

CAMERONITE, A NEW COPPER-SILVER TELLURIDE FROM THE GOOD HOPE MINE, VULCAN, COLORADO

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ABSTRACT

Cameronite, a new mineral species, is a rare constituent of three museum specimens of tellurium-bearing ore from the Good Hope mine, Vulcan, Colorado. Associated metallic minerals are native tellurium; rickardite, vulcanite, arsenopyrite and pyrite. Cameronite is opaque, grey and metallic; in hand specimen it physically resembles tetrahedrite. It is brittle, possesses a subconchoidal fracture, a black streak and no observable cleavage. Masses of cameronite up to 2 mm by 2 mm are known. Individual grains are anhedral, equidimensional and average about 200 μm in diameter. Cameronite is slightly birefractant and is pleochroic from pale grey to pale brownish grey; it is distinctly anisotropic with medium grey to slate-grey to brownish grey rotation-tints. Measured reflectance values for 6 grains in air and oil are tabulated. VHN_{100} 163 (range 150-173), VHN_{200} 160 (range 151-172); calculated Mohs hardness $3\frac{1}{2}$ - 4. Averaged electron-microprobe data yield the chemical formula $\text{Cu}_{7.10}\text{Ag}_{1.09}\text{Te}_{10}$, calculated on the basis of 10 Te atoms or, ideally, $\text{Cu}_7\text{AgTe}_{10}$. The mineral is tetragonal, space group $P4_2/mmc$, $P4_2/mc$ or $P4_2c$ (diffraction aspect $P4/**c$) with unit-cell parameters: a 12.695(2), c 42.186(6) Å, V 6798.8(3.1) Å³, c/a 3.323. With $Z = 16$, the calculated density is 7.144 g/cm³. A pronounced subcell has $a' = a/3 = 4.232$, $c' = c/7 = 6.027$ Å. The strongest five reflections of the X-ray powder pattern [d in Å(hkl)] are: 3.45(100)(307), 2.118(100)(3314, 600), 1.804(60)(637), 1.377(40)(6321, 907) and 1.222(40)(9314). The name honors Eugene N. Cameron, who first realized that the mineral is a new species.

Keywords: cameronite, new mineral species, Good Hope mine, Vulcan, Colorado, electron-microprobe analyses, reflectance data, X-ray data.

SOMMAIRE

La cameronite, nouvelle espèce minérale, est un constituant rare de trois échantillons de musée d'un minéral de tellure de la mine Good Hope, à Vulcan, au Colorado. Les minéraux métalliques qui lui sont associés sont tellure natif, rickardite, vulcanite, arsénopyrite et pyrite. La cameronite est opaque, grise et cassante et se caractérise par un éclat

métallique, un trait noir et une cassure subconchoïdale; aucun clivage n'a été observé. Les échantillons macroscopiques ressemblent physiquement à la tétraédrite. On a trouvé des masses de cameronite atteignant 2 mm sur 2 mm. Chaque grain est allotrimorphe, équidimensionnel et d'un diamètre moyen d'environ 200 μm . Le minéral est faiblement biréfléctant et pléochroïque, gris pâle à gris brunâtre pâle; il est manifestement anisotrope, les teintes de rotation allant du gris moyen au gris ardoise et au gris brunâtre. Les données de réflectance pour six grains dans l'air et dans l'huile sont présentées sous forme de tableau. VHN_{100} 163 (de 150 à 173), VHN_{200} 160 (de 151 à 172). La dureté Mohs calculée est de $3\frac{1}{2}$ à 4. La moyenne des analyses à la microsonde électronique donne la composition $\text{Cu}_{7.10}\text{Ag}_{1.09}\text{Te}_{10}$, calculée pour dix atomes de Te, soit une composition idéale de $\text{Cu}_7\text{AgTe}_{10}$. La cameronite est tétragonale, de groupe spatial $P4_2/mmc$, $P4_2/mc$ ou $P4_2c$ (aspect de diffraction $P4/**c$); les paramètres de la maille sont a 12.695(2), c 42.186(6) Å, V 6798.8(3.1) Å³, c/a = 3.323. La masse spécifique calculée pour $Z = 16$ est de 7.144 g/cm³. Une maille sous-multiple prononcée donne $a' = a/3 = 4.232$ Å et $c' = c/7 = 6.027$ Å. Les cinq raies les plus intenses du cliché de poudre obtenu par diffraction X [d en Å(hkl)] sont: 3.45(100)(307), 2.118(100)(3314, 600), 1.804(60)(637), 1.377(40)(6321, 907) et 1.222(40)(9314). Le nom honore Eugene N. Cameron, qui identifia le minéral comme espèce nouvelle.

Mots-clés: cameronite, nouvelle espèce minérale, mine Good Hope, Vulcan, Colorado, analyses à la microsonde électronique, données de réflectance, données de rayons X.

INTRODUCTION

Cameronite, ideally $\text{Cu}_7\text{AgTe}_{10}$, is a newly defined mineral species from the Good Hope mine, Vulcan, Colorado. This mineral was originally identified and partially characterized by Cameron & Threadgold (1961) in their paper on the mineral species *vulcanite*. In their study, they examined specimens number R-933 (Smithsonian Institution, Roebling Collection). They reported qualitative optical properties and qualitative microchemical tests that indicated the presence of Cu and Te. Incomplete

single-crystal studies suggested hexagonal symmetry. Unfortunately, no numerical powder nor single-crystal data were published, and insufficient material precluded further characterization at that time.

In 1974, one of us (W.W.P.) obtained, on exchange from the Smithsonian Institution, Washington, D.C., a specimen of rickardite with native tellurium from the Good Hope mine. The specimen, which bears Roebing Collection number R-934 and measures about $3.0 \times 2.5 \times 1.5$ cm, consists of rich cleavage plates of native tellurium, masses of reddish-violet-colored rickardite, and bronze-colored vulcanite and centimetre-sized elongate crystals of arsenopyrite. In addition, several millimetre-sized areas of a grey metallic phase that physically resembles tetrahedrite are closely associated with the rickardite and vulcanite. Subsequent mineralogical study has shown that this grey phase is the same as that described by Cameron & Threadgold (1961).

Thirty rickardite- and native-tellurium-bearing mineral specimens from the Good Hope mine were examined by optical microscopy prior to the completion of this study, but only four were found to contain visible amounts of cameronite. On these four specimens the mineralization appears to be identical; native tellurium with associated dark altered areas of fragmented rock cemented together by the secondary tellurides rickardite, vulcanite and cameronite as well as pyrite and, locally, elongate crystals of arsenopyrite. The largest cameronite-bearing specimen was broken in half, and the pieces designated as P-100 and P-101. All polished sections were cut from (and subsequent mineralogical study undertaken on) P-101, which now measures $3.0 \times 3.0 \times 2.5$ cm.

Cameronite is named after Dr. Eugene N. Cameron, Professor Emeritus at the Department of Geology and Geophysics, University of Wisconsin, Madison, Wisconsin, U.S.A., for his contributions to the science of ore mineralogy. He and Threadgold were the first to report the mineral as a potentially new species. The mineral and the mineral name have been approved by the Commission on New Minerals and Mineral Names, I.M.A. Type material, consisting of two polished sections and several mineral fragments, is preserved within the Systematic Reference Series of the National Mineral Collection at the Geological Survey of Canada, Ottawa under catalogue number NMC 64596 and in polished sections, BM1984, 356, E.1000 and R-933 at the British Museum (Natural History), London. The bulk of the cameronite-bearing material, including the hand specimens (R-934, P-100 and P-101) and one polished section (R-933), forms part of the collection at the Pinch Mineralogical Museum, Rochester, New York. The Smithsonian Institution has one polished section (162713), and E.N. Cameron has one small piece.

PHYSICAL PROPERTIES

In hand specimen, cameronite is opaque, metallic with a grey color that resembles that of tetrahedrite. It is brittle, with a distinctive subconchoidal fracture; it possesses a black streak. No evidence of cleavage was detected. Masses of cameronite up to 2×2 mm have been observed in the hand specimens. In polished section, individual grains are anhedral, equidimensional and average slightly more than 200 μm in diameter. There was insufficient pure material for a measurement of specific gravity by Berman balance.

Microhardness measurements were made with a Leitz Miniload 2 tester. The range for VHN₁₀₀ from 11 indentations is 150–173, the mean 163. The range for VHN₂₀₀ from 17 indentations is 151–172, mean 160. All indentations had perfect square outlines with only slight fracturing at the corners. The calculated Mohs hardness is in the range $3\frac{1}{2}$ to 4.

QUALITATIVE OPTICAL PROPERTIES

The optical properties of cameronite, then an unknown mineral, were originally described by Cameron & Threadgold (1961). Our observations of the appearance of the mineral in air are in accord with theirs. In plane-polarized light, with an unfiltered quartz-halogen lamp (at 3000–3200 K), cameronite is slightly bireflectant and pleochroic from pale grey (higher *R*) to pale brownish grey. Between crossed polars it is distinctly anisotropic. The sequence of rotation tints is medium grey to slate-grey to grey with a brownish tint. When the analyzer is uncrossed by 3° , these change to light bluish grey to purplish grey to a rich golden brown. None of the grains is twinned. When immersed in oil, and in plane-polarized light, the bireflectance and reflectance pleochroism are subjectively more pronounced than in air, from a clear pale grey to pale brownish grey. The anisotropy remains distinct, with mid-grey to light grey to purplish grey rotation-tints. With the analyzer uncrossed by 3° , the sequence is dark grey to bluish grey to mid-grey to dark brown to light brown.

QUANTITATIVE OPTICAL DATA

Specimen preparation, equipment and conditions of measurement for the data reported herein were identical to those described by Criddle *et al.* (1983). In all, the reflectance spectra of six grains were measured at the British Museum; 3 from each of the polished sections, BM 1984, 356, E.1000 and R-933. Initially, measurements were made on the cleaned surfaces of sections as received from Canada. The results were consistent and reproducible. Experience with the other known Cu-Ag telluride, henryite, had shown that after polishing, its reflectance slowly

increased. This was associated with a slight change in the dispersion of its reflectance (Criddle *et al.* 1983). For this reason, both sections were ground lightly and repolished, and measurements were

repeated immediately on the grains originally measured. In this instance their reflectances showed a consistent increase of about 1% throughout the spectrum. These are the data reported in Table 1.

TABLE 1. REFLECTANCE DATA FOR CAMERONITE

nm	R_o						R'_e					
	1	2	3	4	5	6	1	2	3	4	5	6
400	23.7	23.3	24.4	23.9	23.6	23.8	26.3	27.5	29.7	29.0	28.4	28.5
10	24.6	24.2	25.05	24.7	24.6	24.5	27.2	28.4	30.2	29.7	29.3	29.2
20	25.55	25.1	25.7	25.4	25.6	25.3	28.0	29.2	30.8	30.5	30.1	29.8
30	26.4	26.05	26.4	26.2	26.5	26.0	28.8	30.0	31.3	31.0	30.8	30.4
40	27.2	27.0	27.1	26.9	27.4	26.8	29.5	30.8	31.8	31.65	31.4	30.9
450	27.95	27.8	27.8	27.6	28.2	27.45	30.2	31.4	32.2	32.2	32.0	31.4
60	28.6	28.5	28.5	28.3	28.9	29.15	30.75	31.9	32.6	32.7	32.5	31.8
70	29.25	29.2	29.1	29.0	29.6	29.8	31.2	32.3	33.0	33.0	32.8	32.2
80	29.8	29.8	29.7	29.5	30.1	29.35	31.7	32.7	33.3	33.3	33.1	32.5
90	30.3	30.2	30.1	30.0	30.6	29.8	32.0	32.9	33.5	33.5	33.4	32.8
500	30.65	30.7	30.5	30.4	31.0	30.2	32.3	33.2	33.6	33.7	33.6	33.0
10	31.05	31.0	30.8	30.8	31.3	30.6	32.55	33.3	33.7	33.8	33.7	33.15
20	31.3	31.3	31.1	31.1	31.65	30.9	32.7	33.4	33.8	33.9	33.7	33.3
30	31.6	31.6	31.4	31.4	31.9	31.2	32.85	33.45	33.8	33.9	33.8	33.3
40	31.8	31.8	31.6	31.55	32.1	31.4	33.0	33.5	33.8	33.9	33.8	33.3
550	32.05	32.0	31.8	31.8	32.3	31.7	33.1	33.5	33.75	33.8	33.75	33.3
60	32.2	32.2	32.0	32.0	32.5	31.9	33.15	33.5	33.6	33.7	33.7	33.3
70	32.4	32.4	32.1	32.1	32.65	32.1	33.2	33.45	33.6	33.7	33.6	33.2
80	32.5	32.5	32.25	32.2	32.8	32.2	33.2	33.4	33.45	33.6	33.6	33.15
90	32.65	32.65	32.4	32.35	32.9	32.3	33.2	33.4	33.4	33.5	33.45	33.1
600	32.8	32.75	32.5	32.4	33.0	32.5	33.2	33.3	33.2	33.4	33.4	33.0
10	32.8	32.85	32.6	32.5	33.1	32.55	33.1	33.2	33.1	33.3	33.3	32.9
20	32.9	32.9	32.65	32.6	33.1	32.7	33.1	33.2	33.0	33.1	33.2	32.8
30	33.0	33.0	32.7	32.7	33.2	32.8	33.1	33.1	32.8	33.1	33.1	32.7
40	33.0	33.1	32.8	32.8	33.3	32.9	33.1	33.0	32.7	32.9	33.0	32.6
650	33.05	33.1	32.9	32.85	33.4	33.0	33.0	33.0	32.6	32.8	32.8	32.6
60	33.1	33.2	32.9	32.9	33.4	33.1	33.0	32.9	32.5	32.75	32.7	32.5
70	33.2	33.25	33.0	33.0	33.5	33.1	32.9	32.8	32.3	32.6	32.6	32.4
80	33.2	33.3	33.1	33.0	33.5	33.2	32.85	32.6	32.2	32.45	32.55	32.2
90	33.2	33.4	33.15	33.1	33.6	33.25	32.8	32.6	32.1	32.3	32.4	32.1
700	33.3	33.5	33.2	33.2	33.65	33.3	32.75	32.5	32.0	32.1	32.3	31.95
	im_{R_o}						$im_{R'_e}$					
400	12.15	12.3	12.6	12.3	12.8	12.7	14.2	15.8	17.0	16.8	16.7	17.1
10	12.9	13.0	13.2	13.0	13.5	13.4	14.9	16.3	17.4	17.4	17.25	17.5
20	13.6	13.65	13.8	13.75	14.2	14.05	15.5	16.8	17.8	17.9	17.8	17.9
30	14.3	14.3	14.4	14.4	14.85	14.7	16.0	17.3	18.2	18.3	18.3	18.2
40	15.0	14.9	15.0	15.1	15.5	15.3	16.6	17.7	18.6	18.8	18.6	18.6
450	15.6	15.5	15.7	15.75	16.1	15.8	17.1	18.1	18.9	19.1	19.0	18.9
60	16.1	16.1	16.2	16.3	16.6	16.4	17.5	18.5	19.2	19.4	19.4	19.2
70	16.6	16.6	16.7	16.75	17.1	16.9	17.9	18.8	19.45	19.6	19.6	19.4
80	17.0	17.0	17.1	17.2	17.5	17.3	18.2	19.0	19.6	19.8	19.8	19.6
90	17.4	17.4	17.4	17.5	17.9	17.6	18.5	19.2	19.7	19.9	19.9	19.7
500	17.6	17.65	17.7	17.8	18.2	17.85	18.65	19.3	19.8	20.0	20.0	19.8
10	17.9	17.9	17.95	18.05	18.5	18.1	18.8	19.35	19.8	20.0	20.1	19.9
20	18.1	18.1	18.1	18.2	18.7	18.3	18.9	19.4	19.8	20.0	20.1	19.8
30	18.3	18.3	18.3	18.4	18.9	18.5	19.0	19.4	19.75	20.0	20.1	19.8
40	18.5	18.5	18.5	18.55	19.05	18.6	19.0	19.4	19.7	19.9	20.1	19.8
550	18.6	18.6	18.6	18.7	19.2	18.8	19.0	19.3	19.6	19.8	20.0	19.7
60	18.7	18.7	18.7	18.8	19.3	18.9	19.1	19.3	19.5	19.7	19.9	19.65
70	18.8	18.85	18.8	18.9	19.4	19.0	19.0	19.2	19.3	19.55	19.8	19.5
80	18.9	18.9	18.9	19.0	19.5	19.0	19.0	19.1	19.2	19.4	19.7	19.4
90	19.0	19.0	19.0	19.0	19.5	19.1	19.0	19.1	19.1	19.3	19.6	19.3
600	19.05	19.0	19.0	19.1	19.6	19.1	19.0	19.0	18.9	19.2	19.45	19.1
10	19.1	19.1	19.1	19.15	19.6	19.2	19.0	18.9	18.8	19.0	19.35	19.0
20	19.15	19.1	19.1	19.2	19.6	19.25	18.9	18.8	18.7	18.9	19.2	18.95
30	19.2	19.2	19.2	19.2	19.7	19.3	18.8	18.7	18.6	18.8	19.1	18.9
40	19.2	19.2	19.2	19.3	19.7	19.4	18.8	18.6	18.4	18.7	19.0	18.8
650	19.2	19.3	19.3	19.3	19.75	19.4	18.7	18.5	18.3	18.6	18.8	18.7
60	19.2	19.3	19.3	19.35	19.8	19.5	18.7	18.5	18.2	18.5	18.7	18.5
70	19.3	19.4	19.4	19.4	19.8	19.5	18.65	18.4	18.1	18.4	18.6	18.4
80	19.3	19.4	19.3	19.4	19.9	19.5	18.6	18.3	17.95	18.2	18.5	18.2
90	19.3	19.4	19.3	19.4	19.9	19.6	18.5	18.2	17.9	18.1	18.45	18.1
700	19.4	19.5	19.4	19.5	19.9	19.6	18.5	18.1	17.8	18.0	18.35	18.0

None of the grains in the sections is isotropic. As has been noted previously, the anisotropy of cameronite is distinct; nevertheless, the extinction positions could only be guessed within a few degrees by eye. Thus, the photometer was used to establish the orientation of the R maxima and minima at 560 nm for the six grains, and these orientations were used for the measurement of the reflectance spectra. The dispersion of the R and ${}^{im}R$ spectra (Fig. 1) strongly suggests that the mineral is uniaxial. The trend of the R_o and ${}^{im}R_o$ curves for the six grains is sympathetic, whereas the curves diverge at the blue end of the spectrum for R'_e and ${}^{im}R'_e$. Reproducibility of measurements with the microscope photometer used is consistently within the $\pm 1\%$ relative

accuracy suggested as reasonable by Piller & Gehlen (1964). It is thus surprising, given the constancy of the mineral's composition (Table 3), excellent polish, and relatively large grain-size, that the difference in R_o for the six sets of measurements is as much as $\pm 0.5\%$ absolute at 400 nm and $\pm 0.2\%$ absolute at 700 nm (Table 1). The sign of the bireflectance is positive from 400 to between 625 and 645 nm (where the mineral is isotropic) and negative from there to 700 nm; Cameron & Threadgold (1961) had noted that the mineral is essentially isotropic at 650 nm. In immersion oil the sign of the bireflectance is the same, but the crossover occurs between 595 and 605 nm.

Color values were calculated from the reflectance

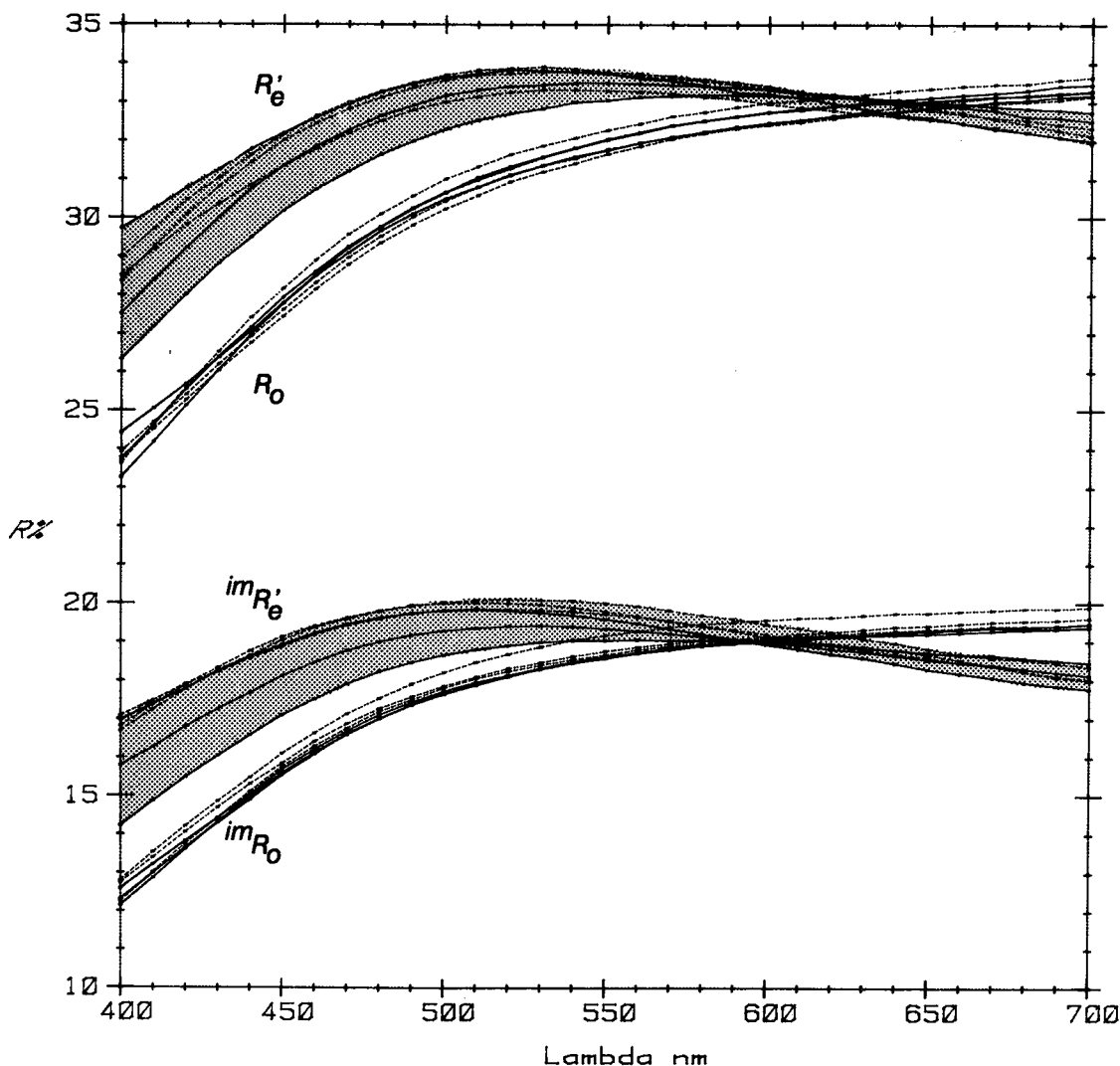


FIG. 1. R'_e , R_o and ${}^{im}R'_e$, ${}^{im}R_o$ spectra between 400 and 700 nm for 6 grains of cameronite.

data for the six grains relative to the CIE illuminants A and C (correlated color-temperatures of 2856 K and 6774 K, respectively). These values differ little from grain to grain; hence, only the range of values for the rectangular and polar co-ordinates are quoted in Table 2.

Interpretation in terms of the qualitative observations are best made with respect to illuminant A, as this is much nearer the color temperature of the light source used. The reason that R_o and ${}^{im}R_o$ are perceived as pale brownish grey and slightly darker than the pale grey of R'_e and ${}^{im}R'_e$ is found in the lower luminance, higher and consistent excitation-purities, and consistent dominant wavelengths. The range of luminances for both vibration directions is very nearly the same; however, the variation in the dispersion of R'_e and ${}^{im}R'_e$ is emphasized by the spread in the dominant wavelengths and excitation purities. It is interesting to note that Cameron & Threadgold (1961) reported a reflectance, presumably in 'white' light, of 32%, coincident with the luminance values obtained in this study for R_o .

ELECTRON-MICROPROBE DATA

The analyses were performed with a CAMEBAX electron microprobe operated at 20 kV and with a beam current of 30 nA. The analytical results are given in Table 3. Composition 1 is the average of 6 analyses using the following X-ray lines and standards: $CuK\alpha$ (synthetic $Cu_{11}FeSb_4S_{13}$), $TeL\alpha$ (synthetic $FeTe_2$) and $AgL\alpha$ (Ag metal). Composition 2 is the average of 8 analyses using pure metals as standards. Estimated standard deviations are listed in brackets after each analytical result. The empirical formula for the average of composition 1 and 2, for 10 atoms of Te, is $Cu_{7.10}Ag_{1.09}Te_{10}$. The theoretical formula is Cu_7AgTe_{10} . Cameron & Threadgold (1961) identified the elements Cu and Te by microchemical tests but lacked sufficient material for quantitative chemical or spectrographic analyses.

Cameronite is only the second reported phase in the Cu-Ag-Te ternary system, the first one being the recently described mineral *henryite* (Criddle *et al.* 1983).

CRYSTALLOGRAPHY

Four fragments of cameronite were dug out of a polished section, mounted, and examined by precession single-crystal methods. Levels collected were $h0l \rightarrow h9l$, $hk0 \rightarrow hk2$, hkl and $0kl$. Precession films indicate tetragonal symmetry with measured unit-cell parameters a 12.6 and c 42.0 Å. Systematic absences dictate diffraction aspect $P4_2/mmc$. The permissible space-groups are, therefore, $P4_2/mmc$ (131), $P4_2mc$ (105) or $P4_2c$ (112). Strong diffraction-nodes define

TABLE 2. SUMMARY OF COLOR VALUES

Illuminant A	R_o		R'_e	
	AIR	OIL	AIR	OIL
\bar{x}	.456 - .457	.458 - .459	.447 - .452	.443 - .481
\bar{y}	.413 - .414	.415	.411 - .412	.412 - .414
\bar{z}	31.9 - 32.5	18.7 - 19.3	33.0 - 33.6	18.0 - 19.7
λ_d	583 - 584	583	564 - 580	514 - 578
$P_o\%$	10.0 - 10.8	12.2 - 13.0	1.9 - 6.3	1.0 - 6.8
Illuminant C				
\bar{x}	.322 - .323	.325 - .328	.311 - .317	.308 - .317
\bar{y}	.332 - .333	.336 - .337	.322 - .328	.321 - .330
\bar{z}	31.6 - 32.2	18.5 - 19.1	32.9 - 33.6	18.9 - 19.8
λ_d	574	573	560 - 571	524 - 569
$P_o\%$	4.8 - 7.9	9.1 - 9.8	1.9 - 4.8	0.9 - 6.5

These values define the range obtained by calculation from the reflectance spectra for six grains of cameronite.

TABLE 3. COMPOSITION OF CAMERONITE

	Weight Percent			
	Cu	Ag	Te	Total
Anal.1	24.45 (.14)	6.29 (.05)	68.27 (.20)	99.01
Anal.2	24.44 (.11)	6.38 (.08)	69.94 (.14)	100.76
Ave.	24.45	6.34	69.11	99.90

Analyses carried out using the CAMEBAX electron microprobe. Estimated standard deviations are in brackets.

TABLE 4. X-RAY POWDER DATA FOR CAMERONITE

test.	d° meas.	d° calc.	hkl	test.	d° meas.	d° calc.	hkl
100	3.456	3.463	307	20	1.227	1.227	6028
20	2.958	2.963	332	40	1.222	1.223	9314
10	2.635	2.637	0016	5	1.158	1.159	3033
10	2.531	2.539	430			1.154	9021
5	2.344	2.342	3015	30	1.151	1.152	967
100	2.118	2.123	3314	10	1.062	1.062	6628
		2.116	600	5	1.058	1.058	1200
30	1.815	1.815	3021	10	1.017	1.017	6333
60	1.804	1.805	637	5	1.014	1.013	9621
3	1.755	1.755	639	20	1.012	1.012	1237
5	1.650	1.650	6016	10	0.9521	0.9522	3342
10	1.507	1.507	0028			0.9469	9914
20	1.496	1.496	660	30	0.9465	0.9462	1260
		1.378	6321	10	0.9164	0.9163	9035
40	1.377	1.373	907	30	0.9140	0.9139	12321

114.6-mm Gandolfi camera. Co radiation, Fe filter ($CoK\alpha$ 1.79021 Å, $CoK\beta$ 1.78890 Å for lines below 1.377 Å). Film no. 1182 run at CANMET by Mr. E.J. Murray, corrected for shrinkage; indexed on a 12.695, a 12.186 Å.

a subcell with $a' = a/3 = 4.232$ and $c' = c/7 = 6.027$ Å. Zero- and upper-level reflections of the type hkl with $h, k = 3n$ and $l = 7n$ dominate in the single-crystal films and predominate in the indexing of the X-ray powder-diffraction pattern (Table 4). The

refined unit-cell parameters, a 12.695(2), c 42.186(6) Å, V 6798.8(3.1) Å³ and a c/a of 3.323, are based on 16 X-ray powder lines between 3.456 and 0.9140 Å for which unambiguous indexing was possible. All indexed reflections were checked on single-crystal precession films. The X-ray powder data in Table 4 are consistent with a tabulated set of d values sent to one of us (D.C.H.) by E.N. Cameron in 1964. His data contain, in addition, a number of weak, unindexable reflections that can be ascribed to impurities. With $Z = 16$, the calculated density for theoretical $\text{Cu}_7\text{AgTe}_{10}$ is 7.144 g/cm³.

Cameron & Threadgold (1961) stated, "Incomplete single crystal studies indicate that the mineral is hexagonal". Our studies failed to locate any symmetry elements in support of that statement. Considering the identity of the qualitative optical properties and the X-ray powder data, there seems little doubt that the unknown of Cameron & Threadgold and cameronite are one and the same. The reason for the difference in symmetry remains unresolved at this time.

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