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LAPIEITE $CuNiSbS_3$, A NEW MINERAL SPECIES FROM THE YUKON TERRITORY

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ABSTRACT

Lapieite, a new mineral species, is a rare constituent of a mineralized glacial erratic found at the confluence of Glacier Creek and Lapie River, St. Cyr Ranges, Yukon Territory. The highly metamorphosed rock consists mainly of quartz, magnesite, altered spinel and disseminated Cr-bearing mica. The sulfide minerals associated with lapieite are Ni-rich pyrite, gersdorffite, polydymite, millerite, tetrahedrite, marcasite and chalcopyrite. The mineral is opaque and metallic, with fair cleavage parallel to [100]. Individual subhedral grains do not exceed 150 μm in length. Lapieite is moderately bireflectant and is pleochroic in shades of greenish grey to grey: it is strongly anisotropic with very pale blue to intense yellowish pink rotation-tints. Reflectance measurements for 3 grains in air and oil are tabulated. Averaged electron-microprobe data yield the chemical formula $Cu(Ni_{1.00}Fe_{0.01})(Sb_{0.98}As_{0.01})S_{2.97}$, calculated on the basis Cu = 1 or, ideally, $CuNiSbS_3$. Lapieite is orthorhombic, space group $P2_12_12_1$, *a* 7.422(2), *b* 12.508(3), *c* 4.900(1) Å, *V* 454.9 Å^3, *a*:*b*:*c* 0.593:1:0.392. With Z = 4, the calculated density is 4.966 g/cm^3. The strongest five reflections of the X-ray powder pattern [*d* in Å (I) (*hkl*)] are: 3.178(90) (031), 2.959(100) (201), 1.855(60)(161,400), 1.837(90)(232) and 1.601(30)(431).

Keywords: lapieite, new mineral species, Lapie River, Yukon Territory, analysis by electron microprobe, reflectance data, X-ray data.

SOMMAIRE

La lapieïte, nouvelle espèce minérale, est un composant très accessoire d'un bloc erratique glaciaire minéralisé, découvert à la confluence du crique Glacier et de la rivière Lapie, dans la chaîne St-Cyr (territoire du Yukon). La roche, fortement métamorphisée, se compose essentiellement de quartz, magnésite, spinelle altéré et mica chromifère disséminé. Les sulfures qui lui sont associés sont: pyrite riche en Ni, gersdorffite, polydymite, millerite, tétraédrite, marcasite et chalcopyrite. C'est un minéral opaque, métallique, avec clivage passable parallèle à [100]. Les grains individuels subidiomorphes ne surpassent pas 150 μm en longueur. La lapieïte possède une biréflectance moyenne et un pléochroïsme de gris verdâtre à gris; elle est fortement anisotrope, avec teintes de rotation bleu très pâle à rose jaunâtre. On a mesuré le pouvoir réflecteur sur trois grains dans l'air et dans l'huile. La formule chimique moyenne a été déterminée à partir de données obtenues par microsonde électronique: $Cu(Ni_{1.00}Fe_{0.01})(Sb_{0.98}As_{0.01})S_{2.97}$ (Cu = 1) ou, plus simplement, $CuNiSbS_3$. La lapieïte est orthorhombique, groupe spatial $P2_12_12_1$, *a* 7.422(2), *b* 12.508(3), *c* 4.900(1) Å, *V* 454.9 Å^3, *a*:*b*:*c* 0.593:1:0.392. Avec Z = 4, la densité calculée est de 4.966. Les cinq raies les plus intenses du diagramme de diffraction X (méthode des poudres) [*d* en Å (I) (*hkl*)] sont: 3.178(90)(031), 2.959(100)(201), 1.855(60)(161,400), 1.837(90)(232) et 1.601(30)(431).

Mots-clés: lapieïte, nouvelle espèce minérale, rivière Lapie, territoire du Yukon, analyse à la microsonde électronique, données optiques quantitatives, données aux rayons X.

INTRODUCTION

Lapieite, ideally $CuNiSbS_3$, is a new mineral species recently encountered during a mineralogical study of a glacial erratic found near the Lapie River, Yukon Territory. The mineral is named for the locality and should be pronounced LĂ•PĪ•AIT. The river, in turn, was named by Robert Campbell, Yukon explorer, for one of his Indian guides. The mineral and mineral name have been approved by the Commission on New Minerals and Mineral Names, I.M.A. Type material, consisting of several polished sections, polished thin sections and rock fragments, has been deposited in the Reference Series of the National Mineral Collection housed at the Geological Survey of Canada, Ottawa, under catalogue numbers 63844, 63845 and 63846.

OCCURRENCE AND ASSOCIATED MINERALS

The glacier boulder containing lapieite was found by one of us (I.R.J.) near the confluence of Glacier Creek and Lapie River, St. Cyr Ranges, Yukon Territory (Lat. 61°52′30″N, Long. 132°50′W). The presence of a distinctive green micaceous phase in this intensely altered erratic, similar to that in the fuchsitic gold-bearing rocks of the Kirkland Lake area, Ontario, was the principal reason a portion of the rock was collected for study.

The nonmetallic matrix mainly consists of quartz with variable amounts of altered spinel, magnesite and mica. Energy-dispersion analyses of the greenish mineral so evident in hand specimen indicate the presence of Cr, Mn, Mg, Al, K and Si. X-ray powder mounts of material from areas with the most intense green color contain mixtures of quartz + magnesite + mica. We believe that the green color is due to finely disseminated grains of Cr-bearing mica.

The associated primary sulfide minerals are Ni-rich pyrite, polydymite, gersdorffite and millerite. Minor to trace amounts of marcasite, tetrahedrite and chalcopyrite were also observed in polished section.

Physical and Optical Properties

Individual grains of lapieite do not exceed 150 μm in length and are mostly anhedral to subhedral. Fragments contained in a concentrate exhibit fair cleavage parallel to [100]. The mineral is opaque with a metallic lustre. The paucity of material as well as the small grain-size prevented both direct observation of color in hand specimen and determination of specific gravity.

Polished sections of heavy-mineral concentrates provided most of the material for study; unfortunately, mineral grains embedded in epoxy are not suitable for reliable determinations of the Vickers microhardness. The polishing hardness of individual grains suggests a Mohs hardness between 4½ and 5.

TABLE 1. REFLECTANCE DATA FOR LAPIEITE

	Grain 1				Grain 2				Grain 3			
λnm	R_1	R_2	imR_1	imR_2	R_1	R_2	imR_1	imR_2	R_1	R_2	imR_1	imR_2
400	33.4	32.1	19.4	19.1	36.5	32.3	23.4	19.5	33.3	35.7	19.6	22.9
410	33.7	32.1	19.7	19.2	36.6	32.4	23.4	19.7	33.7	35.8	20.0	22.9
420	34.0	32.2	20.0	19.2	36.7	32.6	23.3	19.8	34.0	35.8	20.4	22.8
430	34.3	32.3	20.2	19.3	36.7	32.7	23.1	20.1	34.3	35.8	20.6	22.7
440	34.6	32.5	20.3	19.4	36.7	32.9	22.9	20.3	34.5	35.8	20.7	22.4
450	34.8	32.8	20.5	19.5	36.8	33.2	22.6	20.6	34.7	35.8	20.7	22.1
460	34.9	33.3	20.5	19.8	36.8	33.5	22.4	21.0	34.8	35.8	20.7	21.8
470	34.9	33.8	20.5	20.1	36.7	34.0	22.1	21.4	34.8	35.8	20.7	21.5
480	34.8	34.5	20.4	20.7	36.7	34.5	21.9	21.9	34.7	35.7	20.6	21.3
490	34.7	35.2	20.2	21.2	36.6	35.0	21.7	22.3	34.6	35.7	20.4	21.1
500	34.5	35.8	20.0	21.7	36.6	35.4	21.6	22.7	34.4	35.8	20.2	21.0
510	34.2	36.2	20.0	22.1	36.5	35.8	21.6	23.0	34.2	35.7	19.9	20.9
520	34.1	36.5	19.6	22.3	36.4	36.0	21.4	23.0	33.9	35.7	19.7	20.8
530	34.0	36.7	19.5	22.4	36.2	36.2	21.2	23.1	33.8	35.6	19.5	20.7
540	33.9	36.8	19.5	22.5	36.0	36.3	21.0	23.2	33.7	35.4	19.4	20.5
550	34.0	36.8	19.6	22.4	35.8	36.5	20.7	23.3	33.7	35.2	19.4	20.2
560	34.1	36.7	19.7	22.3	35.5	36.5	20.4	23.3	33.7	34.9	19.5	19.9
570	34.2	36.7	19.8	22.2	35.2	36.6	20.1	23.3	33.8	34.6	19.5	19.6
580	34.3	36.7	19.8	22.2	34.8	36.6	19.8	23.3	33.8	34.3	19.5	19.3
590	34.3	36.7	19.9	22.2	34.5	36.7	19.5	23.3	33.8	33.9	19.5	19.0
600	34.3	36.8	19.9	22.3	34.1	36.7	19.1	23.3	33.8	33.5	19.5	18.6
610	34.4	36.9	20.0	22.4	33.8	36.7	18.8	23.3	33.8	33.2	19.5	18.3
620	34.4	37.0	20.1	22.5	33.4	36.7	18.4	23.3	33.8	32.8	19.6	18.0
630	34.6	37.1	20.2	22.6	33.1	36.8	18.2	23.4	34.0	32.4	19.8	17.7
640	34.8	37.3	20.5	22.7	32.8	37.0	17.9	23.6	34.3	32.1	20.2	17.4
650	35.2	37.5	20.9	23.0	32.6	37.4	17.7	24.0	34.8	31.7	20.7	17.1
660	35.6	37.8	21.3	23.3	32.4	37.8	17.5	24.4	35.3	31.4	21.2	16.9
670	36.1	38.2	21.8	23.7	32.3	38.3	17.4	24.9	35.9	31.2	21.7	16.7
680	36.6	38.6	22.4	24.1	32.2	38.8	17.3	25.4	36.6	31.0	22.4	16.5
690	37.2	39.1	22.9	24.5	32.1	39.3	17.3	26.0	37.2	30.9	23.0	16.5
700	37.8	39.5	23.5	24.9	32.1	39.8	17.4	26.6	37.9	30.9	23.6	16.5
Color values relative to the CIE illuminant C												
x	0.310	0.318	0.310	0.319	0.302	0.318	0.294	0.319	0.309	0.303	0.307	0.294
y	0.315	0.329	0.312	0.331	0.313	0.327	0.306	0.330	0.314	0.314	0.310	0.306
Y%	34.2	36.6	19.8	22.2	35.3	36.3	20.4	23.1	33.9	34.7	19.7	19.8
λd	553	572	555	571	486	573	483	572	454	488	449	483
P_e%	0.7	5.5	1.5	6.5	3.1	4.8	6.8	6.0	0.8	2.8	2.1	6.9
Color values relative to the CIE illuminant A												
x	0.448	0.453	0.448	0.454	0.439	0.453	0.430	0.454	0.447	0.439	0.446	0.430
y	0.406	0.413	0.404	0.414	0.410	0.412	0.407	0.413	0.406	0.409	0.404	0.407
Y%	34.3	36.7	19.9	22.3	35.0	36.5	20.0	23.3	33.9	34.3	19.6	19.4
λd	564	581	561	581	497	582	495	582	578	499	577	495
P_e%	0.5	7.5	1.2	8.8	2.1	6.6	4.1	8.0	0.4	2.0	1.1	4.1

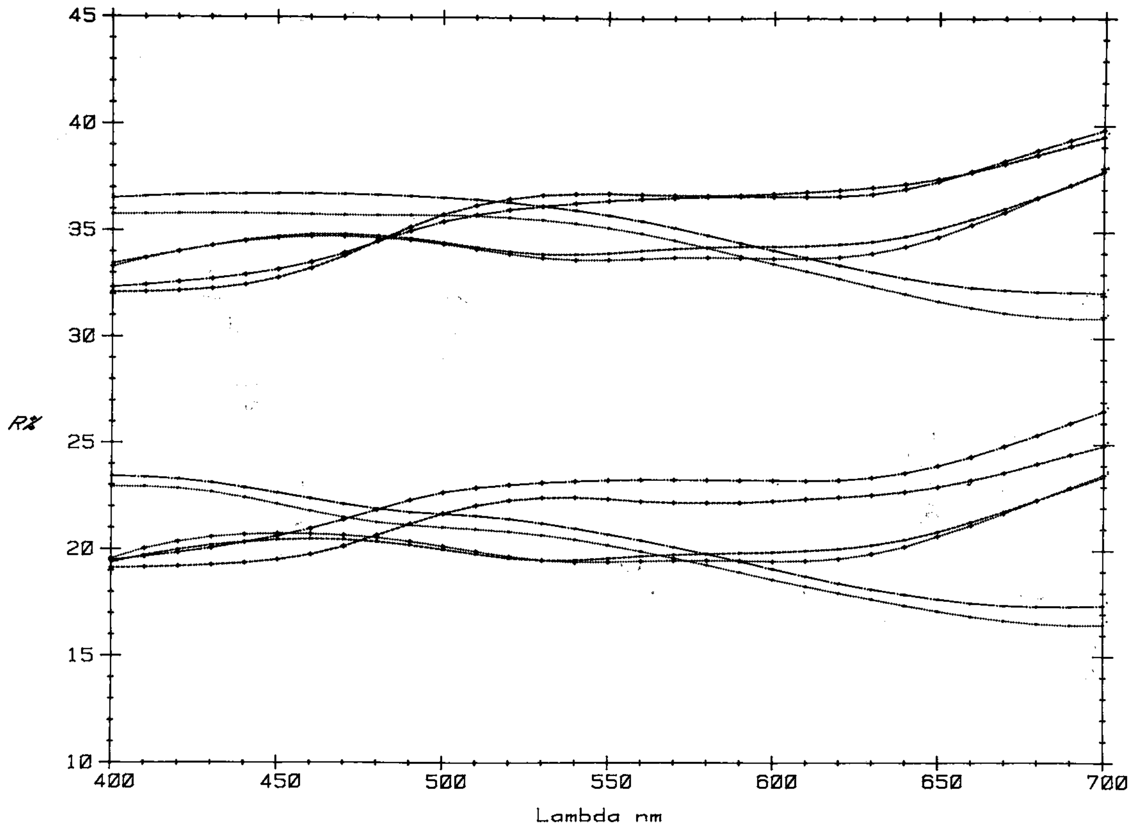

FIG. 1. R_1, R_2 (upper curves) and ${}^{im}R_1$, ${}^{im}R_2$ spectra (lower curves) between 400 and 700 nm for three grains of lapieite.

In reflected, plane-polarized light, lapieite is moderately bireflectant and is pleochroic in shades of greenish grey to grey. In crossed nicols it is strongly anisotropic with very pale blue to intense yellowish pink rotation-tints. The reflectance measurements between 400 and 700 nm for 3 unoriented grains are presented in Table 1 and are graphically illustrated in Figure 1. These measurements were made with the same equipment and procedures as described by Cabri *et al.* (1981, appendix), except that × 16 objectives were used with their potential numerical apertures of 0.35(air) and 0.4(oil) adjusted to effective apertures of 0.2.

From Figure 1 it can be seen that the optical orientation of the three measured grains differs appreciably. This is not unexpected from random sections of an orthorhombic mineral, but it does mean that the R_1 and R_2 spectra for any one grain cannot be taken as characteristic for the species [R_1 and R_2 in Table 1 are assigned, respectively, to the vibration directions of lower and higher luminance, $Y\%$, relative to the CIE illuminants A and C, following Criddle (1980)]. Too few grains were available for the statistical derivation of R_g, R_m and R_p ; however, in terms of identification, the color values and qualitative optical properties of the mineral are distinctive. The color values relative to illuminant A (nearest the color temperature of 3000–3200 K of the unfiltered quartz halogen lamp used) for grains 2 and 3 confirm the qualitative observation of reflectance pleochroism from greenish grey (dominant wavelength λ_d 495–499) to grey (λ_d 577–582), particularly when the grains are immersed in oil. Grain 1, although the most bireflectant, is the least pleochroic, with $\lambda_d R_1$ of 564 and $\lambda_d R_2$ of 581. In both vibration directions, the grey appearance of the mineral is due to luminances of about 35% in air and 20% in oil that are sensed by the eye as much lower than the corresponding luminances of 54% and 40% of the gersdorffite (white) with which it is associated.

ELECTRON-MICROPROBE ANALYSIS

The analyses were performed on a Materials Analysis Company electron microprobe operating at 20

TABLE 2. COMPOSITION OF LAPIEITE

		Gr. 1	Gr. 2	Gr. 3	Gr. 4
Cu	Wt.%	18.6	18.5	18.2	18.7
Ni		17.0	16.9	17.3	17.1
Fe		-	0.2	-	0.1
As		-	0.2	0.1	0.2
Sb		35.2	35.3	34.6	34.8
S		27.9	27.6	27.4	27.9
Total		98.7	98.7	97.6	98.8

Analyses carried out using the electron microprobe

kV and with a specimen current of 0.025 μA. The following X-ray lines and standards were used: Cu*Kα*, Fe*Kα*, Sb*Lα*, S*Kα* (synthetic $Cu_{11}FeSb_4S_{13}$), Ni*Kα* (synthetic NiS) and As*Kα* (synthetic $FeAs_2$). No other element with atomic number greater than 11 was detected by energy-dispersion analysis. The data were corrected using a modified version of the EMPADR VII computer program of Rucklidge & Gasparrini (1969). Results of the analyses are presented in Table 2.

The average analytical formula, based on Cu = 1, is Cu $(Ni_{1.00}Fe_{0.01})(Sb_{0.98}As_{0.01})S_{2.97}$ or, ideally, $CuNiSbS_3$. Chemically, this is the Ni-analogue of bournonite, although lapieite and bournonite are structurally distinct.

TABLE 3. X-RAY-DIFFRACTION DATA FOR LAPIEITE

*I*est.	*d*Å meas.	*d*Å calc.	*hkl*	*I*est.	*d*Å meas.	*d*Å calc.	*hkl*
10	4.56	4.562	011	10	2.149	2.149	241
10	3.56	3.557	210	20	2.073	2.074	250
10	3.43	3.423	121	10	2.032	2.032	132
90	3.178	3.175	031	3	2.008	2.007	160
5	3.132	3.127	040	5	1.953	1.952	331
100	2.959	2.958	201	60	1.855	1.857	161
3	2.921	2.919	131			1.855	400
15	2.880	2.882	140	90	1.837	1.836	232
		2.879	211	3	1.704	1.704	261
20	2.769	2.772	230	3	1.677	1.677	322
20	2.637	2.636	041	3	1.635	1.637	171
3	2.480	2.484	141	1	1.619	1.620	013
15	2.452	2.450	002	30	1.601	1.602	431
15	2.414	2.413	231	15	1.582	1.582	113
3	2.324	2.326	102	3	1.562	1.563	080
3	2.287	2.287	112	3	1.552	1.552	162
20	2.229	2.228	051	20	1.521	1.521	033
3	2.180	2.180	122				

114.6-mm Gandolfi camera, Cu*Kα* radiation, Ni filter; film G186 (λ = 1.54178 Å). Indexed with *a* 7.422, *b* 12.508, *c* 4.900 Å.

X-Ray Studies

Precession single-crystal films of two fragments of lapieite dug from a polished section of heavy-mineral concentrates indicate orthorhombic symmetry and measured unit-cell parameters *a* 7.38, *b* 12.5 and *c* 4.88Å. The space group was uniquely determined to be $P2_12_12_1(19)$ since the only systematic absences observed are *h*00 with *h* = 2*n*, 0*k*0 with *k* = 2*n* and 00*l* with *l* = 2*n*. The refined unit-cell parameters, based on 28 lines in the X-ray powder-diffraction pattern (Table 3) between 3.555 and 1.521 Å for which unambiguous indexing was possible, are: *a* 7.422(2), *b* 12.508(3), *c* 4.900(1) Å, *V* 454.9 $Å^3$ and *a*:*b*:c 0.593:1:0.392. With *Z* = 4, the calculated density for stoichiometric $CuNiSbS_3$ is 4.966 g/cm^3.

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