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## IZOKLAKEITE, A NEW MINERAL SPECIES FROM IZOK LAKE, NORTHWEST TERRITORIES


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### ABSTRACT

Izoklakeite, a new copper – lead – antimony – bismuth sulfosalt, has been found in the massive zinc – copper – lead sulfide deposit at Izok Lake, Northwest Territories. It occurs as lead-grey acicular aggregates, a few millimetres in size, associated with galena, minor pyrrhotite and pyrite in drill hole 61 at 60.04 m. The mineral is opaque with a metallic lustre, has a grey-black streak, a good cleavage parallel to *c* and a very distinctive conchoidal fracture. The measured specific gravity is 6.47; calculated density for the analytical formula and $Z = 1$ is 6.505 g/cm$^3$. $VHN_{50}$ 150–212. In reflected plane-polarized light the mineral is weakly to moderately bireflectant from pale greenish white to darker greenish white or grey. It is moderately anisotropic. Reflectance spectra and color values for three areas are supplied. The structural cell is orthorhombic, *a* 33.88(2), *b* 38.02(2), *c* 4.070(2) Å, *V* 5243 Å$^3$ and *a*:*b*:*c* = 0.891:1:0.107. The space group is either *Pnnm* (#58) or *Pnn*2 (#34). The strongest six lines in the X-ray powder-diffraction pattern [*d* in Å(I)(*hkl*)] are 3.398(100)(780, 10.00, 2.11.0, 690), 3.305(40)(3.11.0, 451), 2.878(40)(751), 2.149(60)(0.15.1, 13.10.0, 10.10.1), 2.038(40b)(14.10.0, 2.16.1, 002) and 1.745(40)(10.02). Three electron-microprobe analyses of the same specimen, but by means of three different instruments, gave the average composition Cu 1.0, Fe 0.2, Ag 2.0, Pb 46.6, Bi 20.5, Sb 13.3, S 17.0, total 100.6 wt.%, which corresponds to $Pb_{45.94}Sb_{22.30}Bi_{20.04}Ag_{3.78}Cu_{3.21}Fe_{0.73}S_{108.30}$. The theoretical formula is $2[(Cu,Fe)_2Pb_{27}(Sb,Bi)_{19}S_{57}]$.



*Keywords:* izoklakeite, Pb–Sb–Bi–Cu sulfosalt, Izok Lake, Northwest Territories, reflectance data, microprobe analyses, X-ray data.



### SOMMAIRE

Un nouveau sulfosel de cuivre – plomb – antimoine – bismuth, l'izoklakéite, a été découvert dans le gisement de sulfure massif de zinc – cuivre – plomb du lac Izok, Territoires du Nord-Ouest. L'izoklakéite est un minéral opaque qui se présente sous forme d'agrégats aciculaires à l'échelle du millimètre, associés à de la galène et à de petites quantités de pyrrhotine et de pyrite dans le forage 61, à une profondeur de 60.04 m. Elle a un éclat métallique, un trait noir et une cassure conchoïdale très caractéristique; elle présente aussi un bon clivage parallèle à *c*. La densité mesurée est de 6.47, ou 6.505 (valeur calculée pour la formule analytique et $Z = 1$). $VHN_{50}$ 150–212. Le minéral est faiblement à moyennement biréflectant en lumière réfléchie polarisée; sa valeur varie du blanc verdâtre pâle au blanc verdâtre plus foncé ou gris. Il est plus ou moins anisotrope. Les spectres de réflectance et les valeurs des couleurs sont fournis pour trois régions. La maille élémentaire est orthorhombique, *a* 33.88(2), *b* 38.02(2), *c* 4.070(2) Å, *V* 5243 Å$^3$ et *a*:*b*:*c* 0.891:1:0.107. Le groupe spatial est soit *Pnnm* (no. 58) soit *Pnn*2 (no. 34). Les six raies les plus intenses du cliché de poudre obtenu par diffraction X [*d* en Å(I)(*hkl*)] sont les suivantes: 3.398(100)(780, 10.00, 2.11.0, 690), 3.305(40)(3.11.0, 451), 2.878(40)(751), 2.149(60)(0.15.1, 13.10.0, 10.10.1), 2.038(40b)(14.10.0, 2.16.1, 002) et 1.745(40)(10.02). La moyenne des analyses à la microsonde électronique d'un seul échantillon, effectuées à l'aide de trois instruments différents, donne la composition suivante: Cu 1.0, Fe 0.2, Ag 2.0, Pb 46.6, Bi 20.5, Sb 13.3, S 17.0, total 100.6 (en poids), qui correspond à $Pb_{45.94}Sb_{22.30}Bi_{20.04}Ag_{3.78}Cu_{3.21}Fe_{0.73}S_{108.30}$. La formule théorique est donc $2[(Cu,Fe)_2Pb_{27}(Sb,Bi)_{19}S_{57}]$.



*Mots-clés:* izoklakéite, sulfosel de Pb–Sb–Bi–Cu, lac Izok, Territoires du Nord-Ouest, données de réflectance, analyses à la microsonde, données de rayons X.


### INTRODUCTION

Izoklakeite, ideally $(Cu,Fe)_2Pb_{27}(Sb,Bi)_{19}S_{57}$, is a newly described sulfosalt from the massive zinc–

TABLE 1. CHEMICAL COMPOSITION OF IZOKLAKEITE, IZOK LAKE, NORTHWEST TERRITORIES*

| INSTITUTION | WEIGHT PERCENT | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | Cu | Fe | Ag | Pb | Bi | Sb | S | |
| GSC[1] | 0.9 | 0.2 | 2.0 | 46.5 | 20.1 | 13.2 | 17.4 | 100.3 |
| BM[2] | 1.0 | 0.2 | 2.1 | 46.7 | 20.9 | 13.3 | 16.5 | 100.7 |
| Vrije[3] | 1.0 | 0.2 | 2.0 | 46.5 | 20.4 | 13.4 | 17.1 | 100.6 |
| Average | 1.0 | 0.2 | 2.0 | 46.6 | 20.5 | 13.3 | 17.0 | 100.6 |

* based on electron-microprobe data

[1] Geological Survey of Canada, Analyst: D.C. Harris; Instrumentation: MAC electron probe run at 20kV; standards: synthetic CuS, $AgSbS_2$, PbS, $Bi_2S_3$ and $FeS_2$; Lines: Cu*Kα*, Ag*Lα*, Sb*Lα*, Pb*Lα*, Bi*Lα*, Fe*Kα*, S*Kα*.

[2] British Museum (Natural History), Analyst: C.J. Stanley; Instrumentation: Microscan IX electron probe run at 20kV; Standards: pure elements, PbS and FeS; Lines: Cu*Kα*, Fe*Kα*, Ag*Lα*, Pb*Mα*, Bi*Mα*, Sb*Lα*, S*Kα*.

[3] Vrije Universiteit, Analyst: C. Kieft; Instrumentation: Microscan IX electron probe; Standards: pure elements, $Sb_2S_3$, FeS, $CuFeS_2$ and PbS; Lines: Cu*Kα*, Fe*Kα*, Ag*Lα*, Pb*Lα*, Bi*Lα*, Sb*Lα*, S*Kα*.

copper–lead sulfide deposit at Izok Lake, Northwest Territories. Shortly after the discovery, a second occurrence was reported in skarn ore from a cobalt deposit at Vena, Bergslagen metallogenic province, Sweden (Zakrzewski 1984). The mineral is named after Izok Lake, where it was first recognized. The mineral and the name have been approved by the Commission on New Minerals and Mineral Names, I.M.A. Type material is preserved at the British Museum (Natural History) in polished mount E.812 BM 1983,75. Drill core and other polished sections are housed in the National Mineral Collection, Systematic Reference Series, at the Geological Survey of Canada, Ottawa (NMC 64415, 64416 and 64417) and also at the Royal Ontario Museum, Toronto.

## Occurrence

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

The major ore-minerals are pyrite, sphalerite, pyrrhotite, silver-bearing chalcopyrite (Harris *et al.* 1984a, Cabri *et al.* 1984), magnetite and silver-bearing galena, with minor to trace amounts of thirty-one other metallic minerals, including the second known occurrence of jaskólskiite (Harris *et al.* 1984b). Izoklakeite is rare in the deposit, having been identified only in drill hole 61 at a depth of 60.04 m, where it occurs as millimetre-sized acicular aggregates intergrown with galena, minor pyrrhotite and pyrite.

## Electron-Microprobe Analyses

A single polished section containing izoklakeite was analyzed using different electron-microprobes at the Geological Survey of Canada, Ottawa, at the British Museum (Natural History), London and at the Vrije Universiteit, Amsterdam. The results are listed in Table 1; the excellent agreement in results from the different institutions demonstrates the reliability of these microprobe data.

The structural analysis of material from the Vena deposit (Makovicky & Mumme 1984) has shown that izoklakeite is a homologue of kobellite for N = 4, the composition varies between $T_4^+Pb_{52}M^{3+}{}_{40}S_{114}$ and $T^{2+}{}_4Pb_{56}M^{3+}{}_{36}S_{114}$ where $T^+$ = Cu, Ag, $T^{2+}$ = Fe, Cu, and $M^{3+}$ = Sb, Bi. Based on 96 cations, the averaged result of the microprobe analyses of Izok Lake material can be recalculated to $Pb_{45.94}Sb_{22.30}Bi_{20.04}Ag_{3.78}Cu_{3.21}Fe_{0.73}S_{108.30}$ in the unit cell. Fe and Cu are assigned to tetrahedral positions. Ag must be assigned to the large metal co-ordination polyhedra according to the substitution scheme $Ag^+ + (Sb,Bi)^{3+} = 2\ Pb^{2+}$. Comparison of the analytical results with the structural formulae having Ag + (Sb,Bi) assigned to the Pb site leads to $Pb_{53.5}(Sb,Bi)_{38.56}(Cu,Fe)_{3.94}S_{108.3}$. The theoretical formula for izoklakeite is $2[(Cu,Fe)_2Pb_{27}(Sb,Bi)_{19}S_{57}]$. Further details about the calculation scheme are outlined in Zakrzewski & Makovicky (1986).

## Physical and Optical Properties

The mineral is lead grey in color, opaque with a

TABLE 2. IZOKLAKEITE: REFLECTANCE DATA

| | Grain 1 | | | | Grain 2 | | | | Grain 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| λnm | $R_1$ | $R_2$ | $im_{R_1}$ | $im_{R_2}$ | $R_1$ | $R_2$ | $im_{R_1}$ | $im_{R_2}$ | $R_1$ | $R_2$ | $im_{R_1}$ | $im_{R_2}$ |
| 400 | 44.9 | 46.1 | 29.3 | 30.9 | 43.5 | 44.9 | 29.3 | 30.7 | 44.6 | 48.5 | 29.7 | 34.2 |
| 410 | 44.5 | 45.7 | 29.0 | 30.6 | 43.3 | 44.7 | 29.0 | 30.4 | 44.3 | 48.5 | 29.4 | 34.0 |
| 420 | 44.1 | 45.3 | 28.7 | 30.2 | 43.1 | 44.5 | 28.7 | 30.1 | 44.1 | 48.4 | 29.0 | 33.7 |
| 430 | 43.7 | 44.9 | 28.4 | 29.8 | 42.8 | 44.3 | 28.3 | 29.7 | 43.8 | 48.3 | 28.6 | 33.4 |
| 440 | 43.3 | 44.5 | 28.0 | 29.4 | 42.6 | 44.1 | 27.9 | 29.3 | 43.5 | 48.0 | 28.3 | 33.0 |
| 450 | 42.9 | 44.2 | 27.7 | 29.0 | 42.3 | 43.8 | 27.5 | 29.0 | 43.2 | 47.8 | 27.9 | 32.7 |
| 460 | 42.6 | 43.8 | 27.3 | 28.6 | 42.1 | 43.5 | 27.1 | 28.6 | 42.8 | 47.4 | 27.5 | 32.3 |
| 470 | 42.3 | 43.5 | 26.9 | 28.2 | 41.8 | 43.2 | 26.7 | 28.2 | 42.5 | 47.2 | 27.1 | 31.9 |
| 480 | 42.0 | 43.2 | 26.5 | 27.9 | 41.5 | 42.9 | 26.3 | 27.8 | 42.2 | 46.9 | 26.7 | 31.5 |
| 490 | 41.7 | 42.9 | 26.2 | 27.5 | 41.2 | 42.6 | 26.0 | 27.5 | 41.9 | 46.6 | 26.4 | 31.2 |
| 500 | 41.4 | 42.6 | 25.9 | 27.2 | 40.9 | 42.3 | 25.7 | 27.1 | 41.6 | 46.2 | 26.1 | 30.8 |
| 510 | 41.1 | 42.3 | 25.6 | 26.9 | 40.7 | 42.0 | 25.4 | 26.8 | 41.3 | 46.0 | 25.8 | 30.5 |
| 520 | 40.8 | 42.0 | 25.3 | 26.6 | 40.4 | 41.8 | 25.1 | 26.5 | 41.0 | 45.7 | 25.5 | 30.1 |
| 530 | 40.6 | 41.8 | 25.1 | 26.3 | 40.2 | 41.5 | 24.8 | 26.2 | 40.8 | 45.5 | 25.2 | 29.8 |
| 540 | 40.3 | 41.6 | 24.8 | 26.1 | 40.0 | 41.3 | 24.6 | 26.0 | 40.6 | 45.2 | 24.9 | 29.6 |
| 550 | 40.1 | 41.4 | 24.6 | 25.9 | 39.7 | 41.1 | 24.4 | 25.8 | 40.3 | 45.0 | 24.7 | 29.3 |
| 560 | 39.9 | 41.2 | 24.4 | 25.8 | 39.6 | 40.9 | 24.2 | 25.6 | 40.1 | 44.8 | 24.5 | 29.1 |
| 570 | 39.7 | 41.0 | 24.3 | 25.6 | 39.4 | 40.7 | 24.0 | 25.4 | 40.0 | 44.6 | 24.4 | 28.9 |
| 580 | 39.6 | 40.8 | 24.1 | 25.4 | 39.2 | 40.6 | 23.9 | 25.2 | 39.8 | 44.4 | 24.2 | 28.7 |
| 590 | 39.4 | 40.7 | 23.9 | 25.2 | 39.1 | 40.4 | 23.7 | 25.1 | 39.7 | 44.3 | 24.1 | 28.5 |
| 600 | 39.3 | 40.6 | 23.8 | 25.1 | 39.0 | 40.3 | 23.6 | 24.9 | 39.6 | 44.1 | 24.0 | 28.4 |
| 610 | 39.2 | 40.4 | 23.6 | 24.9 | 38.8 | 40.2 | 23.5 | 24.8 | 39.5 | 44.0 | 23.9 | 28.2 |
| 620 | 39.0 | 40.3 | 23.5 | 24.8 | 38.7 | 40.1 | 23.4 | 24.7 | 39.3 | 43.8 | 23.8 | 28.1 |
| 630 | 38.9 | 40.2 | 23.4 | 24.7 | 38.6 | 39.9 | 23.2 | 24.6 | 39.2 | 43.7 | 23.6 | 27.9 |
| 640 | 38.8 | 40.0 | 23.3 | 24.5 | 38.5 | 39.8 | 23.1 | 24.4 | 39.1 | 43.5 | 23.4 | 27.8 |
| 650 | 38.6 | 39.9 | 23.2 | 24.4 | 38.3 | 39.6 | 22.9 | 24.3 | 38.9 | 43.4 | 23.3 | 27.6 |
| 660 | 38.5 | 39.7 | 23.0 | 24.2 | 38.2 | 39.5 | 22.8 | 24.1 | 38.8 | 43.2 | 23.2 | 27.4 |
| 670 | 38.3 | 39.6 | 22.9 | 24.1 | 38.0 | 39.4 | 22.7 | 24.0 | 38.6 | 43.1 | 23.0 | 27.3 |
| 680 | 38.2 | 39.4 | 22.7 | 23.9 | 37.9 | 39.2 | 22.5 | 23.8 | 38.5 | 42.9 | 22.9 | 27.1 |
| 690 | 38.0 | 39.2 | 22.5 | 23.7 | 37.7 | 39.1 | 22.3 | 23.7 | 38.3 | 42.7 | 22.7 | 26.9 |
| 700 | 37.8 | 39.1 | 22.4 | 23.6 | 37.6 | 38.9 | 22.2 | 23.5 | 38.2 | 42.5 | 22.5 | 26.7 |
| Color values relative to the CIE illuminant C | | | | | | | | | | | | |
| x | 0.303 | 0.303 | 0.298 | 0.298 | 0.303 | 0.303 | 0.298 | 0.298 | 0.303 | 0.303 | 0.298 | 0.298 |
| y | 0.309 | 0.309 | 0.303 | 0.304 | 0.309 | 0.309 | 0.303 | 0.303 | 0.309 | 0.310 | 0.303 | 0.304 |
| Y% | 40.1 | 41.4 | 24.6 | 25.9 | 39.7 | 41.1 | 24.4 | 25.8 | 40.3 | 45.0 | 24.8 | 29.3 |
| λd | 477 | 477 | 477 | 477 | 478 | 478 | 476 | 476 | 477 | 478 | 476 | 477 |
| $P_e$% | 3.6 | 3.5 | 6.1 | 5.9 | 3.3 | 3.3 | 6.2 | 6.0 | 3.5 | 3.2 | 6.1 | 5.7 |
| Color values relative to the CIE illuminant A | | | | | | | | | | | | |
| x | 0.441 | 0.441 | 0.436 | 0.436 | 0.441 | 0.441 | 0.436 | 0.436 | 0.441 | 0.441 | 0.436 | 0.437 |
| y | 0.405 | 0.406 | 0.403 | 0.404 | 0.406 | 0.406 | 0.403 | 0.403 | 0.405 | 0.406 | 0.403 | 0.404 |
| Y% | 39.8 | 41.1 | 24.3 | 25.6 | 39.4 | 40.8 | 24.1 | 25.5 | 40.1 | 44.7 | 24.5 | 29.0 |
| λd | 490 | 490 | 489 | 489 | 490 | 490 | 489 | 488 | 490 | 491 | 488 | 489 |
| $P_e$% | 1.8 | 1.7 | 2.9 | 2.9 | 1.7 | 1.7 | 3.0 | 2.9 | 1.7 | 1.6 | 2.9 | 2.8 |

metallic lustre; it has grey-black streak. Izoklakeite is brittle, with a good cleavage parallel to *c* and a very distinctive conchoidal fracture. The measured specific gravity, based on a 4.26 mg hand-picked sample using a Berman balance, is 6.47. The calculated density for $Pb_{45.94}Sb_{22.30}Bi_{20.04}Ag_{3.78}Cu_{3.21}Fe_{0.73}S_{108.30}$ and $Z = 1$ is 6.505 g/cm$^3$. The microhardness $VHN_{50}$, based on 10 indentations, is in the range 150-212, which is equivalent to a Mohs hardness of 3.7-4.2.

In reflected, plane-polarized light, izoklakeite is weakly to moderately bireflectant. Its appearance with an unfiltered quartz-halogen source (at 3100 K) varies from pale greenish white to a slightly darker greenish white or grey. The greenish tint is most noticeable where it is intergrown with the slightly higher reflecting and purer white galena and, at its own grain boundaries, in polycrystalline areas. In oil, the tints are unchanged, but the bireflectance is a little stronger. It is distinctly anisotropic with greenish mid-grey to dark grey to brownish grey rotation-tints. With the analyzer uncrossed by 3°, the rotation tints are: mid-bluish grey to light greenish grey to greenish white to mid-grey. In oil, the rotation tints appear more intense.

Reflectance measurements were made on three grains of izoklakeite using the equipment and procedure described by Criddle *et al.* (1983). Virtually all the grains of the mineral in polished section E.812 are weakly bireflectant. Grains 1 and 2 (Table 2) are typical in having a measured bireflectance of about 1% throughout the visible spectrum. The abundance of weakly bireflecting izoklakeite in this section suggests a preferred crystallographic orientation of most of the grains; however, a few more bireflectant grains were located, and one, grain 3 (Table 2), was meas-

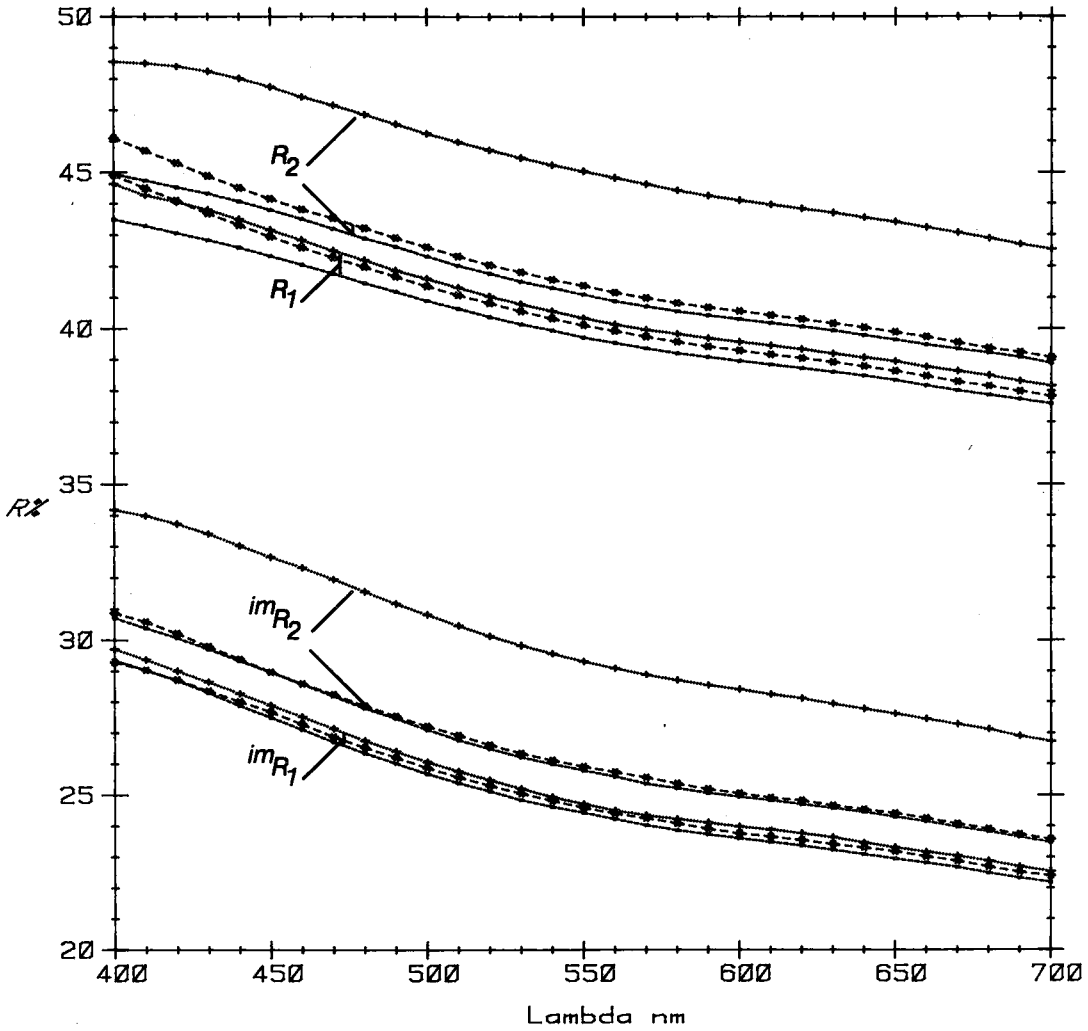


FIG. 1. $R_1$, $R_2$ and $^{im}R_1$, $^{im}R_2$ spectra between 400 and 700 nm for three grains of izoklakeite.

ured. $R_1$ and $R_2$ for this grain have the same dispersion as those for grains 1 and 2, but its bireflectance of about 5% in air and oil (Fig. 1) is much stronger than those of grains 1 and 2.

The color values (Table 2) calculated from these spectra confirm the visual impression of the weak greenish tint of the mineral, *d* for illuminant A (comparable in color temperature with the quartz-halogen lamp used in the description of the mineral) being in the green sector. The weakness of this tint is explained by the consistently low levels of excitation purity of $\leq 3\%$. It is worth noting that if a blue-filtered light-source had been used (as is the case in many laboratories), the mineral would have appeared blue or bluish grey, not green, as may be seen in the color values for illuminant C (Table 2).

## X-RAY STUDIES

Two acicular crystals were examined by precession and Weissenberg single-crystal techniques employing Zr-filtered Mo radiation for the former and unfiltered Cu radiation for the latter. One crystal was oriented parallel to, and the other normal to, the axis of elongation (*c*). X-ray photographs collected were *hk*0, *hkl*, *hk*2, 0*kl*, *and h*0*l*.

Izoklakeite is orthorhombic, with measured unit-cell parameters *a* 33.9, *b* 38.1 and *c* 4.06 Å. Systematic absences, *h*0*l* with $h+l \neq 2n$ and 0*kl* with $k+l \neq 2n$, dictate either *Pnnm* (#58) or *Pnn*2 (#34) as permissible space-groups.

The X-ray powder-diffraction data for izoklakeite are listed in Table 3. Refined unit-cell parameters,

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

| Iest[1] | dÅ[2] meas. | dÅ[3] calc | hkl | Iest[1] | dÅ[2] meas. | dÅ[3] calc | hkl |
|---|---|---|---|---|---|---|---|
| 3 | 8.44 | 8.43 | 330 | 5 | 2.530 | 2.530 | 10100 |
| 3 | 5.67 | 5.65 | 600 | 5 | 2.496 | 2.494 | 1121 |
| 3b | 4.59 | 4.63 | 560 | 1 | 2.462 | 2.463 | 1051 |
| | | 4.53 | 650 | 3 | 2.346 | 2.347 | 1290 |
| 20 | 4.24 | 4.23 | 800 | 20 | 2.316 | 2.313 | 991 |
| 3 | 4.11 | 4.10 | 290 | 3 | 2.283 | 2.284 | 1081 |
| 15 | 3.91 | 3.94 | 211 | 5 | 2.253 | 2.254 | 1141 |
| | | 3.89 | 580 | | | 2.191 | 1311 |
| 30 | 3.77 | 3.78 | 490 | 3 | 2.188 | 2.189 | 6131 |
| 20b | 3.60 | 3.60 | 3100 | | | 2.187 | 12110 |
| 5 | 3.56 | 3.57 | 151 | | | 2.152 | 0151 |
| | | 3.55 | 341 | 60 | 2.149 | 2.150 | 13100 |
| 5 | 3.48 | 3.47 | 4100 | | | 2.148 | 10101 |
| | | 3.420 | 351 | 25 | 2.110 | 2.112 | 0180 |
| | | 3.407 | 161 | | | 2.109 | 1351 |
| 100 | 3.398 | 3.391 | 780 | 20 | 2.080 | 2.081 | 13110 |
| | | 3.388 | 1000 | | | 2.042 | 14100 |
| | | 3.387 | 2110 | 40b | 2.038 | 2.037 | 2161 |
| | | 3.383 | 690 | | | 2.035 | 002 |
| 40 | 3.305 | 3.305 | 3110 | 10 | 2.007 | 2.006 | 1451 |
| | | 3.304 | 451 | | | 1.980 | 12101 |
| 30 | 3.159 | 3.154 | 6100 | 10 | 1.978 | 1.976 | 1461 |
| | | 3.119 | 641 | | | 1.975 | 1501 |
| 3 | 3.113 | 3.115 | 701 | 10 | 1.946 | 1.948 | 1391 |
| | | 3.115 | 2120 | 20 | 1.893 | 1.893 | 1690 |
| 25 | 3.035 | 3.041 | 281 | | | 1.850 | 16100 |
| | | 3.029 | 651 | 20 | 1.848 | 1.850 | 3181 |
| 10 | 2.978 | 2.990 | 7100 | | | 1.849 | 7190 |
| | | 2.960 | 741 | | | 1.847 | 8161 |
| 5 | 2.921 | 2.920 | 191 | 25 | 1.816 | 1.816 | 10151 |
| 40 | 2.878 | 2.882 | 751 | 15 | 1.788 | 1.788 | 912 |
| 30 | 2.831 | 2.837 | 391 | 3 | 1.766 | 1.765 | 17100 |
| | | 2.823 | 1200 | 40 | 1.745 | 1.744 | 1002 |
| 15 | 2.799 | 2.796 | 761 | | | | |
| 20 | 2.741 | 2.742 | 2101 | | | | |
| 3 | 2.690 | 2.690 | 591 | | | | |
| 3 | 2.639 | 2.640 | 4101 | | | | |
| 10 | 2.596 | 2.597 | 951 | | | | |

[1] intensities visually estimated b = broad line
[2] 114.6 mm Debye-Scherrer powder camera, Cu radiation, Ni filter (λ Cukα = 1.54178Å)
[3] indexed with a = 33.88, b = 38.02 and c = 4.070Å

based on 25 powder lines between 4.14 and 1.745 Å for which unambiguous indexing, based on both precession and Weissenberg single-crystal films, was possible, gave *a* 33.88(2), *b* 38.02(2), *c* 4.070(2) Å, *V* 5243 Å$^3$ and *a*:*b*:*c* 0.891:1.0.107.

## ACKNOWLEDGEMENTS

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