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JASKÓLSKIITE FROM IZOK LAKE, NORTHWEST TERRITORIES

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Abstract

A second occurrence of jaskólskiite has been found in the massive zinc–copper–lead sulfide deposit at Izok Lake, Northwest Territories. The mineral occurs as lath-shaped crystals up to 150×300 μm in galena associated with pyrite, pyrrhotite, marcasite, chalcopyrite, tetrahedrite and native bismuth. In reflected, plane-polarized light the mineral is strongly bireflectant from greenish grey to greenish white, with no reflectance pleochroism. It is strongly anisotropic. VHN_{50} 148–185. Reflectance spectra and color values for three grains are supplied. The structural cell is orthorhombic with dimensions: *a* 11.31(1), *b* 19.79(2), *c* 4.087(4) Å. Two space groups are possible: *Pbnm* and $Pbn2_1$. The strongest six lines of the X-ray powder pattern [*d* in Å (I) (*hkl*)] are: 2.751(100)(301, 241, 311), 3.73(90)(150,240,310), 2.957 (90)(231), 3.59(60)(121), 3.33(60)(131), 1.787(60) (312,0$\underline{10}$1). An electron-microprobe analysis of a single specimen gave Cu 0.8, Pb 48.5, Bi 17.4, Sb 14.6, S 17.6, total 98.9 wt.%, which corresponds to the formula $Pb_{2+x}Cu_x(Sb,Bi)_{2-x}S_5$, with Sb > Bi, $x=0.15$.

Keywords: jaskólskiite, Pb–Cu–Sb–Bi sulfosalt, Izok Lake, Northwest Territories, reflectance data, microprobe analysis, X-ray powder data.

Sommaire

On signale la deuxième localité de la jaskólskiite, dans le gîte de sulfures massifs de Zn, Cu et Pb du lac Izok (Territoires du Nord-Ouest). Les cristaux, en minces plaquettes qui atteingnent 150×300 μm, se présentent dans la galène qui fait partie de l'assemblage pyrite, pyrrhotine, marcasite, chalcopyrite, tétraédrite et bismuth natif. En lumière réfléchie polarisée rectilignement, cette espèce est fortement biréflectante de gris verdâtre à blanc verdâtre. Elle ne montre aucun pléochroïsme de réflectance, mais elle est fortement anisotrope. VHN_{50} 148–185. On présente des spectres de réflectance et une évaluation de la couleur pour trois grains. La maille est orthorhombique, *a* 11.31(1), *b* 19.79(2), *c* 4.087(4) Å. Le groupe spatial est *Pbnm* ou $Pbn2_1$. Les six raies les plus intenses du cliché de poudre [*d* en Å (I) (*hkl*)] sont: 2.751(100)(301,241,311), 3.73(90)(150,240,310), 2.957(90)(231), 3.59(60)(121), 3.33(60)(131), 1.787(60) (312,0$\underline{10}$1). Une analyse à la microsonde électronique a donné: Cu 0.8, Pb 48.5, Bi 17.4, Sb 14.6, S 17.6, total 98.9% (en poids), ce qui correspond à la formule $Pb_{2+x}Cu_x(Sb,Bi)_{2-x}S_5$, dans laquelle Sb > Bi et $x=0.15$.

Mots-clés: jaskólskiite, sulfosel de Pb–Cu–Sb–Bi, lac Izok (Territoires du Nord-Ouest), réflectance, analyse à la microsonde électronique, cliché de poudre.

Introduction

Jaskólskiite is a newly discovered Pb–Cu–Sb–Bi sulfosalt from the Vena deposit, Sweden, described in this issue by Zakrzewski (1984). Simultaneously, a second occurrence of this mineral was discovered during a study of the Izok Lake massive sulfide deposit, Northwest Territories. Polished sections of jaskólskiite from Izok Lake are deposited in the National Mineral Reference Collection housed at the Geological Survey of Canada, Ottawa, the British Museum (Natural History), the Royal Ontario Museum, Toronto and the Bureau de Recherches Géologiques et Minières, Orléans, France.

Occurrence

Izok Lake is located at 65°39′N, 112°49′W in the northern part of the Slave structural province, Northwest Territories. It is 366 km north of Yellowknife and 300 km south-southeast of Coppermine, the two nearest settlements. The geology and exploration history of the deposit are given by Money & Heslop (1976) and Bostock (1980). The deposit occurs in highly metamorphosed Archean metavolcanic rocks that have undergone at least three major phases of folding.

The major ore-minerals are pyrite, sphalerite, pyrrhotite, silver-bearing chalcopyrite, magnetite and silver-bearing galena, with minor to trace amounts of thirty-one other species. A complete mineralogical description of the Izok Lake deposit will be reported elsewhere. Jaskólskiite is rare in the deposit, having been identified in only 3 of the 38 drill holes examined. It is most abundant in drill hole 88, where it occurs in galena-rich stringer ore between 44.2 to 48.2 m and between 58.8 to 60.4 m. In drill hole 13,it is less abundant, occurring between 58.8 to 59.7 m in disseminated galena within a chlorite–biotite–

TABLE 1. COMPOSITION OF JASKÓLSKIITE FROM IZOK LAKE

Sample	Cu	Ag	Pb	Bi	Sb	S	Total
	Weight percent						
Hole 88, 153.1	0.8	-	48.5	17.4	14.6	17.6	98.9
Hole 13, 193.0	0.8	0.2	49.4	18.0	14.1	18.0	100.5
Hole 8, 222.0	0.6	-	49.3	15.7	15.2	17.9	98.7
	Atomic proportions						
Hole 88, 153.1	0.11	-	2.13	0.76	1.09	5	
Hole 13, 193.0	0.12	0.02	2.12	0.77	1.03	5	
Hole 8, 222.0	0.08	-	2.13	0.67	1.12	5	

Theoretical Formula $Pb_{2+x}Cu_x(Sb, Bi)_{2-x}S_5$ with Sb > Bi, x about 0.15.

Compositions are derived from electron-microprobe data.

cordierite footwall of the massive ore-zone. In drill hole 8, it was identified in one polished section at 67.7 m, occurring with native bismuth as inclusions in galena. Since all Izok Lake drill-core lengths were recorded in feet, the sample-number designation used in the tables and figures refers to feet.

Electron-Microprobe Analyses

The analyses were performed with a Materials Analysis Company electron microprobe operated at 20 kV and a specimen current of 0.025 microamperes. X-ray lines examined and standards used are $CuK\alpha$ (synthetic CuS), $AgL\alpha$, $SbL\alpha$ (synthetic $AgSbS_2$), $PbL\alpha$, $SK\alpha$ (synthetic PbS), and $BiL\alpha$ (synthetic Bi_2S_3). The data were corrected using a modified version of the EMPADR VII computer program of Rucklidge & Gasparrini (1969). Results of the analyses are given in Table 1. These are in close agreement with those reported by Zakrzewski (1984). The formula is ideally $Pb_{2+x}Cu_x(Sb,Bi)_{2-x}S_5$, where Sb exceeds Bi and x is equal to 0.15. For a normalized formula $Pb_{2.15}Cu_{0.15}Sb_{1.08}Bi_{0.77}S_5$, the calculated density is 6.59 g/cm^3 with $Z = 4$.

Physical and Optical Properties

Jaskólskiite occurs as lath-shaped crystals (Figs. 1a, b) in galena, commonly associated with pyrite, pyrrhotite, marcasite, chalcopyrite, tetrahedrite and native bismuth. The mineral is generally free of inclusions, but a few crystals contain small blebs of galena, whereas other crystals have a reaction rim consisting of an intergrowth of tetrahedrite, native bismuth, galena and an unidentified Ag–Pb–Sb–Bi sulfosalt (Figs. 2a, b). Jaskólskiite crystals seldom exceed 150 × 300 μm. Many crystals exhibit a good cleavage parallel to the elongation direction. The microhardness VHN_{50}, based on three indentations, falls between 148 and 185, equivalent to a Mohs hardness of 4. The minerals could not be isolated in sufficient quantity for a determination of density.

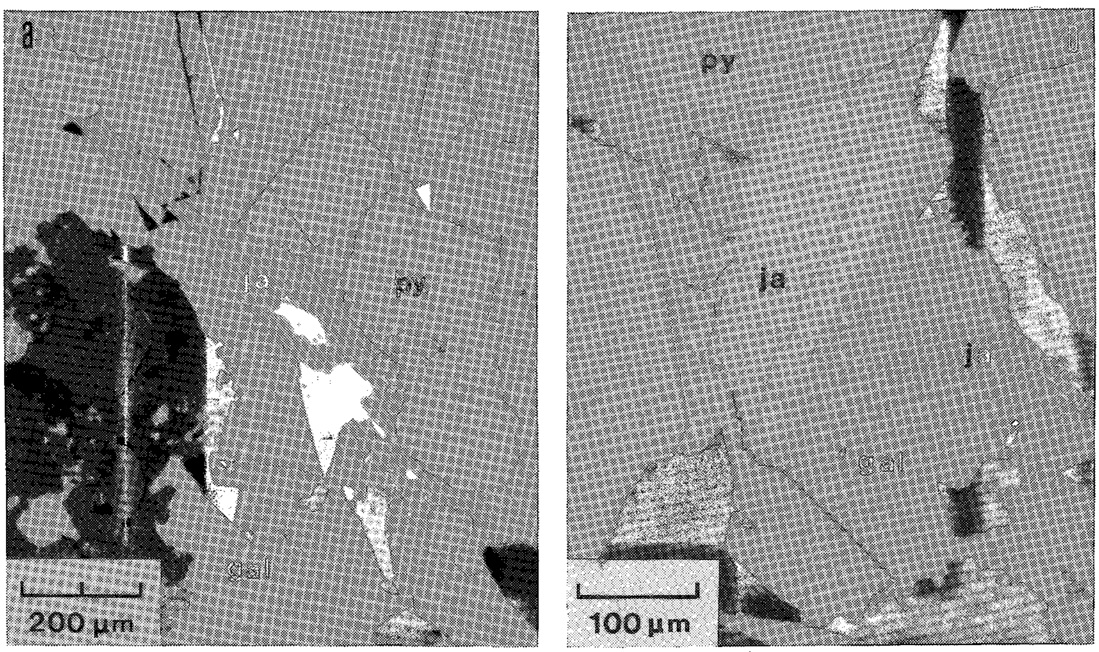

Fig. 1.a. Elongate crystal of jaskólskiite (ja) in a matrix of galena (gal) with anhedral pyrite (py). Nicols slightly crossed. Hole 88, 153.1. b. Several lath-shaped crystals in galena with anhedral pyrite. Small white blebs in galena are native bismuth. Note the anisotropism of jaskólskiite. Crossed nicols. Hole 88, 153.1.

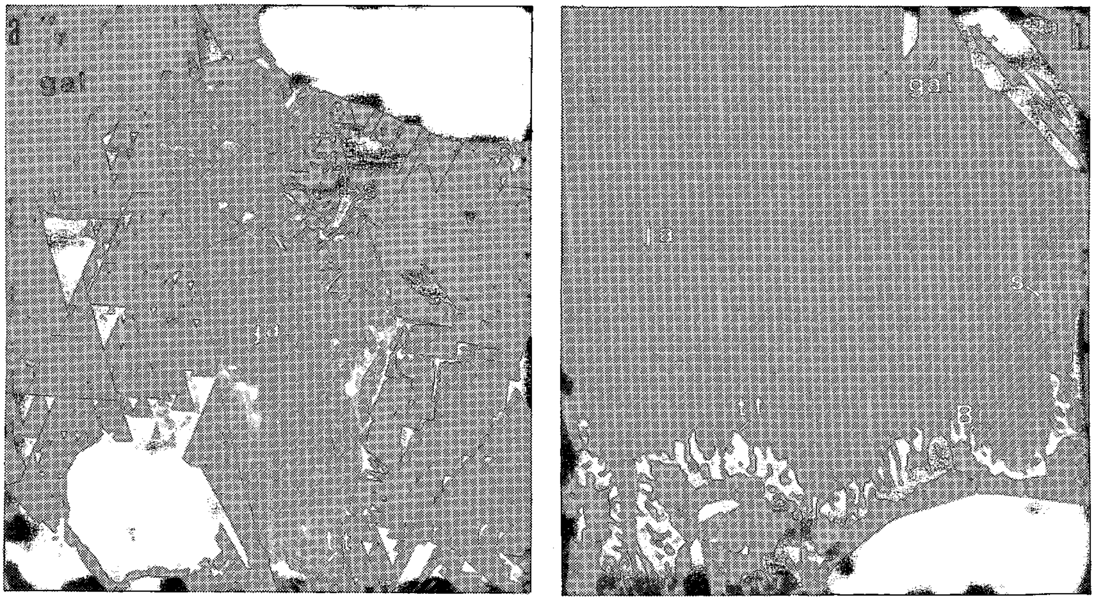

FIG. 2.a. SEM back-scattered image of euhedral jaskólskiite (ja) in galena. Parts of the crystal contain a reaction rim consisting of tetrahedrite, galena, native bismuth and an unidentified sulfosalt (s). Hole 88, 198.0. b. SEM back-scattered image of a jaskólskiite crystal with a reaction rim of intergrown tetrahedrite (tt), native bismuth (Bi), galena and an unidentified sulfosalt (s). Small blebs of galena occur as inclusions in the jaskólskiite.

In reflected, plane-polarized light, jaskólskiite is strongly bireflectant. Reflectance pleochroism is absent (Table 2, Fig. 3), but the strength of the bireflectance is such that the greenish white to greenish grey appearance of the mineral in some orientations can give a false impression of pleochroism, or pseudopleochroism. It is strongly anisotropic; some sections are symmetrical, others asymmetrical, with the result that the sequence of rotation tints can be from extinction to brownish grey, greenish grey, greenish white, brownish to purplish grey, brownish grey to extinction and then, dark blue, slate grey, pale-bluish grey, bluish white, light grey, dark grey, purple, to extinction. With the analyzer uncrossed by 1–2°, the rotation tints do not change except to become more vivid. The asymmetry in crossed polars is the strongest optical evidence that jaskólskiite is biaxial, since the reflectance spectra measured on three grains could reasonably be interpreted as fitting a uniaxial mineral. In Table 2, R_2 and $^{im}R_2$ for grains 1 and 3 are remarkably similar, and R' and $^{im}R'$ for grain 2 are within 1% of these, that is, within acceptable measurement error for microscope photometry. It is relatively unusual to locate an isotropic grain in a random section of a biaxial mineral since this means that the grain has been cut and polished normal to one of the mineral's rotation axes. Indeed, it is so unusual that the Committee on Symbols and Definitions of the IMA/COM has not provided a symbol for this case. For this reason, in Table 2, the more general symbol for an anisotropic mineral that is

TABLE 2. JASKÓLSKIITE: REFLECTANCE DATA

	Grain 1				Grain 2		Grain 3			
λnm	R_1	R_2	$^{im}R_1$	$^{im}R_2$	R'	$^{im}R'$	R_1	R_2	$^{im}R_1$	$^{im}R_2$
400	41.7	44.7	27.0	29.9	44.6	29.4	38.4	44.9	23.7	30.5
410	41.6	44.5	26.8	29.6	44.3	29.0	38.4	44.8	23.5	30.1
420	41.5	44.3	26.6	29.3	43.9	28.6	38.4	44.6	23.3	29.7
430	41.3	44.2	26.3	28.9	43.5	28.2	38.3	44.4	23.0	29.3
440	41.1	43.9	26.0	28.6	43.2	27.8	38.1	44.1	22.7	28.8
450	40.9	43.6	25.7	28.3	42.9	27.5	38.0	43.9	22.4	28.4
460	40.7	43.4	25.4	27.9	42.7	27.2	37.8	43.6	22.1	28.0
470	40.4	43.2	25.1	27.7	42.5	27.0	37.6	43.4	22.0	27.7
480	40.2	42.9	24.9	27.4	42.3	26.7	37.4	43.1	21.8	27.4
490	40.0	42.8	24.6	27.2	42.1	26.5	37.2	42.9	21.6	27.1
500	39.8	42.6	24.5	27.0	41.9	26.3	37.0	42.6	21.4	26.9
510	39.7	42.4	24.3	26.8	41.8	26.1	36.9	42.4	21.3	26.7
520	39.6	42.3	24.2	26.6	41.6	26.0	36.7	42.3	21.1	26.5
530	39.5	42.2	24.1	26.5	41.6	25.9	36.6	42.1	21.0	26.4
540	39.4	42.1	24.0	26.4	41.5	25.8	36.5	42.0	21.0	26.2
550	39.3	42.0	23.8	26.3	41.3	25.7	36.4	41.8	20.9	26.1
560	39.2	41.8	23.7	26.2	41.2	25.6	36.3	41.7	20.8	26.0
570	39.1	41.7	23.6	26.0	41.1	25.4	36.2	41.6	20.7	25.9
580	39.0	41.6	23.5	25.9	41.0	25.3	36.1	41.5	20.6	25.8
590	39.0	41.5	23.4	25.8	40.9	25.2	36.0	41.4	20.5	25.7
600	38.9	41.4	23.3	25.7	40.8	25.1	36.0	41.3	20.4	25.5
610	38.8	41.3	23.2	25.6	40.6	24.9	35.9	41.1	20.4	25.4
620	38.7	41.2	23.1	25.4	40.5	24.7	35.8	41.0	20.3	25.3
630	38.6	41.0	23.0	25.3	40.3	24.5	35.6	40.8	20.2	25.1
640	38.4	40.9	22.8	25.1	40.1	24.4	35.5	40.7	20.1	24.9
650	38.2	40.6	22.6	24.9	39.9	24.1	35.4	40.5	19.9	24.8
660	38.0	40.4	22.5	24.6	39.6	23.9	35.2	40.2	19.8	24.5
670	37.8	40.1	22.2	24.4	39.4	23.7	35.0	40.0	19.6	24.3
680	37.6	39.9	22.0	24.2	39.1	23.5	34.8	39.8	19.4	24.1
690	37.3	39.7	21.8	23.9	38.9	23.2	34.6	39.6	19.2	23.9
700	37.0	39.4	21.5	23.6	38.6	23.0	34.4	39.3	19.0	23.7
Color values relative to the CIE illuminant C										
x	0.306	0.306	0.302	0.302	0.305	0.302	0.305	0.035	0.302	0.301
y	0.312	0.312	0.308	0.308	0.312	0.308	0.312	0.311	0.308	0.306
Y%	39.3	41.9	23.8	26.2	41.2	25.6	36.4	41.8	20.8	26.1
λ_d	477	478	476	477	478	478	477	477	476	475
P_e%	2.1	2.0	3.9	4.0	2.2	3.9	2.5	2.2	4.4	3.8
Color values relative to the CIE illuminant A										
x	0.443	0.443	0.440	0.440	0.443	0.440	0.443	0.442	0.440	0.439
y	0.406	0.407	0.405	0.405	0.407	0.406	0.406	0.406	0.405	0.405
Y%	39.1	41.7	23.6	26.0	41.1	25.4	36.2	41.6	20.7	25.9
λ_d	491	491	490	490	492	491	491	491	490	489
P_e%	1.0	1.1	1.9	2.0	1.2	2.0	1.1	1.3	1.9	2.1

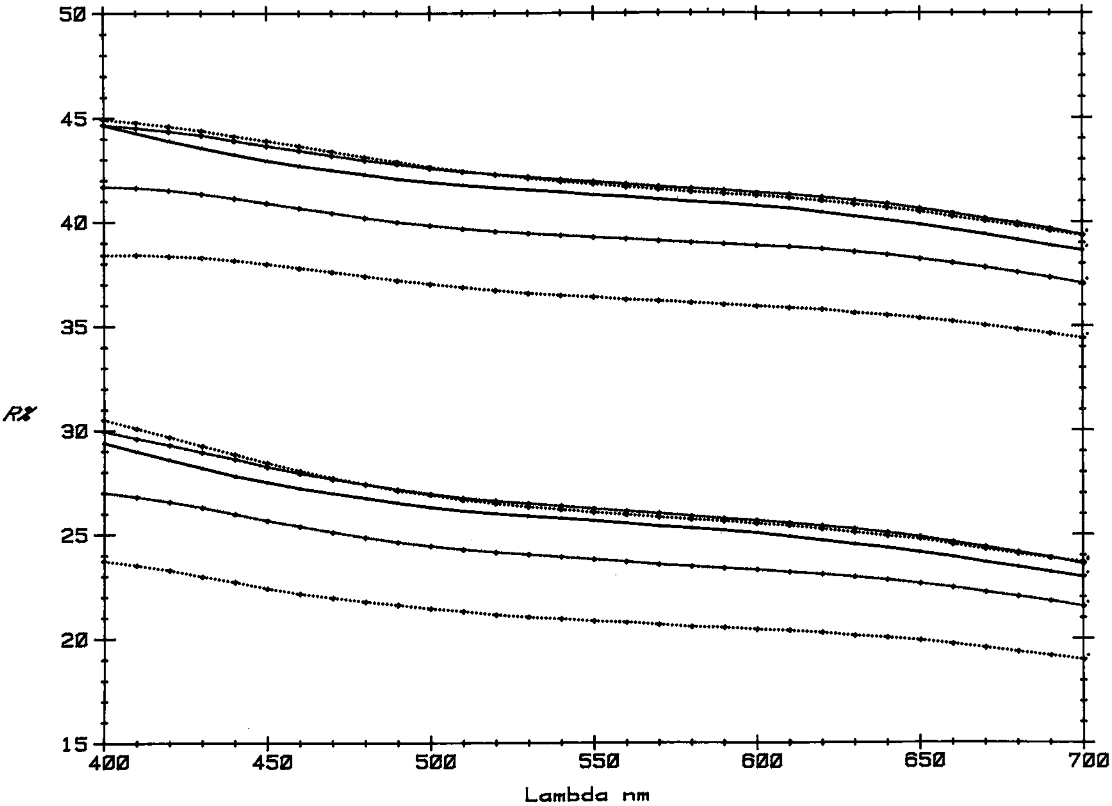

FIG. 3. R_1, R_2 (upper curves) and ${}^{im}R_1$, ${}^{im}R_2$ spectra (lower curves) between 400 and 700 nm for three grains of jaskólskiite. Sample is from hole 88, 153.1. All the spectra were measured relative to a WTiC standard, Zeiss number 314. The ${}^{im}R$ spectra were measured using Zeiss oil N_D 1.515. Measurement procedures and equipment are as described by Harris *et al.* (1984).

TABLE 3. X-RAY POWDER-DIFFRACTION DATA FOR JASKÓLSKIITE, IZOK LAKE, N.W.T.

Hole 88 153.1

Iest[1]	dÅmeas.[2]	dÅcalc[3]	hkl	Iest	dÅmeas.	dÅcalc	hkl
10	5.67	5.70	130	40	2.120	2.116	081
5	5.45	5.44	210	25b	2.041	2.043	002
3	4.96	4.95	040			1.979	0100
20	4.30	4.29	230	10	1.981	1.979	$\bar{3}71$
		3.74	150			1.979	501
90	3.73	3.72	240	20	1.964	1.963	550
		3.70	310			1.900	461
60	3.59	3.58	121	50	1.903	1.899	390
60	3.33	3.32	131			1.895	531
20	3.24	3.24	250			1.884	600
50	3.16	3.17	160	60	1.787	1.789	312
30	3.14	3.14	221			1.781	0101
90	2.957	2.960	231	3	1.757	1.760	$1\overline{10}1$
40	2.842	2.849	260			1.752	$3\overline{10}0$
		2.770	301	40	1.724	1.722	$\bar{3}91$
100	2.751	2.752	241				
		2.744	311				
10	2.523	2.529	270				
		2.278	171				
50	2.268	2.270	351				
		2.263	421				
40	2.192	2.192	431				
5	2.149	2.150	271				
		2.146	460				

[1]intensities estimated from 114.6 mm Gandolfi camera pattern employing Ni filtered Cu radiation (λ CuKα = 1.54178Å)
[2]114.6 mm. Debye-Scherrer powder camera, Cu radiation, Ni filter (λ CuKα = 1.54178Å); admixed galena lines omitted, b = broad lines
[3]indexed with a = 11.31, b = 19.79 and c = 4.087Å

measurably isotropic R' is used (Criddle 1980).

Color values for the three grains show excellent agreement between the observed and calculated color, λ_d in all instances being in the green sector; the low P_e% confirms the eye's impression of low saturation of this tint.

X-RAY STUDIES

Two fragments of jaskólskiite, dug out of a polished section, were examined by precession X-ray diffractometry employing Zr-filtered Mo radiation. Precession photographs of *hk*0, *hk*1 and 310*Λc* (with 310* as the dial axis) were taken of one fragment and 0*kl*→2*kl*, *h*0*l*→*h*3*l* (with *c** as the dial axis) were taken of the other fragment. The small size of the crystals necessitated one-week exposures for all final photographs.

Jaskólskiite is orthohombic, with measured cell-parameters *a* 11.4, *b* 19.8 and *c* 4.08 Å. Systematic absences, *h*0*l* with $h+l=2n$ and 0*kl* with $k=2n$, dictate either *Pbnm* (62) or $Pbn2_1$ (33) as permissible space-groups.

The X-ray powder-diffraction data for jaskólskiite from Izok Lake are listed in Table 3. These data are in good agreement with those obtained by Zakrzewski (1984) on material from Vena, Sweden. Refined unit-cell parameters, based on 13 powder lines between 4.30 and 1.724 Å for which unambigous indexing was possible, gave *a* 11.31(1), *b* 19.79(2), *c* 4.087(4) Å, *V* 914.8 $Å^3$ and *a*:*b*:*c* = 0.572:1:0.207.

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