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CHROMBISMITE, $Bi_{16}CrO_{27}$, A NEW MINERAL SPECIES FROM THE JIALU GOLD MINE, SHAANXI PROVINCE, CHINA

ZHOU XINCHUN

The 14th Branch Team for Gold Exploration, Changan 710100, Shaanxi Province, China

YAN JINCAI

Department of Geology, Northwest University, Xi'an 710069, China

WANG GUANXIN

Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Wushan 510640, Guangzhou, China

WANG SHIZHONG

The 14th Branch Team for Gold Exploration, Changan 710100, Shaanxi Province, China

LIU LIANG

Department of Geology, Northwest University, Xi'an 710069, China

SHU GUIMING

Department of Geology, Beijing University, Beijing 100871, China

Abstract

Chrombismite, ideally $Bi_{16}CrO_{27}$, is a new mineral species that occurs as isolated crystals about 2 × 5 to 25 × 50 μm in size or as fine-grained aggregates about 10 to 500 μm in quartz veins in the Jialu gold mine, Luonan County, Shaanxi Province, China. The mineral is orange to brown in color, translucent, brittle, tetragonal [*a* 8.469(3), *c* 17.24(1) Å, *V* 1289.6(6) Å^3], $Z = 2$, without distinct cleavage. Its hardness is greater than 3, and its density, 9.85 g/cm^3 on the basis of the empirical formula. The strongest six lines in the X-ray powder pattern [*d* in Å(I)(*hkl*)] are: 3.19(100)(123), 2.730(40)(310), 1.980(40)(316), 1.715(30)(219), 1.655(55)(503,433) and 1.124(25)(53). The name refers to the main elements present.

Keywords: chrombismite, new mineral species, bismuth chromium oxide, Jialu gold mine, Luonan County, Shaanxi Province, China.

Sommaire

La chrombismite, de composition idéale $Bi_{16}CrO_{27}$, est une nouvelle espèce minérale découverte en cristaux isolés mesurant entre 2 × 5 et 25 × 50 μm ou en agrégats à granulométrie fine d'environ 10 à 500 μm dans des veines de quartz veins du gisement d'or de Jialu, comté de Luonan, province de Shaanxi, en Chine. Il s'agit d'un minéral orange à brun, translucide, cassant, tétragonal [*a* 8.469(3), *c* 17.24(1) Å, *V* 1289.6(6) Å^3], $Z = 2$, sans clivage distinct. Sa dureté dépasse 3, et sa densité serait 9.85 en supposant la formule empirique. Les six raies les plus intenses du spectre de diffraction X [*d* en Å(I)(*hkl*)] sont: 3.19(100)(123), 2.730(40)(310), 1.980(40)(316), 1.715(30)(219), 1.655(55)(503,433) et 1.124(25)(53). Le nom rappelle les éléments essentiels qui sont présents.

(Traduit par la Rédaction)

Mots-clés: chrombismite, nouvelle espèce minérale, oxyde de bismuth et de chrome, gisement d'or de Jialu, comté de Luonan, province de Shaanxi, Chine.

Introduction

Synthetic $Bi_{16}CrO_{27}$ was originally described in 1983 by Zhitomirskii *et al.* Their account enabled us to establish its identity with material found at the Jialu gold mine, Luonan County, Shaanxi Province, China (Lat. 34°22′22″ – 34°23′48″N, Long. 110°07′35″ – 110°11′18″E). The name *chrombismite* refers to the main elements present in the mineral. The mineral and mineral name have been approved by the Commission on New Minerals and Mineral Names, IMA. The holotype specimen of chrombismite is stored in the Geological Museum of China, Beijing.

Occurrence

The Jialu gold mine, located in the southwestern part of the well-known Xiao Qinling gold belt, is hosted by an Archean metamorphic complex consisting mainly of biotite–amphibole gneiss, amphibole–biotite gneiss, amphibole–plagioclase gneiss, gneissoid migmatite and amphibolite. Gold-bearing sulfide–quartz veins are the main type of mesothermal gold mineralization. Chrombismite is a rare constituent of the quartz veins; it is associated most closely with quartz, pyrite, chalcopyrite and gold (Fig. 1), and thus a primary phase.

Properties

Physical and optical properties

Chrombismite varies from orange to yellowish brown in hand specimens and thin sections. It shows an adamantine luster, a brownish yellow streak, translucency and very weak pleochroism. The hardness ranges from 95.8 to 128.0 (mean: 113.3), as determined with an ORTHOLUX2–POL microhardness tester with a load of 100 g. No distinct cleavages were observed. The density is 9.80(3) g/cm^3 measured by the micro-specific gravity method, and the calculated density, on the basis of the empirical formula, is 9.85(1) g/cm^3. In polished sections, it is gray to light orange in color, with orange internal reflections, very weak bireflectance and anisotropy.

Chrombismite is uniaxial positive, with $n_\varepsilon = 2.55(2)$, $n_\omega = 2.50(2)$. The indices of refraction were measured in a SeS melt (index of refraction: 1.98 – 2.70). Values of reflectance from 400 to 700 nm were measured against a SiC reflectance standard with a Leitz MPV–3 microphotometer. Reflectance values are given in Table 1.

Chemical composition

Fifteen crystals of chrombismite were analyzed with an EPM–8100 electron microprobe; analytical conditions were 10 kV, 10 mA. The following standards were used: pure bismuth (Bi), crocoite (Cr), wollastonite (Ca), corundum (Al), and downeyite (O). The results are given in Table 2. The average of these analyses gave 87.23 wt.% Bi, 1.35 wt.% Cr and 11.27 wt.% O, as well as minor Ca (CaO 0–0.07%) and Al (Al_2O_3 0–0.04%). The empirical formula is $Bi_{16.006}Cr_{0.997}O_{27}$ (based on 27 atoms of oxygen). The ideal formula is $Bi_{16}CrO_{27}$.

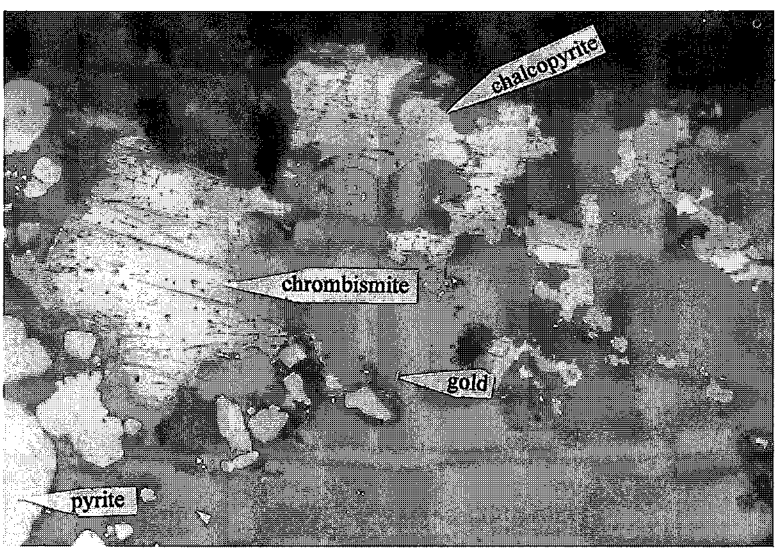

FIG. 1. Relationship of grains of chrombismite to grains of chalcopyrite, pyrite and gold. Width of the field of view: 0.12 mm.

The valences of Cr and Bi in chrombismite were determined by X-ray photoelectron spectroscopy (PH5300 instrument), with Mo$K\alpha$ radiation at 12.5 kV, 20 mA (Table 3). Values of the binding energy were calibrated by the chemical ionization spectroscopy (CIS) method (the binding energy of CIS is set to be equal to 284.6 eV). The results show that the valence of Cr is 6+, and that of Bi is 3+.

TABLE 1. REFLECTANCE DATA FOR CHROMBISMITE

λ (nm)	Re'(%)	Ro(%)	λ (nm)	Re'(%)	Ro(%)
400	—	—	560	28.7	25.8
420	21.9	16.3	580	29.8	26.1
440	22.9	19.9	589	29.8	26.2
460	21.4	19.5	600	29.3	26.3
470	21.4	19.4	620	29.4	27.1
480	21.9	20.1	640	30.2	26.5
500	23.7	21.6	650	29.9	25.9
520	25.3	23.6	660	29.1	25.6
540	27.1	24.2	680	28.3	24.8
546	27.5	25.2	700	27.7	24.7

TABLE 2. ELECTRON-MICROPROBE DATA FOR CHROMBISMITE

No.	Bi	Cr	O	Total
1	87.1	1.2	11.1	99.4
2	87.5	1.2	11.2	99.9
3	87.7	1.2	11.2	100.1
4	87.0	1.2	11.1	99.3
5	87.2	1.4	11.3	99.9
6	87.2	1.5	11.5	100.2
7	87.1	1.5	11.4	100.0
8	87.1	1.5	11.4	100.0
9	86.6	1.3	11.1	99.0
10	87.6	1.4	11.4	100.4
11	87.1	1.3	11.2	99.6
12	87.3	1.4	11.3	100.0
13	87.1	1.5	11.4	100.0
14	87.2	1.3	11.2	99.7
15	87.6	1.3	11.3	100.2
Average	87.23	1.35	11.27	99.85

Compositions are expressed in weight %.

TABLE 3. RESULTS OF X-RAY PHOTOELECTRON SPECTROSCOPIC ANALYSIS OF CHROMBISMITE

Elements	Energy (eV)	Chrom-bismite	Synthetic K_2CrO_4	Reference values*
Cr 2p	binding	579.8	579.2	Cr^{3+} 579.3
	kinetic	673.8	674.4	674.3
Bi 4f	binding	160.5		Bi^{3+} 159.7
	kinetic	1093.1		1093.9

* Wagner et al., (1979).

CRYSTALLOGRAPHY

Crystal habit

Chrombismite appears as isolated crystals or fine-grained aggregates in the quartz veins. Individual crystals have a columnar or acicular habit, with a size ranging from 2 × 5 μm to 25 × 50 μm. Its aggregates are spherical or irregular, and vary from 10 to 500 μm across, and even up to 1–1.5 mm.

X-ray powder-diffraction data

The data for chrombismite were obtained with a Debye–Scherrer camera 57.3 mm in diameter, with Fe$K\alpha$ radiation. The pattern was indexed by analogy with information on synthetic $Bi_{16}CrO_{27}$ (PDF 37–958). The strongest six lines of the X-ray powder-diffraction pattern, in order of decreasing intensity (d in Å), are: 3.19, 2.730, 1.980, 1.715, 1.655 and 1.124 (Table 4). We have established that chrombismite is tetragonal, probable space-group $I\bar{4}$, $I4$ or $I\bar{4}/m$, and that its unit-cell parameters are: a 8.649(3), c 17.24(1) Å, with c/a = 1.9933. The unit-cell volume of chrombismite is 1289.6(6) Å^3, $Z = 2$.

The crystallography and powder-diffraction data of chrombismite are similar to those of synthetic $Bi_{16}CrO_{27}$ (Table 5), except for differences in the intensity of high d-values because of the different

TABLE 4. X-RAY POWDER-DIFFRACTION DATA FOR CHROMBISMITE

Intensity	d_{meas}(Å)	d_{calc}(Å)	*hkl*	I	d_{meas}(Å)	d_{calc}(Å)	*hkl*
100	3.19	3.209	123	2	1.452	1.453	2111
10	2.870	2.874	006	2	1.433	1.437	0012
40	2.730	2.735	310	5	1.364	1.364	2012
2	2.610	2.607	312	20	1.284	1.284	439
5	2.494	2.494	224	18	1.270	1.272	3112
40	1.980	1.981	316	15	1.255	1.256	4111
20	1.932	1.934	420	10	1.233	1.235	626
2	1.837	1.843	334	8	1.220	1.221	538
2	1.766	1.765	424,228	15	1.152	1.153	4212
30	1.715	1.717	219	25	1.124	1.124	5310
5	1.692	1.693	318	15	1.104	1.104	707,549
55	1.655	1.656	503,433	15	1.069	1.070	639
15	1.604	1.604	426	25	1.054	1.054	3314
10	1.595	1.596	309	10	0.990	0.991	6212

TABLE 5. COMPARISON OF CHROMBISMITE AND SYNTHETIC $Bi_{16}CrO_{27}$

	Chrombismite	Synthetic $Bi_{16}CrO_{27}$
Symmetry	tetragonal	tetragonal
Space Group	I4,I$\bar{4}$ or I4/m	I4/*
a (Å)	8.649(3)	8.677(4)
c (Å)	17.24(1)	17.21(1)

experimental methods. The crystal structure of chrombismite has not been determined, as there are no good single crystals, and even powder samples are difficult to obtain.

Discussion of the Conditions of Formation

Zhitomirskii *et al.* (1983) obtained crystalline $Bi_{16}CrO_{27}$ by burning pure Bi_2O_3 and Cr_2O_3 at 700°C for three hours or 800°C for one hour in an alkaline hydrothermal solution, and studied how the variation of temperature affects the unit-cell parameters from 30 to 600°C in air. This information helps to constrain the upper-temperature limit of chrombismite formation (800°C), and the lower-temperature limit (30°C) of its stable existence in geological conditions. These values are judged useful in a discussion of its genesis.

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