable suggestions.

REFERENCES

- DESHPANDE S. P., 1959: Current Science 28, 10, 406.
FRONDEL C., 1953: New manganese oxides: Hydrohausmanite and woodruffite. Amer. Miner. 38, 761—769.
FRONDEL C., HEINRICH E. W., 1942: New data on hetaerolite, hydrohetaerolite, coronadite and hollandite. Amer. Miner., 27, 1, 48—56.
HEWETT D. T., FLEISCHER M., 1960: Deposits of the manganese oxides. Econ. Geol. 55, 1—55.
KULIG M., 1974: Hydrohetaerolite from the „Orzeł Biały” mine (Upper Silesia) and the problem of zincdibraunite. Miner. Pol. 3.
[NIENADKIEWICZ K.] НЕНАДКЕВИЧ К., 1911: Материалы к познанию химического состава минералов России. Труды Геол. Муз. Имп. А. Н., Т. 5. Петербург.
RAMDOHR P., 1960: Die Erzmineralien und ihre Verwachsungen. Berlin, Akademie-Verlag.
UYTENBOGAARDT W., BURKE E. A. J., 1972: Tables for microscopic identification of ore minerals. Elsevier Publishing Company, Amsterdam, London, New York.
VILLIERS J. E., 1945: Trans. Proc. Geol. Soc. S. Africa, 48, 17.
VUJANOVIĆ V., 1954: Chalkophanite aus Janjevo bei Pistina (Serbien). Neues Jahrb. Mineral., Monatsh. 40—47.
WADSLEY A. D., 1950: Synthesis of some hydrated manganese minerals. Amer. Miner. 33, 7—8, 485.
WADSLEY A. D., 1955a: The crystal structure of chalkophanite $ZnMn_8O_7 \cdot 3H_2O$. Acta Cryst. 8, 165—172.

Maria KULIG

CHALKOFANIT ZE ŚLĄSKO-KRAKOWSKICH ZŁOŻ Zn-Pb

Streszczenie

Chalkofanit rozpoznano w muzealnych próbkach tlenkowych mineralów Mn pochodzących ze strefy wietrzenia śląsko-kraowskich złóż Zn—Pb, a figurujących w kolekcji Uniwersytetu Wrocławskiego jako psylomelan, wad i piroluzyt. Obecność tego minerału stwierdzono również w brunatno-czarnej substancji występującej w spekaniach triasowych dolomitów i galmanów w kopalniach Dąbrówka Wielka i Olkusz. W podobnej substancji rozpoznano już uprzednio hydroheterolit oraz towarzyszącemu mu, bliżej niezidentyfikowany, tlenkowy minerał Mn—Pb. Identyfikację chalkofanitu oparto na wynikach badań rentgenowskich (najśilniejsze linie: 6,91, 3,46, 2,556, 2,455, 2,228 Å) oraz mikroskopowych w świetle odbitym. Reaktywność (R %) chalkofanitu, mierzona w powietrzu, wynosi: dla światła białego $R = 30,0—10,5$, dla światła zielonego $R = 28,1—9,6$. Podano również wyniki badań termicznych (silny efekt endotermiczny z maksimum 190—200°C) oraz spektrofotometrycznych w podczerwieni wszystkich próbek zawierających chalkofanit. Stwierdzono, że podczas prażenia chalkofanit przechodzi stopniowo w hydroheterolit, a następnie w heterolit.

OBJAŚNIENIA FIGUR

- Fig. 1. Fragment widma spektrofotometrycznego w podczerwieni chalkofanitu MK-6 i MK-7 z rejonu Tarnowskich Górz oraz MK-9 i MK-97 z rejonu Bytomia
- Fig. 2. Krzywe termiczne próbek zawierających chalkofanit
a — próba MK-7 z rejonu Tarnowskich Górz, b — próba MK-3 z rejonu Bytomia
- Fig. 3. Fragment widma spektrofotometrycznego w podczerwieni heterolitu uzyskanego w wyniku prażenia do 1000°C próbek chalkofanitu MK-7 (rejon Tarnowskich Górz) i hydroheterolitu MK-72 (rejon Bytomia) oraz hausmanitu (Ilmenau)

Мария КУЛИГ

ХАЛЬКОФАНИТ ИЗ СИЛЕЗСКО-КРАКОВСКИХ СВИНЦОВО-ЦИНКОВЫХ МЕСТОРОЖДЕНИЙ

Резюме

Халькофанит был определен в музейных образцах окисных минералов марганца из зоны гипергенеза Силезско-Краковских свинцово-цинковых месторождений, находящихся в коллекции Вроцлавского университета в качестве псиломелана, вада и пиролюзита. Кроме того, указанный минерал был выявлен в буровато-черном веществе, запалняющем трещины в триасовых доломитах и галмейной руде в рудниках „Домбрувка-Велька” и „Олькуш”. В таком веществе ранее был определен гидрогетеролит и сопровождающий его, детально не определенный окисный минерал Mn—Pb. Определение халькофанита основывается на данных рентгеноспектрального анализа (самые интенсивные линии: 6.91, 3.46, 2.556, 2.455, 2.228 Å) и микроскопического исследования в отраженном свете. Отражательная способность ($R \%$) халькофанита, измеряемая в воздухе, составляет: для белого света $R = 30,0 — 10,5$, для зеленого света $R = 28,1 — 9,6$. Приводятся результаты термического анализа (сильный эндотермический эффект с максимумом 190—200°) и инфракрасного спектрального анализа всех образцов, содержащих халькофанит. Констатировано, что при прокаливании халькофанит переходит постепенно в гидрогетеролит, а затем в гетеролит.

ОБЪЯСНЕНИЯ К ФИГУРАМ

- Фиг. 1. Часть ИК-спектра халькофанита MK-6 и MK-7 из района Тарновске-Гуры и MK-97 из района Бытома
- Фиг. 2. Термические кривые образцов, содержащих халькофанит
a — образец MK-7 из района Тарновске-Гуры, b — образец MK-3 из района Бытома
- Фиг. 3. Часть ИК-спектра гетеролита, полученного в результате прокаливания до 1000°C образцов халькофанита MK-7 (район Тарновске-Гуры), гидрогетеролита MK-72 (район Бытома) и гаусманита (Ильменау)

PLATE I (PLANSZA I, ТАБЛИЦА I)

Phot. 1. Aggregate of plate, lancet-like crystals of chalcophanite MK-6 from the Tarnowskie Góry region. Scanning electron micrograph, enlarged 3000 \times , Jeol ISM-S1

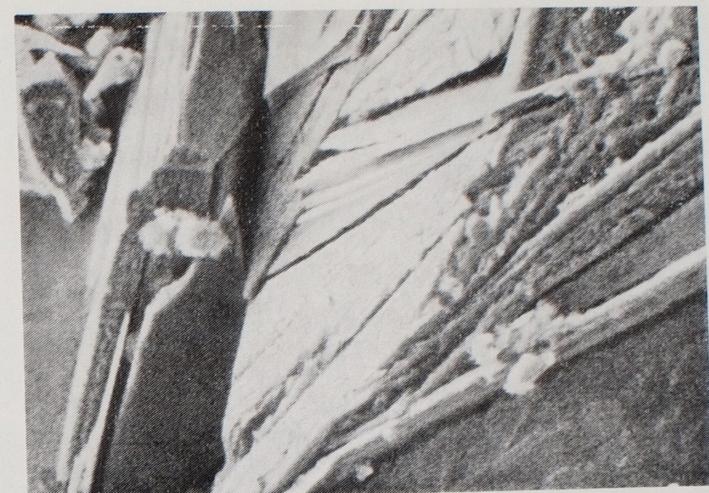
Chalkofanit MK-6 z rejonu Tarnowskich Górz. Agregat płytowych kryształów. Mikroskop skanningowy Jeol ISM-S1, pow. 3000 \times

Халькофанит MK-6 из района Тарновске-Гуры. Агрегат пластинчатых кристаллов. Сканинг-микроскоп Jeol ISM-S1, увел. 3000 \times

Phot. 2. Chalcophanite MK-6 from the Tarnowskie Góry region. Reflected light, enlarged 125 \times

Chalkofanit z rejonu Tarnowskich Górz. Światło odbite, pow. 125 \times

Халькофанит MK-6 из района Тарновске-Гуры. Отраженный свет, увел. 125 \times



Phot. 1

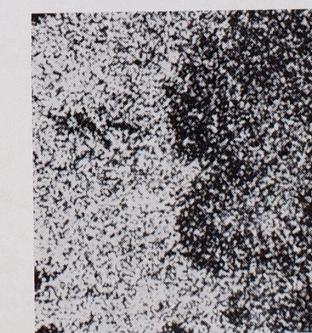
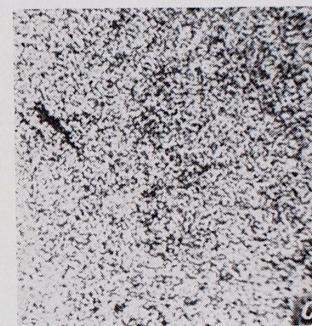


Phot. 2

Maria KULIG — Chalcophanite from the Silesian Cracovian Zn—Pb deposits

PLATE II (PLANSZA II, ТАБЛИЦА II)

Phot. 3. Sample MK-6 from the Tarnowskie Góry region. Chalcophanite and colloform aggregate of psilomelane. Electron-probe microanalyse, CAMECA MS-46
 a — image of secondary electrons (topography) $300 \times 300 \mu$; b — image of absorbed electrons $300 \times 300 \mu$; c-f — Mn—K_a, Zn—K_a, O—K_a Ba—K_a X-ray microprobe images $300 \times 300 \mu$
 Próbka MK-6 z rejonu Tarnowskich Górz. Chalkofanit i kolomorficzne skupienia psylomelanu. Analiza rentgenospektralna w mikroobszarze. CAMECA MS-46
 a — elektronowy obraz topograficzny $300 \times 300 \mu$; b — elektronowy obraz absorpcyjny $300 \times 300 \mu$; c-f — Obrazy rozmieszczenia Mn—K_a, Zn—K_a, O—K_a, Ba—K_a w mikroobszarze $300 \times 300 \mu$
 Образец MK-6 из района Тарновске-Гуры. Халькофанит и колломорфные скопления псиломелана. Рентгеноспектральный анализ микроучастка. САМЕСА MS-46
 a — электронный топографический вид $300 \times 300 \mu$, b — электронный образ поглощения $300 \times 300 \mu$; c-f — виды распределения Mn—K_a, Zn—K_a, O—K_a, Ba—K_a на микроучастке $300 \times 300 \mu$



Phot. 3

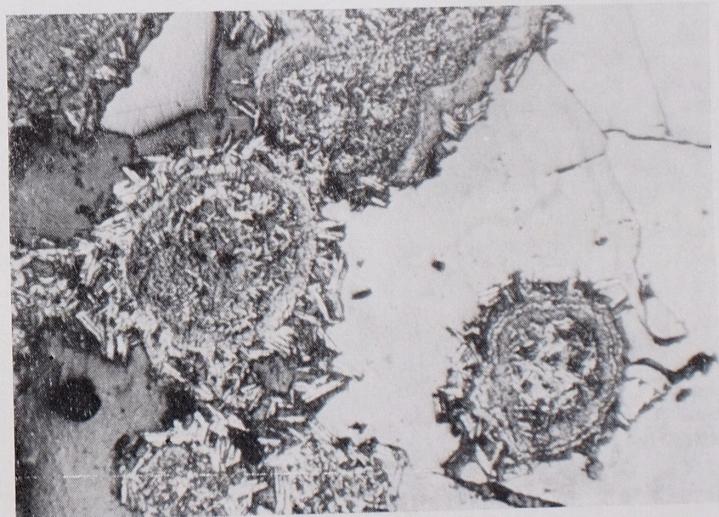
Maria KULIG — Chalcophanite from the Silesian Cracovian Zn—Pb deposits

PLATE III (PLANSZA III, ТАБЛИЦА III)

- Phot. 4. Chalcophanite MK-3 from the Bytom region. Aggregate of platy crystals. Scanning electron micrograph, enlarged 3000 \times , Jeol ISM-S1
 Chalkofanit MK-3 z rejonu Bytomia. Mikroskop skanningowy Jeol ISM-S1, pow. 3000 \times
 Халькофанит MK-3 из района Бытома. Агрегат пластинчатых кристаллов. Сканирующий микроскоп Jeol ISM-S1, увел. 3000 \times
- Phot. 5. Chalcophanite MK-8 from the Bytom region. Microcrystalline aggregates among psilomelane. Reflected light, enlarged 125 \times
 Chalkofanit MK-8 z rejonu Bytomia. Mikrokrystaliczne skupienia wśród psylomelanu. Światło odbite, pow. 125 \times
 Халькофанит MK-8 из района Бытома. Мелкокристаллические скопления в псиломелане. Отраженный свет, увел. 125 \times



Phot. 4



Phot. 5

Maria KULIG — Chalcophanite from the Silesian Cracovian Zn—Pb deposits