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**ELEMENTS OF
OPTICAL MINERALOGY**

**ELEMENTS OF
OPTICAL MINERALOGY**

AN INTRODUCTION TO
MICROSCOPIC PETROGRAPHY

BY

A. N. WINCHELL

Part I. Principles and Methods. Fifth Edition. Cloth; 6 by 9; 262 pages; 305 figures.

Part II. Descriptions of Minerals. With Special Reference to their Optic and Microscopic Characters. Third Edition. Cloth; 6 by 9; 439 pages; 362 figures.

Part III. Determinative Tables. Second Edition, New Printing. Cloth; 6 by 9; 230 pages; three folding charts.

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ELEMENTS OF OPTICAL MINERALOGY

AN INTRODUCTION TO
MICROSCOPIC PETROGRAPHY

BY

ALEXANDER N. WINCHELL, *Doct. Univ. Paris*
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SECOND EDITION, SECOND PRINTING

PART III. DETERMINATIVE TABLES

WITH A COLORED CHART AND TWO DIAGRAMS

NEW YORK
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PREFACE TO THE SECOND EDITION

SECOND PRINTING

DURING the ten years since the publication of the second edition of these tables many new minerals have been described. About fifty of these are included in the third edition of Part II, which was published in 1933, while nearly seventy are of more recent date. The author has attempted to include in supplementary tables in this printing all the new minerals which seem to be well established and adequately described as to their optical properties. Unfortunately it has not been feasible to incorporate them in the main tables, but this is probably not a very serious difficulty since the minerals in question are all very rare.

It is hoped that the use of colored paper for the table (III) classifying minerals on the basis of their color (and pleochroism) in thin section will make it easy to find the various tables quickly and conveniently.

In the preparation of this printing the author has benefited by the assistance and encouragement of his wife, Florence S. Winchell.

ALEXANDER N. WINCHELL

MADISON, WISCONSIN
March, 1939

PREFACE TO THE SECOND EDITION

OF course tables prepared for the determination of minerals by optical methods should be based on the chief optical properties of the minerals. However, it is not at all obvious just which optical property should be used first in classifying the minerals. After several attempts to combine the most important properties in one table so that more than one of them could be used first, it seemed wiser to simplify the arrangement by making separate tables for each important property. In addition to the tables which are given, tables might be prepared based primarily upon the optic angle, optic sign, or extinction angles. However, the practical groups based upon optic angle or optic sign are too few in number to be satisfactory, while extinction angles are almost useless in distinguishing between tetragonal, hexagonal and orthorhombic minerals. Thus it comes about that the chief tables which are given are based upon refringence, or birefringence, or color (and pleochroism). As the dispersion methods of determining minerals come into wider use the table based upon dispersion will become more complete and more useful.

It is a pleasure to acknowledge that these tables have been improved as a result of thoughtful constructive criticism of the first draft by Professor F. F. Grout of the University of Minnesota; the writer has also had the advantage of an opportunity to examine copies of determinative mineral tables prepared by Professor Grout and others prepared by Professor D. J. Fisher of the University of Chicago. He has also benefited notably by frequent consultations with Professor R. C. Emmons of the University of Wisconsin.

Plate II, based on refringence and birefringence, has been prepared along lines suggested by Professor C. O. Swanson of the Michigan College of Mines and Professor R. H. B. Jones of the State College of Washington.

ALEXANDER N. WINCHELL.

MADISON, WISCONSIN,
January, 1929

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For an explanation of the plates see page..... 213

ABBREVIATIONS USED IN THE TABLES

(Miller symbols and chemical formulas need no explanation here)

<i>a</i>	= front and rear crystal axis.	Efferv.	= effervesces (with acid)
Abn.	= abnormal	El.	= elongation
Abs.	= absorption	Elong.	= elongation
Acic.	= acicular	Eq.	= equant
Alter.	= alteration	Ext.	= extinction
Ang.	= angle	Extr.	= extreme
Aniso.	= anisotropic		
Antim.	= antimonate	Fib.	= fibrous or fibers
Arsen.	= arsenate	Frac.	= fracture
<i>b</i>	= right and left crystal axis	G.	= specific gravity
Biax.	= biaxial	Gel.	= gelatinizes with
Biref.	= birefringence	Gr.	= green
Bl.	= blue	Gran.	= granular
Bor.	= borate		
Br.	= brown	H.	= hardness
Bx.	= bisectrix	Hal.	= halide
		Hex.	= hexagonal
		Hygro.	= hygroscopic
<i>c</i>	= vertical crystal axis		
Carb.	= carbonate	Ign.	= igneous
Chem.	= chemical (nature or composition)	Incl.	= inclusions
Chrom.	= chromate	Insol.	= insoluble
Cin.	= cinnamon	Int.	= interference
Cl.	= cleavage	Is.	= isometric
Cleav.	= cleavage	Isom.	= isometric
Col.	= color	Isotr.	= isotropic
Coll.	= colloidal		
Colum.	= columbate	Lam.	= lamellar
Comp.	= complex	Lg.	= large
Conch.	= conchoidal		
Cont.	= continued	Mass.	= massive
Cub.	= cubic	Max.	= maximum
Cryst.	= crystal	Mod.	= moderate
		Molyb.	= molybdate
		Mon.	= monoclinic
Dec.	= decomposed by	N	= index of refraction
Decrep.	= decrepitates	N _e	= index of refraction for the extraordinary ray
Deliques.	= deliquescent	N _g	= greatest index of refraction
Disp.	= dispersion	N _m	= mean index of refraction
Dist.	= distinct	N _o	= index of refraction for the ordinary ray
Dodec.	= dodecahedral		
Dom.	= domatic		

N_p	= least index of refraction	Tab.	= tabular
Nit.	= nitrate	Tant.	= tantalate
Oct.	= octahedral	Tel.	= tellurate
Opt.	= optic	Tet.	= tetragonal
Or.	= orientation	Tetar.	= tetartohedral
Orth.	= orthorhombic	Tet'h.	= tetrahedral
Ox.	= oxide	Tit.	= titanate
Oxal.	= oxalate	Tr.	= triclinic.
Part.	= parting	Trap.	= trapezohedral
Perf.	= perfect	Tung.	= tungstate
Phos.	= phosphate	Twin.	= twinning
Pinac.	= pinacoidal	V	= half of true optic angle
Pleo.	= pleochroic or pleochroism	Van.	= vanadate
Prism.	= prismatic	Var.	= variable
Pneumat.	= pneumatolytic	Vit.	= vitreous
Pt.	= parting	X	= vibration direction of the fast ray
Ps.	= pseudo.	Y	= vibration direction of the intermediate ray
Pyr.	= pyramidal	Yel.	= yellow
Rh.	= rhombohedral	Z	= vibration direction of the slow ray
Rhom.	= rhombohedral	>	= greater than
Sel.	= selenate	$\geq$	= greater than or equal to
Sil.	= silicate	<	= less than
Skel.	= skeleton	$\wedge$	= angle between
Sm.	= small	$\perp$	= normal to
Sol.	= soluble in	||	= parallel to
Str.	= strong	$\pm$	= plus or minus (or nearly)
Sul.	= sulphate		
Syst.	= system		

The sign of the extinction angle in monoclinic minerals is positive when it is measured in the obtuse angle between a and c and negative when it is measured in the acute angle β .

OPTICAL MINERALOGY

PART III

INTRODUCTION

DETERMINATIVE TABLES

IN order to use determinative tables based on optical properties successfully the worker must be familiar with optical principles and the methods of applying them to the measurement or estimation of the optical properties of minerals; these topics are discussed in Part I of this work.

The following tables are as complete as available data permit so far as transparent or translucent minerals are concerned. Only a few of the commoner opaque minerals are included, because the ordinary petrographic methods are not well adapted for the study of such minerals.

In general, the tables summarize the data for the minerals described in Part II of this work. In some cases minerals are described somewhat incompletely in Part II and this condition may lead to their necessary omission from one or more of the tables composing (this) Part III. In a few other cases, data, published since the appearance of Part II, have been used in the tables. The tables include all natural minerals whose optic properties are known.

The first of the following tables deals with the common opaque minerals; so far as these are always opaque in standard thin sections they are not included in the other tables. Those minerals which are sometimes opaque and sometimes translucent in thin section are included in this first table and also in the other tables, so far as available data regarding them permit.

The second table which follows is based primarily upon the birefringence of minerals and secondarily upon their refringence. In order to use this property of refringence with more precision the following scale has been adopted:

SCALE OF REFRACTANCE

1. Fluorite, $N = 1.434$. Negative distinct. $N < 1.48$.
Limit: Natrolite, $N_m = 1.48 \pm$. Castor oil, $N = 1.48 \pm$.
2. Leucite, $N = 1.509$. Negative low. $N > 1.48 < 1.54$.
Limit: $\left\{ \begin{array}{ll} \text{Microcline, } N_o = 1.529. & \text{Clove oil, } N = 1.531-1.533. \\ \text{Fennel oil, } N = 1.54. & \\ \text{Quartz, } N_o = 1.544. & \text{Canada balsam, } N = 1.533-1.541. \end{array} \right.$
3. Labradorite, $N_m = 1.557-1.567$. Positive low. $N > 1.53 < 1.59$.
Limit: Muscovite, $N_m = 1.59 \pm$. Bromoform, $N = 1.589$.
4. Apatite, $N_o = 1.634$. Positive moderate. $N > 1.59 < 1.66$.
Limit: Enstatite, $N_m = 1.66 \pm$. α -Monobromnaphthalene, $N = 1.65-1.66$.
5. Augite, $N_m = 1.71 \pm$. Positive high. $N > 1.66 < 1.74$.
Limit: Staurolite, $N_m = 1.741-1.753$. Methylene iodide, $N = 1.742$.
6. Zircon, $N_o = 1.93-1.96$. Positive very high. $N > 1.74 < 2.00$.
Limit: Zincite, $N_o = 2.008$. Amorphous sulphur, $N = 1.998$.
7. Rutile, $N_o = 2.61 \pm$. Positive extreme. $N > 2.00$.

Whenever an unknown mineral is in contact with any of the minerals or liquids which form the limits of this scale of refringence, so that a direct comparison of indices can be made by the method of vertical or inclined illumination, an accurate classification is possible even if the differences in the indices are very slight. For this purpose not only are the minerals and liquids named above available, but other common minerals and liquids which are near these limits may be used. The following table may be useful in this connection:

COMMON MINERALS NEAR THE LIMITS OF THE SCALE OF REFRACTANCE

Between 1 (negative distinct) and 2 (negative low):

Natrolite.....	$N = 1.48 \pm$	Cristobalite.....	$N = 1.486$
Chabazite.....	$N_m = 1.48 \pm$	Analcite.....	$N = 1.487$
Gmelinite.....	$N_m = 1.48 \pm$	Borax.....	$N_o = 1.472$
Sodalite.....	$N = 1.483-1.487$	Tridymite.....	$N_o = 1.473$

Between 2 (negative low) and 3 (positive low):

Microcline.....	$N_o = 1.529$	Quartz.....	$N_o = 1.544$
Orthoclase.....	$N_o = 1.526$	Oligoclase.....	$N_m = 1.543$
Gypsum.....	$N_o = 1.530$	Chalcedony.....	$N_m = 1.537$
Albite.....	$N_m = 1.529$	Nephelite.....	$N_o = 1.536-1.547$
Anorthoclase.....	$N_m = 1.529$	Cordierite.....	$N_m = 1.543 \pm$

Between 3 (positive low) and 4 (positive moderate):

Muscovite.....	$N_g = 1.59 \pm$	Anorthite.....	$N_g = 1.585 \pm$
Chlorite.....	$N_m = 1.57-1.62+$	Beryl.....	$N_o = 1.58-1.60$
Talc.....	$N_m = 1.58-1.59$	Scapolite ($\text{Ma}_{25}\text{Me}_{75}$)..	$N_o = 1.59 \pm$

Between 4 (positive moderate) and 5 (positive high):

Enstatite.....	$N_m = 1.66$	Forsterite.....	$N_m = 1.66$
Calcite.....	$N_o = 1.6585$	Gehlenite.....	$N_c = 1.658$
Sillimanite.....	$N_m = 1.66 \pm$	Spodumene.....	$N_p = 1.65-1.67$
Tourmaline.....	$N_o = 1.668$ (average)		$1.65-1.67$ (blue and green)

Between 5 (positive high) and 6 (positive very high):

Staurolite.....	$N_m = 1.74-1.75$	Chloritoid.....	$N_m = 1.74 \pm$
Grossularite.....	$N = 1.735$	Rhodonite.....	$N = 1.73-1.76$
Hedenbergite.....	$N_m = 1.737$	Augite.....	$N_g = 1.71-1.73$
Epidote (of moderate birefringence)	$N_m = 1.74-1.75$		

Between 6 (positive high) and 7 (positive extreme):

Zincite.....	$N_o = 2.008$	Titanite.....	$N_g = 2.01 \pm$
Cassiterite.....	$N_o = 1.997$	Sulphur.....	$N_m = 2.038$
Schorlomite.....	$N = 1.95-2.01$	Picotite.....	$N = 2.05 \pm$

It is evident that an unknown mineral will not be found in contact with all these limit minerals. However, in thin sections, the unknown mineral is always immersed in Canada balsam, and the index of this substance is therefore commonly taken as a standard. If a mineral has a lower index than balsam its relief (and refringence) may be said to be negative, and, if higher, positive. Unfortunately balsam is rarely pure and therefore its index is not invariable; actual measurements have shown that it rarely passes the limits, 1.533 and 1.541; but, in order to be on the safe side, the tables include in the division of "negative low relief" minerals of indices up to 1.544 ($= N_o$ in quartz), and in the division of "positive low relief" minerals of indices as low as 1.529 ($= N_g$ in microcline). Even then there may be difficulty with sections prepared in the last few years since balsam dissolved in xylol has come into use, because such balsam may have an index less than that of orthoclase, perhaps even below 1.520. Therefore it is desirable to check the index of the balsam by a comparison with that of known minerals, especially potash feldspar.

It is believed that minerals can be classed accurately in this scale whenever they belong near the middle of one of the divisions, simply by comparing the relief of the unknown mineral with that of the various type minerals selected or with that of the minerals selected as limits. For this purpose the type minerals or the limit minerals may be sought in sections already available, or, more conveniently, the

type minerals or the limit minerals may all be mounted with the proper orientation to show the indices desired on a single slide. Such a slide would then serve as a standard for comparisons. When unknown minerals belong near a limit between two divisions of the scale of refringence a comparison of the relief is not sufficient to classify them accurately, and, if the unknown mineral is not in contact with a limit mineral (or substitute), and cannot be tested with a liquid, it may be necessary to assume that the mineral may belong in either one of the two divisions concerned.

So far as the refringence is concerned minerals are classified in the tables on the basis of N , N_o , or N_m . That is, the single index, N is used if the mineral is isotropic, the index of the ordinary ray, N_o , is used if the mineral is uniaxial, and the intermediate index, N_m , is used if the mineral is biaxial. This can lead to no difficulties with isotropic minerals. If the mineral is uniaxial, every grain or anhedron, in whatever position it may be, can be made to give the relief due to N_o simply by turning the stage to that position of extinction at which the vibration direction of the ordinary ray in the mineral coincides with the vibration direction of the lower nicol. Any position of a basal section may be used. If the mineral is biaxial every grain or anhedron has two indices of refraction; N_o' and N_p' , such that $N_o' \geq N_m \geq N_p'$. That is, one index is always greater than, or equal to, N_m , and the other is always equal to, or less than, N_m . Every section or grain normal to an optic axis, and therefore having minimum birefringence, has two equal indices of refraction which are each equal to N_m . Any section or grain normal to a bisectrix or merely normal to the optic plane can be used to obtain N_m accurately, since it is only necessary to turn the mineral until the direction normal to the optic plane is parallel with the vibration direction of the lower nicol. Therefore, it is always possible to estimate, at least approximately, the value of N_m for an unknown biaxial mineral. If the birefringence of the unknown mineral is not great the relief of any grain or section in any position is sufficient to give a close approximation to the value of N_m ; if the birefringence is strong or extreme it is important to study the relief in each extinction position, and on several grains or anhedra.

However, the most important advantage of using N , N_o and N_m in the tables is that their use makes it possible to estimate the refringence correctly without any preliminary study as to biaxial or uniaxial character. It is only necessary to select that grain or section which

shows the minimum interference color in order to obtain from it in any position the index which is used in the tables.

Of course, all minerals whose index of refraction varies (usually because of variation in composition) are entered in the tables in as many places as necessary to express the complete range of variation.

The main divisions in the table are based on the birefringence. For convenience in the use of this character the following scale has been employed.

SCALE OF BIREFRINGENCE

No. Mineral	Birefringence	Max. interf. colors in sections 0.03 mm. thick
1. Leucite.	Very weak. $N_g - N_p < 0.0035$.	Dark grays.
2. Orthoclase.	Weak. $N_g - N_p > 0.0035 < 0.0095$.	Gray and white } First order
3. Hypersthene.	Moderate. $N_g - N_p > 0.0095 < 0.0185$.	Yellow and red } Second order
4. Augite.	Rather strong. $N_g - N_p > 0.0185 < 0.0275$.	Blue and green } Second order
5. Tourmaline.	Strong. $N_g - N_p > 0.0275 < 0.0365$.	Yellow and red } Third order
6. Muscovite.	Very strong. $N_g - N_p > 0.0365 < 0.0545$.	Blue to red. Third order
7. Titanite.	Extreme. $N_g - N_p > 0.0545$.	Greenish and violet grays. Higher orders

Since all anisotropic minerals may be oriented so as to give the lowest interference colors, only the *maximum* birefringence is a property of determinative value, and it is necessary to assume that the maximum interference color can be obtained from the given unknown mineral (or, at least, a color near the maximum). In the case of minerals whose (maximum) birefringence varies with variation in composition, as in hornblende and epidote, the names are entered in as many subdivisions as necessary to express the complete range of variation.

The second table is based primarily upon birefringence and secondarily upon refringence. The fifty six groups thus established are subdivided still further on the basis of color and crystallization for the groups dealing with isotropic minerals and on the basis of optic sign, cleavages, elongation, extinction directions with respect to elongation or cleavages and color. For the purposes of this table cleavages are not considered to be "visible" unless they are described as "perfect" or are known to be readily observed in thin section. Thus, the "distinct" cleavage of olivine is so difficult of observation in thin section that it is not considered "visible."

The third table which follows, like the second, is designed primarily for use in connection with the study of thin sections. It is based,

first, on the color and pleochroism of minerals in thin sections, and secondarily upon the birefringence. In each subdivision, thus formed, the minerals are arranged in the order of increasing refringence. Of course, minerals vary in color; they are entered in the table in as many places as necessary to express all these variations, so far as known; but too much reliance should not be put on color alone as a means of identifying minerals. The table may, nevertheless, be useful as a means of suggesting possibilities in many cases.

The fourth and fifth tables are designed primarily for use with powders and immersion liquids, though the fourth table can also be used to good advantage under favorable circumstances in the study of thin sections. The fourth table is based primarily upon the refringence of minerals. It is divided into two parts, the first one including the isotropic minerals and the second one including the anisotropic minerals. In each part the minerals are arranged in the order of increasing refringence and all known variations in refringence are shown by means of vertical lines at the right of the column of indices. In the second part of the table positive minerals are distinguished from negative ones by indenting the indices of refraction of negative minerals two spaces to the right.

The fifth table is based primarily on the dispersion of minerals, that is, on the difference in index of refraction (N , N_o or N_m) in light of the F line wave-length and light of the C line wave-length. In each group, thus established, the minerals are arranged in the order of increasing refringence. This table is intended for use with powdered minerals and immersion liquids. It presents all available data, but is remarkably incomplete.

Neither the relative abundance nor the relative importance of minerals can be measured quantitatively; both are matters of estimate and vary with time and place. Nevertheless, minerals vary so greatly in these respects that it seems worth while to express this variation, even though the expression be only the author's estimate of the condition. For this purpose the names of minerals in the tables are set in different styles of type, as follows:

1. Bold-face capital letters are used for very common minerals, like quartz, calcite and orthoclase, and also for a few very important minerals like nephelite.

2. Bold-face lower case letters are used for common minerals, like tremolite, rutile, tourmaline, etc., and also for a few important minerals, like analcite, andalusite and cordierite.

3. Ordinary Roman type is used for less common minerals, like chabazite, humite and pectolite, and also for minerals quite abundant or important in rare rocks, ores and other unusual mineral aggregates, such as aegirite, arsenopyrite, diamond, galena, halite, malachite, etc.

4. Italic type is used for many very rare minerals, such as agricolite, cervantite and hillebrandite.

TABLE I.—OPAQUE MINERALS

The petrographic microscope is not well adapted to the study of minerals which are opaque in thin section; therefore only those few of the commonest opaque minerals are included in the following table which were included in Part II of this work. No one working with the petrographic microscope should expect to identify an opaque mineral with certainty unless it has a *characteristic* color in reflected light, a condition which is quite rare. Nevertheless, the commoner opaque minerals can be recognized with a high degree of probability in many cases, and the table of opaque minerals will assist in this work. For accurate study of opaque minerals special mineragraphic microscopes should be used and the samples should not be mounted in thin sections, but very highly polished on one uncovered side. For more complete directions for such work reference may be made to the works of Murdoch, Davy and Farnham, Schneiderhöhn and van der Veen.

Minerals which are always opaque in thin sections are included in the following table, and, in general, not included in the other tables; minerals which are subtranslucent to opaque in thin section are included for convenience both in the following table and in the other tables, so far as known data permit.

The page references in the following table refer to the third edition of Part II of this work.

TABLE I.—OPAQUE MINERALS

TABLE I.—OPAQUE MINERALS

MINERALS, WHICH ARE OPAQUE BECAUSE OF AGGREGATE EFFECTS, LIKE LEUCOXENE,
SOME LIMONITE, GLAUCONITE, ETC., ARE NOT INCLUDED HERE

1. Always opaque in thin sections of standard thickness

Color in Reflected Light	Cleavage	System	Mineral	Chemical	Other Characters	Page
Steel blue.....	111 part.	Isom.	MAGNETITE	Fe_3O_4	Magnetic. Common	63
	None	Rhom.	Ilmenite	FeTiO_3	Alters to leucoxene	66
	None	Rhom.	HEMATITE	Fe_2O_3	Oxidation product	44
Iron black to steel gray.....	111 part.	Isom.	<i>Franklinite</i>	Ox.	In rare ores	63
	None	Isom.	Chromite	FeCr_2O_4	Oct. In ign. rocks	62
	100 perf.	Isom.	<i>Iron</i>	Fe	Very magnetic. Rare	16
	?	Isom.	<i>Ulrichite</i>	$\text{UO}_2?$	In veins and pegmatites	68
	?	Isom.	<i>Metacinnabarite</i>	HgS	Unstable. Rare	21
	001 dist.	Tet.	<i>Hausmannite</i>	Mn_3O_4	In ores. Rare	64
Lead gray.....	111 perf.	Tet.	<i>Braunite</i>	Mn_2O_3	In ores. Rare	66
	0001 perf.	Hex.	Graphite	C	Very soft. Uncommon	14
	100 dist.	Orth.	Columbite	Colum.	In pegmatite. Rare	165
	110 perf.	Orth.	<i>Enargite</i>	Cu_3AsS_4	In Cu ores. G. = 4.4	28
	010 perf.	Mon.	Wolframite	Tung.	In veins and pegmatites	101
	100 perf.	Isom.	Galena	PbS	In veins, contacts, etc.	19
Silver white.....	None	Isom.	<i>Argentite</i>	AgS	In veins. Rare	19
	0001 perf.	Hex.	Molybdenite	MoS_2	In veins and pegmatites	26
	001, 100	Orth.	Chalcocite	Cu_2S	In veins, etc. Rare	18
	110 dist.	Orth.	Arsenopyrite	FeAsS	In veins, etc. Rare	24
	None	Isom.	<i>Silver</i>	Ag	In veins, etc. Rare	16
	None	Isom.	<i>Gold</i>	Au	In veins, placers, etc.	16
Brass yellow.....	None	Isom.	Pyrite	FeS_2	G. = 5. Widely distributed	22

TABLE I.—OPAQUE MINERALS

Brass yellow, dark.....	None	Tet.	Chalcopyrite	CuFeS ₂	In veins, etc.	26
Bronze yellow.....	ooor poor	Hex.	Pyrrhotite	FeS	Magnetic. Not rare	21
Bronze yellow.....	110 dist.	Orth.	Marcasite	FeS ₂	In coal, veins, etc.	24
Copper red.....	None	Isom.	<i>Copper</i>	Cu	In veins, etc. Rare	16
Copper red, brownish.....	None	Isom.	<i>Bornite</i>	Cu ₃ FeS ₄	In veins, etc. Rare	26
Copper red, pale.....	None	Hex.	<i>Nickelite</i>	NiAs	In veins, etc. Rare	20
Deep red.....	None	Rhom.	HEMATITE	Fe ₂ O ₃	Oxidation product	44
Indigo blue.....	ooor perf.	Hex.	<i>Coëllite</i>	CuS	In veins, etc. Rare	20

2. Subtranslucent to opaque in thin section. In reflected light most of the following minerals are steel gray; hematite is usually red, but specularite is like steel in reflected light

Red, cherry.....	None	Isom.	Tetrahedrite	Cu ₉ Sb ₂ S ₆	Spinel luster. Rare	26
Red, dark.....	None	Isom.	<i>Magnisoferrite</i>	MgFe ₂ O ₄	About volcanoes. Rare	61
Red, brownish.....	None	Isom.	Chromite	FeCr ₂ O ₄	Oct. In ign. rocks	62
Red, dark.....	110 dist.	Tet.	Rutile	TiO ₂	Sparse, but not rare	59
Red, brownish.....	∞1 perf.	Tet.	<i>Heterolite</i>	ZnMn ₂ O ₄	In ores. Rare	65
Red, blood.....	None	Rhom.	HEMATITE	Fe ₂ O ₃	Oxidation product	44
Red, dark.....	∞10 perf.	Orth.	Stibnite	Sb ₂ S ₃	In veins, etc. Rare	25
Red, dark.....	100 dist.	Orth.	<i>Tantalite</i>	Tant.	In pegmatites, etc.	165
Red, dark.....	∞10 poor	Mon.	<i>Miargyrite</i>	AgSbS ₂	In veins, etc. Rare	27
Red, blood.....	None	Mon. ?	<i>Arizonaite</i>	Ox. ?	In pegmatite. Rare	68
	None	Tet.	<i>Platnerite</i>	PbO ₂	In oxide zone of veins	53
Brown.....	∞1 dist.	Tet.	<i>Hausmannite</i>	Mn ₃ O ₄	In ores. Rare	64
	∞10 poor	Orth.	<i>Samaraskite</i>	Colum.	In pegmatites. Rare	166
	?	Orth.	<i>Hjelmite</i>	Tant.	In pegmatites. Rare	166
	100	Isom.	<i>Dysanilite</i>	Tit.	In contacts, etc. Rare	163
Brown or green.....	∞1, ∞10	Orth.	Ilvaite	Sil.	In contacts, etc. Rare	431
	∞1 perf.	Mon.	Cronstedtite	Sil.	In ores, etc. Not common	285

TABLE II.—BIREFRINGENCE OF MINERALS

In thin section it is usually possible to estimate the birefringence of any unknown mineral at least approximately by means of its maximum interference color and a measure or estimate of the thickness of the section. Therefore a determinative table based primarily on the birefringence is highly desirable. It is true that the chart of birefringences (Plate I) is based on the same property, but the colored chart shows only the rock-forming minerals and is therefore incomplete and unsatisfactory when studying ores and other uncommon mineral aggregates. Furthermore, the colored chart shows only the birefringence of minerals, while the following table of birefringence serves to identify the minerals also by means of their refringence, cleavage, color, crystal form, optic sign, optic angle, optic orientation, etc.

Many minerals vary more or less in their chemical composition and therefore in their physical properties, including their birefringence. Each mineral is entered in the tables in as many places as necessary to express all variations in its properties, so far as they are known.

For methods of estimating or measuring the birefringence of minerals, see the fifth edition of Part I, pages 116-124 and 135-137.

For methods of estimating or measuring the refringence of minerals, see Part I, pages 75-85 and (for minerals in powder form) pages 228-239 and 248-253.

For a discussion of cleavage, see Part I, pages 29-32. For the purposes of this table cleavages are not considered to be "visible" unless they are known to be observed readily in thin section or are described as "perfect."

For a discussion of color and absorption, see Part I, pages 55-56.

For methods of determining pleochroic formulas, see Part I, pages 170, 171, 204, and 211.

For definitions of X, Y and Z, see Part I, pages 117 and 160.

For methods of distinguishing between X, Y and Z, see Part I, pages 124, 130, 137, and 211.

For a discussion of crystal forms and crystal systems, see Part I, pages 2-26.

For methods of determining the optic sign, see Part I, pages 129-132, 138, 148-154, 169, and 206-213.

For methods of estimating or measuring the optic axial angle, see Part I, pages 186-189, 211, 226, and 245.

For methods of determining the optic orientation of a mineral, see Part I, pages 170, 171, 205, and 212.

For methods of measuring extinction angles, see Part I, pages 126, 137, 173, 174, and 178.

For a list of abbreviations and symbols used in the table see page xiii.

The last column in the table gives the page of the third edition of Part II of this work on which a more complete description of each mineral may be found.

Success in using the table is absolutely dependent upon accuracy in assigning an unknown mineral to the subdivision to which it belongs; therefore the following outline classification should be used with the utmost care.

Birefringence. ($N_g - N_p$)	Optic Sign	Refringence (N , N_o or N_m)						
		< 1.48	> 1.48 < 1.54	> 1.53 < 1.59	> 1.59 < 1.66	> 1.66 < 1.74	> 1.74 < 2.00	> 2.00
		Group	Group	Group	Group	Group	Group	Group
0.000		1	2	3	4	5	6	7
< 0.0035	+	8	9a	10a	11a	12	13	14
	-		9b	10b	11b			
> 0.0035 < 0.0095	+	15a	16a	17a	18a	19a	20a	21
	-	15b	16b	17b	18b	19b	20b	
> 0.0095 < 0.0185	+	22a	23a	24a	25a	26a	27a	28a
	-	22b	23b	24b	25b	26b	27b	28b
> 0.0185 < 0.0275	+	29a	30a	31a	32a	33a	34a	35a
	-	29b	30b	31b	32b	33b	34b	35b
> 0.0275 < 0.0365	+	36	37a	38a	39a	40a	41a	42
	-		37b	38b	39b	40b	41b	
> 0.0365 < 0.0545	+	43	44a	45a	46a	47a	48a	49a
	-		44b	45b	46b	47b	48b	49b
> 0.0545	+	50	51a	52a	53a	54a	55a	56a
	-		51b	52b	53b	54b	55b	56b

TABLE II.—BIREFRINGENCE OF MINERALS

O. BIREFRINGENCE ZERO: $N_g - N_p = 0.000$

Cleavage, Optic Orient.	Habit, etc.	Color	N	Mineral	Chem.	Other Characters	Page
Group 1. Refrindex negative and distinct: $N < 1.48$							
A. Uncolored in thin section and not isometric							
None	Clay	Colorless	1.40?	<i>Termitite</i>	Sil.	G. = 1.2? Sol. HCl	415
None	Mass.	Colorless	1.41-6	<i>Opal</i>	Ox.	G. = 2.1. Sol. HF or KOH	57
None	Vit.	Colorless	1.458	<i>Lechatelierite</i>	SiO ₂	G. = 2.2. Sol. HF	57
None	Clay	Colorless	1.47-9	<i>Allophane</i>	Sil.	G. = 1.87. Gel. HCl	415
None	Clay	Colorless	1.47-1.57	<i>Halloysite</i>	Sil.	G. = 2.1. Sol. HF	415
B. Uncolored in thin section and isometric							
111 perf.	Oct.	Colorless	1.339	<i>Hieratite</i>	Hal.	G. = 2.75. Sol. H ₂ O	36
110 perf.	Oct.	Colorless	1.339	<i>Cryolithionite</i>	Hal.	G. = 2.78. Sol. H ₂ O	34
None	Oct.	Colorless	1.427	<i>Ralsstonite</i>	Hal.	Also biref. with 2V = Ig.	36
111 perf.	Cub.	Colorless	1.434	<i>Fluorite</i>	CaF ₂	G. = 3.18. Sol. H ₂ SO ₄	31
111	Gran.	Colorless	1.435-1.45	<i>Yttriofluorite</i>	Hal.	Color fades in light	35
?	Cub.	Colorless	1.45-6	<i>Melanophlogite</i>	SiO ₂	Black on heating	54
None	Dodec.	Colorless	1.454	<i>Sulfosalite</i>	Sul.	G. = 2.5. Sol. H ₂ O	118
None	Isom.	Colorless	1.456	<i>Potassalumite</i>	Sul.	G. = 1.76. Sol. H ₂ O	113
None	Fib.	Colorless	1.457	<i>Tschermigite</i>	Sul.	G. = 1.64. Sol. H ₂ O	113
111 dist.	Oct.	Colorless	1.48	<i>Faujasite</i>	Sil.	Also biref. Gel. HCl*	382
001 diff.	Trap.	Colorless	1.48-9	<i>Analcite</i>	Sil.	Also biref. Gel. HCl	293
C. Colored in thin section							
111 perf.	Cub.	Tinted ±	1.434	<i>Fluorite</i>	CaF ₂	G. = 3.18. Sol. H ₂ SO ₄	31
111 poor	Gran.	Violet	1.435	<i>Yttrocerite</i>	Hal.	G. = 3.5. Sol. HCl	36

III	Yel., gr.	1.435-1.45	<i>Yttrifluorite</i>	Hal.	Color fades in light	35
?	Yellow $\pm$	1.45-6	<i>Malanophlogite</i>	SiO ₂	Black on heating	54
None	Yel., br.	1.45-7	<i>Hisingerite</i>	Sil.	G. = 3. Dec. HCl	415
None	Brown	1.47?	<i>Neotocite</i>	Sil.	G. = 2.7. Dec. HCl	413

Group 2. Refractive negative and low: $N > 1.48 < 1.54$

A. Uncolored in thin section and not isometric

None	Clay	1.47-9	<i>Allophane</i>	Sil.	G. = 1.87. Gel. HCl	415
None	Conch.	1.485	<i>Evansite</i>	Phos.	G. = 1.94. Sol. H ₂ SO ₄	145
None	Mass.	1.49+	<i>Vashegyite</i>	Phos.	G. = 1.96. Sol. HCl	144
None	Mass.	1.50 $\pm$	<i>Stenensite</i>	Sil.	Alter. of pectolite	419
None	Mass.	1.50 $\pm$	<i>Montmorillonite</i>	Sil.	G. = 2. $\pm$	434
None	Mass.	1.517	β - <i>Sepiolite</i>	Sil.	G. = 2.	410
None	Mass.	1.517	<i>Planerite</i>	Phos.	G. = 2.65. Dec. HCl	145
None	Mass.	1.53	<i>Kehoeite</i>	Phos.	G. = 2.34. Sol. HCl	158
None	Mass.	1.53 $\pm$	<i>Spadaite</i>	Sil.	Pearly luster. Gel. HCl	413

B. Uncolored in thin section and isometric

III dist.	Oct.	1.48	<i>Faujasite</i>	Sil.	Also biref. Gel. HCl	382
100 diff.	Trap.	1.48-9	<i>Analcite</i>	Sil.	Also biref. Gel. HCl	293
100 poor	Dodec.	1.485	<i>Sodalite</i>	Sil.	G. = 2.14-2.4. Gel. HCl	289
?	Oct.	1.486	<i>Metacrystobalite</i>	SiO ₂	G. = 2.27. Sol. HF	54
100 perf.	Cub.	1.49	Sylvite	KCl	G. = 1.98. Sol. H ₂ O	30
100 poor	Trap.	1.508	LEUCITE	Sil.	G. = 2.47. Dec. HCl	291
None	Oct.	1.508	<i>Tychite</i>	Sul.	G. = 2.5. Sol. HCl	118
None	Oct.	1.514	<i>Northupite</i>	Carb.	Also biref. G. = 2.38	85
None	Cub.	1.525	<i>Pollucite</i>	Sil.	G. = 2.9. Dec. HCl	293
?	Tetar.	1.535	<i>Langbeinite</i>	Sul.	G. = 2.83. Sol. H ₂ O	110

TABLE II.—BIREFRINGENCE OF MINERALS

O. BIREFRINGENCE ZERO: $N_g - N_p = 0.000$ —continued

Cleavage, Optic Orient.	Habit, etc.	Color	N	Mineral	Chem.	Other Characters	Page
Group 2. Refrindex negative and low: $N > 1.48 < 1.54$ —continued							
C. Colored in thin section							
110 poor	Dodec.	Blue, etc.	1.48-9	Noselite	Sil.	G. = 2.3. Gel. HCl	290
110 poor	Dodec.	Yel., bl., red	1.485	Sodalite	Sil.	G. = 2.14-2.4. Gel. HCl	289
110 poor	Dodec.	Violet	1.487	Hackmanite	Sil.	G. = 2.4 Gel. HCl	290
110 poor	Dodec.	Blue, etc.	1.49-1.51	Haunite	Sil.	G. = 2.4. Gel. HCl	290
110 poor	Dodec.	Blue	1.50±	Lazurite	Sil.	G. = 2.4. Gel. HCl	290
None	Coll.	Yellow	1.5±	Rosierite	Phos.	G. = 2.2. Sol. HNO ₃	145
None	Coll.	Bl., br.	1.525-1.55	Cornuile	Sil.	G. = 2. Opaline. Sol. HCl	413
None	Coll.	Yellow	1.53-4	Succinite	C, H	G. = 1.07. Sol. alcohol	89
None	Mass.	Brown	1.53-7	Neotocite	Sil.	G. = 2.7. Dec. HCl	413
Group 3. Refrindex positive and low: $N > 1.53 < 1.59$							
A. Uncolored in thin section							
None	Mass.	Colorless	1.53	Kelovite	Phos.	G. = 2.34. Sol. HCl	158
None	Mass.	Colorless	1.53±	Spadinite	Sil.	Pearly luster. Gel. HCl	413
?	Tet'h	Colorless	1.535	Langbeinite	Sil.	G. = 2.83. Sol. H ₂ O	110
100 perf.	Cub.	Colorless	1.544	Halite	Hal.	G. = 2.17. Sol. H ₂ O	29
None	Mass.	Colorless	1.55	Montmorillonite	Sil.	G. = 2.±	434
None	Mass.	Colorless	1.555	Collyrite	Sil.	G. = 2.±. F. = 7.	435
None	Mass.	Colorless	1.56-1.61	Bauxite	Ox.	G. = 2.55. Sol. H ₂ SO ₄	49
?	Tet'h.	Pink	1.57	Manganoalangeinite	Sul.	G. = 3. Sol. H ₂ O	110
None	Mass.	Colorless	1.57-1.62	Collophane	Phos.	G. = 2.6-2.9. Sol. HNO ₃	161
None	Mass.	Colorless	1.584	Schroetterite	Sil.	G. = 2.±	415

III ?	Tet'h. Cub.	Colorless Colorless	1.59± 1.59	<i>Zunyite</i> <i>Kochite</i>	Sil. Sil.	G.=2.87. Sol. G.=2.93	HF HF	414 414
B. Colored in thin section								
None	Coll.	Bl. or br.	1.525-1.55	<i>Cornüite</i>	Sil.	G.=2. Opaline. Sol.	HCl	413
None	Coll.	Yellow	1.53-4	<i>Succinile</i>	C, H	G.=1.07. Sol.	alcohol	89
None	Mass.	Brown	1.53-1.7	Allanite	Sil.	G.=3.±. Gel.	HCl	316
None	Coll.	Brown	1.53-7	<i>Neotile</i>	Sil.	G.=2.7. Dec.	HCl	413
oor perf.	Lam.	Green	1.55-1.68	Chlorite	Sil.	G.=2.6-3.0. Dec.	HCl	276
None	Mass.	Green	1.56-1.61	<i>Zaräite</i>	Carb.	G.=2.6±. Sol.	HCl	85
None	Mass.	Brown	1.57-1.67	<i>Borickite</i>	Phos.	G.=2.7±. Sol.	HCl	157
None	Mass.	Brown	1.57±	<i>Hisingerite</i>	Sil.	G.=3. Dec.	HCl	415
None	Mass.	Green	1.59	<i>Garnierite</i>	Sil.	G.=2.5±. Dec	HCl	261
Group 4. Refrindex positive and moderate: $N > 1.59 < 1.66$								
A. Uncolored in thin section								
?	Cub.	Colorless	1.59	<i>Kochite</i>	Sil.	G.=2.93		414
None	Mass.	Colorless	1.6-1.87	<i>Stibiconite</i>	Ox.	G.=5.2±. Also biref.		68
oor dist.	Var.	Colorless	1.607	<i>Eudialite</i>	Sil.	Colored in mass. G.=3±		417
None	Mass.	Colorless	1.62-1.70	<i>Diadochite</i>	Sul.	Opaline		121
III poor	Cub.	Colorless	1.642	<i>Salmonianite</i>	NH ₄ Cl	G.=1.53. Sol.	H ₂ O	30
B. Yellow in thin section								
None	Mass.	Orange	1.59±	<i>Hisingerite</i>	Sil.	G.=3. Dec.	HCl	415
None	Mass.	Yellow	1.61±	<i>Gummite</i>	Ox.	G.=4±. Sol.	HCl	68
None	Mass.	Yellow±	1.62-1.70	<i>Diadochite</i>	Sul.	Opaline		121
None	Mass.	Yel., br.	1.63-5	<i>Griphite</i>	Phos.	G.=3.4. Sol.	HCl	155
None	Mass.	Yellow	1.64	<i>Picite</i>	Phos.	G.=2.83		145
None	Mass.	Yellow	1.64±	<i>Lagonite</i>	Bor.	Earthy		94
None	oor	Yellow±	1.64	<i>Homilite</i>	Sil.	Also biref. G.=3.3±		424
None	Mass.	Yel., gr.	1.65	<i>Grenatite</i>	Sil.	G.=2.8±. Sol.	HCl	413

TABLE II.—BIREFRINGENCE OF MINERALS
O. BIREFRINGENCE ZERO: $N_g - N_p = 0.000$ —*continued*

Cleavage, Optic Orient.	Habit, etc.	Color	N	Mineral	Chem.	Other Characters	Page
Group 4. Refrindex positive and moderate: $N > 1.59 < 1.66$ — <i>continued</i>							
C. Brown in thin section							
None	Mass.	Brown	1.53–1.7	Allanite	Sil.	G. = 3±. Gel. HCl	316
None	Mass.	Brown	1.57–1.67	<i>Borckite</i>	Phos.	G. = 2.7±. Sol. HCl	157
None	Mass.	Brown	1.59±	<i>Hisingerite</i>	Sil.	G. = 3. Dec. HCl	415
None	Mass.	Br., yel.	1.63–5	<i>Griphite</i>	Phos.	G. = 3.4. Sol. HCl	155
None	Mass.	Red-br.	1.635	<i>Pitticite</i>	Sul.	G. = 2.2–2.5. Sol. HCl	121
None	Mass.	Br., gr.	1.65	<i>Greenalite</i>	Sil.	G. = 2.8±. Sol. HCl	413
D. Green in thin section							
oor perf.	Lam.	Green	1.55–1.68	Chlorite	Sil.	G. = 2.6–3.0. Dec. HCl	276
None	Mass.	Green	1.59	<i>Garnierite</i>	Sil.	G. = 2.5±. Dec. HCl	261
?	Oct.	Green	1.60±	<i>Volhite</i>	Sul.	G. = 2.75. Sol. HCl	115
None	Mass.	Gr., br.	1.65	<i>Greenalite</i>	Sil.	G. = 2.8±. Sol. HCl	413
Group 5. Refrindex positive and high: $N > 1.66 < 1.74$							
A. Uncolored in thin section							
None	Mass.	Colorless	1.6–1.87	<i>Stibiconite</i>	Ox.	G. = 5.2±. Also biref.	68
None	Oct.	Colorless	1.67±	<i>Hibschite</i>	Sil.	Also biref. G. = 3. Sol. HCl	429
None	Dodec.	Colorless	1.675	<i>Plasolite</i>	Sil.	G. = 3.1	183
iii poor	Tet'h.	Colorless	1.694	<i>Rhodizite</i>	Bor.	Also biref. G. = 3.35	94
None	Isom.	Tinted ±	1.71+	Pyrope	Sil.	G. = 3.6±. Insol.	178
None	?	Colorless	1.727	<i>Berzelite</i>	Arsen.	G. = 4. Sol. HNO ₃	122
iii poor	Oct.	Tinted ±	1.73±	Spinel	Ox.	G. = 3.6. Sol. H ₂ SO ₄	62
None	Dodec.	Colorless	1.735+	Grossularite	Sil.	G. = 3.5±. Insol.	180

100 perf. None	Cub. Mass.	Colorless Colorless	1.735± 1.74±	<i>Percidase</i> <i>Pilbarite</i>	MgO Ox.	G.=3.65. Sol. HCl G.=4.6. Sol. HCl	41 185
B. Yellow, brown, or red in thin section							
None	Mass.	Brown	1.53-1.7	Allanite	Sil.	G.=3±. Gel. HCl	316
None	Mass.	Brown	1.57-1.67	<i>Borikite</i>	Phos.	G.=2.7±. Sol. HCl	157
110 ?	Tet.	Yel., br.	1.68-1.72	<i>Thorite</i>	Ox.	Also biref. G.=5±	185
110 poor	Cub.	Yellow ±	1.69	<i>Pharmacosiderite</i>	Phos.	G.=3.0. Sol. HCl	143
None	Orth.	Brown	1.70	<i>Polyrase</i>	Column.	G.=5.0. Dec. H ₂ SO ₄	167
None	Isom.	Br., red	1.71±	Pyrope	Sil.	G.=3.6±. Insol.	178
None	Mass.	Br., yel.	1.72	<i>Delvauxite</i>	Phos.	G.=1.9±. Concretions	145
111 poor	Oct.	Red, etc.	1.73±	<i>Spinel</i>	Ox.	G.=3.6. Sol. H ₂ SO ₄	62
None	Rhom.	Yel., br.	1.73-1.76	<i>Tritomite</i>	Sil.	G.=4.3. Dec. HCl	420
None	Dodec.	Yel.-red	1.735+	Grossularite	Sil.	G.=3.5±. Insol.	180
111 poor	Tet'h	Pink	1.737	<i>Dandite</i>	Sil.	G.=3.4. Gel. HCl	291
111 poor	Tet'h.	Yellow	1.739	<i>Helvite</i>	Sil.	G.=3.2. Gel. HCl	291
None	Rhom.	Yel.-br.	1.74±	<i>Caryocerite</i>	Sil.	G.=4.3. Dec. HCl	420
C. Green or blue in thin section							
001 perf.	Lam.	Green	1.55-1.68	Chlorite	Sil.	G.=2.6-3.0. Dec. HCl	276
100 poor	Cub.	Green	1.69	<i>Pharmacosiderite</i>	Phos.	G.=3.0. Sol. HCl	143
None	Isom.	Green	1.725	<i>Rosandite</i>	Sil.	G.=4.5. Gel. HCl	420
111 poor	Oct.	Blue, green	1.73±	<i>Spinel</i>	Ox.	G.=3.6. Sol. H ₂ SO ₄	62
Group 6. Refrference positive and very high: $N > 1.74 < 2.00$							
A. Uncolored in thin section and not isometric							
None	Mass.	Colorless	1.6-1.87	<i>Stibiconite</i>	Ox.	G.=5.2. Also biref.	68
None	Mass.	Colorless	1.74	<i>Pilbarite</i>	Ox.	G.=4.6. Sol. HCl	185
None	Tet.	Colorless	1.77	<i>Ma-kintoshite</i>	Ox.	G.=5.4. Sol. HCl	185
None	Tet.	Colorless	1.82-1.93	<i>Malacon</i>	Ox.	G.=4±. Dec. H ₂ SO ₄	184
None	Var.	Colorless	1.88-2.06	<i>Cernantite</i>	Ox.	G.=4. Sol. HCl	67

TABLE II.—BIREFRINGENCE OF MINERALS
 O, BIREFRINGENCE ZERO: $N_g - N_p = 0.000$ —continued

Cleavage, Optic Orient.	Habit, etc.	Color	N	Mineral	Chem.	Other Characters	Page
Group 6. Refrindex positive and very high: $N > 1.74 < 2.00$—continued							
B. Uncolored in thin section and isometric							
iii poor	Oct.	Tinted $\pm$	1.74 $\pm$	Spinel	Ox.	G. = 3.6. Sol. H_2SO_4	62
None	Dodec.	Tinted $\pm$	1.74 $\pm$	Grossularite	Sil.	G. = 3.5 $\pm$. Insol.	180
None	Oct.	Colorless	1.755	Arsenolite	As_2O_3	G. = 3.7. Sol. H_2O	43
None	Oct.	Tinted $\pm$	1.87 $\pm$	Chalcocampprite	Colum.	G. = 3.77. Insol.	164
None	Oct.	Tinted $\pm$	1.92 $\pm$	Betafite	Tit.	G. = 4. Insol.	164
None	Oct.	Tinted $\pm$	1.92-1.96	Samirésite	Colum.	G. = 5.24. Insol.	164
None	Oct.	Colorless	1.93	Microsite	Tant.	G. = 5.5. Insol.	164
100	Cub.	Colorless	1.93	Nantokite	CuCl	G. = 3.93. Sol. H_2O	30
None	Oct.	Colorless	1.95-1.99	Neotantalite	Tant.	G. = 5.2. Insol.	164
None	Oct.	Tinted $\pm$	1.98 $\pm$	Hatchelolite	Colum.	G. = 4.8 $\pm$. Insol.	164
C. Yellow in thin section							
iii poor	Oct.	Yel., red, etc.	1.74 $\pm$	Spinel	Ox.	G. = 3.6. Sol. H_2SO_4	62
None	Dodec.	Yellow $\pm$	1.74 $\pm$	Grossularite	Sil.	G. = 3.5 $\pm$. Insol.	180
None	Rhom.	Yel., brown	1.74 $\pm$	Caryocrite	Sil.	G. = 4.3. Dec. HCl	420
100	Cub.	Yel.-br.	1.812	Beckelite	Sil.	G. = 4.1. Sol. HCl	420
iii	Cub.	Yellow	1.82-7	Roméite	Antim.	G. = 5. Insol.	159
iii	Oct.	Yel., br.	1.96-2.02	Pyrochlore	Tit.	G. = 4.3. Dec. H_2SO_4	163
None	Orth.	Br., yel.	2.0 $\pm$	Wiikite	Colum.	G. = 3.8-4.8. Insol.	167
D. Brown in thin section							
iii poor	Oct.	Br., red, etc.	1.74 $\pm$	Spinel	Ox.	G. = 3.6. Sol. H_2SO_4	62
None	Dodec.	Brown $\pm$	1.74 $\pm$	Grossularite	Sil.	G. = 3.5 $\pm$. Insol.	180

None	Rhom.	Yel., br.	1.74±	<i>Caryocrite</i>	Sil.	G.=4.3. Dec. HCl	420
None	?	Brown	1.77	<i>Melanocrite</i>	Sil.	G.=4±. Sol. HCl	420
None	Dodec.	Br., red	1.78-1.83	Almandite	Sil.	G.=4.2±. Insol.	178
None	Prism.	Gr., br.	1.78±	Gadolinite	Sil.	G.=4±. Gel. HCl	424
iii fair	Oct.	Gr., bl., br.	1.79-1.81	<i>Gahnite</i>	Ox.	G.=4.5±. Sol. H ₂ SO ₄	63
None	Oct.	Brown	1.8±	<i>Manganspinel</i>	Ox.	G.=4. Insol.	62
None	Tet.	Gr., br.	1.82	<i>Naegite</i>	Ox.	G.=4.1. Insol.	65
None	Mass.	Gr., br.	1.86±	<i>Bindheimite</i>	Antim.	G.=4.6. Insol.	160
None	Dodec.	Br., red	1.86-2.01	Schorlomite	Sil.	G.=3.7-3.9. Insol.	183
iii	Oct.	Yel., br.	1.96-2.02	Pyrochlore	Tit.	G.=4.3. Dec. H ₂ SO ₄	159
None	Orth.	Br., yel.	2.0±	<i>Wükkite</i>	Column.	G.=3.8-4.8. Insol.	167

E. Red in thin section

iii poor	Oct.	Red, br., etc.	1.74±	Spinel	Ox.	G.=3.6. Sol. H ₂ SO ₄	62
None	Dodec.	Red	1.76-1.82	Rhodolite	Sil.	G.=3.8. Insol.	178
None	Dodec.	Red, br.	1.77-1.81	Spessartite	Sil.	G.=4±. Insol.	178
None	Dodec.	Red, br.	1.78-1.83	Almandite	Sil.	G.=4.2±. Insol.	178
None	Dodec.	Red, br.	1.85-1.89	Andradite	Sil.	G.=3.7-4.1. Insol.	180
None	Dodec.	Red, br.	1.86-2.01	Schorlomite	Sil.	G.=3.7-3.9. Insol.	183

F. Green or blue in thin section

iii poor	Oct.	Gr., red, etc.	1.74±	Spinel	Ox.	G.=3.6. Sol. H ₂ SO ₄	62
None	Orth.	Green	1.758	<i>Yttrialite</i>	Sil.	G.=4.6. Sol. HCl	414
None	Isom.	Green	1.77-1.80	<i>Hercynite</i>	Ox.	G.=3.9. Insol.	62
None	Prism.	Gr., br.	1.78±	Gadolinite	Sil.	G.=4±. Gel. HCl	424
iii fair	Oct.	Gr., bl., br.	1.79-1.81	<i>Gahnite</i>	Ox.	G.=4.5±. Sol. H ₂ SO ₄	63
None	Tet.	Gr., br.	1.82	<i>Naegite</i>	Ox.	G.=4.1. Insol.	65
None	Mass.	Gr., br.	1.86±	<i>Bindheimite</i>	Antim.	G.=4.6. Insol.	160
None	Dodec.	Green	1.87±	<i>Uvarovite</i>	Sil.	G.=3.7. Insol.	180

TABLE II.—BIREFRINGENCE OF MINERALS

O. BIREFRINGENCE ZERO: $N_o - N_p = 0.000$

Cleavage, Optic Orient.	Habit, etc.	Color	N	Mineral	Chem.	Other Characters	Page
Group 7. Refrindex positive and extreme: $N > 2.00$							
A. Uncolored in thin section							
110 poor	Tet'h.	Colorless	2.05	<i>Eulytite</i>	Sil.	G. = 6.1. Gel. HCl	414
None	Mass.	Gray, etc.	2.06-2.25	<i>Cerargyrite</i>	Hal.	G. = 5.4-6. Sol. NH_4OH	30
None	Oct.	Colorless	2.065	<i>Mosevite</i>	Hal.	Also biref. Soft	34
111 poor	Oct.	Colorless	2.087	<i>Senarmonite</i>	Sb_2O_3	G. = 5.2. Sol. HCl	43
?	Mass.	Colorless	2.15-2.28	<i>Bismutite</i>	Carb.	G. = 7.0. Sol. HNO_3	86
111 dist.	Isom.	Colorless	2.20	<i>Levivite</i>	Antim.	G. = 4.95. Insol.	162
111 perf.	Isom.	Tinted $\pm$	2.42	Diamond	C	G. = 3.5. H. = 10. Insol.	13
B. Yellow in thin section							
None	Mass.	Yellow	2.0-2.1	Limonite	Ox.	G. = 3.8 $\pm$. Sol. HCl	47
?	Orth.?	Yel., br.	2.0 $\pm$	<i>Wüchite</i>	Colum.	G. = 3.8-4.8. Insol.	167
111 dist.	Oct.	Yellow	2.09	<i>Schneebergite</i>	Antim.	G. = 5.4.	160
?	Orth.	Amber	2.12-2.15	<i>Yttrocassite</i>	Tit.	G. = 4.8. Sol. H_2SO_4	167
110	Tet'h.	Yellow	2.20	<i>Miersite</i>	Hal.	G. = 5.64. Sol. NH_4OH	30
?	Isom.	Yellow	2.21	<i>Wedienite</i>	Antim.	G. = 4.97	160
100	Cub.	Yel., br.	2.33	<i>Dysanadite</i>	Tit.	G. = 4.1. Dec. HCl	163
110	Tet'h.	Yellow	2.35	<i>Marshallite</i>	CuI	G. = 5.59. Extr. disp.	30
110 perf.	Tet'h.	Yel., br.	2.37-2.47	Sphalerite	ZnS	G. = 4 $\pm$. Sol. HCl	19
111 perf.	Isom.	Tinted $\pm$	2.42	Diamond	C	G. = 3.5. H. = 10. Insol.	13
None	Dodec.	Yellow	2.49	<i>Eglestonite</i>	Hal.	G. = 8.3. Dec. HCl	37

C. Brown in thin section and not isometric

?	Orth.?	Br., yel.	2.0±	<i>Wittite</i>	Colum.	G. = 3.8-4.8. Insol.	167
?	Tet.	Red-br.	2.05	<i>Risoerite</i>	Tant.	G. = 4.18. Sol. H_2SO_4	165
None	Orth.	Red-br.	2.06-2.26	<i>Euxenite</i>	Tit.	G. = 4.8. Insol.	167
oto poor	Orth.	Brown	2.10-2.25	<i>Samarskite</i>	Colum.	G. = 5.7±. Insol.	166
111 poor	Tet.	Brown	2.10-2.19	<i>Fergusonite</i>	Colum.	G. = 5.8. Dec. H_2SO_4	164
None	Orth.	Br.-red	2.13	<i>Amphangabêite</i>	Colum.	G. = 4.0-4.3. Sol. HCl	166
oto poor	Orth.	Brown	2.14	<i>Blomstrandinite</i>	Tit.	G. = 4.9±. Insol.	167
oto poor	Orth.	Red-br.	2.15	<i>Yttrantalite</i>	Tant.	G. = 5.5-5.9. Insol.	166
?	Orth.	Red-br.	2.20-2.26	<i>Eschynite</i>	Colum.	G. = 4.9-5.1. Insol.	167
100, oto	Orth.	Red-br.	2.215	<i>Polymignite</i>	Tit.	G. = 4.8. Insol.	167
?	Tet.	Gr., br.	2.30	<i>Brannerite</i>	Ox.	G. = 4.5-5.4. Sol. HCl	69

D. Brown in thin section and isometric

None	Dodec.	Red, br.	1.86-2.01	Schorlomite	Sil.	G. = 3.7-3.9. Insol.	183
111 poor	Oct.	Brown	2.05	Picotite	Ox.	G. = 4.1±. Sol. H_2SO_4	62
None	Oct.	Br., red	2.07-2.16	Chromite	Ox.	G. = 4.5. Insol.	62
None	Oct.	Red-br.	2.19	<i>Zirkite</i>	Ox.	G. = 4.72. Insol.	164
?	Cub.	Red-br.	2.20	<i>Thorianite</i>	Ox.	G. = 9.3. Sol. HNO_3	50
100 poor	Cub.	Brown	2.30	<i>Knopite</i>	Tit.	G. = 4.1-4.3. Dec. H_2SO_4	163
100	Cub.	Brown	2.33	<i>Dysanallite</i>	Tit.	G. = 4.13. Dec. HCl	163
110 perf.	Tet'h.	Brown	2.37-2.47	Sphalerite	ZnS	G. = 4±. Sol. HCl	19
100 poor	Cub.	Br., red	2.38	Perovskite	Tit.	G. = 4. Dec. H_2SO_4	163

E. Red in thin section and not isometric

?	Tet.	Red-br.	2.05	<i>Risoerite</i>	Tant.	G. = 4.18. Sol. H_2SO_4	165
None	Orth.	Red-br.	2.06-2.26	<i>Euxenite</i>	Tit.	G. = 4.8. Insol.	167
None	Orth.	Br.-red	2.13	<i>Amphangabêite</i>	Colum.	G. = 4.0-4.3. Sol. HCl	166

TABLE II.—BIREFRINGENCE

TABLE II.—BIREFRINGENCE OF MINERALS
O. BIREFRINGENCE ZERO: $N_g - N_p = 0.000$ —continued

Cleavage, Optic Orient.	Habit, etc.	Color	N	Mineral	Chem.	Other Characters	Page
E. Red in thin section and not isometric—continued							
010 poor	Orth.	Red-br.	2.15	<i>Ytrotantalite</i>	Tant.	G.=5.5-5.9. Insol.	166
100, 010	Orth.	Red-br.	2.20-2.26	<i>Eschynite</i>	Colum.	G.=4.9-5.1. Insol.	167
None	Mass.	Red	2.2-2.3	<i>Limonite</i>	Ox.	G.=4±. Sol. HCl	47
F. Red in thin section and isometric							
None	Dodec.	Red, br.	1.86-2.01	Schorlomite	Sil.	G.=3.7-3.9. Insol.	183
None	Oct.	Br., red	2.07-2.16	Chromite	Ox.	G.=4.5. Insol.	62
?	Dodec.	Red	2.12-2.18	<i>Koppite</i>	Tant.	G.=4.5. Dec. H ₂ SO ₄	164
?	Oct.	Red	2.16	<i>Pyrrhite</i>	Tant.	G.=4.5. Dec. H ₂ SO ₄	164
None	Oct.	Red-br.	2.19	<i>Zirkelite</i>	Ox.	G.=4.72. Insol.	164
?	Cub.	Red-br.	2.20	<i>Thorianite</i>	Ox.	G.=9.3. Sol. HNO ₃	50
100 poor	Cub.	Br., red	2.38	Perovskite	Tit.	G.=4. Dec. H ₂ SO ₄	163
111 perf.	Isom.	Tinted±	2.42	Diamond	C	G.=3.5. H.=10. Insol.	13
100 poor	Oct.	Red	2.69	<i>Hauerite</i>	MnS ₂	G.=3.46. Sol. HCl	24
None	Tet'h.	Red	2.72+	Tetrahedrite	Cu, Sb, S	G.=4.4-5.1. Dec. HNO ₃	26
111 poor	Oct.	Red	2.85	Cuprite	Cu ₂ O	G.=6±. Sol. H ₂ SO ₄	40
G. Blue or green in thin section							
100	Cub.	Blue	2.05	<i>Percyite</i>	Hal.	G.=2.25. Sol. HNO ₃	37
100	Oct.	Green	2.16	<i>Manganosite</i>	MnO	G.=5.18. Sol. HCl	41
?	Oct.	Green	2.23	<i>Bunsenite</i>	NiO	G.=6.4 Sol. HCl	41
?	Tet.	Gr., br.	2.30	<i>Brannerite</i>	Ox.	G.=4.5-5.4. Sol. HCl	69
111 perf.	Isom.	Tinted±	2.42	Diamond	C	G.=3.5. H.=10. Insol.	13
100 perf.	Tet'h.	Green	2.70	<i>Alabandite</i>	MnS	G.=4.0. Sol. HCl	20

I. BIREFRINGENCE VERY WEAK: $N_o - N_p < 0.0035$

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 8. Refrindex negative and distinct: N_o or $N_m < 1.48$. Optically + or —							
100	?	0°	Tet.	<i>Villiamite</i>	NaF	X = yellow; Z = red. Sign —	30
1010 dist.	Prism.	0°	Hex.	<i>Yttrocalcite</i>	Hal.	G. = 3.2. Sol. HCl. Sign —	36
111 dist.	Oct.	0°	?	<i>Faujasite</i> (—H ₂ O)	Sil.	Also isotropic. Sign +	382
X = c	Prism.	Sm.	Orth.	<i>Maladrite</i>	Hal.	G. = 2.75. Sign —	37
Y 1100 cl.	Prism.	57°	Orth.	<i>Pilolite</i>	Sil.	X = c. G. = 2.1. Insol. HCl. Sign —	389
Z = a	Fib.	Lg.	Orth.	<i>Variscite</i> (—H ₂ O)	Phos.	a = lavender; c = violet	140
X = c. Y = b	oor	Lg.	Orth.	<i>Avogadrite</i>	Hal.	G. = 2.6. Sign —	34
oor, 100	Ps. Rh.	Sm.	Mon.	Gmelinite	Sil.	G. = 2.1. Dec. HCl. Sign ≠	385
oor, 110	Ps. Is.	43°	Mon.	<i>Cryolite</i>	Hal.	X = b. Z ∧ c = —44°. Sign +	34
Group 9a. Refrindex negative and low: N_o or $N_m > 1.48 < 1.54$. Optically +							
111 dist.	Oct.	0°	?	<i>Faujasite</i> (—H ₂ O)	Sil.	Also isotropic	382
Z 100 cl.	Prism.	0°	Tet.	Apophyllite	Sil.	Abn. int. colors. G. = 2.35 ±	262
1010 perf.	Prism.	0°	Hex.	<i>Daryne</i>	Sil.	K-cancrinite	301
110 poor	Trap.	Sm.	?	<i>Leucite</i>	Sil.	Also isotr. Alters easily	291
1011 dist.	Ps. Rh.	Sm.	Mon.	Chabazite	Sil.	G. = 2.1. Dec. HCl	384
100, 010	El. || c	70° ±	Mon.	Phillipsite	Sil.	Ps. Tet. twin. G. = 2.2	393
Y ∧ c = 3° ±	Fib.	80°	Tr.	<i>Mesolite</i>	Sil.	Comp. twin. G. = 2.27	399
Z ∧ c = 20°	Fib.	Sm.	Tr.	<i>Pseudomesolite</i>	Sil.	Prism. cleav.	399
Group 9b. Refrindex negative and low: N_o or $N_m > 1.48 < 1.54$. Optically —							
X 1011 cl.	Prism.	0°	Tet.	Apophyllite	Sil.	Abn. int. colors. G. = 2.35 ±	262
X = c	Pyr.	0°	Tet.	<i>Cristobalite</i>	SiO ₂	G. = 2.27. Sol. HF	53
X = c	Prism.	0°	Hex.	NEPHELITE	Sil.	G. = 2.6. Gel. HCl	298
1010 perf.	Prism.	0°	Hex.	<i>Daryne</i>	Sil.	K-cancrinite	301

TABLE II.—BIREFRINGENCE OF MINERALS

I. BIREFRINGENCE VERY WEAK: $N_g - N_p < 0.0035$ —*continued*

Cleavage, Optic Orient.	Habit, etc.	$2V$	System	Mineral	Chem.	Other Characters	Page
Group 9b. Refrindex negative and low: N_o or $N_m > 1.48 < 1.54$. Optically—, <i>continued</i>							
$X=c$	Prism.	$0^\circ \pm$	Hex.	<i>Milarite</i>	Sil.	G. = 2.57. Insol.	429
oor diff.	Ps. Is.	Sm.	?	<i>Analcite</i>	Sil.	Comp. twin. Isotr. at 130° C.	293
100	Ps. Is.	Sm.	?	<i>Chlorocalcite</i>	Hal.	Comp. twin. Hygros.	33
$Z \perp$ oro cl.	Prism.	$60^\circ \pm$	Orth.	<i>Cordierite</i>	Sil.	Ps. Hex. twin. $X=c$. Colorless or $X=$ yel., $Y=$ blue, $Z=$ blue	307
1011 dist.	Ps. Rh.	Sm.	Mon.	Chabazite	Sil.	G. = 2.1. Dec. HCl	384
$X \wedge c = 43^\circ$	Var.	71°	Mon.	<i>Bloodite</i>	Sul.	G. = 2.23. Sol. H_2O	112
Group 10a. Refrindex positive and low: N_o or $N_m > 1.53 < 1.59$. Optically +							
$Z \perp$ oor cl.	Prism.	0°	Tet.	Apophyllite	Sil.	Abn. int. colors. G. = $2.35 \pm$	262
1010 dist.	Rhom.	0°	Rhom.	<i>Rinneite</i>	Hal.	Abn. int. colors. G. = 2.35	33
$Z=c$	?	0°	Rhom.	<i>Chloemankalite</i>	Hal.	Yellow. Deliques.	33
$Z \perp$ oor cl.	oor	Sm.	Mon.	<i>Penninite</i>	Sil.	Green. Ultra blue int. colors	281
Group 10b. Refrindex positive and low: N_o or $N_m > 1.53 < 1.59$. Optically —							
$X \perp$ oor cl.	Prism.	0°	Tet.	Apophyllite	Sil.	Abn. int. colors. G. = $2.35 \pm$	262
$X=c$	Prism.	0°	Hex.	NEPHELITE	Sil.	G. = 2.6. Gel. HCl	298
$X=c$	Prism.	$0^\circ \pm$	Hex.	<i>Milarite</i>	Sil.	G. = 2.57. Insol.	429
$Z \perp$ oro cl.	Prism.	$60^\circ \pm$	Orth.	<i>Cordierite</i>	Sil.	Ps. Hex. twin. $X=c$. Colorless or $X=$ yel., $Y=$ blue, $Z=$ blue	307
$X \perp$ oor cl.	oor	Sm.	Mon.	<i>Penninite</i>	Sil.	Green. Ultra blue int. colors	281
$X \perp$ oor cl.	oor	Sm.	Mon.	Delessite	Sil.	Green or pink. Str. disp.	282
$X \perp$ oor cl.	oor	Sm.	Mon.	<i>Kaemmererite</i>	Sil.	Purple: $X < Y = Z$. G. = $2.8 \pm$	286
Group 11a. Refrindex positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +							
$Z \perp$ oor cl.	oor	$0^\circ \pm$	Tet.	<i>Metatorbernite</i>	Phos.	Abn. int. colors	145

$Z=c$	?	Rhom.	<i>Chormankalite</i>	Hal.	Yellow. Deliques. $G.=2.3$	33
$Z \perp \text{oooi cl.}$	Var.	Rhom.	Eudialite	Sil.	Colorless or $X=\text{yel.}$, $Z=\text{red}$	417
$Z \perp \text{ooi cl.}$	ooi	Mon.	Ripidolite	Sil.	Green. Abn. int. colors	284
Group 11b. Refrindex positive and moderate: N_0 or $N_m > 1.59 < 1.66$. Optically —						
$X=c$	Prism.	Hex.	<i>Apatite</i>	Phos.	Colorless or tinted	129
iofo dist.	?	Hex.	<i>Merrillite</i>	Phos.	Also biax. ? Sol. HNO_3	149
$X \perp \text{oooi cl.}$	?	Hex.	<i>Gillespite</i>	Sil.	$G.=3.33$. Sol. HCl	401
$X \perp \text{oooi cl.}$	Var.	Rhom.	<i>Euclite</i>	Sil.	Colorless or $X=\text{red}$, $Z=\text{yel.}$	417
$X \perp \text{ooi cl.}$	ooi	Mon.	Diabantite	Sil.	Green. Abn. int. colors	283
$X \perp \text{ooi cl.}$	ooi	Mon.	Aphrosiderite	Sil.	Green. Abn. int. colors	284
$X \perp \text{ooi cl.}$	ooi	Mon.	Daphnite	Sil.	Green. Abn. int. colors	285
$X \perp \text{ooi cl.}$	ooi	Mon.	<i>Kaemmererite</i>	Sil.	Purple: $X < Y = Z$. $G.=2.8 \pm$	286
Group 12. Refrindex positive and high: N_0 or $N_m > 1.66 < 1.74$. Optically + or —						
$Z=c$	Prism.	Tet.	<i>Viluite</i>	Sil.	Tinted $\pm$. Sign +	207
$X=c$	Prism.	Tet.	Vesuvianite	Sil.	Tinted $\pm$. Sign —	207
$X=c$	Prism.	Hex.	<i>Chlorapatite</i>	Phos.	$G.=3.2$. Sign —	129
$Z \wedge c = 10^\circ \pm$	oio	Mon.	<i>Sapphirine</i>	Sil.	Blue; pleo. Sign —	427
ooi, oio ?	Fib.	Mon.	<i>Sarcopside</i>	Phos.	Yellow. $G.=3.64$. Sign?	134
Group 13. Refrindex positive and high: N_0 or $N_m > 1.74 < 2.00$. Optically + or —						
$X \perp \text{oooi cl.}$	Prism.	Hex.	<i>Svedenborgite</i>	Antim.	$G.=4.3$. Insol. Sign —	149
No cleav.	Prism.	Orth.	<i>Cerite</i>	Sil.	Colorless or $Z=\text{red}$. Sign +	422
Two at 90°	?	Orth.	<i>Hyalokite</i>	Sil.	$G.=3.8$. Sol. HF . Sign +	422
?	Fib.	Mon.	<i>Agricolite</i>	Sil.	$G.=6$. Gel. HCl . Sign +?	414
Group 14. Refrindex positive and extreme: N_0 or $N_m > 2.00$. Optically + or —						
110 poor	Ps. Is.	?	<i>Eulyite</i>	Sil.	$G.=6.1$. Gel. HCl . Sign —	414
$X=c$, $Y=b$	Ps. Is.	Orth.	Perovskite	Tit.	Gray or brown. Sign +	163
?	Fib.	Mon.	<i>Agricolite</i>	Sil.	$G.=6$. Gel. HCl . Sign +?	414

TABLE II. BIREFRINGENCE OF MINERALS

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II. BIREFRINGENCE WEAK: $N_o - N_p > 0.0035 < 0.0095$

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 15a. Refrindex negative and distinct: N_o or $N_m < 1.48$. Optically +							
A. No visible cleavage							
$Z \perp 0001$ pt.	0001	0°	Hex.	Ice	H ₂ O	Skel. cryst. are "snow"	40
$Z \perp 001$ pt.	001	35°	Orth.	Tridymite	SiO ₂	Ps. Hex. twin. $G = 2.27$	58
$X = c = \text{elong.}$	Fib.	Sm.	Orth.	<i>Paraluminite</i>	Sul.	$G = 1.66$. Sol. HCl	109
$Z \wedge c = 28^\circ \pm$	Fib.	Mod.	Mon.	<i>Pickeringite</i>	Sul.	$Y = b$. $G = 1.85$. Sol. H ₂ O	116
1010 dist.	Ps. Rh.	Sm.	Mon.	Gmelinite	Sil.	Comp. twin. $G = 2.75$	385
$Z \wedge 001$ cl. = 22°	Prism.	76°	Mon.	<i>Pachnolite</i>	Hal.	100 twin. $G = 3.0$	36
B. One or more visible cleavages							
$X \perp 100$ cl.	El. || c	50°	Orth.	<i>Ferrierite</i>	Sil.	$Z = c$. $G = 2.15$	389
$X \perp 010$ cl.	c or 010	Lg.	Mon.	<i>Mordenite</i>	Sil.	$Z \wedge c = -73^\circ$. $G = 2.1$	398
$X \wedge 201$ cl. = 37°	Prism.	50°	Mon.	<i>Boussingaultite</i>	Sul.	$Y = b$. $G = 1.72$	113
$X \perp 010$ cl.	c or 010	69°	Mon.	<i>Alunogen</i>	Sul.	$Z \wedge c = 42^\circ$. $G = 1.65$	109
Group 15b. Refrindex negative and distinct: N_o or $N_m < 1.48$. Optically -							
$X \perp 001$ cl.	Pyr.	0°	Tet.	<i>Chiolite</i>	Hal.	$G = 3$. Very rare	34
1010 perf.	Acic.	0°	Hex.	<i>Etringite</i>	Sul.	$G = 1.8$. Sol. HCl	115
1010 dist.	Ps. Rh.	Sm.	Mon.	Gmelinite	Sil.	Comp. twin. $G = 2.75$	385
$X \wedge 001$ cl. = 41°	Ps. Is.	50°	Mon.	<i>Thomsonolite</i>	Hal.	$Z = b$. $G = 3.0$	36
$Y \wedge c = \text{Lg.}$	Acic.	Mod.	Mon.	<i>Gearksutite</i>	Hal.	Chalky. $G = 2.75$	35
$Z \wedge 100$ cl. = 29°	Prism.	76°	Mon.	Mirabilite	Sul.	$Y = b$. $G = 1.46$. Sol. H ₂ O	97

Group 16a. Refrference negative and low: N_o or $N_m > 1.48 < 1.54$. Optically +

A. No visible cleavage

	Acic.		Hex.	<i>Leifite</i>	Sil.	G. = 2.27. Sol. HCl	429
1010 dist.	0001		Rhom.	<i>Aphthalite</i>	Sul.	G. = 2.7. Sol. H ₂ O	96
1011 dist.	Ps. Rh.		Mon.	Chabazite	Sil.	0001 twin. G. = 2.1	384
$X \wedge c = 4^\circ$	010		Mon.	<i>Wellsite</i>	Sil.	$Y = b$. G. = 2.3	395
$Y \perp oro$ cl.	El. || c		Mon.	<i>Harmolome</i>	Sil.	$X \wedge c = 62^\circ$. G. = 2.5	395
$Z \wedge c = 20^\circ$	El. || c		Mon.	Phillipsite	Sil.	$Y = b$. G. = 2.0	393
$Z \wedge c = 50^\circ$	010		Mon.	<i>Prosopite</i>	Hal.	$Y = b$. G. = 2.9	34
$Y \wedge fib. = Lg.$	Fib.		Mon.	<i>Zn-Cu-Melanterite</i>	Sul.	$Z = b$. G. = 2	106

B. One or more visible cleavages

			Hex.	<i>Microsomite</i>	Sil.	G. = 2.45. Gel. HCl	301
1010 perf.	Prism.		Orth.	<i>Siruite</i>	Phos.	$Z \perp oro$ cl. 001 twin.	151
$X \perp 001$ cl.	Prism.		Orth.	Thomsonite	Sil.	$Y = c$. G. = 2.3	387
$Z \perp 010$ cl.	Prism.		Orth.	<i>Gonnardite</i>	Sil.	$Z = c$. G. = 2.25	387
$X \perp$ cleav.	Fib.		Orth.	Heulandite	Sil.	$Y \wedge c = 6^\circ$. G. = 2.2	397
$Z \perp 010$ cl.	010		Mon.	Gypsum	Sul.	$Z \wedge c = 52^\circ$. G. = 2.94	104
$Y \perp 010$ cl.	c or 010		Mon.	<i>Chalcoalumite</i>	Sul.	Bl.-green. Abn. int. colors	117
$Z \parallel$ elong.	Lath.		Tr.?	PLAGIOCLASE	Sil.	Lam. twin. G. = 2.6 ±	368
001, 010	a or 010		Tr.				

Group 16b. Refrference negative and low: N_o or $N_m > 1.48 < 1.54$. Optically -

A. No visible cleavage and no marked elongation

			Hex.	β - <i>Kaliophyllite</i>	Sil.	G. = 2.56. Gel. HCl	300
$X = c$	Prism.		Hex.	NEPHELITE	Sil.	G. = 2.6. Gel. HCl	298
$X = c$	Prism.		Hex.	<i>Levyrite</i>	Sil.	G. = 2.1. Gel. HCl	386
$X = c$	Rhom.		Rhom.	<i>Tachyhydrite</i>	Hal.	Deliques.	32
1011 dist.	?		Rhom.	α - <i>Kaliophyllite</i>	Sil.	G. = 2.6. Gel. HCl	300
$X = c$	?		Orth.	Cordierite	Sil.	Ps. Hex. twin. X = c. Colorless or X = yel., Y = blue, Z = blue	307
$Z \perp 010$ cl.	Prism.		Orth.				

TABLE II.—BIREFRINGENCE OF MINERALS

II. BIREFRINGENCE WEAK: $N_g - N_p > 0.0033 < 0.0095$ —*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 16b. Refrindex negative and low: N_o or $N_m > 1.48 < 1.54$. Optically —, <i>continued</i>							
A. No visible cleavage and no marked elongation— <i>continued</i>							
101̄ dist.	Ps. Rh.	Sm.	Mon.	Chabazite	Sil.	0001 twin. G.=2.1	384
X=b. Z=a±	Ps. Tet.	83°	Mon.	Gismondite	Sil.	G.=2.27. Gel. HCl	373
Z∧c=Sm.	Tab.	86°	Mon.	Leonite	Sul.	Y=b. G.=2.25. Sol. H ₂ O	112
No cleav.	?	84°	Mon.	Vanthoffite	Sul.	G.=2.7. Sol. H ₂ O	111
?	Prism.	13°±	Tr.	Carnegieite	Sil.	G.=2.5. Gel. HCl	299
B. No visible cleavage and marked elongation							
100 dist.	El. || c	0°	Tet.	Marialite	Sil.	G.=2.57. Also +?	296
X=c?	Fib.	0°?	Hex.?	Chalcedonite	SiO ₂	G.=2.6. Sol. HF	57
Z=c	Fib.	25°±	Orth.	Sepiolite	Sil.	G.=2.0	410
Z∧c=37°	Fib.	Mod.	Mon.	Pickeringite	Sul.	Y=b. G.=1.85	116
Z∧c=29°	Fib.	Sm.	Mon.	Apjohnite	Sul.	Y=b. G.=1.8	117
X∧c=43°	Prism.	71°	Mon.	Bloedite	Sul.	Also 001 tab. G.=2.2	112
Z∧c=30°	Fib.	?	Mon.	Halotrichite	Sul.	G.=1.9. Sol. H ₂ O	116
C. One or more visible cleavages							
101̄o perf.	Prism.	0°	Hex.	Cancrinite	Sil.	G.=2.45. Gel. HCl	301
101̄o perf.	Prism.	0°	Hex.	Natrodywaine	Sil.	G.=2.45. Gel. HCl	301
Y 101̄o cl.	010	33°	Mon.	Stilbite	Sil.	X∧c=5°. G.=2.15	395
110 perf.	Prism.	36°	Mon.	Scolecite	Sil.	X∧c=16°. Z=b. G.=2.3	390
100 perf.	?	Lg.	Mon.	Searlesite	Sil.	Z=b. X∧c=30°	423
001, 010	Prism.	70°	Mon.	ADULARIA	Sil.	X∧a=6°. Z=b. G.=2.56	361

001, 010	010	Sm.	Mon.	SANIDINE	Sil.	$X \wedge a = 6^\circ$. $Y = b$. $G. = 2.57$	361
001, 010	Prism.	$76^\circ \pm$	Mon.	Hyalophane	Sil.	$X \wedge a = 0^\circ - 20^\circ$. $Z = b$	360
001, 010	Prism.	$83^\circ \pm$	Tr.	MICROCLINE	Sil.	Two sets lam. twin.	364
001, 010	Prism.	$45^\circ \pm$	Tr.	ANORTHOCLASE	Sil.	Lam. twin. Also 010 tab.	366
001, 010	a or 010	$85^\circ \pm$	Tr.	OLIGOCLASE	Sil.	Lam. twin. Also prism.	371

Group 17a. Refrindex positive and low: N_o or $N_m > 1.53 < 1.59$. Optically +							
A. No visible cleavage							
$Z = c$	Prism.	0°	Hex.	QUARTZ	SiO ₂	$G. = 2.65$. Sol. HF	54
100 poor	Prism.	0°	Rhom.	Coquimbite	Sul.	Abn. int. colors. $G. = 2.1$	107
$Z \parallel$ fib.	Fib.	0°	?	Cerulocalcite	Phos.	Colorless or blue	143
$Z \parallel$ fib.	Fib.	Sm.	Orth.	Noumélite	Sil.	Green. Dec. HCl	261
$Z \wedge$ fib. = 31°	Fib.	?	Mon.	Jarupaite	Sil.	$G. = 2.75$. Sol. HCl	412
$Z \perp$ 010 cl.	El. $\parallel c$	47°	Mon.	Bavenite	Sil.	$X \wedge a = 2^\circ$. 100 twin.	438

B. One or more visible cleavages							
$Z \perp$ 010 cl.	Prism.	$54^\circ \pm$	Or.	Thomsonite	Sil.	$Y' \parallel$ elong. $G. = 2.3$	387
$Z \perp$ 001 cl.	001	Sm.	Mon.	Clinocllore	Sil.	Green; weak pleo. $G. = 2.7 \pm$	283
$Z \perp$ 001 cl.	001	Sm.	Mon.	Prochlorite	Sil.	Green; weak pleo. $G. = 2.8 \pm$	284
$Z \wedge$ 001 cl. = 28°	001	30°	Mon.	Eudidymlite	Sil.	001 twin. $G. = 2.55$	418
001, 010	a or 010	$82^\circ \pm$	Tr.	ANDESINE	Sil.	Lam. twin.	372
001, 010	a or 010	$82^\circ \pm$	Tr.	LABRADORITE	Sil.	Lam. twin	374

Group 17b. Refrindex positive and low: N_o or $N_m > 1.53 < 1.59$. Optically -							
B. No visible cleavage							
110 dist.	El. $\parallel c$	0°	Tet.	Marialite	Sil.	$G. = 2.57$. Also +?	296
001 dist.	Prism.	0°	Hex.	Eucryptite	Sil.	$G. = 2.67$. Gel. HCl	300
$X = c$	Fib.	0°	Hex.?	Chalcodonite	SiO ₂	$G. = 2.6$. Sol. HF	57
$X = c$	Prism.	0°	Hex.	β -Kaliophyllite	Sil.	$G. = 2.55$. Gel. HCl	300
$X = c$	Prism.	0°	Hex.	NEPHELITE	Sil.	$G. = 2.6$. Gel. HCl	298

TABLE II.—BIREFRINGENCE OF MINERALS

II. BIREFRINGENCE WEAK: $N_g - N_p > 0.0035 < 0.0095$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 17b. Refrindex positive and low: N_o or $N_m > 1.53 < 1.59$. Optically —, continued							
B. No visible cleavage—continued							
$X=c$	Prism.	0°	Hex.	Beryl	Sil.	Colorless; blue, green; pleo.	212
?	?	39°	Orth.	α -Kaliophyllite	Sil.	Ps. Hex. twin. $G.=2.5\pm$	300
$Z \perp$ opto cl.	Prism.	$60^\circ \pm$	Orth.	Cordierite	Sil.	Ps. Hex. twin. $X=c$. Colorless or $X=\text{yel.}$, $Y=\text{blue}$, $Z=\text{blue}$	307
$X=b$, $Z=a\pm$	Ps. Tet.	83°	Mon.	Gismondite	Sil.	$G.=2.27$. Gel. HCl	373
$Z \wedge c = 12^\circ$	Fib.	Lg.	Mon.	Crestmorite	Sil.	$G.=2.2$. Dec. HCl	409
B. One visible cleavage (lamellar)							
001 perf.	001	0°	Tet.	Metazeunerite	Arsen.	Green: $X < Z$. $G.=3$. Sol. HNO_3	146
001 perf.	001	0°	Rhom.	Reyerite	Sil.	$G.=2.52$. Sol. HCl	408
$X \perp 001$ cl.	001	$0^\circ \pm$	Rhom.	Zoophyllite	Sil.	$G.=2.76$. Also biax.	408
$X \perp 001$ cl.	Ps. Hex.	$0^\circ \pm$	Mon.?	Calcioferite	Phos.	$G.=2.53$. Dec. HCl	156
001 perf.	001	60°	Mon.	Kaolinite	Sil.	$Y \wedge a = 11^\circ$. $Z=b$. $G.=2.6$	204
$X \perp 001$ cl. $\pm$	001	?	Mon.	Feralschite	Sil.	Sol. HCl	416
$X \perp 001$ cl. $\pm$	001	$90^\circ \pm$	Mon.	Miloschite	Sil.	Bl.-green. $G.=2.1$	416
$X \perp 001$ cl. $\pm$	001	$40^\circ \pm$	Mon.	Antigorite	Sil.	Green; weak pleo. $G.=2.57$	280
$X \perp 001$ cl. $\pm$	001	Sm.	Mon.	Jenkinsite	Sil.	Green; weak pleo. Sol. HCl	281
C. Two visible cleavages							
100 , 010	Prism.	$0^\circ \pm$	Orth.	β -Hopeite	Phos.	$X=b$. $G.=3.0$	124
001 , 010	001	23°	Orth.	Epididymite	Sil.	$X=b$. $Y=c$. $G.=3.55$	418
001 , 010	Prism.	$75^\circ \pm$	Mon.	Hyalophane	Sil.	$X \wedge a = 0^\circ-25^\circ$. $Z=b$.	360

001, 010	a or 010	85° ±	Tr.	OLIGOCLASE	Sil.	Lam. twin.	371
001, 010	a or 010	82° ±	Tr.	ANDESINE	Sil.	Lam. twin.	372
001, 010	a or 010	85° ±	Tr.	BYTOWNITE	Sil.	Lam. twin.	376

Group 18a. Refrindex positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +

A. No visible cleavage

001, 110	001	0°	Tet.	Akermanite	Sil.	G. = 3.18. Gel. HCl	209
$Z = c$	?	0°	Rhom.	Gorczite	Phos.	G. = 3.1	153
0001 dist.	Var.	0°	Rhom.	Eudialite	Sil.	Colorless or yel. to red	417
$Z \parallel \text{fib.}$	Fib.	Sm.	Orth.	Noumélite	Sil.	Gr.; weak pleo. G. = 2.5 ±	261
$Z \parallel \text{fib.}$	Fib.	Sm.	Orth.	Foshagite	Sil.	G. = 2.36. Gel. HCl	408
$Z = c$	Ps. Tet.	0° ±	Orth.	Uranocalcite	Sul.	X, Y = green, Z = gr.-yellow	117

B. One or more visible cleavages

0001 perf.	0001	0°	Rhom.	Goyazite	Phos.	Colorless or yellow	153
$Z \perp 001$ cl.	Prism.	60° +	Orth.	Topaz	Sil.	Y = b. G. = 3.55 ±	198
001, 110	001	51°	Orth.	Celestite	Sul.	Y = b. Z = a. G. = 4.0	99
110 at 88°	Prism.	70° ±	Orth.	ENSTATITE	Sil.	Y = b. Z = c. G. = 3.2	217
110 at 88°	Prism.	53°	Mon.	CLINOENSTATITE	Sil.	Y = b. Z $\wedge$ c = +22°	220
$Z \perp 001$ cl. ±	001	Sm.	Mon.	Prochlorite	Sil.	Y = b. Green; weak pleo.	284
010, 100	El. $\parallel c$	40°	Mon.	Picroparmacolite	Arsen.	X $\wedge$ c = 37°. Y = b	125

Group 18b. Refrindex positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically -

A. No visible cleavage and no marked elongation

X = c	Prism.	0°	Hex.	Apatite	Phos.	Colorless or tinted	129
X = c	Prism.	0°	Hex.	Wilkeite	Phos.	G. = 3.2. Sol. HCl	440
0001 poor	Prism.	0°	Hex.	Beryl	Sil.	G. = 2.6-2.9. Sol. HF	212
0001 dist.	Var.	0°	Rhom.	Euclite	Sil.	Colorless or yel. to red	417
X $\parallel$ 110 cl.	Prism.	84°	Orth.	Andalusite	Sil.	Y = b. Colorless or yel. to red	201

TABLE II.—BIREFRINGENCE OF MINERALS

II. BIREFRINGENCE WEAK: $N_g - N_p > 0.0035 < 0.0095$ —*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 18b. Refrindex positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically —, <i>continued</i>							
A. No visible cleavage and no marked elongation— <i>continued</i>							
$X = b$. $Y = c$	Prism.	89°	Orth.	Danburite	Sil.	$G = 3.0$. Sol. HF	210
$X \wedge c = 35^\circ \pm$	El. || b	Lg.	Mon.	Allanite	Sil.	$Y = b$. $X = \text{yellow}$, $Z = \text{brown}$	316
?	?	Lg.	Mon.	Palatite	Phos.	$G = 3.2$. Sol. HCl	124
B. No visible cleavage and marked elongation							
$X = c$	c or 0001	0°	Hex.	Francolite	Phos.	$G = 3.1$. Sol. HCl	161
$Z \parallel \text{fib.}$	Fib.	0°	Hex.	Dahlite	Phos.	Also biax. $G = 3$.	161
$Z \parallel 110 \text{ cl.}$	Prism.	70°?	Orth.	Hillebrandite	Sil.	$Y = b$. $G = 2.7$. Sol. HCl	408
$Z \wedge 100 \text{ cl.} = 12^\circ$	El. || c	Lg.	Mon.	Crestmorite	Sil.	$G = 2.22$. Dec. HCl	409
C. One or more visible cleavages							
0001 perf.	Var.	0°	Hex.	Fluocerite	Hal.	$G = 5.7-6.1$. Sol. H_2SO_4	33
110 at 56°	Prism.	Sm.	Mon.	Crossite	Sil.	$X \wedge c = 70^\circ \pm$. $Z = b$. $X = \text{yellow}$, $Z = \text{violet}$	259
$X \perp 001 \text{ cl.}$	001	Sm.	Mon.	Thuringite	Sil.	$X = \text{colorless}$; $Y, Z = \text{green}$	285
$X \perp 001 \text{ cl.}$	001	Sm.	Mon.	Jenkinssite	Sil.	Olive green	281
Group 19a. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +							
A. No visible cleavage							
0001 dist.	Rhom.	0°	Rhom.	Florencite	Phos.	$G = 3.6$. Brownish in mass	142
$X = c$. $Y = b$	Prism.	52°	Orth.	Harsigite	Sil.	$G = 3$	432
$X \perp 100 \text{ cl.}$	100	Lg.	Orth.	Draunidite	Phos.	$Y = c$. Yellow. $G = 4$	148
001 dist.	Ps. Rh.	Sm.	Mon.	Filicovite	Phos.	Yellow. $G = 3.4$	123
No cleav.	?	90° ±	Tr.?	Serendibite	Sil.	Lam. twin. Blue; pleo.	425

B. One or more visible cleavages

oto perf.	Prism.	30° ±	Orth.	Zoisite	Sil.	Y = b (or c). Z = a. G = 3.3	311
Z || 110 cl.	Prism.	70° ±	Orth.	ENSTATITE	Sil.	Y = b. G = 3.2	217
001, 010	Prism.	Var.	Orth.	Triphylite	Phos.	X = c. Y = a. G = 3.5	149
Z ∧ 001 cl. = 20°	El. || b	85° ±	Mon.	Clinoisite	Sil.	Y = b. G = 3.36	312
110 at 88°	Prism.	53°	Mon.	Clinoenstatite	Sil.	Z ∧ c = +22°. Y = b	220
Z ∧ 100 cl. = 4°	Prism.	Mod.	Mon.	Triplidite	Phos.	X = b. G = 3.7. Sol. HCl	134
Z ⊥ 001 cl. ±	001	50° ±	Tr.	Chloritoid	Sil.	X = green, Y = blue, Z = yellow	438

Group 19b. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically -

A. No visible cleavage

X = c	Prism.	0°	Tet.	Vesuvianite	Sil.	Colorless or tinted. G = 3.4	207
X = c	Prism.	0°	Tet.	Gehlenite	Sil.	G = 3.0. Gel. HCl	209
0001 poor	Prism.	0°	Hex.	Stabilite	Arsen.	G = 3.5. Sol. HCl	129
Y = b	Ps. Is.	Sm.	Mon.	Pharmacosiderite	Phos.	G = 3.0. Sol. HCl	143
Z ∧ c = 10°	010	69°	Mon.	Sapphirine	Sil.	Y = b. X = yellow; Y, Z = blue	427
X ∧ c = 35° ±	El. || b	Lg.	Mon.	Allanite	Sil.	Y = b. X = yellow; Z = brown	316

B. One or more visible cleavages

110 at 56°	Prism.	Lg.	Mon.	Riebeckite	Sil.	X ∧ c = Sm. Z = b. X, Y = blue; Z = green	257
110 at 56°	Prism.	Lg.	Mon.	Arfvedsonite	Sil.	Z = b. X = blue, Y = violet, Z = yellow	257
110 at 56°	Prism.	Sm.	Mon.	Crossite	Sil.	Z = b. X = yellow, Y = blue, Z = violet	259

Group 20a. Refrindex positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +

1011	Rhom.	0°	Rhom.	Arsenopcleite	Arsen.	Blood red. Sol. HCl	153
No cleav.	Prism.	25°	Orth.	Cerite	Sil.	Colorless or red: X < Z	422
X ⊥ 100 cl.	100	Lg.	Orth.	Decandrite	Phos.	Yellow. G = 4.1	148
Z ∧ c = +8°	Prism.	85°	Mon.	Gadolinite	Sil.	Y = b. G = 4.3 ±. Gel. HCl	424
110 at 66°	Prism.	32°	Tr.	Enigmatite	Sil.	Y = b. Z ∧ c = 45° ±. Brown; pleo.	428
Z ⊥ 001 cl. ±	001	50° ±	Tr.	Chloritoid	Sil.	X = green, Y = blue, Z = yellow	438

TABLE II.—BIREFRINGENCE OF MINERALS

II. BIREFRINGENCE WEAK: $N_g - N_p > 0.0035 < 0.0095$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 20b. Refrindex positive and very high: N_o or $N_m > 1.74 < 2.00$, Optically —							
0001 part.	Var.	0°	Hex.	Corundum	Al_2O_3	Colorless or blue, red, etc.	43
0001 dist.	Rhom.	0°	Rhom.	<i>Beudanticite</i>	Sul.	Also biax. $G = 4.1$	119
0001 dist.	Rhom.	0°	Rhom.	<i>Corkite</i>	Sul.	Also biax. $G = 4.2$	119
Group 21. Refrindex positive and extreme: N_o or $N_m > 2.00$, Optically + or —							
X || fib.	Fib.	0°	Tet.	<i>Minium</i>	Pb_3O_4	X = red — br., Z = colorless. Sign ?	65
111 poor	Ps. Is.	Lg.	Orth.	<i>Senarmonite</i>	Sb_2O_3	Octahedral. Sign +	43
X = a, Z = b	Ps. Is.	90° ±	Orth.	<i>Dysanadite</i>	Tit.	X = gray, Z = green. Sign +	163
?	Acic.	?	Orth.	<i>Cerantite</i>	Ox.	G = 4. Sol. HCl	67
III. BIREFRINGENCE MODERATE: $N_g - N_p > 0.0095 < 0.0185$							
Group 22a. Refrindex negative and distinct: N_o or $N_m < 1.48$, Optically +							
A. No visible cleavage							
Z || elong.	Fib.	0°?	?	Chrysocola	Sil.	Opt. data discordant	411
?	Conch.	36°	Orth.	<i>Taylorite</i>	Sul.	G = 2.5? Sol. H_2O	96
X || fib.	Fib.	Lg.	Orth.	<i>Aluminite</i>	Sul.	G = 1.66. Sol. HCl	109
Z || fib.	El. || c	65°?	Orth.	<i>Erionite</i>	Sil.	G = 2.0. Sol. HCl	389
Y ⊥ a. c l.	Var.	83°	Orth.	<i>Thenardite</i>	Sul.	G = 2.68. Sol. H_2O	96
Z || 110 cl.	Fib.	0° ±	Mon.	<i>Laubandite</i>	Sil.	G = 2.2. Gel. HCl	438
B. One or more visible cleavages							
100, 110	Prism.	0°	Tet.	<i>Sellaite</i>	MgF_2	G = 3.17. Sol. H_2SO_4	32
X || 110 cl.	Prism.	62° ±	Orth.	Natrolite	Sil.	Y = b. Ps. Tet. G = 2.55	390
201 perf.	Prism.	48°	Mon.	<i>Picromerite</i>	Sul.	X ∧ c = 14°. Y = b. G = 2.1	112
X ⊥ 100 cl.	Fib.	69°	Mon.	<i>Alunogen</i>	Sul.	Z ∧ c = 42°. G = 1.65. Sol. H_2O	109
001, 110	Fib.	86°	Mon.	<i>Melanterite</i>	Sul.	Y = b; Z ∧ c = -62°. G = 1.9	106

Group 22b. Refrference negative and distinct: N_o or $N_m < 1.48$. Optically -

$Y \parallel 110$ cl.	Prism.	40°	Orth.	Leconite	Sul.	$X = a$.	Sol.	H_2O	97
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Group 23a. Refrference negative and low: N_o or $N_m > 1.48 < 1.54$. Optically +
A. Extinction parallel with elongation or cleavage in chief zones

$Z = c$	0°	$Douglasite$	Hal.	Sol. H_2O	34
$Z \parallel 110$ cl.	Sm.	Orth.	Sil.	Colorless or yel. to green	260
$Z \perp 001$ cl.	48°	Orth.	Sul.	$G = 2.33$. Sol. HCl	109
$X \perp 010$ cl.	50°	Orth.	Sil.	$Y = c$. Dec. HCl	389
$Z \perp 010$ cl.	54°	Orth.	Sil.	$Y = c$. $G = 2.3$. Gel. HCl	382
$X \parallel 110$ cl.	62°	Orth.	Sil.	$Y = b$. Ps. Tet. $G = 2.55$.	390
$Z \perp 010$ cl.	Mod.	Mon.	Carb.	$Y \wedge c = -43^\circ$. $G = 2.16$	85

B. Extinction inclined to elongation or cleavage

$Z \perp 010$ cl.	Mod.	Mon.	Hydromagnesite	Carb.	$Y \wedge c = -43^\circ$. $G = 2.16$	85
$Y \perp 010$ cl.	44°	Mon.	<i>Epistilbite</i>	Sil.	$Z \wedge c = -10^\circ$. $G = 2.25$	396
$Y \wedge c = 30^\circ$	60°	Mon.	<i>Tamarugite</i>	Sul.	$Z = b$. $G = 2.3$. Sol. H_2O	115
$Z \perp 010$ cl.	65°	Mon.	<i>Breusterite</i>	Sil.	$X \wedge c = +22^\circ \pm$. Dec. HCl	397
001 perf.	84°	Mon.	<i>Petalite</i>	Sil.	$X \wedge a = 5^\circ$. $Z = b$. $G = 2.4$	309
Lg. ext. ang.	Lg.	Mon.	<i>Aluminite</i> (alt.)	Sul.	Dehydrated? $G = 1.77$	109
$Z \wedge c = 29^\circ$	Lg.	Mon.	<i>Diatrichite</i>	Sul.	$X = b$. Sol. H_2O	117
$Z \wedge c = 33^\circ$	Lg.	Mon.	<i>Micseite</i>	Sul.	$G = 2.24$. Sol. H_2O	96
$001, 010$	$75^\circ \pm$	Tr.	ALBITE	Sil.	$Y \wedge c = 7^\circ \pm$. $Z \wedge 010 = 75^\circ \pm$	369

Group 23b. Refrference negative and low: N_o or $N_m > 1.48 < 1.54$. Optically -

A. No visible cleavage

$Z \perp \text{oro cl.}$	$60^\circ \pm$	Orth.	Cordierite	Sil.	Ps. Hex. twin. $X = c$. Colorless or $X = \text{yel.}$, $Y = \text{blue}$, $Z = \text{blue}$	307
$110, 001$	70°	Orth.	<i>Sulfoborite</i>	Bor.	$X = c$. $Y = b$. $G = 2.4$	120
$Z = c$	Var.	Orth.	Sepiolite	Sil.	$G = 2.0$. Sol. HF	410
No cleav.	Lg.	?	<i>Raccinite</i>	Sil.	$G = 1.96 \pm$. Green to brown	433

TABLE II.—BIREFRINGENCE OF MINERALS
III. BIREFRINGENCE MODERATE: $N_g - N_p > 0.0095 < 0.0185$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 23b. Refrindex negative and low: N_o or $N_m > 1.48 < 1.54$. Optically —, continued							
A. No visible cleavage—continued							
$Y \perp oio$ cl.	?	$80^\circ \pm$	Mon.	<i>Didymolite</i>	Sil.	$X \wedge c = 40^\circ$. $G. = 2.7$	428
?	Prism.	Mod.	Tr.	<i>Sideroit</i>	Sul.	Bl.-green. $G. = 2.2$	107
?	?	Mod.	Tr.	<i>Co-chalcantite</i>	Sul.	$G. = 2.2$ Sol. H_2O	107
B. One or more visible cleavages							
ooo perf.	ooo	0°	Hex.	<i>Hydrotalcite</i>	Carb.	$G. = 2.06$. Sol. HCl	87
$ioio$ perf.	Acic.	0°	Hex.	<i>Eltringite</i>	Sul.	$G. = 1.79$. Sol. HCl	115
$X \perp ooo$ cl.	ooo	0°	Rhom.	<i>Gyrolite</i>	Sil.	$G. = 2.4$. Also biax.?	408
$Y \perp oio$ cl.	El. || c	44°	Orth.	<i>Stellerite</i>	Sil.	$X = c$. $G. = 2.12$	389
$Y \perp ioio$ cl.	Prism.	40°	Orth.	<i>Epidesmine</i>	Sil.	$X = c$. $G. = 2.16$	388
$Y \perp oio$ cl.	El. || c	33°	Mon.	Stilbite	Sil.	$X \wedge c = 5^\circ$. $G. = 2.2$	395
$Y \perp oio$ cl.	Prism.	25°	Mon.	Laumontite	Sil.	$Z \wedge c = -27^\circ$. $G. = 2.3$	391
io, io	Prism.	28°	Mon.	<i>Syngenite</i>	Sul.	$Y \wedge c = -3^\circ$. $Z = b$. $G. = 2.6$	111
oto perf.	Fib.	Lg.	Tr.	<i>Okenite</i>	Sil.	$Z = c \pm$. $G. = 2.3$. Gel. HCl	413
Group 24a. Refrindex positive and low: N_o or $N_m > 1.53 < 1.59$. Optically +							
A. No visible cleavage and no marked elongation							
$Z = c$	Pyr.	0°	Tet.	<i>Soumansite</i>	Phos.	$G. = 2.87$. Also biax.	151
$Z = c$	Prism.	0°	Tet.	<i>Pinnite</i>	Bor.	$G. = 2.29$. Sol. HCl	92
ooo dist.	ooo	0°	Rhom.	<i>Natrodonite</i>	Sul.	$G. = 2.6$	114
?	?	0°	Rhom.	<i>Loevigite</i>	Sul.	$G. = 2.58$ Sign ?	114
$X = b$. $Y = c$	?	Mod.	Orth.	<i>Grothine</i>	Sil.	$G. = 3.1$. Sol. H_2SO_4	432
$Z \wedge c = -22^\circ$	?	26°	Mon.	<i>Wagnerite</i>	Phos.	$Y = b$. $G. = 3.0$	134
$Z \perp oio$ cl.	oio	32°	Tr.	<i>Vauxite</i>	Phos.	$X' \wedge c = -27^\circ$. Blue: $X = Z < Y$	157

B. No visible cleavage, but marked elongation

Z fib.	Fib.	Sm.	Orth.	Chrysotile	Sil.	Colorless or yel. to gr.	260
Z || fib.	Fib.	Sm.	Orth.	Deweyite	Sil.	Colorless or yel. to gr.	261
Z = c	Fib.	Mod.	Orth.	Barrandite	Phos.	G. = 2.6. Sol. HCl	140
X || 110 cl.	Fib.	75°	Orth.	Elpidite	Sil.	G. = 2.58	400

C. One visible cleavage

Z fib.	Fib.	Sm.	Orth.	Xonolite	Sil.	One cleav. || elong.	409
X 110 cl.	El. || c	50°	Orth.	Echellite	Sil.	Y = c. Dec. HCl	389
Z 110 cl.	El. || c	54°	Orth.	Thomsonite	Sil.	Y = c. G. = 2.3. Gel. HCl	387
Z 100 cl. ±	Ps. Hex.	Sm.	Mon.	Amesite	Sil.	Y = b. G. = 2.8	285
Z 100 cl. ±	Ps. Hex.	Sm.	Mon.	Sheridanite	Sil.	Y = b. G. = 2.7	283
Z 100 cl. ±	Ps. Hex.	Sm.	Mon.	Corundophillite	Sil.	Y = b. G. = 2.9	283
Y 110 cl.	Acic.	50°	Mon.	Isoclastite	Phos.	Z ∠ c = Sm. G. = 2.9	137
001, 110	Gran.	60°	Mon.	Custerite	Sil.	X = b. Z ∠ c = 7°. G. = 2.9	412
010, 100	El. || c	Mod.	Mon.	Hydromagnesite	Carb.	Y ∠ c = -43°. Z = b. 100 twin.	85

D. Two or more visible cleavage directions

110 at 56°	Prism.	80° ±	Orth.	Anthophyllite	Sil.	X = a. Z = c. Colorless or X, Y = brown Z = yellow or green	240
110, 101	Var.	51°	Mon.	Angelite	Phos.	Y = b. Z ∠ c = -34°. G. = 2.7	143
Z 110 cl.	El. || c	Ig.	Mon.	Brushite	Phos.	301 cl. G. = 2.2.	123
110 at 56°	Fib.	Ig.	Mon.	Kupfferite	Sil.	Y = b. Z ∠ c = -11°. G. = 3.1	244
001, 010	Prism.	Ig.	Mon.	Celsian	Sil.	Y = b. Z ∠ a = +28°. G. = 3.4	359

Group 24b. Refrindex positive and low: N_o or $N_m > 1.53 < 1.59$. Optically -

A. No visible cleavage

100 dist.	Prism.	0°	Tet.	Dipyre	Sil.	G. = 2.65 ±. Sol. HF	296
X 100	001	0°	Hex.	Melanotline	Sul.	X = colorless, Z = orange	114
X 100	Lam.	0°	?	Saponite	Sil.	G. = 2.26. Sol. HF	437
110, 001	Prism.	70°	Orth.	Sulfoborite	Bor.	X = c. Y = b. G. = 2.4	120

TABLE II.—BIREFRINGENCE OF MINERALS

III. BIREFRINGENCE MODERATE: $N_g - N_p > 0.0095 < 0.0185$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 24b. Refrindex positive and low: N_o or $N_m > 1.53 < 1.59$. Optically —, continued							
A. No visible cleavage—continued							
$Z \perp oio$ cl.	Prism.	$60^\circ \pm$	Orth.	Cordierite	Sil.	Ps. Hex. twin. $X=c$. Colorless or $X=$ yel., $Y=$ blue, $Z=$ blue	307
$X \perp$ cleav.	?	Sm.	Orth.	<i>Centrolasite</i>	Sil.	$G=2.5$. Sol. HCl	409
$X \wedge c = +30^\circ$	Lam.	25°	Mon.	<i>Minrite</i>	Phos.	$Y=b$. $G=2.94$	138
?	Prism.	Mod.	Tr.	<i>Siderolil</i>	Sul.	Bl.-green. $G=2.2$. Sol. H_2O	107
?	?	Mod.	Tr.	<i>Co-Chalcanthile</i>	Sul.	Pink. $G=2.2$. Sol. H_2O	107
B. One or more visible cleavage directions							
$X \perp ooor$ cl.	o o o i	0°	Hex.	<i>Pyroaurite</i>	Carb.	$X=$ colorless, $Z=$ red	87
$X \perp ooor$ cl.	o o o i	0°	Rhom.	<i>Gyroilite</i>	Sil.	$G=2.4$. Also biax.?	408
$X \perp o o i$ cl.	El. || b	68°	Orth.	<i>Beryllonite</i>	Phos.	$Y \perp i o o$ cl. $G=2.85$	149
$X \parallel i i o$ cl.	Ps. Tet.	$50^\circ \pm$	Orth.	<i>Edingtonite</i>	Sil.	$Y=b$. $G=2.7$	389
$X \perp o o i$ cl.	o o i	Mod.	Mon.	Antigorite	Sil.	$Y=b$. $G=2.57$	280
$Z \perp o i o$ cl.	El. || c	79°	Mon.	<i>Pharmacolite</i>	Arsen.	$X \wedge c = +70^\circ$. $G=2.7$	123
o o i perf.	o o i	?	Mon.	<i>Volchonskoite</i>	Sil.	Bl.-green. $G=2.3$	416
o i o perf.	Fib.	Lg.	Tr.	<i>Okenite</i>	Sil.	$X=c \pm$. $G=2.3$. Gel. HCl	413
o o i, o i o	a or o i o	Lg.	Tr.	BYTOWNITE	Sil.	$Z \wedge o i o = 42^\circ$. $Z \wedge o o i = 45^\circ$	376
o o i, o i o	a or o i o	Lg.	Tr.	ANORTHITE	Sil.	$Z \wedge o i o = 43^\circ$. $Z \wedge o o i = 50^\circ$	378
Group 25a. Refrindex positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +							
A. No visible cleavage							
110 dist.	Prism.	0°	Tet.	<i>Auerite</i>	Ox.	Yellow. $G=4.5 \pm$	185
1120 dist.	Prism.	0°	Rhom.	Phenacite	Sil.	$G=3.0$. Sol. HF	185

Y || oro cl.	Prism.	45° ±	Orth.	Mullite	Sil.	Z = c. G. = 3.0 2 cleav. at 90°. X = colorless, Z = orange	201
Z || fib.	Fib.	Lg.	Orth.	<i>Salmonsie</i>	Phos.	Y = b. G. = 3.0	156
Z ⊥ 100 cl. ±	Prism.	74°	Mon.	<i>Mosandrite</i>	Sil.	Y = b. Brown to red	423
Z ∠ c = -44°	oro	80°	Mon.	<i>Hellandite</i>	Sil.	Yellow; not pleo. G. = 3.9	425
K ⊥ oro ±	Lath.	Lg.	Tr.?	<i>Uranophite</i>	Sul.		117
B. One visible cleavage							
ooo perf.	ooo	0°	Rhom.	<i>Goyazite</i>	Phos.	Colorless to br. Also biax.	153
ooo perf.	ooo	0°	Rhom.	<i>Svanbergite</i>	Phos.	G. = 3.5. Sol. HCl	119
Z ⊥ 100 cl.	Ps. Hex.	15°	Orth.	<i>Manandonite</i>	Sil.	G. = 2.9. Sol. HF	95
Z ⊥ 100 cl.	Prism.	60° ±	Orth.	Topaz	Sil.	Y = b. G. = 3.55	198
Z ⊥ 100 cl. ±	Ps. Hex.	Sm.	Mon.	Amesite	Sil.	Y = b. G. = 2.8	285
ooo perf.	El. || b	55°	Mon.	<i>Afuillite</i>	Sil.	X ∠ c = 31°. Y = b. G. = 2.6	412
ooo, 110	Gran.	60°	Mon.	<i>Custerite</i>	Sil.	X = b. Z ∠ c = 6°. G. = 2.9	412
ooo, 110	Gran.	62°	Mon.	<i>Cuspidine</i>	Sil.	Y = b. Z ∠ c = 5°. G. = 2.96	412
X ⊥ 100 cl. ±	ooo	Var.	Mon.	<i>Nontronite</i>	Sil.	X = yell., Z = yell., gr., br.	415
oro, 100	Eq.	Lg.	Tr.	<i>Fairfieldite</i>	Phos.	Ext. in oro at 10° to c	127
C. Two or more visible cleavage directions							
ooo, 110	El. || a	38°	Orth.	Barite	Sul.	Y = b. Z = a. G. = 4.5	100
Z || 110 cl.	Pyr.	70°	Orth.	<i>Stokesite</i>	Sil.	Y = b. G. = 3.2	409
110 at 56°	Prism.	80°	Orth.	Anthophyllite	Sil.	Y = b. Z = c. G. = 3 ±	240
110 at 87°	Prism.	45°	Mon.	Clinoenstatite	Sil.	X = b. Y ∠ c = 25° ±. G. = 3.2	220
110 at 87°	Prism.	Sm.	Mon.	Pigeonite	Sil.	X or Y = b. Z ∠ c = +30° ±	227
110 at 87°	Prism.	70° ±	Mon.	Jadete	Sil.	Y = b. Z ∠ c = +32°. G. = 3.4	235
110 at 56°	Prism.	Lg.	Mon.	<i>Kupfferite</i>	Sil.	Y = b. Z ∠ c = +11°. G. = 3.1	244
Group 25b. Refrindex positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically -							
A. No visible cleavage							
X = c	ooo	0°	Hex.	<i>Melanotline</i>	Sul.	X = yell., Z = orange. G. = 2.5	114
X = c	Fib.	0°	Hex.	<i>Crandallite</i>	Phos.	H. = 4. Decrep.	154

TABLE II.—BIREFRINGENCE OF MINERALS

III. BIREFRINGENCE MODERATE: $N_g - N_p > 0.0095 < 0.0185$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 25b. Refrindex positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically —, continued							
A. No visible cleavage—continued							
$X=c$	Fib.	0°	Hex.	<i>Dahlite</i>	Phos.	$G=3.0$. Also biax.	161
$X=c$	Prism.	0°	Hex.	<i>Tourmaline</i>	Sil.	Colorless or X = colorless, Z = pink or blue. $G=3.1$	301
110 at 89°	Prism.	84°	Orth.	<i>Andalusite</i>	Sil.	$X=c$. $Y=b$. $G=3.1-3.2$	201
$X \parallel$ elong.	Fib.	?	Orth.	<i>Koninkite</i>	Phos.	$G=2.4$. Sol. HCl	142
$X=c$	Ps. Hex.	Sm.	Orth.	<i>Eremeyevite</i>	Bor.	$c \parallel$ elong. $G=3.28$	94
100?	?	Lg.	Mon.	<i>Crestmorite</i>	Sil.	$Z \wedge$ elong. = 12°. $G=2.2$	409
$X \wedge c = 30^\circ$	El. $\parallel b$	Lg.	Mon.	<i>Allanite</i>	Sil.	$X = \text{yel.}$, $Y = \text{br.}$, $Z = \text{red-br.}$	316
100 dist.	Prism.	74°	Mon.	<i>Hureaulite</i>	Phos.	$X=b$. $Z \wedge c = +75^\circ$. $G=3.2$	124
B. One visible cleavage							
$X \perp 001$ cl.	Ps. Tet.	10°	Orth.	<i>Uranocircite</i>	Arsen.	$X = \text{colorless}$, $Y, Z = \text{yel.}$. $G=3.5$	147
$X \perp 001$ cl.	Ps. Tet.	Sm.	Orth.	<i>Torbernite</i>	Phos.	$X = \text{green}$, $Z = \text{yel.}$. $G=3.2$	145
$X \perp 001$ cl.	001	0°±	Mon.	<i>Ectropile</i>	Sil.	$Y=b$. $Z=a \pm$. $G=2.46$	409
$X \perp 001$ cl.±	001	Sm.	Mon.	<i>Chamosite</i>	Sil.	$X = \text{yel.}$, $Y, Z = \text{green.}$ $G=3$	286
$X \perp 001$ cl.±	001	Sm.	Mon.	Glauconite	Sil.	$X = \text{yel.}$, $Y, Z = \text{green.}$ $G=2.5 \pm$	436
$X \perp 001$ cl.±	001	Sm.	Mon.	Celadonite	Sil.	$X = \text{yel.-gr.}$, $Y, Z = \text{green}$	436
$X \perp 001$ cl.±	001	Sm.	Mon.	<i>Scybertite</i>	Sil.	$X = \text{colorless}$, $Y, Z = \text{yel.}$. $G=3.1$	286
$X \perp 001$ cl.±	001	20°±	Mon.	<i>Xanthophyllite</i>	Sil.	$X = \text{brown}$, $Y, Z = \text{green.}$ $G=3.1$	286
$X \perp 001$ cl.±	001	25°+	Mon.	<i>Brandisite</i>	Sil.	$X = \text{yel.}$, $Y, Z = \text{gr.}$ $G=3.1$	286
$X \perp 001$ cl.±	001	35°	Mon.	<i>Margarite</i>	Sil.	$Z=b$. $G=3.0-3.1$	288

C. Two or more visible cleavage directions

100, 001	70°	Mon.	Wollastonite	Sil.	$X \wedge c = -32^\circ$. $Y = b$. $G = 2.9$	401
$X \perp 100$ cl. $\pm$	49°	Mon.	<i>Spencerite</i>	Phos.	$Z \perp 010$ cl. $G = 3.1$. Sol. HCl	137
110 at 56°	45° $\pm$	Mon.	Glaucophane	Sil.	$Y = b$. $Z \wedge c = +5^\circ$. $G = 3.1$. $X = \text{colorless}$, $Y = \text{blue}$, $Z = \text{lavender}$	258

Group 26a. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +

A. No visible cleavage and parallel extinction in the chief zones

$Z \parallel \text{elong.}$	?	?	<i>Stibiconite</i>	Ox.	$G = 5.2$. Insol.	68
$Y \perp 010$ cl.	45° +	Orth.	Mullite	Sil.	$Z = c$. $G = 3$	201
001, 012	70°	Orth.	<i>Barylite</i>	Sil.	$X = b$. $Y = a$. $G = 4.0$	401
010, 100?	Lg.	Orth.	<i>Salmonsile</i>	Phos.	$Z = c$. $X = \text{colorless}$, $Z = \text{orange}$	156
$Y = a?$	83°	Orth.	<i>Boracite</i>	Bor.	$G = 2.95$. Sol. HCl. Isom. above 265° C.	94

B. No visible cleavage and inclined extinction in the chief zones

$X \perp 010$ cl.	23°	Mon.	<i>Brandtite</i>	Arsen.	$Y \wedge c = +8^\circ$. $G = 3.6$	125
100 dist.	43°	Mon.	<i>Rinkite</i>	Sil.	$X = b$. $Y \wedge c = -8^\circ$. $G = 3.5$	423
$Z \perp 100$ cl. $\pm$	70°	Mon.	<i>Johnstrupite</i>	Sil.	$Y = b$. Lam. twin. $G = 3.3$	423
$Z \wedge 001$ cl. = 20°	85° $\pm$	Mon.	<i>Clinzoisite</i>	Sil.	$Y = b$. $G = 3.35$. Sol. HF	312
001, 011	Lg.	Tr.	<i>Johannite</i>	Sul.	Green. $G = 3.3$	118
$Z \perp 010$ cl. $\pm$	Lg.	Tr.	<i>Hainite</i>	Sil.	Yel.; pleo. $G = 3.2$	406
110 at 90° $\pm$	90° $\pm$	Tr.	<i>Guarinite</i>	Sil.	Yel.; pleo. $G = 3.3$	406

C. One visible cleavage

$X \perp 001$ cl.	Lg.	Orth.	<i>Pumpellyite</i>	Sil.	$Y \parallel \text{fibers}$. $X, Z = \text{colorless}$, $Y = \text{green}$	432
$Y \perp 001$ cl.	65°	Orth.	Lithiophilite	Phos.	$Z \perp 010$ cl. $G = 3.5$	149
001, 010	72°	Orth.	<i>Natrophilite</i>	Phos.	$Y = c$. $Z = b$. Yel. $G = 3.4$	150
One $\parallel$ elong.	18°	Mon.	<i>Lozite</i>	Sil.	Green in mass. $G = 3.2$	433
$Y \perp 001$ cl. $\pm$	Mod.	Mon.	<i>Dickinsonite</i>	Phos.	$X = b$. Olive: $X > Y > Z$. $G = 3.3$	122
$Z \perp 001$ cl. $\pm$	50° $\pm$	Mon.	<i>Sismondine</i>	Sil.	$Y = b \pm$. $X = \text{gr}$, $Y = \text{bl}$, $Z = \text{yel-gr}$.	438
$Z \perp 010$ cl.	67°	Mon.	<i>Merrillite</i>	Sil.	$X \wedge c = 36^\circ$. $G = 3.15$	194
$X \perp 100$ cl. $\pm$	Mod.	Tr.	<i>Roselite</i>	Arsen.	$X, Y = \text{pink}$, $Z = \text{colorless}$	127
$Z \perp 001$ cl. $\pm$	50° $\pm$	Tr.	Chloritoid	Sil.	Bl.-green; pleo. $G = 3.5$	438

TABLE II.—BIREFRINGENCE OF MINERALS

III. BIREFRINGENCE MODERATE: $N_g - N_p > 0.0093 < 0.0185$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 26a. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +, continued							
D. Two or more visible cleavage directions							
001, 110	001 or <i>a</i>	40°±	Orth.	<i>Barite (Pb)</i>	Sul.	$Y=b$. $Z=a$. $G=5\pm$	100
$X=b$. $Y=c$	Prism.	Mod.	Orth.	<i>Tianno-elpidite</i>	Sil.	Yellow: $X<Y$. $G=2.55$	400
110 at 88°	Prism.	70°±	Orth.	ENSTATITE	Sil.	$Y=b$. $Z=c$. $G=3.3\pm$	217
110 at 87°	Prism.	Sm.	Mon.	<i>Pigeonite</i>	Sil.	X or $Y=b$. $Z\wedge c = +30^\circ\pm$	227
110 at 87°	Prism.	45°±	Mon.	<i>Clinoenstatite</i>	Sil.	$X=b$. $Z\wedge c = +25^\circ$. $G=3.2$	220
110 at 87°	Prism.	60°	Mon.	<i>Hedenbergite</i>	Sil.	$Y=b$. $Z\wedge c = 48^\circ$. Green: $X<Y<Z$	224
110 at 87°	Prism.	60°±	Mon.	<i>Spodumene</i>	Sil.	$Y=b$. $X\wedge c = +25^\circ\pm$. Tinted ±	236
110 at 87°	Prism.	70°	Mon.	<i>Jadeite</i>	Sil.	$Y=b$. $Z\wedge c = +30^\circ\pm$. $G=3.4$	235
Group 26b. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically —							
A. No visible cleavage and uniaxial							
$X\perp 001$ cl.	Prism.	0°	Tet.	<i>Gehlenite</i>	Sil.	$G=3.0$. Gel. HCl	209
$X\perp 001$ cl.	Prism.	0°	Tet.	<i>Hardystonite</i>	Sil.	$G=3.4$. Gel. HCl	209
$X\perp 001$ cl.	Prism.	0°	Tet.	<i>Justite</i>	Sil.	$G=3.1$. Gel. HCl	209
$X=c$	0001	0°	Rhom.	<i>Melanocerite</i>	Sil.	$G=4.1$. Dec. HCl. Yellow	420
B. No visible cleavage and biaxial							
$X \parallel 110$ cl.	Prism.	20°	Orth.	<i>Kornerupine</i>	Sil.	$Y=a$. $G=3.3$	421
$Z\perp 100$ cl.	Fib.	30°	Orth.	<i>Dumortierite</i>	Sil.	Blue; pleo. $Y=b$. $G=3.3$	422
$X=c$; $Y=b$	Prism.	Mod.	Orth.	<i>Kempite</i>	Hal.	Green. $G=2.9$	39
One dist.	Prism.	Mod.	Orth.	<i>Cenosite</i>	Sil.	Yellow. $G=3.4$	440
$X=b$; $Y=c$	Prism.	75°	Orth.	<i>Monticellite</i>	Sil.	$G=3.2$. Gel. HCl	187

$Y \wedge c = -2^\circ$	100	70°	Mon.	<i>Thalénite</i>	Sil.	$Z = b$. $G. = 4.3$	414
$X \wedge c = 30^\circ$	El. || b	Lg.	Mon.	Allanite	Sil.	Green or brown: $X < Z$	316
100 dist.	El. || b	83°	Mon.	<i>Chlorophoenicite</i>	Arsen.	$Y = b$. $G. = 3.5$	134
112, 130	Wedge	73°	Tr.	Axinite	Sil.	$X \perp o11 \pm$. Yel, violet, etc.	425
$X \perp o01$ cl. $\pm$	Ps. Hex.	83°	Tr.	<i>Trimerite</i>	Sil.	$G. = 3.5$. Sol. HCl	401

C. One or more visible cleavage directions

$X \perp o01$ cl.	001	$0^\circ \pm$	Tet.	<i>Sincosite</i>	Phos.	$X = \text{yel.}$, $Z = \text{green.}$ $G. = 2.8$	147
110 at 88°	Prism.	$75^\circ \pm$	Orth.	HYPERSTHENE	Sil.	$X = a$. $Y = b$. $X = \text{red.}$, $Y = \text{br.}$, $Z = \text{gr.}$	219
$X \perp o01$ cl. $\pm$	001	20°	Mon.	<i>Xanthophyllite</i>	Sil.	$X = \text{brown.}$, $Y, Z = \text{green.}$ $G. = 3.1$	286
$X \perp o01$ cl. $\pm$	001	25°	Mon.	<i>Brandisite</i>	Sil.	$X = \text{yel.}$, $Y, Z = \text{green.}$ $G. = 3.1$	286
$X \perp 100$ cl. $\pm$	100	63°	Mon.	<i>Tinsénite</i>	Sil.	$Y = b$. Green: $X > Y > Z$.	428
$Z \wedge o01$ cl. $= 25^\circ$	El. || b	$80^\circ \pm$	Mon.	EPIDOTE	Sil.	Golden: $Y > Z > X$. $G. = 3.3$	314
110 at 88°	Prism.	Lg.	Mon.	<i>Clinohypersthene</i>	Sil.	$X = b$. $Z \wedge c = +30^\circ \pm$. $G. = 3.4$	221
$Z \perp o10$ cl.	Var.	Lg.	Mon.	<i>Clinohedrite</i>	Sil.	$Y \wedge c = -28^\circ$. $G. = 3.3$	413
010, 110	Prism.	44°	Tr.	<i>Bustamite</i>	Sil.	$X \perp o10 \pm$. $Z' \wedge c = 36^\circ$ on 010	406
$X \perp 100$ cl. $\pm$	El. || c	83°	Tr.	Kyanite	Sil.	100 lam. twin. $G. = 3.6$	205

 Group 27a. Refractive positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +

A. No visible cleavage

$Z \parallel 110$ cl.	Prism.	0°	Tet.	<i>Thortite</i>	ThSiO ₄	Yellow. $G. = 5.3$	185
111 dist.	Pyr.	0°	Tet.	<i>Scheelite</i>	CaWO ₄	$G. = 6.1$	97
111 dist.	Pyr.	0°	Tet.	<i>Povellite</i>	CaMoO ₄	Yellow. $G. = 4.4$	98
$Z \perp o001$ cl.	Prism.	0°	Hex.	<i>Nasonite</i>	Sil.	$G. = 5.4$. Sol. HCl	407
$Z \parallel \text{fib.}$	Fib.	?	Orth.	<i>Silbicomite</i>	Ox.	$G. = 5.2$. Insol.	68
$Y = b$. $Z = a$	100	30°	Orth.	<i>Holdenite</i>	Arsen.	$G. = 4$. Pink	136
$Y = b$. $Z = c$	100	55°	Orth.	<i>Chrysoberyl</i>	Ox.	Colorless or pleo.; red, gr.	65
$X \perp o10$ cl.	Prism.	85°	Orth.	Staurolite	Sil.	$Z = c$. Yellow: $X < Y < Z$	202
$X \wedge c = \text{Sm.}$	010	$0^\circ \pm$	Mon.	<i>Huegelite</i>	Van.	$Z = b$. Yellow; pleo. $G. = 5$	127
No cleav.	Eq.	Mod.	Mon.	<i>Barthite</i>	Arsen.	Green. $G. = 4.2$	160
$Z \wedge c = +8^\circ$	Prism.	85°	Mon.	<i>Gadolinite</i>	Sil.	$Y = b$. Gr. or br. $G. = 4.3$	424

TABLE II.—BIREFRINGENCE OF MINERALS

III. BIREFRINGENCE MODERATE: $N_o - N_p > 0.0095 < 0.0185$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 27a. Refrindex positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +, continued							
B. One or more visible cleavage directions							
010, 110	Prism.	$35^\circ \pm$	Orth.	<i>Ardennite</i>	Sil.	$Y = b$. $Z = c$. Yellow: $X > Y > Z$	440
001, 110	Var.	$70^\circ \pm$	Orth.	<i>Anglesite</i>	$PbSO_4$	$Y = b$. $Z = a$. $G = 6.3$	99
110 at 87°	Prism.	60°	Mon.	<i>Hedenbergite</i>	Sil.	$Y = b$. $Z \wedge c = +48^\circ$. Green: $X < Y < Z$	224
110 at 87°	Prism.	30°	Tr.	<i>Pyroxmangite</i>	Sil.	Opt. Pl. 1.00 $\pm$. $G = 3.8$	406
$Z \perp 001$ cl. $\pm$	001	$50^\circ \pm$	Tr.	Chloritoid	Sil.	Green, blue; pleo. $G = 3.5$	438
$Z \perp 001$ cl. $\pm$	001	$50^\circ +$	Tr.	<i>Sismondine</i>	Sil.	Green, blue; pleo. $G = 3.4$	438
110, 110	Prism.	Lg.	Tr.	<i>Rhodonite</i>	Sil.	$G = 3.5$. Sol. HF	403
Group 27b. Refrindex positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically —							
$X = c$	0001	0°	Hex.	<i>Dusserite</i>	Arsen.	$G = 3.75$. Sol. HCl. Yel.-green. $X < Z$	153
No cleav.	?	Mod.	Mon.	<i>Chekinite</i>	Sil.	Brown: $X < Y < Z$. $G = 4.5$	423
Group 28a. Refrindex positive and extreme: N_o or $N_m > 2.00$. Optically +							
$Z = c?$	?	0°	Tet.	<i>Struenerite</i>	Tit.	$X = br$, $Z = gr$. to opaque	164
$Z \perp 0001$ cl.	Prism.	0°	Hex.	<i>Iodyrite</i>	AgI	Yel. Abn. int. colors	30
Group 28b. Refrindex positive and extreme: N_o or $N_m > 2.00$. Optically —							
$X = c?$	?	0°	Tet.	<i>Struenerite</i>	Tit.	$X = gr$. to opaque; $Z = br$.	164
$X = c$	Prism.	0°	Hex.	Pyromorphite	Phos.	Colorless or $X = yel$, $Z = gr$.	131
$X = c$	Prism.	0°	Hex.	<i>Mimette</i>	Arsen.	Colorless or yel.: $X < Z$	132
1011 dist.	Prism.	0°	Hex.	<i>Finnemanite</i>	Arsen.	Olive green. $G = 7.3$	159
$X = c$	?	0°	Rhom.	<i>Senante</i>	Ox.	Nearly opaque. $G = 5.5 \pm$	67
$X \perp$ plates	Platy	Sm.	Mon.	<i>Montanite</i>	Tel.	Abn. int. colors. $G = 3.8$	109

IV. BIREFRINGENCE RATHER STRONG: $N_g - N_p > 0.0185 < 0.0275$

Group 29a. Refrference negative and distinct: N_o or $N_m < 1.48$. Optically +

$Y = b$. $Z = a$	Ps. Hex.	70°	Orth.	Carnallite	Hal.	G. = 1.6. Sol. H ₂ O	34
$Y \perp$ oor cl.	Var.	83°	Orth.	<i>Thenardite</i>	Sul.	Z = a. G. = 2.7. Sol. H ₂ O	96

Group 29b. Refrference negative and distinct: N_o or $N_m < 1.48$. Optically -

$X = c$	Fib.	0°	?	<i>Mendosite</i>	Sul.	G. = 1.7. Sol. H ₂ O	113
100, 110	Prism.	40°	Mon.	Borax	Bor.	$X = b$. $Z \wedge c = -55^\circ$. G. = 1.7	90
?	Fib.	48°	Mon.	<i>Wallerite</i>	Sul.	G. = 1.8. Sol. HCl	112
100 perf.	Prism.	64°	Mon.	<i>Credite</i>	Sul.	$Y = b$. $Z \wedge c = 42^\circ$. Purple $\pm$	121

Group 30a. Refrference negative and low: N_o or $N_m > 1.48 < 1.54$. Optically +

$Z = c$	?	0°	?	<i>Ozocerite</i>	H, C	Also biax. G. = 0.9	18
$Y = b$. $Z = a$	Prism.	78°	Orth.	<i>Flagstaffite</i>	H, C, O	G. = 1.1. Sol. alcohol	88
$Y \perp$ 010	100	45°	Orth.	<i>Neuberyite</i>	Phos.	Z = c. G. = 2.1. Sol. HNO ₃	123
$Z \perp$ 010 cl.	Prism.	54° $\pm$	Orth.	Thomsonite	Sil.	$Y = c$. G. = 2.3. Gel. HCl	387
101, 010	Fib.	72°	Orth.	Wavellite	Phos.	$Y = a$. Z = c. G. = 2.3. Sol. HCl	144
$Y \perp$ 100 cl.	Acic.	74°	Orth.	<i>Tavistockite</i>	Phos.	Z = c. Sol. HCl	154
$Y \wedge c = 23^\circ$	El. || c	Mod.	Mon.	Ulexite	Bor.	Z = b. G. = 1.8 $\pm$. "Cotton balls"	93
$Z \perp$ 010 cl.	El. || c	Mod.	Mon.	<i>Hydromagnesite</i>	Carb.	$Y \wedge c = 43^\circ$. 100 twin. G. = 2.1	85
$Z \perp$ 010 cl.	Eq.	35°	Mon.?	<i>Wapplerite</i>	Arsen.	Z = b $\pm$. G. = 2.5	124

Group 30b. Refrference negative and low: N_o or $N_m > 1.48 < 1.54$. Optically -

A. No visible cleavage

$X \perp$ oor cl.	?	0°	Tet.	<i>Locvite</i>	Sul.	G. = 2.4. Sol. H ₂ O	111
$X = c$	?	0°	Tet.?	<i>Bechlite</i>	Bor.	Doubtful species	92
$X \perp$ oor cl.	Var.	0°	Hex.	<i>Hanksite</i>	Sul.	G. = 2.56. Sol. H ₂ O	119
$X = c$	Acic.	0°	Hex.	<i>Nocerite</i>	Hal.	G. = 2.96	38
$X = c$	ooo	0°	Hex.	<i>Zincaluminite</i>	Sul.	G. = 2.26. Sol. HCl	115
100, 110	Tab.	85°	Mon.	<i>Kainite</i>	Sul.	$X \wedge c = -8^\circ$. $Y = b$. G. = 2.13	120

TABLE II.—BIREFRINGENCE OF MINERALS

IV. BIREFRINGENCE RATHER STRONG: $N_g - N_p > 0.0185 < 0.0275$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 30b. Refrindex negative and low: N_o or $N_m > 1.48 < 1.54$. Optically —, continued							
A. No visible cleavage—continued							
001 dist. 110 at 73°	Tab. 001	70° Mod.	Mon.	<i>Iryolite</i>	Bor.	$X \wedge c = +37^\circ$. $Y = b$. $G = 1.88$	92
?	Prism.	60°	Mon.	<i>Lueneburgite</i>	Phos.	$Y = b?$ $Z \wedge c = 45^\circ$. $G = 2$	161
			Tr.	<i>Fe-Cu-chalcantinite</i>	Sul.	Pale blue. $G = 2.1$	107
B. One or more visible cleavage directions							
1010 perf.	Prism.	0°	Hex.	<i>Cancrinite</i>	Sil.	$G = 2.5$. Gel. HCl	301
001 perf.	001	0°	Hex.	<i>Stichtite</i>	Carb.	Lilac: $X < Z$. $G = 2.16$	87
X 1010 cl.	Acic.	42°	Orth.	<i>Morenosite</i>	Sul.	Greenish. $G = 2$	103
X 1001 cl. $\pm$	001	Sm.	Mon.	<i>Antigorite</i>	Sil.	Greenish. $N_m = 1.57$ usually	280
001 perf.	El. || c	7°	Mon.	Glauberite	Sul.	$X \wedge c = +31^\circ$. $Z = b$. $G = 2.85$	110
100 perf.	El. || c	Mod.	Mon.	<i>Scarlite</i>	Sil.	$X \wedge c = +30^\circ$. $Z = b$. $G = 2.45$	423
X 1010 cl.	El. || c	Lg.	Mon.	<i>Minasragrite</i>	Sul.	Blue: $X > Y > Z$. Sol. H_2O	110
Group 31a. Refrindex positive and low: N_o or $N_m > 1.53 < 1.59$. Optically +							
A. No visible cleavage							
Z 10001 cl.	001	0°	Rhom.	<i>Alunite</i>	Sul.	$G = 2.6$	113
$Z = c$	Ps. Is.	0°	Rhom.	<i>Alumtinite</i>	Sul.	$G = 2.74$. Sol. HCl	107
Z || fb.	Fib.	?	?	<i>Zepharovichite</i>	Phos.	$G = 2.37$. Sol. Cl	141
Z || fb.	Fib.	Sm.	Orth.	<i>Xyloite</i>	Sil.	Yellow: $X = Y < Z$. $G = 2.5$	261
?	Mass.	$49^\circ \pm$	Orth.	<i>Norbergite</i>	Sil.	$G = 3.4$. Gel. HCl	196
Z 1 100 $\pm$	100	Lg.	Mon.	<i>Martinite</i>	Phos.	$Y = b$. $G = 2.9$. Sol. HCl	124
010 dist.	Prism.	35°	Tr.	<i>Parasaurite</i>	Phos.	On 010 $Y' \wedge c = 38^\circ$	157

B. One or more visible cleavage directions

	$\circ^\circ$	Rhom.	Brucite	$Mg(OH)_2$	$G = 2.4$. Sol. HCl	
$Z \perp o o o i$ cl.	$54^\circ \pm$	Orth.	Thomsonite	Sil.	$Y = c$. $G = 2.3$. Gel. HCl	42
$Z \perp o r o$ cl.	72°	Orth.	Wavellite	Phos.	$Y = a$. $Z \parallel$ fib. $G = 2.33$	387
$Y \perp o i o$ cl.	74°	Orth.	<i>Tavistockite</i>	Phos.	$Z = c$. Sol. HCl	144
$o o i$ perf.	Sm.	Mon.	Gibbsite	$Al(OH)_3$	X (or Y) = b . $Z \wedge c = 30^\circ \pm$. $G = 2.35$	154
$o i o$ perf.	35°	Mon.?	<i>Wapplerite</i>	Arsen.	$Z = b$. Ext. on $o i o = 20^\circ$	48
$X \perp lam.$ $\pm$	60°	Tr.?	<i>Voglite</i>	Carb.	$Z \wedge elong. = 33^\circ$. Lam. twin.	124
						88

 Group 31b. Refrindex positive and low: N_o or $N_m > 1.53 < 1.59$. Optically -

A. No visible cleavage

	$\circ^\circ$	Tet.	Dipyre	Sil.	$G = 2.65$. Sol. HF	
100 dist.	$\circ^\circ$	Tet.?	<i>Bechtleite</i>	Bor.	Doubtful species	296
$X = c$	$\circ^\circ$	Hex.	<i>Zincaluminite</i>	Sul.	$G = 2.26$. Sol. HNO_3	92
$X \parallel$ fib.	Sm.	?	<i>Ascharite</i>	Bor.	$G = 2.7$	115
$Z = c$?	$55^\circ \pm$	Orth.	<i>Variscite</i>	Phos.	$G = 2.54$. Tinted $\pm$	92
One dist.	?	Orth.	<i>Spherite</i>	Phos.	$G = 2.54$	140
110 at 73°	Mod.	Mon.	<i>Lueneburgite</i>	Phos.	$G = 2$. Sol. HCl	144
?	Mod.	Tr.	<i>Co-chalcanthite</i>	Sul.	Pink. $G = 2.2$	161
?	60°	Tr.	<i>Fe-Cu-chalcanthite</i>	Sul.	Pale blue. $G = 2.2$	107
One dist.	60°	Tr.	Polyhalite	Sul.	Ext. on cleav. at 20° and 29°	107
						113

B. One visible cleavage and parallel extinction

	$\circ^\circ$	Hex.	<i>Stichtite</i>	Carb.	Lilac: $X < Z$. $G = 2.16$	87
$\circ\circ\circ i$ perf.	$\circ^\circ$	Orth.	<i>Autunite</i>	Phos.	$X =$ colorless; $Y, Z =$ yellow	146
$KX \perp \circ\circ i$ cl. $\pm$	33°	Orth.	<i>Uranospinite</i>	Arsen.	$X =$ colorless; $Y, Z =$ yellow	147
$X \pm \circ\circ i$ cl. $\pm$	46°	Mon.	<i>Lepidolite</i>	Sil.	$Z = b$. Colorless, pink, violet	270
$KX \perp \circ\circ i$ cl. $\pm$	Sm.	Mon.	Jefferite	Sil.	$X =$ colorless; $Y, Z =$ brown	433
$KX \perp \circ\circ i$ cl. $\pm$	$\circ^\circ \pm$	Mon.	Bowlingite	Sil.	$X =$ yel., $Y, Z =$ gr. or brown	437
$KX \perp \circ\circ i$ cl. $\pm$	Sm.	Mon.	<i>Carbyite</i>	Sil.	Golden br., not pleo. $G = 3 \pm$	415
$Z \perp \circ\circ i$ cl. $\pm$	Sm.	Mon.	<i>Nontzonite</i>	Sil.	$X =$ yel., $Y =$ olive, $Z =$ gr. $G = 2.5$	415
$X \perp \circ\circ i$ cl. $\pm$	Var.	Mon.				

TABLE II.—BIREFRINGENCE OF MINERALS

IV. BIREFRINGENCE RATHER STRONG: $N_g - N_p > 0.0185 < 0.0275$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 31b. Refrindex positive and low: N_o or $N_m > 1.53 < 1.59$. Optically —, continued							
C. One visible cleavage and inclined extinction							
$X \perp ool$ cl. $\pm$	ool	Sm.	Mon.	Lepidolite	Sil.	$Z = b$. Colorless, pink, violet	270
ool perf.	ool	Sm.	Mon.	Glauberite	Sul.	$X \wedge c = +31^\circ$. $Z = b$. $G = 2.85$	110
100 perf.	?	Mod.	Mon.	Scarlésite	Sul.	$X \wedge c + 30^\circ$. $Z = b$. $G = 2.45$	423
$X \perp o$ cl.	oto	62°	Mon.	Basséite	Phos.	Yel.: $X < Y = Z$. $G = 3.1$	146
$X \perp o$ cl.	El. || c	Lg.	Mon.	Minasragrite	Sul.	$Z \wedge c = 12^\circ$. Blue: $X > Y > Z$	110
$X = b \pm$	Prism.	42°	Tr.	Hamaýite	Phos.	$Y \wedge c = 33^\circ$. $G = 1.89$	151
Group 32a. Refrindex positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +							
A. No visible cleavage							
$Z = c$	?	o°	?	<i>Plumbogummite</i>	Phos.	Yellow: $X < Z$. $G = 4.5 \pm$	153
$X = c$	Fib.	Sm.	Orth.	<i>Roebingite</i>	Sil.	$G = 3.4$. Sol. HCl	440
$Yb = Z = a \pm$	100	Lg.	Mon.?	<i>Marinite</i>	Phos.	$G = 2.9$. Sol. HCl	124
$Y \wedge c = 1^\circ?$	ool	Sm. $\pm$	Mon.	<i>Homilite</i> (alt.)	Sil.	Yel. $G = 3.3 \pm$. Sol. HCl	424
B. One visible cleavage							
$X \perp o$ cl.	?	Lg.	Orth.	<i>Krenbergite</i>	Phos.	$Y = c$. $G = 2.14$	141
$Y \perp o$ cl.	Prism.	28° $\pm$	Orth.	Sillimanite	Sil.	$Z = c$. $G = 3.25$	200
$Y \perp o$ cl.	Prism.	50° $\pm$	Mon.	<i>Euclase</i>	Sil.	$Z \wedge c = +41^\circ$. $G = 3$	432
$X \perp o$ cl. $\pm$	?	Lg.	Mon.	<i>Fremontite</i>	Phos.	$G = 3$	152
100 perf.	?	Lg.	Mon.	<i>Triphite</i>	Phos.	$Y = b$. $Z \wedge a = 42^\circ$. Pink to br.	134
ool, 100	?	80° $\pm$	Tr.	Montebrazite	Phos.	$G = 3.0$. Sol. H_2SO_4	152
oto perf.	100	90° $\pm$	Tr.	<i>Parahopéite</i>	Phos.	$X = a \pm$. $G = 3.3$. Sol. HCl	128

C. Two visible cleavages

110 at 76°	Var.	46°	Orth.	Hemimorphite	Sil.	$Y=a$, $Z=c$. $G=3.45$	211
110 at 54°	Fib.	80°±	Orth.	Anthophyllite	Sil.	$Y=b$, $Z=c$. Colorless or tinted	240
110 at 56°	Prism.	60°	Mon.	Pargasite	Sil.	$Y=b$. $Z \wedge c = 27^\circ$. Colorless or $X=$ yel., $Y=$ gr., $Z=$ gr.-blue	247
110 at 56°	Prism.	85°±	Mon.	Cummingtonite	Sil.	$Y=b$. $Z \wedge c = 16^\circ$. Colorless or X , $Y=$ yel., $Z=$ br. $G=3.2 \pm$	243

Group 32b. RefrERENCE positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically -

A. No visible cleavage

$X \perp 100$ cl.	Pyr.	0°	Tet.	<i>Meliphanite</i>	Sil.	Yellow±. $G=3$	210
$X=c$	Prism.	0°	Hex.	<i>Bazile</i>	Sil.	$X=$ blue, $Z=$ yel. $G=2.8$	414
$X=c$	Prism.	0°	Hex.	Tourmaline (Li)	Sil.	Colorless or yel.: $X < Z$	301
$X=c$	Prism.	0°	Hex.	Tourmaline (Mg)	Sil.	Colorless, pink or blue: $X < Z$	301
$X \perp$ cleav.	Platy	30°	Orth.	<i>Astrolite</i>	Sil.	$X=$ colorless, $Y, Z=$ gr. $G=2.8$	429
$Z=c?$	Fib.	Sm.	?	Chrysocolla	Sil.	$X=$ gr., $Z=$ colorless. $G=2.4 \pm$	411
$X \perp 100$ cl.±	001	Sm.	Mon.	<i>Bituite</i>	Sil.	$G=3$. Sol. HF	427
$Z \wedge c = 44^\circ$	100	Lg.	Mon.	<i>Houtite</i>	Bor.	$Y=b$. $G=2.58$	95
$X \wedge c = 35^\circ \pm$	El. || b	Lg.	Mon.	Allanite	Sil.	Brown: $X < Y < Z$. Sol. HCl	316
100	El. || b	60°±	Tr.	Polyhalite	Sul.	Lam. twin.	113

B. One visible cleavage and uncolored

$Z \perp 100$ cl.	Prism.	36°	Orth.	α -Hopite	Phos.	$X \perp 1010$ cl. $G=3.0$	124
$X \perp 100$ cl.	Ps. Tet.	39°	Orth.	<i>Leucophanite</i>	Sil.	$Y=a$. 110 or 001 twin.	210
$X \perp 1010$ cl.	Fib.	60°	Orth.	<i>Carpholite</i>	Sil.	Colorless or yel.: $X, Y > Z$	431
$Z \perp 100$ cl.	Platy	74°	Orth.	<i>Bertrandite</i>	Sil.	$Y=b$. $G=2.6$	410
$X \perp 100$ cl. ±	Platy	50°	Mon.	<i>Phosphophyllite</i>	Phos.	$Z=b$. $Y \wedge c = 50^\circ \pm$. $G=3$.	125
001, 110	Platy	32°	Tr.?	<i>Pricite</i>	Bor.	$X \wedge \perp$ plate = 25°. $G=2.4$	93
001, 100	?	50°	Tr.	Amblygonite	Phos.	X in $\bar{1}10$. $G=3.1$	162

C. One visible cleavage and colored

$X \perp 100$ cl.	Ps. Tet.	0°±	?	<i>Zaenite</i>	Arsen.	Green: $X < Z$. $G=3.2$	146
$X \perp 100$ cl.	001	0°±	Orth.	<i>Beminitite</i>	Sil.	Brown or gray: $X < Y, Z$	409

TABLE II.—BIREFRINGENCE OF MINERALS

IV. BIREFRINGENCE RATHER STRONG: $N_o - N_p > 0.0185 < 0.0275$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 32b. Refrindex positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically —, continued							
C. One visible cleavage and colored —, continued.							
X $\perp$ oor cl.	Ps. Tet.	33°	Orth.	<i>Autunite</i>	Phos.	Golden: X < Y = Z. G. = 3.1	146
X $\perp$ oro cl.	Fib.	60°	Orth.	<i>Carpholite</i>	Sil.	Colorless or yel.: X, Y > Z	431
X $\perp$ oor cl. $\pm$	oor	Sm.	Mon.	<i>Bowlingite</i>	Sil.	Yel., gr., br.; pleo. G. = 3 $\pm$	437
X $\perp$ oor cl. $\pm$	oor	Var.	Mon.	<i>Nontronite</i>	Sil.	Yel., gr., br.; pleo. G. = 2.5	415
oor perf.	oor	Lg.	Mon.	<i>Roscherite</i>	Phos.	X = yel.; Y, Z = br. G. = 2.9	156
D. Two or more visible cleavage directions							
110 at 55°	Fib.	80°	Orth.	<i>Gedrite</i>	Sil.	Y = b. Z = c. G. = 3.0	240
110 at 56°	Prism.	43°	Mon.	<i>Gastaldite</i>	Sil.	Like glaucophane	259
110 at 56°	Prism.	45° $\pm$	Mon.	Glaucophane	Sil.	Y = b. Z $\wedge$ c = +5°. G. = 3.1. X = yel., Y = violet, Z = blue	258
110 at 56°	Prism.	80° $\pm$	Mon.	HORNBLÉNDE	Sil.	Y = b. Z $\wedge$ c = +20° $\pm$. G. = 3.1 $\pm$. X = yel., Y, Z = gr. or br.	247
110 at 56°	Prism.	80° $\pm$	Mon.	Actinolite	Sil.	Y = b. Z $\wedge$ c = +14°. G. = 3.1	245
110 at 56°	Prism.	85° $\pm$	Mon.	Tremolite	Sil.	Y = b. Z $\wedge$ c = +17°. G. = 2.9	245
Group 33a. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +							
A. No visible cleavage							
Z = c	Acic.	0°	Hex.	<i>Connellite</i>	Sul.	Blue $\pm$. G. = 3.4	118
ooo1, 11 $\bar{2}$ 0	Prism.	0°	Rhom.	Willemite	Sil.	G. = 4 $\pm$. Sol. HCl	186
oto, 100	Prism.	Lg.	Orth.	<i>Shannonite</i>	Sil.	X = c. Y = a.	195
X = b	Lam.	55°	Mon.	<i>Graftonite</i>	Phos.	G. = 3.67. Sol. HCl	122
Y $\wedge$ c = -1°	oor	8c°	Mon.	<i>Homilite</i>	Sil.	Z = b. Brown $\pm$. G. = 3.36	424
Z $\wedge$ c = +39°	oor	Lg.	Mon.	<i>Adelite</i>	Arsen.	Y = b. G. = 3.75. Sol. HNO ₃	134

B. One or more visible cleavage directions and parallel extinction in chief zones

Z $\perp$ 0001 cl.	Rhom.	Sm.	?	<i>Hinsdaleite</i>	Sul. +	G. = 4.65. Insol. HCl	119
Z $\perp$ 001 cl.	Pyr.	Sm.	Orth.	<i>Strengite</i>	Phos.	Colorless, pink, blue: X, Y < Z	140
110 at 55°	Fib.	80°	Orth.	Anthophyllite	Sil.	Y = b. Z = c. G. = 3±	240
010, 001	Prism.	84°	Orth.	Lawsonite	Sil.	X = a. Y = b. G. = 3.1	430

C. One or more visible cleavage directions and inclined extinction

110 at 87°	Prism.	59°	Mon.	AUGITE	Sil.	Y = b. Z $\wedge$ c = 44° ±. Colorless ±	228
110 at 89°	Prism.	60°	Mon.	Hedenbergite	Sil.	Y = b. Z $\wedge$ c = 47°. Gr.: X < Y < Z	224
110 at 87°	Prism.	60°	Mon.	DIOPSIDE	Sil.	Y = b. X $\wedge$ c = 42° ±. Colorless or Y = brownish; X, Z = greenish	244
100 perf.	?	Lg.	Mon.	<i>Triplite</i>	Phos.	Y = b. Z $\wedge$ c = 42°. Pink, br.: X > Y > Z	134
110 at 89°	Prism.	75° ±	Mon.	<i>Jadette-diopside</i>	Sil.	Y = b. Z $\wedge$ c = 45° ±. G. = 3.3	235
110 at 55°	Prism.	85° ±	Mon.	Cummingtonite	Sil.	Y = b. Z $\wedge$ c = 17° ±. Yel.: X, Y < Z	243
110, 110	001	Mod.	Tr.	Rhodonite	Sil.	G. = 3.4 ±. Sol. HF	403
110, 110	001	41°	Tr.	<i>Sobralite</i>	Sil.	X $\wedge$ c = 63°. Z $\wedge$ c = 46°	406

Group 33b. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically -

A. No visible cleavage

Z = c	Prism.	32°	Orth.	<i>Uranophane</i>	Sil.	Yellow: X < Y < Z. G. = 3.9	441
X $\wedge$ c = 35°	100	Lg.	Mon.	Allanite	Sil.	Gr. or br. G. = 4 ±	316
Z $\perp$ 010 cl.	Prism.	75° ±	Mon.	<i>Woehlerite</i>	Sil.	Yel.: X, Y < Z. X $\wedge$ c = 45°.	441
Y = b	Prism.	Sm.	Mon.	<i>Chalcomenite</i>	Sel.	Blue. G. = 3.76	118

B. One visible cleavage

X $\perp$ 001 cl.	Mass.	0°	Tet.?	<i>Schallerite</i>	Sil.	G. = 3.37. Sol. HCl	440
Z $\perp$ 001?	?	?	?	<i>Vilatite</i>	Phos.	X = violet, Z = blue. G. = 2.75	140
Z $\perp$ 001 cl.	001	Lg.	Orth.	<i>Gerhardtite</i>	Nit.	X, Y = gr.; Z = blue. G. = 3.4	89
X $\perp$ 001 cl. ±	001	0° ±	Mon.	<i>Strigovite</i>	Sil.	Green: X < Y, Z. G. = 3.1	437
001 perf.	Prism.	25°	Mon.	<i>Ganophyllite</i>	Sil.	X $\wedge$ c = 2°. Z = b. C. = 2.84	436
001 perf.	001	85° ±	Mon.	EPIDOTE	Sil.	Golden: X < Y. G. = 3.3	314

TABLE II.—BIREFRINGENCE OF MINERALS

IV. BIREFRINGENCE RATHER STRONG: $N_g - N_p > 0.0185 < 0.0275$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 33b. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically —, continued							
C. Two or more visible cleavage directions							
$X \perp ooi$ cl. 110 at 56° 110 at 56°	Rhom.	0°	Rhom.	<i>Hemalite</i>	Arsen.	Yel. to br. $G = 3.4$	153
	Prism.	$40^\circ \pm$	Mon.	Barkevite	Sil.	$Y = b$, $Z < c = 12^\circ \pm$. Brown: $X < Y < Z$	254
	Prism.	$80^\circ \pm$	Mon.	HORNBLÉNDE	Sil.	Yel. to gr. or br. $Z \wedge c = 20^\circ \pm$	247
Group 34a. Refrindex positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +							
$Z \perp ooi$ cl. $Z \parallel$ fib. 010 perf. $Z \perp 100$ cl. $Y = b$, $Z = a$? $Z \wedge c = 12^\circ$?	Prism.	0°	Hex.	<i>Nasonite</i>	Sil.	$G = 5.4$. Sol. HCl	407
	Fib.	Sm.	Orth.	<i>Conichalcite</i>	Arsen.	$X = c$, $Y = b$, $G = 4.15$	136
	Prism.	$35^\circ \pm$	Orth.	<i>Ardennite</i>	Sil.	$Y = a$, $G = 3.6$	440
	Prism.	$59^\circ \pm$	Orth.	<i>Warwickite</i>	Bor.	Brown: $X > Y > Z$, $G = 3.4$	95
	Prism.	Lg.	Orth.	<i>Retzianite</i>	Arsen.	Brown: $X < Y < Z$, $G = 4.15$	154
	?	?	?	<i>Cernanite</i>	Ox.	$G = 4$. Sol. HCl	67
	Prism.	85°	Mon.	<i>Gadolinite</i>	Sil.	$Y = b$, $G = 4.3 \pm$. Sol. HCl	424
	?	?	?	<i>Chenervite</i>	Arsen.	Green. $G = 3.9$. Sign ?	156
Group 34b. Refrindex positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically —							
$X = c$ ooi , 101 No cleav. $Z \perp ooi$? 101 dist. ?	Prism.	0°	Hex.	<i>Cappelenite</i>	Sil.	Gr.-brown. $G = 4.4$	420
	Dom.	Sm.	Orth.	<i>Becquerelite</i>	Ox.	$X = c$, $Y = a$. Yellow: $Y < Z$	60
	Ps. Hex.	Lg.	?	<i>Caraculite</i>	Sul.	110 twin.	120
	?	?	?	<i>Vilatite</i>	Phos.	$X = \text{violet}$, $Z = \text{blue}$, $G = 2.75$	140
	Prism.	$5^\circ \pm$	Mon.	<i>Allactite</i>	Arsen.	$X \wedge c = -30^\circ$, $Z = b$. Gr. to yel.	155
	?	Mod.	Mon.	<i>Chenkinite</i>	Sil.	Brown: $X < Y < Z$, $G = 4.5 \pm$	423

$Y \perp o \text{ to cl.}$ ooi perf. $X \wedge c = 35^\circ$ 100 dist.	Fib. ooi 100 El. || b	65° 70° ± Lg. 83°	Mon. Mon. Mon. Mon.	<i>Alamosite</i> EPIDOTE <i>Allanite</i> <i>Sarkinite</i>	Sil. Sil. Sil. Arsen.	G.=6.5. Sol. HNO ₃ Y=b. Golden: X<Y. G.=3.3± Brown: X<Y<Z. G.=4.1± Y=b. Red to yel. G.=4.2	401 314 316 135
Group 35a. Refrindex positive and extreme: N_o or $N_m > 2.00$. Optically +							
110, 100 oooi perf. Z=c oooi dist. 1070 dist. 1070 dist.	Prism. Mass. El. || c Prism. Fib. Prism.	0° 0° 0° 0° 0° 0°	Tet. Hex. Hex. Hex. Hex. Hex.	<i>Phosgenite</i> Zincite <i>Volzite</i> <i>Kleinite</i> <i>Wurtzite</i> <i>Greenockite</i>	Carb. ZnO ZnS+ Hal. ZnS CdS	G.=6.1±. Sol. HNO ₃ Red. G.=5.5± G.=3.7 Yellow. G.=8 Yellow: X>Z. G.=4 Yellow. G.=4.8	85 41 28 38 20 21
Group 35b. Refrindex positive and extreme: N_o or $N_m > 2.00$. Optically -							
X ⊥ ooi cl. X ⊥ ooi cl. X ⊥ ooi cl. X=c One perf. ooi dist. ?	Ps. Is. ? Rhom. Acic. ? Prism.	0° 0° 0° 0° Var. Sm.	Tet. Tet. Rhom. Hex. Mon.? Tr.?	<i>Bokite</i> <i>Loretoite</i> <i>Barysilite</i> <i>Bellite</i> <i>Volborthite</i> <i>Kleinite</i>	Hal. + Hal. Sil. Arsen. Van. Hal.	Gr.-blue. G.=5± Yellow. G.=7.5 G.=6.7. Sol. HNO ₃ Red or yel.: X<Z. G.=5.5 Green. G.=3.5 Yellow. G.=7.9±	37 38 401 119 137 38
V. BIREFRINGENCE STRONG: $N_o - N_p > 0.0275 < 0.0365$							
Group 36. Refrindex negative and distinct: N_o or $N_m < 1.48$. Optically + or -							
X || fib. X ⊥ o to cl. oio, oii Y ∧ c = 13° 100, ooi	Fib. Fib. Prism. Fib. El. || b	0° ± 46° 52° 52° 90° ±	? Orth. Orth. Mon.? Mon.	<i>Mendosite</i> <i>Goslarite</i> Epsomite Kalanite <i>Kernite</i>	Sul. Sul. Sul. Sul. Bor.	G.=1.7. Sign - Y=c. G.=2. Sign - X=b. Y=c. G.=1.68. Sign - Z=b. G.=1.75. Sign - Z=b. G.=1.95. Sign -?	113 104 103 113 90
Group 37a. Refrindex negative and low: N_o or $N_m > 1.48 < 1.54$. Optically +							
Y ∧ c = 23° X ⊥ oio cl. Y ∧ c = 10°	Fib. Acic. Fib.	Mod. 70° ± 79°	Mon. Mon. Mon.	Ulexite <i>Bobierite</i> <i>Bischofite</i>	Bor. Phos. Hal.	Z=b. Cottony. Z ∧ c = 30° ±. G.=2.4. X=b. G.=1.6.	93 125 32

TABLE II.—BIREFRINGENCE OF MINERALS

V. BIREFRINGENCE STRONG: $N_g - N_p > 0.0275 < 0.0365$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 37b. Refrindex negative and low: N_o or $N_m > 1.48 < 1.54$. Optically —							
$X=c$	Pyr.	0°	Tet.	<i>Mellite</i>	Mel.	G. = 1.6. Sol. HNO ₃ .	88
$X=c$	Acic.	0°	Hex.	<i>Thaumasite</i>	Sul.	G. = 1.87. Sol. HCl.	119
10 to perf.	Prism.	0°	Hex.	Cancrinite	Sil.	G. = 2.5. Gel. HCl.	301
$X \perp$ 0001 cl.	0001	0°	Hex.	<i>Brugnatellite</i>	Carb.	Pink. G. = 2±.	87
$X \perp$ 0001 cl.	001	69°	Orth.	<i>Uranospathite</i>	Phos.	Y = b. Yel.: X < Y, Z.	146
110 poor	Var.	56°	Tr.	Chalcantinite	Sul.	Bluish. G. = 2.2.	106
Group 38a. Refrindex positive and low: N_o or $N_m > 1.53 < 1.59$. Optically +							
110 perf.	001	0°	Tet.	<i>Narsarsukite</i>	Sil.	Colorless or yel., X < Z. G. = 2.8	429
$X=a$. Y = b	Prism.	55°±	Orth.	<i>Metavariscite</i>	Phos.	X = colorless; Y, Z = gr.	141
X || fib.	Fib.	Lg.	?	<i>Tengerite</i>	Carb.	Sol. HCl	86
$X \perp$ 001 cl.	001	25°±	Mon.	<i>Cookeite</i>	Sil.	G. = 2.7	435
Z || 010 cl.	Prism.	41°	Mon.	<i>Botryogen</i>	Sul.	X = yel., Y = red, Z = orange	116
$X \perp$ 010	010	60°	Mon.	<i>Hoernesite</i>	Arsen.	Z $\wedge$ c = 31°. G. = 2.6	125
X = c	Y = b	Lg.	?	<i>Cataclite</i>	Sil.	G. = 2.66. Also monoclinic	400
Group 38b. Refrindex positive and low: N_o or $N_m > 1.53 < 1.59$. Optically —							
A. No visible cleavage							
$X=c$	Pyr.	0°	Tet.	<i>Mellite</i>	Mel.	G. = 1.6. Sol. HNO ₃	88
100 dist.	Prism.	0°	Tet.	Mizzonite	Sil.	G. = 2.7±. Dec. HCl	297
110 poor	Var.	56°	Tr.	Chalcantinite	Sul.	Bluish. G. = 2.2	106
B. One visible cleavage							
0001 perf.	0001	0°	Hex.	<i>Brugnatellite</i>	Carb.	Pink. G. = 2±	87
0001 perf.	0001	0°	Hex.	<i>Connarite</i>	Sil.	Green. G. = 2.5	280

0001	0001	0°	Hex.?	<i>Parseltensite</i>	Sil.	Yellow: $X > Y > Z$. G. = 2.7	407
X 1 001 cl.	001	Sm.	?	Talc	Sil.	G. = 2.75. Sol. HF	262
X 1 001 cl.±	Ps. Hex.	0°±	Mon.	<i>Nepotile</i>	Sil.	G. = 3.1±. Sol. HCl	279
X 1 001 cl.±	Ps. Hex.	0°±	Mon.	BIOTITE	Sil.	Y = b. Br. or gr.: $X < Y = Z$	272
X 1 001 cl.±	Ps. Hex.	Sm.	Mon.	Phlogopite	Sil.	Y = b. Colorless or br.: $X < Z$	272
X 1 001 cl.±	Ps. Hex.	25°±	Mon.	Zinnwaldite	Sil.	Z = b. Brown: $X < Y = Z$	270
X 1 001 cl.±	Ps. Hex.	30°±	Mon.	Lepidolite	Sil.	Z = b. Colorless, pink, violet	270
X 1 001 cl.±	Ps. Hex.	45°±	Mon.	MUSCOVITE	Sil.	Z = b. G. = 2.8. Sol. HF	267
X 1 001 cl.±	Ps. Hex.	Mod.	Mon.	Leverrierite	Sil.	Y = b. G. = 2.5-2.6	433
Group 39a. Refrignence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +							
A. No visible cleavage							
010 dist.	Pyr.	41°	Orth.	<i>Reddingite</i>	Phos.	X = colorless, Y = br., Z = yel.	124
|| ext.	?	58°	Orth.	<i>Cebollite</i>	Sil.	G. = 2.96. Alter. of mellite	431
Z 1 001 cl.	001	67°±	Orth.	Prehnite	Sil.	Y = b. G. = 2.9. Iam. twin.	430
Z = c	El. || c	Lg.	Orth.	<i>Barrandite</i>	Phos.	Tinted±. G. = 2.6±	140
010, 001	Var.	85°	Orth.	Forsterite	Sil.	X = b. Y = c. G. = 3.2	188
X $\wedge$ c = 28°	010	75°±	Mon.	Chondrodite	Sil.	Z = b. Colorless or yel.-gr.	196
B. One or more visible cleavage directions							
Z 1 001 cl.	001	0°±	?	<i>Churchite</i>	Phos.	G. = 3.1. Sol. HCl	156
110, 010	Ps. Hex.	25°±	Mon.	<i>Catalepte</i>	Sil.	Y = b. Z = c±. G. = 2.75	400
X 1 010 cl.	Prism.	55°	Mon.	<i>Colemanite</i>	Bor.	Z $\wedge$ c = 83°. G. = 2.4	93
110 at 55°	Fib.	85°±	Mon.	Cummingtonite	Sil.	Y = b. Z $\wedge$ c = 17°±. Yel.: X, Y < Z	243
100, 001	El. || b	48°	Tr.	<i>Schizolite</i>	Sil.	Y $\wedge$ a = 9°. Z $\wedge$ b = Sm. G. = 3±	420
One cl.	100	Mod.	Tr.	<i>Messelite</i>	Phos.	Ext. on 100 at 20° from c.	128
Group 39b. Refrignence positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically -							
A. No visible cleavage							
100 dist.	Prism.	0°	Tet.	Mizzonite	Sil.	G. = 2.7±	297
Y 1 100 cl.	Prism.	40°	Orth.	<i>Eosphorite</i>	Phos.	X = b. X = yel., Y = pink, Z = colorless	156

TABLE II.—BIREFRINGENCE OF MINERALS

V. BIREFRINGENCE STRONG: $N_g - N_p > 0.0275 < 0.0365$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 39b. Refrindex positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically —, continued							
A. No visible cleavage—continued							
$Z=c$	Pyr.	$55^\circ \pm$	Orth.	<i>Variscite</i>	Phos.	$G = 2.54$. Also fibrous	140
$X \wedge c = -10^\circ$	Pyr.	69°	Mon.	<i>Lazulite</i>	Phos.	$Y=b$. X = colorless; Y, Z = blue	154
$Z \wedge c = -3^\circ$	Dom.	74°	Mon.	<i>Herderite</i>	Phos.	$Y=b$. $G = 3.0$. Sol. HCl	134
$X \perp o$ or cl.	Mass.	82°	Mon.	<i>Tilasite</i>	Arsen.	$Z \wedge c = -30^\circ$. $G = 3.8$	134
B. One or more visible cleavage directions and colorless							
$X \perp o$ or cl.	oor	0°	Hex.	<i>Friedelite</i>	Sil.	$G = 3.1$. Gel. HCl	408
rr, or perf.	?	Lg.	Orth.	<i>Catapleite</i>	Sil.	$X=c$. $Y=b$. $G = 2.66$	400
$X \perp o$ or cl.	oor	Sm.	?	Talc	Sil.	$Z=b$. $G = 2.75$	262
$X \perp o$ or cl. $\pm$	Ps. Hex.	$25^\circ \pm$	Mon.	<i>Kryptolite</i>	Sil.	$Y=b$. $G = 2.5 \pm$. Sol. H_2SO_4	421
$X \perp o$ or cl. $\pm$	Ps. Hex.	$25^\circ \pm$	Mon.	<i>Leverierite</i>	Sil.	$Y=b$. Colorless or brown	433
$X \perp o$ or cl. $\pm$	Prism.	25°	Mon.	<i>Ganophyllite</i>	Sil.	$Z=b$. X = yel., Y, Z = colorless	436
$X \perp o$ or cl. $\pm$	Ps. Hex.	$45^\circ \pm$	Mon.	MUSCOVITE	Sil.	$Z=b$. $G = 2.8$. Sol. HF	267
$X \perp o$ or cl. $\pm$	Prism.	60°	Tr.	<i>Inesite</i>	Sil.	$G = 3$. Sol. HCl	413
C. One or more visible cleavage directions and colored							
$X \perp o$ or cl.	oor	$0^\circ \pm$	?	<i>Benerite</i>	Sil.	Yel.; $X < Y = Z$	409
$X \perp o$ or cl. $\pm$	Ps. Hex.	$0^\circ \pm$	Mon.	<i>Nepouite</i>	Sil.	$Y=b$. X = gr.; Y, Z = gr.-yel.	279
$X \perp o$ or cl. $\pm$	Ps. Hex.	$0^\circ \pm$	Mon.	<i>Connarite</i>	Sil.	Yel. - gr. $G = 2.5$	280
$X \perp o$ or cl. $\pm$	Ps. Hex.	$25^\circ \pm$	Mon.	<i>Leverierite</i>	Sil.	$Y=b$. Colorless or brown	433
$X \perp o$ or cl. $\pm$	Ps. Hex.	$25^\circ \pm$	Mon.	<i>Zinnwaldite</i>	Sil.	$Z=b$. X = colorless; Y, Z = br.	270
$X \perp o$ or cl. $\pm$	Prism.	$25^\circ \pm$	Mon.	<i>Ganophyllite</i>	Sil.	$Z=b$. X = yel.; Y, Z = colorless	436
$X \perp o$ or cl. $\pm$	oor	Var.	Mon.?	<i>Nontzonite</i>	Sil.	Br. or gr.; pleo. $G = 2.5$	415

Group 40a. Refrference positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +

A. No visible cleavage

	Prism.	0°	Hex.	Willemite	Sil.	G. = 4 $\pm$. Sol. HCl	186
0001, 1120	?	71°	Orth.	<i>Manganadulasite</i>	Sil.	X = yellow, Y = green, Z = yellow	202
X 110 cl.	Var.	90° $\pm$	Orth.	CHRYSOLITE	Sil.	Y = c. G. = 3.3. Gel. HCl	189
X 100 cl.	Fib.	90° $\pm$	Orth.	<i>Liskeardi</i>	Arsen.	Z = c. G. = 3.0	142
X $\wedge$ a = 7°	Var.	62°	Mon.	<i>Titanclinochumite</i>	Sil.	Z = b. X = reddish; Y, Z = orange	198
X $\wedge$ c = 9°	Var.	76°	Mon.	<i>Clinohumite</i>	Sil.	Z = b. Colorless or yellowish	197
000 dist.	Prism.	69°	Tr.	<i>Spodiosite</i>	Phos.	Ext. on 010 at 38°	135

B. One visible cleavage

	Pyr.	20° $\pm$	Orth.	<i>Strengite</i>	Phos.	Colorless or pink; X, Y < Z	140
Z 100 cl.	Prism.	28°	Mon.	<i>Molengraafite</i>	Sil.	X = b. Yellow: Y < X < Z	418
001 perf.	Prism.	60°	Mon.	<i>Rosenbuschite</i>	Sil.	X = b. Z $\wedge$ c = -13°. Yel.: X < Y < Z	419
Y 100 cl.	Prism.	62°	Mon.	<i>Phosphosiderite</i>	Phos.	X $\wedge$ a = 4°. Colorless or pink: X > Y > Z	142
001 perf.	001	70° $\pm$	Mon.	<i>Piedmontite</i>	Sil.	X $\wedge$ c = -7°. Y = b. Yel. to red	315

C. Two or more visible cleavage directions

	Prism.	60°	Mon.	DIOPSIDE	Sil.	Y = b. Z $\wedge$ c = 40° $\pm$. G. = 3.3	224
110 at 87°	Prism.	60°	Mon.	<i>Aegirinaugite</i>	Sil.	Y = b. Z $\wedge$ c = 70° $\pm$. Yel. to gr.	232
110 at 87°	Prism.	62° $\pm$	Tr.	<i>Babingtonite</i>	Sil.	X = gr., Y = br., Z = br. or gr.	428

 Group 40b. Refrference positive and high: N_o or $N_m > 1.66 < 1.74$. Optically -

A. No visible cleavage

	Prism.	0°	Rhom.	Tourmaline (Fe)	Sil.	Max. absorp. $\perp$ elong.	301
X = c	Prism.	?	Orth.	<i>Soddlite</i>	Ox.	Yellow. G. = 4.6	61
Y = b. Z = c	Prism.	40°	Orth.	<i>Eosaphorite</i>	Phos.	X = b. X = yel., Y = pink, Z = white	156
Y 100 cl.	Fib.	60°	Orth.	<i>Liskeardi</i>	Arsen.	Z = c. G. = 3.0	142
X 100 cl.	100	65°	Orth.	<i>Erythrosiderite</i>	Hal.	X, Z = br., Y = red-yel. G. = 2.3	35
X 100 cl.	100	85° $\pm$	Orth.	Forsterite	Sil.	Y = c. G. = 3.2. Gel. HCl	188
Y 100 cl.	100	85° $\pm$	Orth.	<i>Picrolephroite</i>	Sil.	X = b. Gel. HCl	194

TABLE II.—BIREFRINGENCE OF MINERALS

V. BIREFRINGENCE STRONG: $N_g - N_p > 0.0275 < 0.0365$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 40b. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically —, continued							
B. One or more visible cleavage directions							
0001 perf.	0001	0°	Hex.	<i>Friedelite</i>	Sil.	White or pink. $G = 3.1$	408
0001 perf.	0001	0°	Hex.	<i>Pyromalite</i>	Sil.	Tinted ±. $G = 3.1$	408
0001 perf.	0001	0°	Hex.	<i>Palmiticite</i>	Sul.	$G = 4.5$. Sol. HNO_3	110
X $\perp$ 001 cl.	001	36°	Orth.	<i>Tyrolite</i>	Arsen.	$X = c$. $Y = b$. Green: $X, Z > Y$	161
X $\perp$ lam.	Lam.		Orth.	<i>Trichalite</i>	Arsen.	$Y \parallel$ elong. Bl.-green	124
X $\perp$ cleav.	?	Ig.	Orth.	<i>Sicklerite</i>	Phos.	Yellow: $X > Y > Z$. $G = 3.45$	158
X $\perp$ 010	Ps. Tet.	0° ±	Mon.?	<i>Phosphuranylite</i>	Phos.	Yellow: $X < Y, Z$. Sol. HCl	147
Z $\perp$ 001 cl. ±	Pyr.	Mod.	Mon.	<i>Hodgkinsonite</i>	Sil.	$Y = b$. Pink or br. $G = 3.9$	412
X $\perp$ 010 cl.	010	50°	Mon.	<i>Schroekingite</i>	Carb.	$Z \wedge c = 41^\circ$. Yel.: $X < Y, Z$	86
110 at 56°	Prism.	Ig.	Mon.	OXYHORNBLÉNDE	Sil.	$Y = b, Z \wedge c = 1^\circ - 10^\circ$. $G = 3.4$. $X = \text{yel. } Y, Z = \text{br. or gr.}$	252
X $\perp$ 010 cl.	?	82°	Mon.	<i>Tilasite</i>	Arsen.	$Z \wedge c = 30^\circ$. $G = 3.8$	134
Group 41a. Refrindex positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +							
0001, 10 $\bar{1}$ 0	Prism.	0°	Hex.	<i>Gaomalite</i>	Sil.	$G = 5.6$. Gel. HCl	407
Z $\parallel$ fib.	Fib.	?	?	<i>Ceranite</i>	Ox.	$G = 4$. Sol. HCl . Sign?	67
110	Acic.	?	Orth.	<i>Carminite</i>	Arsen.	Red. $G = 4.1$. Sol. HNO_3	154
?	Gran.	26°	?	<i>Törnbohmlite</i>	Sil.	$X = \text{yel.}, Y = \text{gr.}, Z = \text{pink. } G = 4.9$	414
110, 010	?	41°	Orth.	<i>Carynite</i>	Arsen.	$X = c$. $Y = a$. Brown	122
X = b. $Y = a$	Pyr.	50°	Orth.	<i>Lössenite</i>	Sul. +	Red. Sol. HCl	120
X = b. $Y = a$	Var.	65° ±	Orth.	<i>Scordite</i>	Arsen.	Colorless or $X = \text{gr.}, Z = \text{pink. } Gr. = 3.2 \pm$	139
Y $\perp$ 100 cl. ±	Prism.	28°	Mon.	<i>Molengraafite</i>	Sil.	$X = b$. Yel.: $X, Z > Y$	418
Z $\wedge c = 10^\circ$	Prism.	85°	Mon.	<i>Gadolinite</i>	Sil.	$Y = b$. Gr. or br.	424
No cleav.	Eq.	90° ±	Mon.	<i>Barthite</i>	Arsen.	Colorless or green. $G = 4.2$	160

Group 41b. Refrference positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically -

	α°	Rhom.	<i>Nordenskiöldite</i>	Bor.	Yellow. $G = 4.2$	95
0001 perf.						
$Z \perp 100$ cl.	Sm.	Orth.	Ilvaite	Sil.	X = yel., br., Y = br., Z = gr.	431
$X \perp 100$ cl.	Lg.	Orth.	<i>Tephroite</i>	Sil.	Y = c. $G = 4$. Gel. HCl	194
$X \perp 100$ cl.	Mass.	Orth.	<i>Heterosite</i>	Phos.	X = br., Y = red, Z = violet	141
$X \perp 100$ cl. $\pm$	$\alpha^\circ \pm$	Mon.	Cronstedtite	Sil.	Y = b. X = br. or gr. Y, Z = opaque	285
$X \perp 100$ cl.	Sm.	Mon.	<i>Melanorandite</i>	Van.	Br.: X < Y, Z. $G = 3.5$	102
001 perf.	$70^\circ \pm$	Mon.	EPIDOTE	Sil.	Y = b. Golden: X < Y. $G = 3.3 \pm$	314
$X \perp$ cleav.	74°	Mon.	<i>Leucophenite</i>	Sil.	$G = 3.8$. Sol. HCl	412
$X \wedge c = 20^\circ$	80°	Mon.	<i>Laevanite</i>	Sil.	Y = b. Yellow: X, Y < Z	420
$X \perp 100$ cl. $\pm$	80°	Mon.	<i>Dietsite</i>	Chr.	Y = b. Yellow. $G = 3.7$	121

Group 42. Refrference positive and extreme: N_o or $N_m > 2.00$. Optically + or -

	α°	Tet.	<i>Pseudobellite</i>	Hal.	Deep blue. $G = 4.85$. Sign -	37
$X \perp 100$ cl.	?	?	<i>Cyprotungsite</i>	Tung.	Green. Sign ?	105
One 100 perf.	Sm.	Mon.	<i>Raspite</i>	Tung.	X $\wedge c$ = Lg. Y = b. Yel.: X, Y < Z. Sign +	101

VI. BIREFRINGENCE VERY STRONG: $N_o - N_p > 0.0365 < 0.0545$

Group 43. Refrference negative and distinct: N_o or $N_m < 1.48$. Optically + or -

	α°	?	<i>Paraffin</i>	C, H	$G = 0.9$. Sol. ether. Sign +	17
$Z = c$						
001 dist.	60°	Mon.	<i>Lansfordite</i>	Carb.	X = b. Z $\wedge c$ = Sm. $G = 1.73$. Sign +	85

Group 44a. Refrference negative and low: N_o or $N_m > 1.48 < 1.54$. Optically +

	Sm.	?	<i>Fibroferrite</i>	Sul.	Yellow: X, Y < Z. $G = 1.86$	109
$Z \parallel$ fib.						
$X \perp 100$ cl.	40°	Orth.	<i>Uranohallite</i>	Carb.	Green. Sol. HCl	88
$Y = a$. Z = c	85°	Orth.	<i>Fluellite</i>	Hal.	$G = 2.2$	33
001 perf.	60°	Mon.	<i>Larderite</i>	Bor.	X = b. Z $\wedge c = +24^\circ$	91
100, 001	81°	Mon.	<i>Kaliborite</i>	Bor.	X = b. Z $\wedge c = +65^\circ$. $G = 2.1$	94
100, 010	Lg.	Mon.	<i>Hydroboracite</i>	Bor.	X $\wedge c = 31^\circ$. Y = b. $G = 2.0$	92
001 perf.	39°	Tr.	<i>Ussingite</i>	Sil.	Z $\wedge$ 1001 = $33^\circ \pm$. $G = 2.5$	439

TABLE II.—BIREFRINGENCE OF MINERALS

VI. BIREFRINGENCE VERY STRONG: $N_g - N_p > 0.0365 < 0.0545$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 44b. Refrindex negative and low: N_o or $N_m > 1.48 < 1.54$. Optically —							
$X=c$ $X \perp ooi$ cl. $\pm$	Acic. Ps. Hex.	0° Sm.	Hex. Mon.?	<i>Thumasile</i> <i>Levernietite</i>	Sul. Sil.	$G = 1.87$ Colorless or br.: $X < Y, Z$	119 433
Group 45a. Refrindex positive and low: N_o or $N_m > 1.53 < 1.59$. Optically +							
$Z \parallel fib.$ ooi, oio $100, ooi$ $100, oio$	Fib. Var. Fib. Fib.	Sm. 42° ? Lg.	? Orth. Mon. Mon.	<i>Fibroferrite</i> Anhydrite <i>Magnesiopectolite</i> <i>Hydroboracile</i>	Sul. Sul. Sil. Bor.	Yellow: $X, Y < Z$. $G = 1.86$ $Y = b$. $Z = a$. $G = 2.93$ $Z \parallel fib.$ $G = 2.7$ $X \wedge c = 31^\circ$. $Y = b$. $G = 2.0$	109 98 420 92
Group 45b. Refrindex positive and low: N_o or $N_m > 1.53 < 1.59$. Optically —							
$X \perp ooi$ cl. $\pm$ $X \perp ooi$ cl. $\pm$ $X \perp ooi$ cl. $\pm$ $X \perp ooi$ cl. $\pm$ 100 perf. $X \perp ooi$ cl. $\pm$	ooi ooi El. $\parallel a$ ooi El. $\parallel c$ ooi	Sm. $56^\circ \pm$ $90^\circ \pm$ Sm. Mod. $45^\circ \pm$	? ? ? Mon. Mon. Mon.	Talc Pyrophyllite <i>Janosite</i> <i>Pholidolite</i> <i>Jezekite</i> MUSCOVITE	Sil. Sil. Sul. Sil. Phos. Sil.	$Z = b$. $G = 2.75 \pm$ $G = 2.83 \pm$ $X = \text{yel.-gr.}$, $Y = \text{yel.}$, $Z = \text{yel.}$ $G = 2.4$. Greenish $\pm$ $X \wedge c = +29^\circ$. $Y = b$. $G = 2.94$ $Z = b$. $G = 2.8 \pm$	262 263 108 435 158 267
Group 46a. Refrindex positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +							
A. No visible cleavage							
$Z=c$ $X=a$. $Z=b$ $Z \wedge c = 36^\circ$ $Z \perp oio$ cl. ? $1\bar{1}0 + one$	Fib. Tab. ? El. $\parallel c$ Tab. El. $\parallel c$	0° 68° 38° 77° Sm. 40°	Hex.? Orth. Mon. Mon. Tr.? Tr.	<i>Rhabdophanite</i> Humite <i>Arakwaite</i> <i>Leucospherite</i> <i>Destineite</i> <i>Turquois</i>	Phos. Sil. Phos. Sil. Sul. Phos.	$G = 4$. Sol. HCl Colorless or yel.: $X > Y, Z$ $Y = b$. Green $Y \wedge c = 3^\circ$. $G = 3$ $G = 2.1$. Sol. HCl Ext. on $1\bar{1}0$ at 12° to c . Blue	139 197 138 418 121 157

B. One or more visible cleavage directions

101, 1 perf.	El. || c	o°	Rhom.	<i>Dioprase</i>	Sil.	Green: X > Z. G. = 3.2	186
X ⊥ 010 cl.	010	58°	Orth.	<i>Haidingerite</i>	Arsen.	Z = c. G. = 2.85	123
oor dist.	Ps. Hex.	o° ±	Mon.?	<i>Pseudovallastonite</i>	Sil.	Z = c ±. G. = 2.9	402
100, 001	El. || b	60°	Mon.	<i>Pectolite</i>	Sil.	X = a ±. Z = b. G. = 2.8 ±	419
010, 100	Prism.	80°	Mon.	<i>Vivianite</i>	Phos.	X = b Z ∠ c = +28°. G. = 2.6. X = blue, Y = white, Z = olive	126
101, 010	Fib.	53°	Tr.	<i>Anapaile</i>	Phos.	Ext. on 100 at 15° to c.	128
Group 46b. Refrindex positive and moderate: N_O or $N_M > 1.59 < 1.66$. Optically —							
A. No visible cleavage							
X || 100 cl.	Prism.	c°	Tet.	<i>Meionite</i>	Sil.	G. = 2.75 ±. Dec. HCl	297
X = c	?	o°	Rhom.	<i>Chloraluminite</i>	Hal.	Sol. H ₂ O. Deliques.	33
Y ⊥ 001 cl.	Prism.	Lg.	Orth.	<i>Skłodowskite</i>	Sil.	Yellow: X < Y < Z. G. = 3.5	441
Z ∠ c = -2°	Prism.	74°	Mon.	<i>Datolite</i>	Sil.	Y = b. G. = 2.9-3.0. Gel. HCl	424
B. One or more visible cleavage directions							
001, 010	001	o° ±	Tet.?	<i>Troegerite</i>	Arsen.	Yellow. G. = 3.3. Sol. HCl	147
X ⊥ 001 cl.	001	Sm.	?	Talc	Sil.	G. = 2.75 ±. Sol. HF	262
X ⊥ 100 cl.	El. || c	30°	Orth.	<i>Grandierite</i>	Sil.	Y = c. Green: Y < X < Z	421
X ⊥ 001 cl. ±	001	o° ±	Mon.	<i>Nepouite</i>	Sil.	Y = b. X = gr.; Y, Z = yel.	279
X ⊥ 001 cl. ±	001	o° ±	Mon.	BIOTITE	Sil.	Y = b. Br. or gr.: X < Y, Z	272
X ⊥ 001 cl. ±	001	Sm.	Mon.	<i>Leverrierite</i>	Sil.	Y = b. Colorless or br. X < Y, Z	433
X ⊥ 001 cl. ±	001	45° ±	Mon.	MUSCOVITE	Sil.	Z = b. G. = 2.8 ±	267
X ⊥ 001 cl. ±	001	Mod.	Mon.	<i>Fuchsile</i>	Sil.	Z = b. Colorless or gr.: X < Y, Z	269
Group 47a. Refrindex positive and high: N_O or $N_M > 1.66 < 1.74$. Optically +							
X = b. Y = a	Prism.	29°	Orth.	<i>Euchroite</i>	Arsen.	Green. G. = 3.4. Sol. HNO ₃	136
X ⊥ 100 cl.	Tab.	75° ±	Orth.	<i>Iddingsite</i>	Sil.	Z ⊥ 001 cl. Br.: X < Y < Z	437
Y ⊥ 010 cl.	Prism.	84°	Orth.	<i>Diaspore</i>	Ox.	Z = a. Colorless or br.: X > Z	46
101 dist.	El. || b	88° ±	Orth.	<i>Adamite</i>	Arsen.	X = a. Y = c. Colorless or pink	133
110 at 80°	Prism.	49°	Mon.	<i>Nephtunite</i>	Sil.	Y = b. Z ∠ c = +18°. Br.: X < Y < Z	418
oor perf.	El. || b	70°	Mon.	<i>Piedmontite</i>	Sil.	X ∠ c = -7°. Y = b. X = yel., Y = violet, Z = red	315

TABLE II.—BIREFRINGENCE OF MINERALS

VI. BIREFRINGENCE VERY STRONG: $N_{\theta} - N_{\gamma} > 0.0305 < 0.0545$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 47a. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +, continued							
010 dist.	El. || c	77°	Mon.	<i>Leucosphenite</i>	Sil.	$Y \wedge c = +3^\circ$. $Z = b$. oot twin.	418
001, 100	001	82°	Mon.	<i>Ludlamite</i>	Phos.	$Y = b$. $Z \wedge c = -67^\circ$. Green	137
Group 47b. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically —							
A. No visible cleavage							
$X = c$	Prism.	0°	Rhom.	<i>Tourmaline (Cr)</i>	Sil.	$X = \text{yel.}$, $Z = \text{gr.}$ $G = 3.1$	301
$X = b$. $Y = a$	Prism.	45°	Orth.	<i>Childrenite</i>	Phos.	$G = 3.2 \pm$. Sol. HCl	155
$X = b$. $Y = c$	Prism.	61°	Orth.	<i>Glaucochroite</i>	Sil.	$G = 3.4$. Gel. HCl	187
$X \perp 100$ cl.	Var.	Lg.	Orth.	<i>Tephroite</i>	Sil.	$Y = c$. $G = 4$. Gel. HCl	194
$X = b$. $Y = c$	Prism.	85° ±	Orth.	CHRYSOOLITE	Sil.	$G = 3.3$. Gel. HCl. (= OLIVINE)	189
101 dist.	El. || b	88°	Orth.	<i>Adamite</i>	Arsen.	$X = a$. $Y = c$. Colorless or pink	133
001 dist.	?	40°	Mon.?	<i>Spurrite</i>	Sil.	$X = b$. $Z \wedge a = 0^\circ \pm$. $G = 3 \pm$	442
110 at 70°	Pyr.	57°	Mon.	<i>Durangite</i>	Arsen.	$X \wedge c = -25^\circ$. $Z = b$. Yel.: $X > Y > Z$	151
B. One or more visible cleavage directions							
$X \perp 001$ cl.	0001	0° ±	Rhom.	<i>Pyrochroite</i>	Ox.	Reddish: $X < Z$	42
0001 perf.	0001	0°	Rhom.	<i>Spangolite</i>	Sul.	$X = \text{bl.-gr.}$, $Z = \text{gr.}$ $G = 3.1$	119
$X \perp 100$ cl.	Tab.	75° ±	Orth.	Iddingsite	Sil.	$Z \perp 001$ cl. Brown: $X < Y < Z$	437
$X \perp 100$ cl.	Prism.	Lg.	Orth.	<i>Schoepite</i>	Ox.	Yellow: $X < Y$, Z . $G = 5.7$	60
$X \perp 001$ cl. ±	001	0° ±	Mon.	BIOTITE	Sil.	$Y = b$. $X = \text{yel.}$, Y , $Z = \text{br.}$ or gr.	272
$X \perp 100$ cl.	010	50° ±	Mon.	<i>Schoeningerite</i>	Carb.	$Z \wedge c = 41^\circ$. Yel.: $X < Y$, Z	86
110 at 56°	Prism.	80° ±	Mon.	OXYHORNBLÉNDE	Sil.	$Y = b$. $Z \wedge c = 5^\circ \pm$. $G = 3.4 \pm$. $X = \text{yel.}$, $Y = \text{gr.}$ or br. $Z = \text{br.} \pm$	252
110 at 56°	Prism.	82° ±	Mon.	Grunerite	Sil.	$Y = b$. $Z \wedge c = 12^\circ$. $G = 3.5 \pm$. X , $Y = \text{colorless}$, $Z = \text{yel.}$, or gr.	242
001 perf.	Var.	50°	Tr.	<i>Turbuttite</i>	Phos.	Ext. on oro at 10° to a	135

Group 48a. Refrference positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +

A. No visible cleavage

$Z=c$	Prism.	$\circ^\circ$	Tet.	Zircon	Ox.	Colorless, br., gray. G. = 4.7	183
$Z=c$	Pyr.	$\circ^\circ$	Rhom.	<i>Benitoite</i>	Sil.	Tinted $\pm$: X < Z	212
Y || fib.?	Fib.	Sm.	?	<i>Cornwallite</i>	Arsen.	Green. G. = 4.1	136
X || 120 cl.	Prism.	39°	Orth.	<i>Lorenzenite</i>	Sil.	Z = b. G. = 3.4	400
Y || 110 cl.	Prism.	67°	Orth.	<i>Oriente</i>	Sil.	X = a. Br. to yel.: X > Z > Y	432
Y or Z = c	Acic.	Lg.	Orth.	<i>Leucocaldite</i>	Arsen.	Silky white	136
Y = c. Z = a	001	Lg.	Orth.	<i>Fluinkite</i>	Arsen.	X, Y = gr., Z = br. G. = 3.87	154
X $\wedge$ c = 45°	Prism.	Sm.	Mon.	<i>Synadelphite</i>	Arsen.	Z = b. Br., nearly opaque	155
X $\wedge$ c = 89°	100	Mod.	Mon.	<i>Beraunite</i>	Phos.	Z = b. X, Y = pink, Z = red	144
Z $\wedge$ c = 45°	Fib.	Lg.	Mon.?	<i>Baydonite</i>	Arsen.	X = b. Green. G. = 4.35	137

B. One or more visible cleavage directions

X || 001 cl.	?	38°	Orth.	<i>Purpurite</i>	Phos.	Y = a. X = gray, br., Y = red, Z = purple	141
Z || 001 cl.	Lam.	45° $\pm$	Orth.	<i>Iddingsite</i>	Sil.	X = a. Red-br., X < Y < Z	437
Z || 001 cl. $\pm$	El. || b	16°	Mon.	<i>Monazite</i>	Phos.	X = b. Yellow: Y > X, Z	138
Z || 010 cl.	Fib.	Sm.	Mon.	<i>Kraurite</i>	Phos.	X = a $\pm$. Br. or gr.: X < Y, Z	142
001 perf.	El. || b	70°	Mon.	<i>Piedmontite</i>	Sil.	X $\wedge$ c = 7°. Y = b. G. = 3.5. X = yel., Y = violet, pink, Z = red	315
110 at 87°	Prism.	Lg.?	Mon.?	<i>Jadite-acmite</i>	Sil.	Y = b. Z $\wedge$ c = 85°. G. = 3.5	235

Group 48b. Refrference positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically -

A. No visible cleavage

X = c	0001	$\circ^\circ$	Hex.	Beaverite	Sul.	G. = 4.36. Sol. HCl	115
X = c	Rhom.	$\circ^\circ$	Rhom.	<i>Höghomite</i>	Ox.	X = yel., Z = br. G. = 3.8	65
X || 010 cl.	100	50° $\pm$	Orth.	Fayalite	Sil.	Y = c. Colorless or yellow	192
X || 010 cl.	Var.	55° $\pm$	Orth.	<i>Knebelite</i>	Sil.	Y = c. Colorless or yellow	193
X || 010 cl.	Var.	70° $\pm$	Orth.	OLIVINE	Sil.	Y = c. G. = 4 $\pm$. Gel. HCl	189
X = a. Y = b	Prism.	90° $\pm$	Orth.	<i>Higginsite</i>	Arsen.	X = gr., Y = yel.-gr., Z = bl.-green	132
X || 010 cl.	?	50° $\pm$	Mon.	<i>Pascovite</i>	Sil.	X, Y = yel., Z = orange	160
110 dist.	Prism.	66°	Mon.	<i>Thorstevite</i>	Van.	X $\wedge$ c = 5°. Y = b. X = gr., Y, Z = yel.	211

TABLE II.—BIREFRINGENCE OF MINERALS

VI. BIREFRINGENCE VERY STRONG: $N_g - N_p > 0.0365 < 0.0545$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
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Group 48b. Refrindex positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically —, continued

B. One or more visible cleavage directions

$X \perp 001$ cl.	0001	0°	Rhom.	<i>Molybdothyllite</i>	Sil.	$G = 4.7$	407
$X \perp 001$ cl.	Lam.	Lg.	Orth.	<i>Heterosite</i>	Phos.	$Y = a$. $X = \text{gray, br.}$, $Y = \text{red}$, $Z = \text{violet}$	141
$X \perp 010$ cl.	Prism.	75°	Orth.	<i>Alacemite</i>	Hal.	$Y = a$. Green: $X < Y < Z$	38
$X \perp 010$ cl.	Fib.	Sm.	Mon.	<i>Manganostrite</i>	Antim.	$Z \wedge c = \text{Lg.}$ $X = \text{red-br.}$, $Z = \text{opaque}$	155
001 perf.	001	50°	Mon.	<i>Hancockite</i>	Sil.	$Y = b$. X or $Z = \text{rose}$, $Y = \text{brown}$	316
110 at 88°	Prism.	$60^\circ \pm$	Mon.	<i>Acmite</i>	Sil.	$X \wedge c = 5^\circ \pm$. $Y = b$. $G = 3.5$. Brown or green: $X > Y > Z$	234
001 perf.	001	$70^\circ \pm$	Mon.	EPIDOTE	Sil.	$X \wedge c = 3^\circ$. $Y = b$. $G = 3.5$. Golden: $X < Z < Y$	314
100 perf.	El. || b	80°	Mon.	<i>Linarite</i>	Sul.	$X \wedge c = 24^\circ$. $Z = b$. $G = 5.4$. Blue: $X < Y < Z$	104

Group 49a. Refrindex positive and extreme: N_o or $N_m > 2.00$. Optically +

$Z \perp 0001$ cl.	0001	0°	Rhom.	<i>Moissanite</i>	SiC	Tinted $\pm$: $X > Z$	17
$X \perp 001$ cl.	100	$50^\circ \pm$	Orth.	<i>Pseudobrookite</i>	Ox.	$Z = a$. Red-br.: $X < Y > Z$	165
001 poor	?	4°	Mon.	<i>Atlestite</i>	Arsen.	Yellow. $G = 6.4$	143

Group 49b. Refrindex positive and extreme: N_o or $N_m > 2.00$. Optically —

$X = c$	Prism.	0°	Hex.	<i>Endlichite</i>	Van.	Yellow. $G = 7$	132
$X = c$	Var.	0°	Rhom.	<i>Langbanite</i>	Ox.	Brown: $X < Z$. $G = 4.5$	66
$Z = c$	Fib.	Mod.	?	<i>Bismutite</i>	Carb.	$G = 7$. Sol. HNO_3	86

VII. BIREFRINGENCE EXTREME: $N_g - N_p > 0.0545$ Group 50. Refrindex negative and distinct: N_o or $N_m < 1.48$. Optically + or —

$Z = c$	Fib.	5°	?	Chrysocolla	Sil.	Green, etc.: $X > Z$. $G = 2.4$. Sign?	411
$X \perp 001$ cl. $\pm$	001	7°	Tr.	<i>Sassolite</i>	Ox.	Ext. on 001 at $3^\circ - 20^\circ$ to a . Sign —	50

Group 51a. Refrference negative and low: N_o or $N_m > 1.48 < 1.54$. Optically +

	Sm.	Orth.	<i>Hutchelite</i>	C, H		
$Z \perp$ oor cl.?						18
$V=c$. $Z=b$	33°	Orth.	<i>Pirssonite</i>	Carb.	Fibers have — elong.	87
$X \perp$ oor cl.	58°	Orth.	<i>Sideronatriite</i>	Sul.	$Z \parallel$ fib. Yel.: $X < Y, Z$	115
$X \perp$ oor cl.	60°±	Orth.	<i>Copiapite</i>	Sul.	$Y=b$. $X=gr.$, $Z=yel.$ $G.=2.2$	108
?	62°±	Orth.	<i>Bechite</i>	Bor.	Doubtful species	92
$X \perp$ oor cl.	66°	Orth.	<i>Knorxillite</i>	Sul.	$Y=b$. Yellow-green: $X, Y < Z$	108
110 dist.	34°	Mon.	<i>Quetenite</i>	Sul.	Orange: $X, Y < Z$. $G.=2.1$	116
111, 113 perf.	57°	Mon.	Kieserite	Sul.	$Y=b$. $Z \wedge c = 76^\circ$. $G.=2.57$	104

Group 51b. Refrference negative and low: N_o or $N_m > 1.48 < 1.54$. Optically —

		Orth.	Niter	KNO_3		
011 perf.	7°				$X=c$. $Y=a$. $G.=2.1$	89
$Y \perp$ laths	61°	Orth.	<i>Nitroglauberite</i>	Nit.	Sol. H_2O	120
110 perf.	77°	Orth.	<i>Dawsonite</i>	Carb.	$X=a$. $Y=c$. $G.=2.4$	87
$Y=c$	Lg.	Orth.	<i>Artinite</i>	Carb.	$G.=2.0$. Sol. HCl	84
110?	5°	Mon.	<i>Nitromagnesite</i>	Nit.	Sol. H_2O	89
100, 010 perf.	27°	Mon.	<i>Darapskite</i>	Sul.	$X=b$. $Z \wedge c = 12^\circ$. $G.=2.2$	120
11c perf.	34°	Mon.	<i>Gaylussite</i>	Carb.	$X=b$. $Z \wedge c = 14^\circ$. $G.=1.9$	87
100 perf.	72°	Mon.	<i>Trona</i>	Carb.	$X=b$. $Y \wedge c = 7^\circ$. $G.=2.1$	69
010 perf.	79°	Tr.	<i>Meyerhofferite</i>	Bor.	$Z \perp$ oor±. $G.=2.1$	93

Group 52a. Refrference positive and low: N_o or $N_m > 1.54 < 1.59$. Optically +

		Hex.	<i>Caoxenite</i>	Phos.		
$Z=c$	0°				Yel. $X < Z$. $G.=3.4$	143
1010, 0001	0°	Rhom.	<i>Ferrinatrite</i>	Sul.	$G.=2.56$. Sol. H_2O	114
$X \perp$ oor cl.		Orth.	<i>Rhomboclase</i>	Sul.	$Y=a$. $X=red$, $Y, Z=yel.$, pink	108
$X \perp$ oor cl.	60°±	Orth.	<i>Copiapite</i>	Sul.	$Y=b$. $X=gr.$, $Z=yel.$ $G.=2.2$	108
$Z \parallel$ 110 cl.	Lg.	Orth.	<i>Humboldtite</i>	Oxal.	$Y=b$. $X=gr.$, $Z=yel.$ "Oxalite"	88
010, 100	87°	Orth.	<i>Humbergite</i>	Bor.	$X=a$. $Y=b$. $G.=2.35$	91
110 dist.	34°	Mon.	<i>Quetenite</i>	Sul.	Yel.: $X, Y < Z$. $G.=2.1$	116
111, 113 perf.	57°	Mon.	Kieserite	Sul.	$Y=b$. $Z \wedge c = 76^\circ$. $G.=2.57$	104

TABLE II.—BIREFRINGENCE OF MINERALS

VII. BIREFRINGENCE EXTREME: $N_g - N_p > 0.0545$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 52a. Refrference positive and low: N_o or $N_m > 1.54 < 1.59$. Optically +, continued							
001, c10 + 001 perf.	Var. El. || b	84° 87°	Mon. Mon.	<i>Whevelite</i> <i>Fichtelite</i>	Oxal. C, H	X=b. Z $\wedge$ c=29°. G.=2.2 Z $\wedge$ c=13°. Sol. ether	89 118
Group 52b. Refrference positive and low: N_o or $N_m > 1.53 < 1.59$. Optically —							
101 perf.	Rhom.	0°	Rhom.	<i>Nitratite</i>	NaNO ₃	G.=2.27. Deliques.	89
101 poor	Rhom.	0°	Rhom.	<i>Trudelite</i>	Sul.	G.=1.93. Deliques.	119
X $\perp$ 001 cl.	100	62°	Orth.	<i>Oxammite</i>	Oxal.	Y=a. G.=1.5. Sol. H ₂ O	89
X $\perp$ 001 cl.	001	62°	Orth.	<i>Lanhanite</i>	Carb.	Y=a. G.=2.7±. Sol. HCl	86
Y=c	Fib.	71°	Orth.	<i>Artinite</i>	Carb.	G.=2.0. Sol. HCl	84
110 perf.	Acic.	77°	Orth.	<i>Dawsonite</i>	Carb.	X=a. Y=c. G.=2.4	87
?	?	Lg.	?	<i>Cu-aphtitalite</i>	Sul.	G.=3? Sol. H ₂ O	96
X $\perp$ 001 cl.±	001	Sm.	Mon.	<i>Griphite</i>	Sil.	X=yel., Z=br.-gr.	434
010, 011 perf.	Prism.	79°	Mon.	<i>Kroenkeite</i>	Sul.	X $\wedge$ c=49°. Y=b. Sol. H ₂ O	112
?	001	51°	Tr.	<i>Roemerite</i>	Sul.	Ext. on 101 at 33° to c	117
010 perf.	El. || c	79°	Tr.	<i>Meyerhoffite</i>	Bor.	Z $\perp$ 010±. G.=2.1	93
Group 53a. Refrference positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +							
X $\perp$ laths	Lath.	Sm.	Orth.	<i>Bisbeeite</i>	Sil.	Z=c. Colorless or X, Y=br., Z=gr.	411
Z || fib.	Fib.	Mod.	Orth.	<i>Plancheite</i>	Sil.	X $\perp$ cleav. Blue: X, Y<Z	411
X $\perp$ laths	Lath.	83°	Orth.	<i>Kyanotrichite</i>	Sul.	Z=c. Blue: X, Y<Z	116
010, 100	Prism.	87°	Orth.	<i>Hamborgite</i>	Bor.	X=a. Y=b. G.=2.35	91
001 perf.	Pyr.	37°	Mon.	<i>Natrochalcite</i>	Sul.	Y=b. Z $\wedge$ c=12°. Green	112
Z $\wedge$ c=33°	?	71°	Mon.?	<i>Vesdytite</i>	Phos.	Y=b? Gr.-blue. G.=3.5	138
One perf.	?	90°±(art.)	Mon.	<i>Ssmikite</i>	Sul.	Z=b. Pink±	104

Group 53b. Refrference positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically —

A. No visible cleavage

$X=c$	Acic.	o°	?	<i>Scaibelyite</i>	Bor.	$G=3$. Sol. H_2SO_4	92
$Y \perp lath$	Lath.	Lg.	Orth.	<i>Camellite</i>	Bor.	$X \parallel$ elong.	91
$Z \wedge c = 25^\circ$	?	67°	Mon.	<i>Liroconite</i>	Arsen.	$X=b$. Greenish. $G=2.9$	157
$c \parallel o$ dist.	Fib.	Lg.	Tr.	<i>Stewartite</i>	Phos.	$X \perp 100 \pm$. Yel.: $X < Y < Z$	128

B. One or more visible cleavage directions

	Var.	o°	Rhom.	CALCITE	$CaCO_3$	$G=2.71$. Sol. HCl	71
$101 \perp$ perf.	ooo1	o°	Rhom.	<i>Chalcophyllite</i>	Arsen.	Green. $G=2.5$	136
$X \perp 1001$ cl.	ooo1	35°	Orth.	<i>Serpierite</i>	Sul.	$Y=a$. $X=gr$. $Y, Z=gr$ -blue	102
$X \perp 1001$ cl. $\pm$	ooo1	$o^\circ \pm$	Mon.	BIOTITE	Sil.	$Y=b$. Br. or gr.: $X < Y, Z$	272
$X \perp 1001$ cl. $\pm$	ooo1	$o^\circ \pm$	Mon.	<i>Stilpnomelane</i>	Sil.	$X=yel$. $Y, Z=brown$	435
$X \perp 1001$ cl. $\pm$	ooo1	$o^\circ \pm$	Mon.	<i>Ekmannite</i>	Sil.	Greenish: $X < Y=Z$	281
$X \perp 1001$ cl. $\pm$	ooo1	39°	Mon.	<i>Herrngrundite</i>	Sul.	$Z=b$. Green: $X < Y, Z$. $G=3.1$	104
ooo perf.	ooo1	80°	Mon.	<i>Epistilite</i>	Sil.	$Y=b$. $Z \wedge c = 7^\circ$. $G=2.9$	442
$X \perp 1010$ cl.	Fib.	84°	Mon.	<i>Annabergite</i>	Arsen.	$Z \wedge c = 36^\circ$. Green $\pm$	127
$X \perp 1010$ cl.	Fib.	$90^\circ \pm$	Mon.	<i>Cabrerite</i>	Arsen.	$Z \wedge c = 33^\circ$. Green $\pm$	127
$100, 010$ perf.	Prism.	$28^\circ \pm$	Tr.	<i>Amaranite</i>	Sul.	$X \perp 100 \pm$. Yel.: $X < Y < Z$	109

Group 54a. Refrference positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +

	Var.	o°	Tet.	Xenotime	YPO_4	Colorless or $X=pink$, $Z=brown$	138
110 perf.	Prism.	o°	Hex.	<i>Parisite</i>	Carb.	Yel.: $X < Z$. $G=4.4$	85
$ooo1$ perf.	Prism.	o°	Hex.	<i>Bastnäsile</i>	Carb.	Yellow. $G=5$	85
$ooo1$ part.	Prism.	o°	?	<i>Mixite</i>	Arsen.	Green. $G=3.8$	156
$Z=c$	Acic.	$o^\circ \pm$	Orth.	<i>Ferrimolybdate</i>	Molyb.	$Y=a$. Yel.: $X, Y < Z$. $G=4.5$	108
$Z \perp 1001$ cl.	Fib.	$28^\circ \pm$	Orth.	<i>Anlerite</i>	Sul.	$Y=c$. Green: $Y > Z > X$	102
$X \perp 1010$ cl.	Dom.	35°	Orth.	<i>Planchéite</i>	Sil.	$Z=c$. Blue: $X, Y < Z$	411
$X \perp$ cleav.	Fib.	Mod.	Orth.	<i>Asphyllite</i>	Sil.	$Z=a$. Yellow: $X > Y > Z$	417
$X \perp 1010$ cl.	Prism.	75°	Orth.	<i>Curtisite</i>	C, H, O	$Y=b$. Yellow: $X < Y < Z$	18
$Y \perp 1001$ cl.	?	84°	Orth.	<i>Lindackerite</i>	Sul.	$X \wedge c = 26^\circ$. Green	121
$Y \perp 1010$ cl.	Fib.	73°	Mon.?	<i>Koettigite</i>	Arsen.	$Z \wedge c = 37^\circ$. Carmine	127
$X \perp 1010$ cl.	Fib.	77°	Mon.		Arsen.	$Z \wedge c = 32^\circ$. $X=pink$, $Y=violet$, $Z=red$	127
$X \perp 1010$ cl.	Prism.	89°	Mon.	Erythrite			

TABLE II.—BIREFRINGENCE OF MINERALS

VII. BIREFRINGENCE EXTREME: $N_g - N_p > 0.0545$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 54b. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically —							
A. No visible cleavage							
$X = c$	001	0°	Hex.	<i>Chloromagnesite</i>	Hal.	Sol. H ₂ O. Deliques.	32
010, 110	Acic.	7°	Orth.	<i>Alstonite</i>	Carb.	$X = c$. $Y = b$. $G = 3.7$. Sol. HCl	80
110 dist.	Acic.	11°	Orth.	Strontianite	Carb.	$X = c$. $Y = b$. $G = 3.7$. Sol. HCl	81
010 dist.	Pyr.	16°	Orth.	Witherite	Carb.	$X = c$. $Y = b$. $G = 4.3$. Sol. HCl	81
010, 110	Acic.	18°	Orth.	Aragonite	Carb.	$X = c$. $Y = a$. $G = 2.94$. Sol. HCl	79
$X = c$	Fib.	Sm.	Orth.	<i>Sussurite</i>	Bor.	$G = 3.12$. Sol. HCl	91
$X = a$. $Y = b$?	Pyr.	66°	Orth.	<i>Ancylite</i>	Carb.	Green. $G = 3.95$. Sol. HCl	87
$X \perp 010$ cl.	010	Lg.	Mon.	<i>Zippelite</i>	Sul.	$Z \wedge c = 35^\circ \pm$. Yel.: $X < Y < Z$	110
010 dist.	100	Lg.	Tr.	<i>Stewartite</i>	Phos.	$X = a \pm$. Yel.: $X < Y < Z$. $G = 2.9$	128
B. One visible cleavage							
$X \perp 001$ cl. $\pm$	001	0° $\pm$	Mon.	BIOTITE	Sil.	$Y = b$. Br. or gr.: $X < Y$, Z	272
$X \perp 001$ cl. $\pm$	001	0° $\pm$	Mon.	<i>Ekmannite</i>	Sil.	Gr.-brown: $X < Y = Z$	281
$Y \perp 100$ cl. $\pm$	100	Sm.	Mon.	<i>Aurichalcite</i>	Carb.	$Z \wedge c = \text{Sm}$. Green: $X < Y$, Z	84
$X \perp 001$ cl. $\pm$	001	Sm.	Mon.	<i>Stilpnomelane</i>	Sil.	$X = \text{yel.}$, Y , $Z = \text{gr. or br.}$	435
$X \perp 001$ cl. $\pm$	001	35° $\pm$	Mon.	<i>Roscolite</i>	Sil.	$Z = b$. X , $Y = \text{olive}$, $Z = \text{gr.-br.}$	270
100 perf.	100	40°	Mon.	<i>Hydrocinacite</i>	Carb.	$X = b$. $Z \wedge c = \text{Mod}$. $G = 3.6$	83
$X \perp 010$ cl.	Prism.	87°	Mon.	<i>Symplectite</i>	Arsen.	$Z \wedge c = 32^\circ$. Yel., gr., bl.; pleo.	126
C. Two or more visible cleavage directions							
1011 perf.	Var.	0°	Rhom.	<i>Manganocalcite</i>	Carb.	$G = 2.9 \pm$. Sol. HCl	72
1011 perf.	Var.	0°	Rhom.	<i>Plumbocalcite</i>	Carb.	$G = 2.72 \pm$. Sol. HCl	72
1011 perf.	Rhom.	0°	Rhom.	MG-DOLOMITE	Carb.	$G = 2.9 \pm$. Sol. HCl	73
1011 perf.	Rhom.	0°	Rhom.	Mangandolomite	Carb.	$G = 3.3 \pm$. Sol. HCl	73

1011 perf.	Rhom.	o°	Rhom.	Ankerite	Carb.	G. = 3±.	Sol.	HCl	73
1011 perf.	Rhom.	o°	Rhom.	<i>Brunnerite</i>	Carb.	G. = 3±.	Sol.	HCl	75
1011 perf.	Rhom.	o°	Rhom.	Magnesite	Carb.	G. = 3±.	Sol.	HCl	75
1011 perf.	Rhom.	o°	Rhom.	<i>Mesitite</i>	Carb.	G. = 3.2±.	Sol.	HCl	75
110 perf.	Var.	14°	Mon.	<i>Baryocalcite</i>	Carb.	X∧c = 64°. Z = b.	G. = 3.6		82
110 at 56°	Prism.	80°±	Mon.	OXYHORNBLÉNDE	Sil.	Y = b. Z∧c = 5°±.	Br. or gr.	X < Y, Z	252

Group 55a. Refrignence positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +
A. No visible cleavage and not elongated or with negative elongation

100 dist.	001	o°	Tet.	<i>Calomel</i>	Hg ₂ Cl ₂	Also pyr.	G. = 6.5		39
Z = c	0001	o°	Hex.	<i>Vegasite</i>	Sul.	Yellow: X < Z			116
100, 001	Prism.	Sm.	Orth.	<i>Hoelite</i>	C, H, O	X = c. Y = a. G. = 1.4			18
110 dist.	Wedge	30°±	Mon.	<i>Titanite</i>	Sil.	Y = b. Z∧c = 51°. Colorless or pleo.			204
110 dist.	Wedge	50°±	Mon.	<i>Keilhauite</i>	Sil.	Y = b. Z∧c = 51°. Brown; pleo.			205
011 dist.	Prism.	90°±	Mon.	<i>Lautarite</i>	Iod.	X∧c = 25°. Y = b. G. = 4.6			89

B. No visible cleavage and positive elongation

Z = c	Prism.	o°	Tet.	Zircon	ZrSiO ₄	Colorless or tinted.	G. = 4.7		183
Z || 110 cl.	Prism.	o°	Tet.	Cassiterite	SnO ₂	Colorless or br., etc.	G. = 7		52
Z = c	Prism.	Sm.	Orth.	<i>Ludwigite</i>	Bor.	X, Y = gr., Z = br.	G. = 4		94
Z = c	Acic.	Sm.	Orth.	<i>Mixite</i>	Arsen.	Green. G. = 3.8			156
Z ⊥ 001 cl.	Fib.	28°	Orth.	<i>Ferrinolysite</i>	Molyb.	X = b. Yel.: X, Y < Z. G. = 4.5			108
X ⊥ 010 cl.	Prism.	35°	Orth.	<i>Hemafibrite</i>	Arsen.	Y = a. Red-br. G. = 3.6			136
X ⊥ 100	100	Mod.	Orth.	<i>Uraconite</i>	Sul.	Y = b. Yellow. Sol. HCl			110
X ⊥ 100	100	82°	Orth.	<i>Olivine</i>	Arsen.	Y = c. Olive: X, Y < Z. G. = 4			132
X ⊥ 010	010	58°	Mon.	<i>Schallerite</i>	Arsen.	Z∧c = +66°. G. = 5.94			123
Z∧c = Sm.	Fib.	Ig.	Mon.	<i>Shattuckite</i>	Sil.	X = b. Blue: X < Y < Z. G. = 3.8			411
X∧c = 22°	El. || b	90°±	Tr.?	<i>Dihydrite</i>	Phos.	Z = b±. X = bl., Y = gr., Z = br.			135

C. One or more visible cleavage directions

100 perf.	Pyr.	o°	Tet.	<i>Trippkite</i>	Arsen.	Bl.-green. Sol. HCl			159
X ⊥ 001 cl.	?	38°	Orth.	<i>Purpurite</i>	Phos.	Y = a. X = gray; Y, Z = red			141

TABLE II.—BIREFRINGENCE

TABLE II.—BIREFRINGENCE OF MINERALS

VII. BIREFRINGENCE EXTREME: $N_g - N_p > 0.0545$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 55a. Refrindex positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +, continued							
C. One or more visible cleavage directions—continued							
Z || fib.	Fib.	40°	Orth.	<i>Tarumellite</i>	Sil.	X, Y = red, Z = br. G. = 3.9	427
Two pinac.	?	52°	Orth.	<i>Uranite</i>	Van.	Brown: Y > X > Z	148
X ⊥ 100 cl.	Fib.	Lg.	Orth.	<i>Uranospherite</i>	Uran.	X = b. Yellow. G. = 6.36	109
Y ⊥ 100 cl.	Prism.	48°	Mon.	<i>Claudette</i>	As ₂ O ₃	Z ∧ c = 6°. G. = 4 ±	45
021 perf.	Var.	68°	Mon.	<i>Azurite</i>	Carb.	X = b. Z ∧ c = 12°. Blue: X < Y < Z	82
001 perf.	001	70° ±	Mon.	<i>Piedmontite</i>	Sil.	X ∧ c = 7°. Y = b. X = yel., Z = red	315
Z ⊥ 100 cl.	Fib.	90°	Mon.?	<i>Dufrenite</i>	Phos.	X = c ±. X = br., Y = yel., Z = gr.	142
Group 55b. Refrindex positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically —							
A. No visible cleavage and uniaxial							
X ⊥ 001 cl.	?	0°	Tet.?	<i>Arseniosiderite</i>	Arsen.	X = yel., Z = brown. G. = 3.7 ±	153
X ⊥ 0001 cl.	Prism.	0°	Hex.	<i>Cordyle</i>	Carb.	X = br., Z = gr.-yel. G. = 4.3	86
X = c	Fib.	0°	Hex.	<i>Ferritungstite</i>	Tung.	Yellow. Dec. HCl	107
0001 dist.	0001	0°	Rhom.	<i>Carphosiderite</i>	Sul.	Yellow. G. = 2.6 ±	108
0001 dist.	0001	0°	Rhom.	<i>Jarosite</i>	Sul.	Yellow: X < Z. G. = 3.2	114
0001 dist.	0001	0°	Rhom.	<i>Natrojarosite</i>	Sul.	Yellow: X < Z. G. = 3.2	114
1011 dist.	0001	0°	Rhom.	<i>Plumbojarosite</i>	Sul.	X = golden, Z = red. G. = 3.6	115
X = c	Prism.	0° ±	?	<i>Macapelite</i>	Arsen.	Brown: X < Z. G. = 3.6	156
B. No visible cleavage and biaxial							
Z || elong.	Lath	?	Orth.	<i>Chapmanite</i>	Sil.	Olive green. G. = 3.6	440
X = a. Y = c	Dom.	33°	Orth.	<i>Cornelite</i>	Phos.	Green. G. = 4.1. Sol. HCl	132

$X=b$, $Y=c$ oro cleav. $Z \parallel$ elong. $X \perp$ oro cl. $\pm$ $X \perp$ oro $\pm$	Eq. Fib. Fib. oro oro	83° Sm. 50° 24° 52°	Orth. Mon. Mon. Tr. Tr.	<i>Libethenite</i> <i>Tugite</i> <i>Pseudomalachite</i> <i>Chalcociderite</i> <i>Walpurgite</i>	Phos. Phos. Phos. Phos. Arsen.	Green. $X, Z < Y$. $G.=3.7$ $X \wedge$ elong. = Sm. Green Green. $G.=3.6$ Green: $X < Z$. $G.=3.1$ Yellow. $G.=5.8$	132 137 135 157 148
C. One or two visible cleavage directions and uniaxial or $2V < 40^\circ$							
$X \perp$ 001 cl. $X \perp$ 001 cl. $Z \perp$ cleav. $X \perp$ 001 cl. $X \perp$ 001 cl. $\pm$ $Z \parallel$ elong. 001 perf.	001 Prism. ? 001 001 Lam. 001	0° 22° Mod. 40° 0° $\pm$ Sm. 10°	Tet.? Orth. Orth. Orth. Mon. Mon.? Mon.	<i>Freirinite</i> <i>Durdenite</i> <i>Erinite</i> <i>Carnotite</i> <i>Chalcodite</i> <i>Aurichalcite</i> <i>Leadhillite</i>	Arsen. Tel. Arsen. Van. Sil. Carb. Sul.	Gr.-blue: $X < Z$. Sol. HCl $Y=b$. Yel.: $X < Y < Z$ $Y \parallel$ elong. Green. $G.=4$ $Y=a$. Yellow $\pm$ $X=yel.$; $Y, Z = red-br.$ $G.=3 \pm$ $Y=a \pm$. Green. $X < Y, Z$ $X \wedge c = 5^\circ$. $Z=b$. $G.=6.4$	151 118 133 148 435 84 120
D. One or two visible cleavage directions and $2V > 40^\circ$							
$X \perp$ 001 cl. $X \perp$ 001 cl. $X \perp$ oro cl. $X \perp$ 001 cl. $Z \perp$ 001 cl. $X \perp$ oro $X \perp$ 001 cl. $\pm$ $X \perp$ 001 cl. $\pm$ 110 at 87°	001 001 Prism. El. $\parallel a$ El. $\parallel a$ Fib. El. $\parallel b$ Prism. Prism.	40° 45° $\pm$ 72° 81° 85° 43° 47° 53° 60° $\pm$	Orth. Orth. Orth. Orth. Orth. Mon. Mon. Mon. Mon.	<i>Carnotite</i> <i>Tyuyamunite</i> <i>Brochantite</i> <i>Langite</i> <i>Caladonite</i> <i>Malachite</i> <i>Lanarkite</i> <i>Clinoclaseite</i> Aemite	Van. Van. Sul. Sul. Sul. Carb. Sul. Arsen. Sil.	$Y=a$. Yellow $\pm$ $Y=b$. Yellow: $X < Y < Z$ $Y=a$. Green: $X, Y < Z$ $Y \perp$ oro cl. Green; pleo. $X \perp$ oro cl. Bl.-green; pleo. $X \wedge c = 24^\circ$. $Y=b$. Green: $X < Y < Z$ $Y=b$. $G.=6.6$ $Y=b$. Green; Pleo. $G.=4.3$ $X \wedge c = 5^\circ$. $Y=b$. $G.=3.5$. Gr. or br.; pleo. Sol. HF	148 147 102 102 120 83 102 135 234
E. Three visible cleavage directions							
101̄1 perf. 101̄1 perf. 101̄1 perf.	Rhom. Rhom. Rhom.	0° 0° 0°	Rhom. Rhom. Rhom.	Ankerite <i>Ferrodolomite</i> <i>Mangandolomite</i>	Carb. Carb. Carb.	$G.=3.0$. Sol. HCl $G.=3.3$. Sol. HCl $G.=3.3$. Sol. HCl	73 73 73

TABLE II.—BIREFRINGENCE OF MINERALS

VII. BIREFRINGENCE EXTREME: $N_g - N_p > 0.0545$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 55b. Refrindex positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically —, continued							
E. Three visible cleavage directions—continued							
1011 perf.	Rhom.	0°	Rhom.	<i>Mesitile</i>	Carb.	G. = 3.2. Sol. HCl	75
1011 perf.	Rhom.	0°	Rhom.	<i>Pistomesite</i>	Carb.	G. = 3.5. Sol. HCl	75
1011 perf.	Rhom.	0°	Rhom.	<i>Sideroplesite</i>	Carb.	G. = 3.8. Sol. HCl	75
1011 perf.	Rhom.	0°	Rhom.	<i>Siderite</i>	Carb.	Gray. G. = 3.9. Sol. HCl	76
0111 perf.	Rhom.	0°	Rhom.	<i>Oligonite</i>	Carb.	G. = 3.8. Sol. HCl	76
1011 perf.	Rhom.	0°	Rhom.	Rhodochrosite	Carb.	G. = 3.7. Sol. HCl	77
1011 perf.	Rhom.	0°	Rhom.	<i>Spherochalcite</i>	Carb.	G. = 4.1. Sol. HCl	78
1011 perf.	Rhom.	0°	Rhom.	Smithsonite	Carb.	G. = 4.3. Sol. HCl	78
oro + two	Lam.	83°	Tr.	<i>Margaroselite</i>	Sil.	X' $\wedge$ cleav. in $010 = 44^\circ$. G. = 4.0	406
Group 56a. Refrindex positive and extreme: N_o or $N_m > 2.00$. Optically +							
A. No visible cleavage and no elongation							
Z = c	Pyr.	0°	Tet.	<i>Topilite</i>	Tant.	X = br, Z = opaque	164
Z = a	Var.	Sm.	Orth.	<i>Brookite</i>	TiO ₂	Yel.: X < Y < Z. Ext. Disp.	59
?	?	Sm.	?	<i>Triphylite</i>	Antim.	Gr.-yel. G. = 5.8	160
?	?	Sm.	Orth.	<i>Hjelmite</i>	Tant.	X, Y = yel.-br.; Z = opaque	166
Y = b. Z = c	Pyr.	69°	Orth.	Sulfur	S	G. = 2. Sol. CS ₂	14
B. No visible cleavage and prismatic or lamellar elongation -							
110 dist.	Prism.	0°	Tet.	Rutile	TiO ₂	Br.-red: X < Z. G. = 4.3±	50
0001 dist.	Prism.	0°	Hex.	<i>Penfieldite</i>	Hal.	Sol. HNO ₃ . F = 1	38
?	Prism.	Sm.	Orth.	<i>Derbyite</i>	Tit.	Brown. G. = 4.5	162
Two cleav.	Prism.	67°	Orth.	<i>Melanotekite</i>	Sil.	Brown: X < Y < Z. G. = 5.7	427

110 dist.	Prism.	88°	Orth.	<i>Kentrolite</i>	Sil.	Red-brown: $X < Y < Z$. $G = 6.2$	427
100 dist.	Prism.	Lg.	Orth.	<i>Tantalite</i>	Tant.	Red to opaque. $G = 7.5 \pm$	165
110 at 86°	Prism.	57°	Mon.	<i>Crocoite</i>	Chrom.	$Y = b$. $Z \wedge c = 6^\circ$. Yellow	101
?	Prism.	Lg.	Mon.?	<i>Bruckebuschite</i>	Van.	Brown: $X < Y, Z$	125
One cleav.	Lam.	83°	Mon.	<i>Calcicobornite</i>	Van.	Green. Ext. Disp.	135
C. One or more visible cleavage directions and lamellar elongation							
1010 perf.	0001	0°	Hex.	Cinnabar	HgS	Red. $G = 8.2$	21
One perf.	Tab.	Mod.	Orth.	<i>Phenicochroite</i>	Chrom.	Red. $G = 5.75$. Sol. HCl	100
001 perf.	010	67°	Orth.	<i>Cotunnite</i>	PbCl ₂	$Y = b$. $Z = c$. $G = 5.8$	32
010, 001	010	83°	Orth.	<i>Lepidocrocite</i>	Ox.	Orange: $X < Y < Z$. $G = 4.1$	48
100 perf.	100	Lg.	Orth.	<i>Nadorite</i>	Antim.	Yellow. $X = a$. $Y = b$. $G = 7$	159
100 perf.	100	Lg.	Orth.	<i>Massicotite</i>	PbO	Yel.: $X, Y < Z$. $G = 9.3$	41
010 perf.	010	90° ±	Orth.	<i>Tellurite</i>	TeO ₂	$X = b$. $Y = a$. $G = 5.9$	59
X ⊥ 010 cl.	010	24°	Mon.	Orpiment	As ₂ S ₃	$Z = a \pm$. Yellow. $G = 3.4$	25
D. One or more visible cleavage directions and prismatic elongation							
010, 110	Prism.	Sm.	?	<i>Manganite</i>	Ox.	$Y = b$. $Z = c$. Brown: $X < Z$	48
X ⊥ 100 cl.	Prism.	75° ±	Orth.	<i>Sibiondanalite</i>	Tant.	$Z = c$. Brown ±. $G = 7.9$	167
110, 100, 010	Fib.	Lg.	Orth.	<i>Mendipite</i>	Hal.	$X = a$. $Z = c$. $G = 7$	38
010 perf.	Prism.	Lg.	Orth.	<i>Montroydite</i>	HgO	$Z = c$. Yellow. Sol. HCl	41
100, 001	Prism.	?	Mon.	<i>Lorandite</i>	TlAsS ₂	Red. $G = 4.5$. Sol. HNO ₃	28
100, 101	Dom.	Sm.	Mon.?	<i>Kermesite</i>	Sb ₂ S ₃ O	Y or $Z = b$. Red: $X > Y > Z$	28
X ⊥ 010 cl.	Prism.	73°	Mon.	Huebnerite	Tung.	$Z \wedge c = 18^\circ$. Br., gr.; pleo.	101
56b. Refrindex positive and extreme: N_0 or $N_m > 2.00$. Optically -							
A. No visible cleavage and uniaxial and not red							
101 dist.	?	0°	Tet.	<i>Camengéite</i>	Hal.	Blue. $G = 4.8 \pm$	37
X = c	Pyr.	0°	Tet.	<i>Stolzite</i>	Tung.	$G = 8 \pm$. Dec. HNO ₃	98
X = c	Prism.	0°	Tet.	<i>Platnerite</i>	PbO ₂	Brown. Also biax. $G = 8.5$	53
001 dist.	Pyr.	0°	Tet.	<i>Edemite</i>	Arsen.	Green. Also biax. $G = 7 \pm$	159
111 dist.	001	0°	Tet.	Wulfenite	Molyb.	Colorless or yellow: $X < Z$. $G = 6.9$	98

TABLE II.—BIREFRINGENCE OF MINERALS
VII. BIREFRINGENCE EXTREME: $N_g - N_p > 0.0345$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 56b. Refrindex positive and extreme: N_o or $N_m > 2.00$. Optically —, continued							
A. No visible cleavage and uniaxial and not red—continued							
001 dist.	Pyr.	0°	Tet.	<i>Hansmannite</i>	Ox.	Brown to opaque. $G = 4.8$	64
001, 111	Pyr.	0°	Tet.	<i>Anadase</i>	TiO ₂	Yel. bl.: $X < Z$. $G = 3.8 \pm$	53
X = c	?	0°	?	<i>Bindheimite</i>	Antim.	Gray, etc. $G = 4.8 \pm$	160
X = c	Fib.	0°	Hex.?	<i>Bismutospherite</i>	Carb.	Yellow, etc. $G = 7.4 \pm$	86
X = c	Prism.	0°	Hex.	<i>Vanadinite</i>	Van.	Colorless or yel. $X < Z$	131
B. No visible cleavage and uniaxial and red							
X = c	Rhom.	0°	Rhom.	HEMATITE	Fe ₂ O ₃	Red to black. $G = 5.2$	44
X = c	Fib.	0°	?	<i>Hydrohematite</i>	Ox.	Red. $G = 4.5-5$. Sol. HCl	45
1011, 0001	Prism.	0°	Rhom.	<i>Treckmannite</i>	AgAsS ₂	X = colorless, Z = red. Inverts	27
1011 dist.	Prism.	0°	Rhom.	<i>Pyrargyrite</i>	Ag ₃ SbS ₃	Red. $G = 5.8$	27
1011 dist.	Rhom.	0°	Rhom.	<i>Proustite</i>	Ag ₃ AsS ₃	Red. $G = 5.6$	27
C. No visible cleavage and biaxial with parallel extinction in axial zones							
110 at 90° ±	Prism.	?	?	<i>Livingstonite</i>	HgSb ₄ S ₇	Z = c. Red: X > Z. $G = 4.8$	28
110, 021	010	9°	Orth.	<i>Cerussite</i>	Carb.	X = c. Y = b. $G = 6.57$	80
X ⊥ 100 cl.	010	32°	Orth.	<i>Pinakiotite</i>	Bor.	Y = c. Red-br.: Y > X > Z	94
Y ⊥ 100 cl.	Prism.	38°	Orth.	<i>Hutchinsonite</i>	Tl, As, S	X = b. Scarlet. $G = 4.6$	28
Z || elong.	Lath	Mod.	Orth.	<i>Hewettite</i>	Van.	X, Y = yel.; Z = red. $G = 2.55$	160
Z || elong.	Lath	52°	?	<i>Metahewettite</i>	Van.	X = yel.; Y, Z = red. $G = 2.55$	160
X || elong.	Fib.	60°	Orth.	<i>Cinprodescloizite</i>	Van.	X = colorless; Y, Z = red-br.	133
X = c. Y = b	Pyr.	Lg.	Orth.	<i>Descloizite</i>	Van.	X = yel., Y = gr.-yel., Z = golden	133
X ⊥ 100 cl.	Prism.	82°	Orth.	<i>Laurtonite</i>	Hal.	Y = b. Colorless to gray. $G = 6.2$	38
D. No visible cleavage and biaxial with inclined extinction in axial zones							
001, 100	100	?	Mon.	<i>Fiallerite</i>	Hal.	Z = b. $G = 5.9$. Sol. HNO ₃	39

001 dist.	Ps. Tet.	Sm.	Mon.?	<i>Schwarzenbergite</i>	Hal.	X = c±. Yel. G. = 7.4	38
X || elong. ±	Fib.	Sm.	Mon.	<i>Vanquelinite</i>	Chrom.	Colorless or X = gr., Y, Z = br.	121
X = c±. Z = b	001	20° ±	Mon.	<i>Polysiasite</i>	Ag, Sb, S	Red. G. = 6.1. Dec. HNO ₃	27
Y ⊥ oro cl.	Prism.	40°	Mon.	Reagar	As	X ∧ c = 11°. Orange; pleo.	22
001 dist.	100	?	Mon.	<i>Paralauntonite</i>	Hal.	Y = b. Colorless or violet	39
111, 11̄1, 001	Lath	?	Tr.	<i>Tenorite</i>	CuO	X = br., Z = opaque. G. = 6.4	41
E. One or more visible cleavage directions and uniaxial							
110 perf.	001	0°	Tet.	<i>Lithargite</i>	PbO	Yel.-red. G. = 9.1	41
001 perf.	001	0°	Tet.	<i>Mallockite</i>	Hal.	Yel. or gr. G. = 7.2	37
001 perf.	001?	0°	Tet.	<i>Heterolite</i>	Ox.	Brown: X > Z. G. = 4.8 ±	65
0001 perf.	0001	0°	Hex.	<i>Hydrocrussite</i>	Carb.	G. = 6.8. Sol. HNO ₃	82
0001 perf.	0001	0°	Hex.	<i>Bismite</i>	Ox.	G. = 4.36. Sol. HNO ₃	43
0001 perf.	0001	0°	Rhom.	<i>Chalcofanite</i>	Ox.	X = red, Z = opaque. G. = 3.9	66
1011 perf.	Rhom.	0°	Rhom.	<i>Geikielite</i>	MgTiO ₃	Purple. G. = 3.9. Sol. HCl	67
0221, 1012	?	0°	Rhom.	<i>Pyrophanite</i>	MnTiO ₃	Yel.-red. G. = 4.5. Sol. HCl	67
F. One or more visible cleavage directions and biaxial with parallel extinction in axial zones							
X ⊥ oro cl.	Prism.	Sm.	Orth.	Goethite	Ox.	Yellow; pleo. G. = 4.2	47
oro perf.	Prism.	Sm.	Orth.	<i>Ventinite</i>	Sb ₂ O ₃	X = a. Extr. Disp. G. = 5.76	45
X ⊥ 001 cl.	001	Sm.	Orth.	<i>Tungstine</i>	Ox.	Yellow; X > Y > Z. G. = 5.5	60
X ⊥ 001 cl.	001	19°	Orth.	<i>Pucherite</i>	Van.	Z = b. Red-br. G. = 6.25	138
Z ⊥ oro cl.	Prism.	26°	Orth.	Stibnite	Sb ₂ S ₃	X = c. Red to opaque. G. = 4.6	25
Z ⊥ 100 cl.	100	Lg.	Orth.	<i>Kocchinite</i>	Molyb.	Y = c. Yellow. Sol. HCl	107
G. One or more visible cleavage directions and biaxial with inclined extinction in axial zones.							
001 perf.	001	10°	Mon.	<i>Leadhillite</i>	Sul.	X ∧ c = 6°. Z = b. G. = 6.3 ±	120
Y ⊥ oro cl.	Fib.	20°	Mon.	<i>Emmonsite</i>	Tel.	X ⊥ 001? cl. ±	118
001 perf.	El. || b	20°	Mon.	<i>Terlinguaite</i>	Hal.	Y ∧ c = 7°. Yellow. G. = 8.7	39
001 perf.	100	30°	Mon.	<i>Buddleyite</i>	ZrO ₂	X ∧ c = 12°. Y = b. Gr., br. X > Z	60
100 perf.	001	65°	Mon.	<i>Smithite</i>	AgAsS ₂	Y = b. Z ∧ c = 7°. Scarlet	27
001, 100	El. || b	Lg.	Mon.	<i>Chlorophite</i>	Hal.	X = c±. Z = b. Y = br., Z = gr.	39

SUPPLEMENTARY TABLE II.—BIREFRINGENCE OF MINERALS

O. BIREFRINGENCE ZERO: $N_g - N_p = 0.000$

Cleavage, Optic Orient.	Habit, etc.	Color	N	Mineral	Chem.	Other Characters	Page
Group 1. Refrference negative and distinct: $N < 1.48$ A. Uncolored in thin section and not isometric							
None	Liquid	Colorless	1.333	<i>Water</i>	Ox.	G. = 1.0	40
B. Uncolored in thin section and isometric							
III perf.	Oct.	Colorless	1.369	<i>Cryptohalite</i>	Hal.	G. = 2.00; sol. hot H ₂ O	36
I. BIREFRINGENCE VERY WEAK: $N_g - N_p < 0.0035$							
Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 12. Refrference positive and high: N_o or $N_m > 1.74 < 2.00$. Optically + or —							
$Z = c$	?	0°	Tet.	<i>Cahrite</i>	Arsen.	Abn. int. colors	161
$Z = c$	?	0°	Hex.	<i>Abukamalite</i>	Sil.	G. = 4.35	*
II. BIREFRINGENCE WEAK: $N_g - N_p > 0.0035 < 0.0095$							
Group 15a. REFERENCE NEGATIVE AND DISTINCT: N_o or $N_m < 1.48$. Optically +.							
A. No visible cleavage							
$Z = c$	Rhom.	0°	Rhom.	<i>Schairerite</i>	Sul.	G. = 2.61. Sol. H ₂ O	119
$X = c$	010	11°	Orth.	<i>Ferucite</i>	NaBF ₄	G. = 2.50. Sol. H ₂ O	**
$Y = b$	100	79°	Mon.	<i>Jarite</i>	Hal.	$X \wedge \perp 100 = 16^\circ$	***
B. One or more visible cleavages							
$Z \wedge cl. = 33^\circ$	?	83°	Mon.?	<i>Bakerite</i>	Hal.	G. = 2.96	*4

Group 16a. Refrference negative and low: N_o or $N_m > 1.48 < 1.54$. Optically +				B. One or more visible cleavages					
$X=c$	Prism.	Lg.	Orth.	<i>Minyulite</i>	Phos.	$G = 2.45$			*5
?	?	Lg.	Orth.	<i>Ashtonite</i>	Sil.	Cleav. angles of 83° and 90°			432
100, 001	Prism.	65°	Mon.	<i>Dachiardite</i>	Sil.	$X=b$. $Z \wedge c = -35^\circ$			399
Group 17a. Refrference positive and low: N_o or $N_m > 1.53 < 1.59$. Optically +				B. One or more visible cleavages					
$Z \perp 001$ cl.	Pyr.	0°	Tet.?	<i>Wardite</i>	Phos.	$G = 2.81$			158
100, 001	Prism.	0°	Tet.	<i>Aschroftine</i>	Sil.	$G = 2.61$			*6
Group 17b. Refrference positive and low: N_o or $N_m > 1.53 < 1.59$. Optically —				B. One visible cleavage					
001 perf.	001	70°	Mon.	<i>Dickite</i>	Sil.	$Y \wedge a = 11^\circ$			264
Group 18a. Refrference positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +				A. No visible cleavage					
?	?	0°	Rhom.	<i>Deltaite</i>	Phos.	$G = 2.95$			155
$Z \parallel$ elong.	Fib.	$0^\circ \pm$	Orth.?	<i>Garnierite</i>	Sil.	Bluish green with $X < Z$			*7
Group 18b. Refrference positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically —				B. One or more visible cleavages					
0001 perf.	Fib.	0°	Hex.	<i>Pseudowarrelite</i>	Phos.	$X \parallel$ fibers. $G = 2.92$			155
A. No visible cleavage and no marked elongation				A. No visible cleavage					
$X=c$	Prism.	0°	Hex.	<i>Ellestadite</i>	Sil.	$G = 3.07$			*8

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SUPPLEMENTARY TABLE II.—BIREFRINGENCE OF MINERALS

II. BIREFRINGENCE WEAK: $N_y - N_p > 0.0035 < 0.0095$ —*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 18b. Refrference positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically —, <i>continued</i>							
A. No visible cleavage and no marked elongation— <i>continued</i>							
Z || fib. 001, 100, 010	Prism.	50°?	Orth.	<i>Juanile</i>	Sil.	H. = 5.5 Decom. by acid	*
	Prism.	65°	Orth.	<i>Tuhualite</i>	Sil.	X = a, Y = b; X = pink, Y = purple, Z = violet	**
C. One or more visible cleavages							
0001 perf.	Prism.	0°	Hex.	<i>Déhrnite</i>	Phos. | G. = 3.04		151
Group 19a. Refrference positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +							
B. One or more visible cleavages							
001, 100	Col.	50°	Orth.	<i>Tuamauite</i>	Sil.	X = olive green, Y = brown, Z = emerald green	317
Group 20b. Refrference positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically —							
?	?	5°	Orth.	<i>Calcium-larsenite</i>	Sil.	G. = 4.42	187
?	?	Biax.	?	<i>Lessingite</i>	Sil.	G. = 4.69	422
Group 21. Refrference positive and extreme: N_o or $N_m > 2.00$. Optically + or —							
X = c, Y = a	Ps. Hex.	Sm.	Orth.	<i>Britholite</i>	Sil.	Twins on 110	441
III. BIREFRINGENCE MODERATE: $N_y - N_p > 0.0095 < 0.0185$							
Group 22a. Refrference negative and distinct: N_o or $N_m < 1.48$. Optically +							
A. No visible cleavage							
?	Powder	0°	Rhom.	<i>Tinocalonite</i>	Bor.	G. = 1.88	90
Group 24a. Refrference positive and low: N_o or $N_m > 1.53 < 1.59$. Optically +							
C. One visible cleavage							
Z ⊥ 0001 cl.	Lam.	0°	Rhom.	<i>Manganbrucite</i>	Ox.	Sol. HCl	42
D. Two or more visible cleavage directions							
100, 010	Prism.	70°	Tr.	<i>Bullfonteinite</i>	Sil.	Z' / $\wedge$ c on 010 = 28°, G. = 2.73	***

Group 24b. Refrference positive and low: N_o or $N_m > 1.53 < 1.59$. Optically -

$X=c$	?	$0^\circ \pm$	Tet.	<i>Aminofite</i>	A. No visible cleavage	$G = 2.94$	*4
oro perf.	010	50°	Mon.	<i>Mooreite</i>	Sil.	$X=b, Z \wedge c = 44^\circ$	106
$X \wedge b = 4^\circ \pm$	Ps. Orth.	$60^\circ \pm$	Tr.	<i>Leightonite</i>	Sul.	Blue. $Y \wedge c = 3^\circ$	*5
$X \perp$ 001 cl.	001	61°	Orth.	<i>Salite</i>	B. One or more visible cleavage directions		*6
					Phos.	$G = 3.1$	

Group 25a. Refrference positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +

oro perf.	001	?	Orth.	<i>Boehlrite</i>	A. No visible cleavage		46
$X=a$	010	15°	Orth.	<i>Roselite</i>	Ox.	Optic sign +?	*7
					Bor.	$G = 2.92$	
110	?	Var.	Orth.?	<i>Hydrophillite</i>	C. Two or more visible cleavage directions		32
100, 102, 001	Colum.	44°	Mon.	<i>Paracallastonite</i>	Hal.	Lamellar twinning	*8
100, 010	Prism.	70°	Tr.	<i>Bullfonteinite</i>	Sil.	$G = 2.91$	*9
					Sil.	$Z' \wedge c$ on 010 = 28°	

Group 25b. Refrference positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically -

$X \parallel$ elong.	Fib.	Mod.	Orth.?	<i>Millsite</i>	A. No visible cleavage		158
					Phos.	$G = 2.83$	
0001 Perf.	?	0°	Hex.?	<i>Dennisonite</i>	B. One visible cleavage		155
0001 Perf.	Prism.	Sm.	Hex.?	<i>Dehrnite</i>	Phos.	$G = 2.85$	151
					Phos.	$G = 3.04$	
$X \perp$ 0001 cl.	?	$0^\circ \pm$	Hex.	<i>Lexistonite</i>	C. Two or more visible cleavage directions		151
					Phos.	$G = 3.06$	

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*6 J. Thoreau and J. F. Vaes: *Bull. Soc. Belg. Geol.*, XLII, 1932, p. 96.

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SUPPLEMENTARY TABLE II.—BIREFRINGENCE OF MINERALS

III. BIREFRINGENCE MODERATE: $N_o - N_p > 0.0095 < 0.0185$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 26a. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +							
B. No visible cleavage and inclined extinction in the chief zones							
?	?	Mod.	Mon.	<i>Acrochordite</i>	Arsen.	$X = b$, $Y \wedge c = 40^\circ - 45^\circ$	137
C. One visible cleavage							
0001 perf.	Plates	$0^\circ - 20^\circ$	Rhom.	<i>Woodhouseite</i>	Sul.	$G = 3.01$. Sol. HCl	*
D. Two or more visible cleavage directions							
1010	Prism.	0°	Hex.	<i>Bromellite</i>	Ox.	$G = 3.02$	**
110	Lam.	Mod.	Orth.?	<i>Hydrophilite</i>	Hal.	Lamellar twinning	32
Group 26b. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically —							
A. No visible cleavage and uniaxial							
$X \perp 001$ cl.	Prism.	0°	Tet.	<i>Iron-akemanite</i>	Sil.	$G = 3.23$	209
B. No visible cleavage and biaxial							
$X \parallel$ needles	Prism.	Mod.	Orth.	<i>Gageite</i>	Sil.	$G = 3.58$	***
C. One or more visible cleavage directions							
001, 010	?	Lg.	Orth.	<i>Landesite</i>	Phos.	$\begin{matrix} X = c, Y = a; \\ X = \text{dark brown, } Y = \text{light brown, } Z = \text{yellow} \end{matrix}$	151
110 perf.	Prism.	Lg.	Mono.	<i>Ferrotremolite</i>	Sil.	$Y = b$, $Z \wedge c = 10^\circ$	247
Group 27a. Refrindex positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +							
A. No visible cleavage							
$X = c$	Prism.	0°	Hex.	<i>Hedyphane</i>	Phos.	Bluish in mass	132
$X \wedge c = 45^\circ$	Prism.	37°	Mon.	<i>Synadelphite</i>	Arsen.	$Z = b$. $G = 3.57$	155

B. One or more visible cleavage directions					
001, 010, 100	?	Mod.	Orth.	<i>Alluaudite</i>	Phos. Z ⊥ best cl.
001, 010	Prism.	70°	Orth.	<i>Varulite</i>	Phos. Y = b. Optic sign +?
?	?	68°	Mon.	<i>Reposite</i>	Phos. G. = 3.74.
Group 27b. Refrindex positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically —					
?	?	5°	Orth.	<i>Calcium-larsenite</i>	Sil. G. = 4.42
$X \wedge c = 32^\circ$	?	?	Mon.	<i>Nagelite</i>	Sil. Y = b; X = brownish yellow, Y = reddish brown, Z = pale yellow
IV. BIREFRINGENCE RATHER STRONG: $N_g - N_p > 0.0185 < 0.0275$					
Group 29a. Refrindex negative and distinct: N_o or $N_m < 1.48$. Optically +					
?	Var.	80°	Mon.	<i>Lapparentite</i>	Sul. G. = 1.89
Group 30b. Refrindex negative and low: N_o or $N_m > 1.48 < 1.54$. Optically —					
A. No visible cleavage					
001 poor	?	52°	Mon.	<i>Letovicite</i>	Sul. $X \wedge c = 17^\circ$, Z = b. G. = 1.81
Group 31b. Refrindex positive and low: N_o or $N_m > 1.53 < 1.59$. Optically —					
B. One visible cleavage and parallel extinction					
X ⊥ 001 cl.	001?	15°	Orth.	<i>Foshallasite</i>	Sil. G. = 2.5
X ⊥ cl.	Platy	Sm.	Orth.	<i>Truscottite</i>	Sil. Silky luster
X ⊥ 001 cl. ±	Lam.	Var.	Mon.?	<i>Skolite</i>	Sil. Slowly sol. in acid
C. One visible cleavage and inclined extinction					
X ⊥ 001 cl. ±	001	24°	Mon.	<i>Hydrocalumite</i>	Ox. Y = b. G. = 2.15

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*4 P. Quensel: *Geol. För. Stockholm*, LIX, 1937, p. 77.

*5 P. Quensel: *Geol. För. Stockholm*, LIX, 1937, p. 92.

*6 E. Grill: *Am. Mineral.*, XX, 1935, p. 740.

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Optic sign from personal communication, Nov. 16, 1938.

SUPPLEMENTARY TABLE II.—BIREFRINGENCE OF MINERALS

IV. BIREFRINGENCE RATHER STRONG: $N_g - N_p > 0.0185 < 0.0275$ —*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 32a. Refrindex positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +							
B. One visible cleavage							
001 perf.	Lam.	74°	Mon.	<i>Staurolite</i>	Sil.	$Y = b$; $Z \wedge a = 20^\circ$	442
C. Two or more visible cleavage directions							
Four cl.	Platy	80°	Tr.	<i>Collinsite</i>	Phos.	$G = 2.95$. Sol. in acid	128
$X \perp$ 001 cl.	Lam.	0° ±	Mon.	<i>Schuchardite</i>	Sil.	$X = \text{blue-green}$, $Z = \text{olive}$	*
Group 32b. Refrindex positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically -							
A. No visible cleavage							
$X = c$	Prism.	0°	Tet.	<i>Mitscherlichite</i>	Hal.	Greenish blue	34
B. One visible cleavage and uncolored							
001, 010	?	66° ±	Tr.	<i>Sanbornite</i>	Sil.	Multiple twinning. $G = 4.19$	407
Group 33a. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +							
A. No visible cleavage							
?	?	0° ±	Orth.	<i>Erikite</i>	Phos.	$G = 3.78$	**
B. One or more visible cleavage directions and parallel extinction in chief zones							
100 dist.	010	Mod.	Mon.	<i>Larnite</i>	Sil.	$X \wedge c = 13^\circ - 14^\circ$; $Z = b$.	194
Group 33b. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically -							
A. No visible cleavage							
$Z = c$	Prism.	40°	Orth.	<i>Seamanite</i>	Phos.	$Y = b$, $G = 3.13$	161
?	Gran.	70° ±	?	<i>Metahohmanite</i>	Sul.	$X = \text{yellow}$, $Y = \text{red yellow}$, $Z = \text{brown}$	***
B. One visible cleavage							
$X \perp$ 100 cl.	100	70°	Orth.	<i>Renardite</i>	Phos.	$Y = c$, $G = 4$. $X = \text{colorless}$, Y and $Z = \text{yellow}$	148

Group 34a. Refrference positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +

110 dist.	Prism.	Orth.	Austinite	Arsen.	$Y = a$; $Z = b$.	$G = 4.12$	*4
Plates	100	Orth.	Dumontite	Phos.	$Y = c$; $Z = a$		148

Group 34b. Refrference positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically -

$Y = c$	Ps. Tet.	Orth.	Allodelphite	Sil.	$G = 3.57$		440
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V. BIREFRINGENCE STRONG: $N_o - N_p > 0.0275 < 0.0365$

Group 37b. Refrference negative and low: N_o or $N_m > 1.48 < 1.54$. Optically -

100	Prism.	Mon.	Hexahydrite	Sul.	$X \wedge c = -25^\circ$.	$Y = b$	106
$X = b$	Prism.	Mon.	Inderite	Bor.	$Z \wedge c = 5^\circ$		*5
110 perf.	Prism.	Mon.	Proberite	Bor.	$Y = b$; $Z \wedge c = 12^\circ - 13^\circ$		93

Group 38b. Refrference positive and low: N_o or $N_m > 1.53 < 1.59$. Optically -

$X = c$	?	Hex.	Fluoborite	Bor.	$G = 2.9$		92
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A. No visible cleavage

Group 39a. Refrference positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +

$Z \wedge c = +28^\circ$	Acic.	Mon.	Weinschenkite	Phos.	$X = b$.	Sol. acid	142
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A. No visible cleavage

B. One or more visible cleavage directions

100 perf.	?	Mono.?	Tilleyite	Sil.	$X \wedge c = 18^\circ$.	$Y = b$	*6
010, 100	010	Mono.	Hilgardite	Bor.	$Y = b$.	$Z \wedge c = 1.5^\circ$	*7
001, 110	010	Tr.?	Monelite	Phos.	$Y = b \pm$.	$G = 2.92$	123

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SUPPLEMENTARY TABLE II.—BIREFRINGENCE OF MINERALS

V. BIREFRINGENCE STRONG: $N_g - N_p > 0.0275 < 0.0365$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 39b. Refrference positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically — B. One or more visible cleavage directions and colorless							
$X \perp ooi$ cl.	oooI	0°	Hex.	<i>Portlandite</i>	Ox. |	G. = 2.33. Sol. HCl	*
Group 40a. Refrference positive and high: N_o or $N_m > 1.66 < 1.74$. Optically + C. Two or more visible cleavage directions							
001, 100 110 at 87°	El. || b Prism.	35° 70°	Mon. Mon.	<i>Serandite</i> <i>Johannsenite</i>	Sil. |	$X \wedge a = -57^\circ$. Z = b. G. = 3.21 Y = b. Z $\wedge$ c = 48°	418 **
Group 40b. Refrference positive and high: N_o or $N_m > 1.66 < 1.74$. Optically — A. No visible cleavage							
?	Fib.	Lg.	Mon.	<i>Lechite</i>	Phos.	Lg. extinction angle. G. = 2.89	158 ***
100 dist.	?	Lg.	Mon.	β - <i>Uranotile</i>	Sil.	$X = b$. Y $\wedge$ c = 49°	
Group 41a. Refrference positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +							
110 at 89° 001, 110	? ?	Sm. ?	Mon. Tr.?	<i>Clinoferrosilite</i> <i>Vandenbrandeite</i>	Sil. | Uran.	Y = b. Z $\wedge$ c = 34.5° Optic sign uncertain	*4 *5
Group 41b. Refrference positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically —							
X $\perp$ cl. 010 dist.	oooI ?	0° 53°	Rhom.? Orth.	<i>Taositte</i> <i>Arsenoclasite</i>	Ox. | Arsen.	X = yellow, Z = red brown G. = 4.16. X = b, Y = a.	*6 133
oor? Z = b	El. || b ?	Mod. 72°	Mon. Mon.	<i>Sursassite</i> <i>Alleganyite</i>	Sil. | Sil.	X $\wedge$ a = 55°. G. = 3.25 X $\wedge$ a = 35°	438 *7
VI. BIREFRINGENCE VERY STRONG: $N_g - N_p > 0.0365 < 0.0545$							
Group 43. Refrference negative and distinct: N_o or $N_m < 1.48$. Optically + or —							
?	Tabular	56°	Orth.	<i>Mercurite</i>	Sul. |	G. = 2.31	*8

Group 44b. Refrference negative and low: N_0 or $N_m > 1.48 < 1.54$. Optically -				* ₉ * ₁₀
001 perf. X = c	Plates ?	Rhom. Orth.	Ungemachite Burkete	
		34°		
Group 45a. Refrference positive and low: N_0 or $N_m > 1.33 < 1.59$. Optically +				157
010, 100	010	Tr.	Gordonite	
Group 45b. Refrference positive and low: N_0 or $N_m > 1.53 < 1.59$. Optically -				* ₁₁
X ⊥ 001 cl.	001	?	Dakete	
Group 46a. Refrference positive and moderate: N_0 or $N_m > 1.59 < 1.66$. Optically +				84
Y = b	El. || b	Mon.	Loseyite	
A. No visible cleavage				116
Pin. good	Crust	Orth.	Louderbackite	
B. One or more visible cleavage directions				* ₁₂
X ⊥ 001 cl.	?	Tet.	Bandylite	
Group 47b. Refrference positive and high: N_0 or $N_m > 1.66 < 1.74$. Optically -				* ₁₃
Z = b	Var.	Mon.?	Plumbosynadelphite	
Group 48a. Refrference positive and very high: N_0 or $N_m > 1.74 < 2.00$. Optically +				
			Arsen.	

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SUPPLEMENTARY TABLE II.—BIREFRINGENCE OF MINERALS

VI. BIREFRINGENCE VERY STRONG: $N_g - N_p > 0.0365 < 0.0545$ —*continued*

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 48b. Refrindex positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically —							
A. No visible cleavage							
?	Prism.	$5^\circ \pm$	Mon.	<i>Fersmanite</i>	Tet.	$Y = b$. $X \perp 001 \pm$. Brown	168
B. One or more visible cleavage directions							
120 dist.	Prism.	80°	Orth.	<i>Larsenite</i>	Sil.	$G = 5.9$. $X = a$; $Y = c$	187
$Y \parallel$ elong.	?	Sm.	Orth.?	β - <i>Uranopellite</i>	Sul.	Z in 010	*
$Y \perp 001$ cl.	?	49°	Orth.	<i>Talasskite</i>	Sil.	$X = b$. $G = 4.1$	**
100 perf.	Ps. Orth.	49°	Tr.	<i>Yeatmanite</i>	Sil.	$G = 4.8$. $Z \wedge c = 3.5^\circ$	***
Group 49b. Refrindex positive and extreme: N_o or $N_m > 2.00$. Optically —							
?	Tab.	Lg.	Orth.?	<i>Duffite</i>	Phos.	$G = 6.19$. Sol. acid	132
?	Fib.	Sm.	Mon.	<i>Ferranite</i>	Van.	Extinction slightly inclined	142
VII. BIREFRINGENCE EXTREME: $N_g - N_p > 0.0545$							
Group 51a. Refrindex negative and low: N_o or $N_m > 1.48 < 1.54$. Optically +							
110 perf.	Prism.	53°	Orth.	<i>Nesquehonite</i>	Carb.	$X = a$. $Y = c$. $G = 1.85$	84
010 perf.	?	42°	Mon.	<i>Ginorite</i>	Bor.	$Y = b$. $G = 2.09$	*4
010, 111	Tablets	75°	Mon.	<i>Nahcolite</i>	Carb.	$X \wedge c = +27.5^\circ$	*5
?	?	60°	Tr.	<i>Ammoniohorite</i>	Bor.	Ext. 7° to 13°	91
Group 52a. Refrindex positive and low: N_o or $N_m > 1.54 < 1.59$. Optically +							
$Z = c$	Acic.	0°	Tet.	<i>Julienite</i>	CSN +	$G = 1.65$. Sol. H_2O	*6
010 perf.	Fib.	37°	Mon.	<i>V'eatchite</i>	Bor.	$Y = b$. $Z \wedge c = -38^\circ$. $G = 2.69$	*7
100, 010, 001	Prism.	60°	Orth.	<i>Metasideronatrite</i>	Sul.	$Y = b$; $Z = c$. Yellow: $X < Y < Z$	*8

100, 010	Fib.	52°	Mon.	<i>Alumohydrocalcite</i>	Carb.	Ext. at 10° to fibers	88
Group 52b. Refrference positive and low: N_o or $N_m > 1.53 < 1.59$. Optically —							
Group 53a. Refrference positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically +							
—Elong.	?	Sm.	Orth.	β - <i>Ascharite</i>	Bor.	G. = 2.65	*9
Perf.	Prism.	Sm.	Orth.	<i>Ransomite</i>	Sul.	G. = 2.63	116
001, 100	Cub. $\pm$	Sm.	Mon.	<i>Guildite</i>	Sul.	G. = 2.72. Yellow	117
001, 100	Var.	Lg.	Mon.	<i>Krausite</i>	Sul.	G. = 2.84. $X \wedge c = -35^\circ$. Z = b.	115
Y = b	Var.	80°	Mon.	<i>Szomolnokite</i>	Sul.	$X \wedge c = +26^\circ$	*10
Group 53b. Refrference positive and moderate: N_o or $N_m > 1.59 < 1.66$. Optically —							
A. No visible cleavage							
Y = b	Prism.	Lg.	Mon.	<i>Rogersite</i>	Sul.	$X \wedge c = 27^\circ$	109
B. One or more visible cleavage directions							
010, 110	Var.	Mod.	Tr.	<i>Castanite</i>	Sul.	$X \wedge c$ in 010 = 22°	110
Group 54a. Refrference positive and high: N_o or $N_m > 1.66 < 1.74$. Optically +							
Z = c	Rhom.	0°	Hex.	<i>Synchysite</i>	Carb.	G. = 3.90	85
110, 001	Curved	75°	Orth.	<i>Antofagustite</i>	Hal.	Bluish green	*11
010, 100, 001	?	50°	Tr.	<i>Lopezite</i>	Chrom.	Opt. Pl. $\perp$ 001 $\pm$. Sol. H ₂ O	*12
?	Prism.	Mod.	Mon.	<i>Legrandite</i>	Arsen.	X = b. $Z \wedge c = -38^\circ \pm$. Yellow with Y < Z	17

* R. Nováček: *N. Jahrb. Mineral.*, 1936, I, p. 141.** V. D. Nikitin: *Mineral. Abst.*, VI, 1937, p. 438.*** C. Palache, L. H. Bauer and H. Berman: *Mineral. Abst.*, VII, 1938, p. 14.*4 G. d'Achiardi: *Mineral. Abst.*, V, 1934, p. 484.*5 A. N. Winchell: *Micro. Char. Art. Minerals*, 2d Ed., New York, 1931, p. 199.*6 A. Schoep and V. Billiet: *Zeit. Krist.*, XCI, 1935, p. 229.*7 G. Switzer: *Am. Mineral.*, XXIII, 1938, p. 409.*8 M. C. Bandy: *Am. Mineral.*, XXIII, 1938, p. 714.*9 M. N. Godlevsky: *Mém. Soc. Russe Mineral.*, LXVI, 1937, p. 315.*10 M. C. Bandy: *Am. Mineral.*, XXIII, 1938, p. 714.*11 C. Palache and W. F. Foshag: *Am. Mineral.*, XXIII, 1938, p. 85.*12 M. C. Bandy: *Am. Mineral.*, XXII, 1937, p. 929.

SUPPLEMENTARY TABLE II.—BIREFRINGENCE OF MINERALS

VII. BIREFRINGENCE EXTREME: $N_g - N_p > 0.0545$ —continued

Cleavage, Optic Orient.	Habit, etc.	2V	System	Mineral	Chem.	Other Characters	Page
Group 54b. Refrindex positive and high: N_o or $N_m > 1.66 < 1.74$. Optically —							
B. One visible cleavage							
$X \perp 001$ cl. 010 perf.	001	74°	Orth.	<i>Bermanite</i>	Phos.	Y = b. X = light brown, Y = pale yellow, Z = red	* 108
	Pyr.	Lg.	Orth.	<i>Butlerite</i>	Sul.	G. = 2.55	
C. Two or more visible cleavage directions							
110 at 56°	Prism.	80° ±	Mon.	<i>Karsulite</i>	Sil.	Y = b; Z $\wedge$ c = 2° ±	254
Group 55a. Refrindex positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically +							
A. No visible cleavage and not elongated or with negative elongation							
?	Var.	50°	Orth.	<i>Juquinite</i>	Sil.	Y = b; Z = c. G. = 3.89	417
C. One or more visible cleavage directions							
010 dist.	Prism.	Lg.	Tr.	<i>Rossite</i>	Phos.	Z = c ±. G. = 2.45	158
Group 55b. Refrindex positive and very high: N_o or $N_m > 1.74 < 2.00$. Optically —							
A. No visible cleavage and uniaxial							
0001 dist.	0001	0°	Rhom.	<i>Argentofurosite</i>	Sul.	Yellow: X < Z	114
0001 dist.	0001	0°	Rhom.	<i>Ammoniofurosite</i>	Sul.	Yellow: X < Z	114
B. No visible cleavage and biaxial							
X || Fib.	Fib.	Sm.	Orth.?	<i>Rosasite</i>	Carb.	X = colorless; Y = Z = pale bluish	84
C. One or two visible cleavage directions and uniaxial or 2V < 40°							
X ⊥ 100 cl.	100	Sm.	Orth.	<i>Ianhuinite</i>	Ox.	Y = c. X = colorless, Y = violet, Z = dark violet	60
E. Three visible cleavage directions							
100+	Tab.	64°	Mon.	<i>Murmanite</i>	Sil.	X ⊥ 100 ±. G. = 2.84	**

TABLE III.—COLOR OF MINERALS

COLORLESS minerals are not included in these tables, since they are so numerous that a special table would be too long to be worth while as compared with complete tables based on birefringence or refraction.

Many colored minerals are pleochroic, that is, they exhibit two different tints (true pleochroism) or shades (differential absorption) of color on rotation of the stage. Some minerals are not pleochroic, that is, they show just the same color in any section and in all positions of rotation. Isotropic minerals can not be pleochroic, but anisotropic minerals are not necessarily pleochroic (at least, not sensibly so). Accordingly, non-pleochroic colored minerals are of two kinds, isotropic and anisotropic.

Pleochroic minerals exhibit two (or more) different tints or shades ¹ of color when the transmitted light vibrates first in one and then in a different unlike crystallographic direction. For example, a mineral shows two different tints when it is yellow for light vibrating parallel with the vertical axis and green for light vibrating normal thereto; it shows two different shades of color when it is pale blue (or red, etc.) in one position and dark blue (or red, etc.) in another position of rotation.

Minerals show all possible tints and shades of color, but the colors which are so common as to be important are: yellow, brown, red, blue, and green. A few minerals are gray in thin section.

The following tables are intended for use in the microscopic study of minerals; therefore minerals are included in the tables wholly on the basis of optic properties as observed in thin section or fine powder. For example, sulphur has a yellow color as observed in mass, but it is not included in the table of yellow minerals beginning on page 82, because it is colorless as observed under the microscope. Also, minerals, whose optic properties in thin section or fine powder are unknown, are not included in the tables. For example, lorettoite is orange yellow in mass and perhaps yellow in thin section; it is not

Two (or more) *shades* of color are strictly due to absorption rather than pleochroism, but may be included under pleochroism for convenience.

included in the table of yellow minerals beginning on page 83, because its pleochroic formula (if it is colored in thin section) is unknown. Again, annabergite, erinite, and cornwallite are pale green, but are omitted from the tables for the same reason.

On the other hand, minerals of variable optic properties are included in the tables in as many places as necessary to express all known variations in their properties.

In these tables "brown" includes not only light and dark brown, yellowish brown, red-brown, etc., but also shades such as cinnamon and chestnut brown; similarly, "blue" includes amethyst, indigo, lavender, lilac, purple and violet; "green" includes emerald, oil and olive, "red" includes carmine, cherry, claret, cochineal, crimson, magenta, pink, purple, rose, scarlet and vermilion; and "yellow" includes amber, canary, golden, lemon, ochre, orange, straw and wine colors.

For methods of estimating or measuring the index of refraction of minerals see the fifth edition of Part I, pages 75-85, 228-239 and 248-253.

For methods of estimating or measuring the birefringence of minerals see Part I, pages 116-124, and 135-137.

For definitions of X, Y, and Z see Part I, pages 117 and 160.

For methods of distinguishing between X, Y, and Z see Part I, pages 124, 130, 137, and 211.

For methods of determining pleochroic formulas, see Part I, pages 170, 171, 204, and 211.

For methods of determining the optic sign, see Part I, pages 129-132, 138, 148-154, 169, 206-213.

For methods of estimating or measuring the optic axial angle, see Part I, pages 186-189, 211, 226, and 245.

For methods of measuring extinction angles, see Part I, pages 126, 137, 173, 174, and 178.

Experienced mineralogists will realize that color is not a reliable means for identifying minerals. Many minerals may exhibit nearly any color, depending upon the presence or absence of small amounts of impurities or substances in crystal solution. Even though color in thin section is a more reliable guide than color in mass, it is not wise to rely wholly upon this table in the identification of unknown minerals. Nevertheless, color is so easily observed that this table seems desirable in spite of its inherent weakness.

Of course the intensity of color in minerals is even less constant than the color itself; nevertheless, some minerals are so often dark

colored, like biotite, or light colored, like ordinary chlorite, that it seems desirable to recognize this condition in the tables even though a color given as dark in the tables, for a certain mineral, may be light in that mineral in some cases, and *vice versa*. Accordingly, names of colors which usually appear notably dark in a given mineral are printed in bold-face type and those which usually appear light are printed in italics.

Names of minerals which are very common or very important are printed in bold-faced type, while names of rare minerals are printed in italics. Some unusually long mineral names are abbreviated to save space.

The tables based on color are arranged on the following outline: (the subdivisions are based on birefringence and the minerals in each subdivision are arranged in the order of increasing refringence).

COLORED MINERALS

- I. Minerals pleochroic in yellow and blue.
- II. Yellow minerals, not pleochroic, and isotropic.
- III. Yellow minerals, not pleochroic, but anisotropic.
- IV. Yellow minerals, pleochroic in yellow (including orange to colorless).
- V. Minerals pleochroic in yellow and brown.
- VI. Minerals pleochroic in yellow and red.
- VII. Brown minerals, not pleochroic and isotropic.
- VIII. Brown minerals, not pleochroic, but anisotropic.
- IX. Brown minerals, pleochroic in brown.
- X. Minerals pleochroic in brown and red.
- XI. Red minerals, not pleochroic and isotropic.
- XII. Red minerals, not pleochroic, but anisotropic.
- XIII. Red minerals, pleochroic in red.
- XIV. Minerals pleochroic in red and blue.
- XV. Minerals pleochroic in brown and blue.
- XVI. Blue minerals, not pleochroic and isotropic.
- XVII. Blue minerals, not pleochroic, but anisotropic.
- XVIII. Blue minerals, pleochroic in blue.
- XIX. Minerals pleochroic in blue and green.
- XX. Green minerals, not pleochroic and isotropic.
- XXI. Green minerals, not pleochroic, but anisotropic.
- XXII. Green minerals, pleochroic in green.
- XXIII. Minerals pleochroic in green and yellow.
- XXIV. Minerals pleochroic in green and brown.
- XXV. Minerals pleochroic in green and red.
- XXVI. Gray minerals.

TABLE III.—COLOR OF MINERALS

I. MINERALS PLEOCHROIC IN YELLOW AND BLUE

N_o or N_m	X	Z	Mineral	Chem.	$\pm$	$2V$	Other Characters	Page
(a) Birefringence very weak or weak; $N_o - N_p < 0.0095$								
1.55 $\pm$	Yellow	Blue	Cordierite *	Sil.	—	60°	Y = violet. Ps. Hex. twin.	307
1.64 $\pm$	Yellowish	Blue	Aerinite	Sil.	—	Sm.	Y = Z. X $\perp$ ool cleav.	285
1.66 $\pm$	Yellow	Violet	Crossite	Sil.	—	Sm.	Y = blue. X $\wedge$ c = 70° $\pm$	259
1.69 $\pm$	Gr.-blue	Gr.-yellow	Arfvedsonite	Sil.	—	Lg.	Y = blue. X $\wedge$ c = 10° $\pm$	257
1.695	Blue	Blue-gray	Riebeckite	Sil.	—	Lg.	Y = br.-yellow. 110 cl.	257
1.72	Gr.-yellow	Gr.-blue	Sapphirine *	Sil.	—	69°	Y = gr.-blue. Z $\wedge$ c = 10° $\pm$	427
(b) Birefringence moderate: $N_o - N_p > 0.0095 < 0.0185$								
1.592	Blue	Gr.-yellow	Torbernite	Phos.	—	0° $\pm$	X $\perp$ ool cleav. G. = 3.2	145
1.64 $\pm$	Yellowish	Blue	Glaucophane	Sil.	—	45° $\pm$	Y = violet. Z $\wedge$ c = 5° $\pm$	258
1.685	Yellow	Greenish	Axinite *	Sil.	—	75° $\pm$	Y = blue. X $\perp$ ool $\pm$	425
1.70 $\pm$	Red	Blue	HYPERSTHENE	Sil.	—	70° $\pm$	Y = yellow. X = a. Z = c	219
1.72	Olive green	Yellow	Chloritoid	Sil.	—	50° $\pm$	Y = blue. ool cleav.	438
(c) Birefringence rather strong: $N_o - N_p > 0.0185 < 0.0275$								
1.623	Blue	Gr.-yellow	Bazzite	Sil.	—	0°	Hex. G. = 2.8. Insol.	414
1.63 $\pm$	Gr.-yellow	Gr.-blue	Pargasite	Sil.	+	60° $\pm$	Y = green. Z $\wedge$ c = 28° $\pm$	247
1.638	Yellowish	Blue	Glaucophane	Sil.	—	45°	Y = violet. Z $\wedge$ c = 5° $\pm$	258
1.66 $\pm$	Yellow	Blue	Sillimanite *	Sil.	+	30°	Y = green. Y = a. Z = c	200
1.67 $\pm$	Yellow	Blue, green	HORNBLende	Sil.	—	80° $\pm$	Y = green. Y = b. Z $\wedge$ c = 20° $\pm$	247
1.674	Blue	Colorless	Lawsonite *	Sil.	+	84°	Y = yellow. X = a. Z = c	430
(d) Birefringence strong to extreme: $N_o - N_p > 0.0275$								
1.668	Blue	Yel.-green	Symplectite	Arsen.	—	87°	Y = gr.-yellow. Z $\wedge$ c = 32°	126
1.722	Violet	Yellowish	Diaspore	Ox.	+	84°	Y = ?. X = c. Z = a	46

1.74± 2.146	Yellow Red-yellow	Red Red-yellow	<i>Piedmontite</i> <i>Rafaelite</i>	Sil. Hal.	+	70°± ?	Y=violet. X∧c=7° Y=Violet. 100 twin.	315 39
II. YELLOW MINERALS, NOT PLEOCHROIC AND ISOTROPIC								
N	Color		Mineral	Chem.	Cleav.	Other Characters	Page	
1.434	Purple, yellow, etc.		Fluorite †	CaF ₂	111 perf.	Color in spots	31	
1.485	Yellow, blue, pink		Sodalite	Sil.	110 poor	G.=2.4. Gel. HCl	289	
1.49±	Blue, yellow, etc.		Noselite	Sil.	110 poor	G.=2.4. Gel. HCl	290	
1.5±	Orange		<i>Hisingerite</i>	Sil.	None	G.=3. Dec. HCl	415	
1.50±	Blue, yellow, etc.		Haunite	Sil.	110 poor	G.=2.4. Gel. HCl	290	
1.64±	Ocher-yellow		<i>Lagonite</i>	Bor.	None	Soft. Very rare	94	
1.64±	Brown, yellow		<i>Griphite</i>	Phos.	None	G.=3.4. Sol. HCl	155	
1.65±	Yellow±		<i>Diadochite</i>	Sul.	None	Opaline	121	
1.65±	Green, yellow		<i>Greenalite</i> ‡	Sil.	None	G.=2.8+. Sol. HCl	413	
1.7±	Yellow, brown		<i>Thorite</i>	ThSiO ₄	None	G.=5.3±	185	
1.73±	Red, blue, etc.		Spinel †	MgAl ₂ O ₄	111 poor	G.=3.6. H.=8	62	
1.739	Yellowish		<i>Helvite</i>	Sil.	111 poor	G.=3.2. Gel. HCl	201	
1.75±	Yellow		<i>Tritomite</i>	Sil.	None	G.=4.2. Gel. HCl	420	
1.75±	<i>Yellow, brown</i>		<i>Grossularite</i> †	Sil.	None	G.=3.5±. Insol.	180	
1.87±	Yellow, brown		<i>Andradite</i>	Sil.	None	G.=4±. Insol.	180	
2.1±	Yellow to red		<i>Limonite</i> ‡	Fe, O, H	None	G.=3.8±	47	
2.14±	Amber		<i>Yttrocrasite</i>	Tit.	?	G.=4.8. Sol. H ₂ SO ₄	167	
2.346	Yellow		<i>Marshallite</i>	CuI	110	Red when heated	30	
2.4±	Brown, yellow		Sphalerite	ZnS	110 perf.	G.=4.1. Sol. HCl	19	
2.49 Li	Yellow ±		<i>Eglestonite</i>	Hg ₂ OCl ₂	None	G.=8.3. Volatile	37	

* Usually colorless in section of standard thickness (.02-.03 mm.); pleochroic in thicker sections.

† Often colorless.

‡ Often opaque on account of surface reflection and refraction.

TABLE III.—COLOR OF MINERALS
III. YELLOW MINERALS, NOT PLEOCHROIC, BUT ANISOTROPIC

N_o or N_m	Color	Mineral	Chem.	$\pm$	$2V$	Other Characters	Page
(a) Birefringence very weak or weak: $N_g - N_p < 0.0095$							
1.75 $\pm$	Yellow, brown	Grossularite *	Sil.	$\pm$	Var.	No cleav. $G = 3.5 \pm$	180
1.87 $\pm$	Yellow, brown	Andradite	Sil.	$\pm$	Var.	No cleav. $G = 4 \pm$	180
2.21	Yellow (zones)	Weslevite	Antim.	+	Sm.	Abn. int. colors	160
2.506	Yellow, orange	Greenockite	CdS	+	0°	1010 cleav. $G = 4.8$	21
(b) Birefringence moderate or rather strong: $N_g - N_p > 0.0095 < 0.0275$							
1.623	Lemon yellow	Uranopilite	Sul.	+	Lg.	Abn. int. colors	117
1.666	Yellow	Johnstrupite *	Sil.	+	70°	100 cleav. $G = 3.3$	423
1.73	Yellow	Melanocerite	Sil.	—	0°	No cleav. $G = 4.13$	420
1.733	Yellowish	Hematolite	Arsen.	—	0°	0001 cleav. $G = 3.4$	153
2.18	Yellow	Kleinite	Hg ₂ OCl ₂	—	Sm.	One cleav. $G = 7.98$	38
(c) Birefringence extreme: $N_g - N_p > 0.0545$							
1.68 $\pm$	Reddish yellow	Erythrosiderite	Hal.	—	$65^\circ \pm$	$X = a$. $Y = c$. Deliques.	35
1.763	Canary yellow	Dewindite	Phos.	+	Lg.	$X = a$. $Y = c$. 100 cleav.	148
1.997	Brown, yellow	Cassiterite	SnO ₂	+	0°	$G = 7 \pm$. Zonal	52
2.19	Yellow, brown	Baddeleyite	ZrO ₂	—	30°	$X \wedge c = 12^\circ$. 001 cleav.	60
2.20	Canary yellow	Tripukhite	Antim.	+	Sm.	$G = 5.8$. In gravels	160
2.24	Golden yellow	Tungstite	WO ₃ . H ₂ O	—	Sm.	$X \perp 001$ cleav.	60
2.4 $\pm$	Green-yellow	Stibiotantalite	Tant.	+	$75^\circ \pm$	$X \perp 100$ cleav. $Z = c$	167
2.50	Yellow	Montroydite	HgO	+	Lg.	010 cleav. Sol. HCl	41
2.61	Brown, yellow	Rutile †	TiO ₂	+	0°	Tet. prism. $G = 4.2$	50
2.65	Yellow-orange	Lithargite	PbO	—	0°	110 cleav. $G = 9.13$	41

IV. YELLOW MINERALS, PLEOCHROIC IN YELLOW (INCLUDING ORANGE TO COLORLESS)

N_o or N_m	X	Z	Mineral	Chem.	$\pm$	$2V$	Other Characters	Page
(a) Birefringence very weak or weak: $N_g - N_p < 0.0095$								
1.525 $\pm$	Colorless	Golden	Sepiolite †	Sil.	—	Sm.	Y=Z. Z || fibers	410
1.58 $\pm$	Yellow	Golden	Beryl †	Sil.	—	0°	Hex. G=2.8 $\pm$	212
1.61 $\pm$	Colorless	Yellow	Eudialite †	Sil.	+	0°	0001 cleav. Gel. HCl	417
1.63 $\pm$	Yellow	Colorless	Eucolite †	Sil.	—	0°	0001 cleav. Gel. HCl	417
1.72	Yellow	Colorless	Vesuvianite	Sil.	—	0°	Tet. G=3.4. Contacts	207
>1.74	Yellow	Br. yellow	Schafarzikite	Phos.	+	0°	110 cleav. G=4.3	122
1.915	Yellow	?	Huegelite	Van.	+	Sm.	Y=orange. Abn. int. colors	127
1.93	Golden: X and Y < Z		Corkite	Sul.	—	0°	0001 cleav. G=4.2 $\pm$	119
(b) Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$								
1.545	Colorless	Yellow	Chrysotile †	Sil.	+	30° $\pm$	Y=Z. Z || fibers	260
1.591	Yellow	Yellow	Metanollite	Sul.	—	0°	G=2.53. Scaly	114
1.623	Colorless	Yellow	Uranocircite	Arsen.	—	10° $\pm$	X $\perp$ 001 cleav. Y=b	147
1.637	?	Colorless	Barite †	Sul.	+	37°	Y=yellow. X $\perp$ 001 cl.	100
1.654	Colorless	Red-yellow	Hureaulite	Phos.	—	74°	Y=yellow. Z $\wedge$ c=75°	124
1.654	Colorless	Yellow	Phenakite †	Sil.	+	0°	Y=yellow. G=3.0	185
1.657	Colorless	Br. yellow	Seybertite	Sil.	—	5°	1120 cleav. X $\perp$ 001 cleav.	286
1.66	Colorless	Orange	Salmonsite	Phos.	+	Lg.	Y=yellow. Z || fibers	156
1.666	Yellow	Gr. yellow	Johnstrupite †	Sil.	+	70°	Y=br. yellow. Y=b	423
1.668	Yellow: X < Y < Z		Rinkite	Sil.	+	43°	X=b. Y $\wedge$ c=8°. 100 cl.	423
1.681	Yellow	Colorless	Prismaticite †	Sil.	—	30° $\pm$	Y=br. yellow. X=c	421

* Often colorless.

† Often opaque in standard sections; colored in extremely thin sections.

‡ Usually colorless in sections of standard thickness (.02-.03 mm.); pleochroic in thicker sections.

TABLE III.—COLOR OF MINERALS

IV. YELLOW MINERALS, PLEOCHROIC IN YELLOW (INCLUDING ORANGE TO COLORLESS)—continued

N_g or N_m	X	Z	Mineral	Chem.	$\pm$	2V	Other Characters	Page
(b). Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$ —continued								
1.686	Colorless	?	<i>Tiannodipidite</i>	Sil.	+	Mod.	Y = yellow. X = b, Y = c	400
1.695	Colorless	Yellow	<i>Guarinite</i>	Sil.	+	$90^\circ \pm$	Y = yellowish. G. = 3.27 (= Hainite?)	406
1.75	Colorless	Golden	<i>Stauriolite</i>	Sil.	+	88°	Y = yellowish. Y = a. Z = c	202
1.96	Golden: X and Y < Z		<i>Bendurite</i>	Sul.	—	Mod.	oor cleav. G. = 4.1	119
2.135	Colorless $\pm$	Yellow	<i>Mimeite</i>	Arsen.	—	0°	Hex. Prism. G. = 7.1	132
2.265	Yellow	Golden	<i>Desclotzite</i>	Van.	—	Lg.	Y = gr.-yellow. X = c	133
(c). Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$								
1.57	Yellowish	Golden	<i>Xylotile</i>	Sil.	+	Sm.	Y = X. Z || fib. G. = 2.5 $\pm$	261
1.574	Yellow	Yellow	<i>Bassettite</i>	Phos.	—	62°	Y = yellow. X $\perp$ oro cleav.	146
1.575	Colorless	Golden	<i>Autinite</i>	Phos.	—	33°	Y = golden. X $\perp$ oor cleav.	146
1.586	Colorless $\pm$	Yellow	<i>Uranospinite</i>	Arsen.	—	46°	Y = Z. X $\perp$ oor cleav.	147
1.6 $\pm$	Yellow	Golden	<i>Bowlingite</i>	Sil.	—	Sm.	Y = yellow. X $\perp$ oor cleav.	437
1.613	Gr.-yellow	Br.-yellow	<i>Meliphanite</i> *	Sil.	—	0°	Tet. Pyram. oor cleav.	210
1.62	Yellowish	Yellow	<i>Nontronite</i>	Sil.	—	Var.	Y = orange. X $\perp$ oor cleav.	415
1.63	Golden	Colorless	<i>Carpholite</i>	Sil.	—	60°	Y = X. Y = a. Z = c. oro cleav.	431
1.65 $\pm$	Colorless $\pm$	Yellow	<i>Tourmaline</i>	Sil.	—	0°	Max. abs. $\perp$ elong.	301
1.653	Yellow	Yellow	<i>Plumbogummite</i>	Phos.	+	0°	G. = 4.5. Sol. HNO ₃	153
1.666	Colorless	Yellow	<i>Uranophane</i>	Sil.	—	$40^\circ \pm$	Y = yellow. Abn. int. colors.	441
1.716	Yellow	Wine yellow	<i>Woehrlite</i>	Sil.	—	75°	Y = X. X $\wedge$ c = 45° . oro cl.	441
1.9 $\pm$	Br.-yellow	Yellow	<i>Ardennite</i>	Sil.	+	70°	Y = golden. Y $\perp$ oro cleav.	440
2.356		Yellow: X > Z	<i>Wurtzite</i>	ZnS	+	0°	oro cleav. G. = 4 $\pm$	20

(d) Birefringence strong: $N_g - N_p > 0.0275 < 0.0365$

	Yellow	Yellow	Phos.			
1.510	Yellow	Yellow				
1.57±	Colorless	Br.-yellow	Sil.	—	69°	Y=yellow. X⊥oor cleav.
1.576	Gr. yellow	Yellow±	Sil.	—	10°	Y=Z. X⊥oor cleav.
1.62±	Golden	Yellow	Sil.	—	0°	oor cleav. Dec. HCl
1.63±	Golden	Yellow	Sil.	+	80°±	Y=yellow±. X∧a=30°
1.65±	Yellow	Yellow	Sil.	+	68°	Y=colorless. X=a. Z=b
1.67±	Golden	Br.-yellow	Sil.	+	80°±	Y=yellow. Z∧c=15°
1.68±	Br. yellow	Yellow	Sil.	+	76°	Y=colorless. X∧a=10°
1.687	Yellow: X and Y<Z	Br. yellow	Hal.	—	65°	Y=red-yellow. X=a. Y=c
1.687	Colorless	Yellow	Carb.	+	60°	oor cleav. Z∧c=13°
1.72	Colorless±	Yellow	Phos.	—	40°	Abn. int. colors. oio cl.
1.74	Yellow	Straw yellow	Sil.	+	0°	X⊥oro plates. Sol. HCl
1.75	Yellow	Golden	Sil.	+	28°	Y=colorless. Z∧c=Sm.
1.75	Colorless	Golden	Sil.	+	40°	Y=X. X⊥oro cleav.
2.27	Br.-yellow: X<Z		PbWO ₄	—	80°	Y=X. 100 cleav. X∧c=20°
				+	Sm.	100 cleav. X∧c=Lg.

146	Y=yellow. X⊥oor cleav.
272	Y=Z. X⊥oor cleav.
407	oor cleav. Dec. HCl
196	Y=yellow±. X∧a=30°
197	Y=colorless. X=a. Z=b
243	Y=yellow. Z∧c=15°
197	Y=colorless. X∧a=10°
35	Y=red-yellow. X=a. Y=c
419	oor cleav. Z∧c=13°
86	Abn. int. colors. oio cl.
147	X⊥oro plates. Sol. HCl
418	Y=colorless. Z∧c=Sm.
418	Y=X. X⊥oro cleav.
420	Y=X. 100 cleav. X∧c=20°
101	100 cleav. X∧c=Lg.

(e) Birefringence very strong: $N_g - N_p > 0.0365 < 0.0545$

	Yellow	Fibroferrite	Sul.			
1.534	Colorless±	Quenite	Sul.	+	0°±	Y=colorless±. Z || fib.
1.535	Colorless	Fe-muscovite	Sil.	+	34°	Y=X. 110 cleav. G.=2.12
1.59±	Colorless	Johannite	Sil.	—	Sm.	Y=Z. X⊥oor cleav.
1.595	Colorless	Sklodowskite	Sil.	+	Lg.	Y=yellow. X=b±
1.635	Colorless	Sodinite	Ox.	—	Lg.	Y=yellow. Y⊥oor cleav.
1.662	Colorless	Durangite	Arsen.	+	?	Y=yellow. X=a. Z=c
1.673	Orange-yellow	Grunerite	Sil.	—	57°	Y=orange-yellow
1.697	Colorless	Schoepite	UO ₃ ·2H ₂ O	—	82°	Y=X. Y=b. Z∧c=12°±
1.714	Colorless	Bequerelite	UO ₃ ·2H ₂ O	—	Lg.	Y=Z. X⊥oor cleav.
1.77	?			—	Sm.	Y=yellow. X⊥oor cleav.

109	Y=colorless±. Z || fib.
116	Y=X. 110 cleav. G.=2.12
268	Y=Z. X⊥oor cleav.
118	Y=yellow. X=b±
441	Y=yellow. Y⊥oor cleav.
61	Y=yellow. X=a. Z=c
151	Y=orange-yellow
242	Y=X. Y=b. Z∧c=12°±
60	Y=Z. X⊥oor cleav.
60	Y=yellow. X⊥oor cleav.

* Usually colorless in standard sections; may be pleochroic in thicker sections.

TABLE III.—COLOR OF MINERALS

IV. YELLOW MINERALS, PLEOCHROIC IN YELLOW (INCLUDING ORANGE TO COLORLESS)—*continued*

N_0 or N_m	X	Z	Mineral	Chem.	$\pm$	$2V$	Other Characters	Page
(c) Birefringence very strong: $N_0 - N_p > 0.0365 < 0.0545$ — <i>continued</i>								
1.79	Yellow	Gr.-yellow	Monazite	Phos.	+	12°	$Y = \text{yellow. } Z \wedge c = 4^\circ$	138
1.815	Yellow	Orange	<i>Pascoite</i>	Van.	—	50°	$Y = \text{yellow. } X = b. \ Z \wedge c = 8^\circ$	160
1.864	Yellowish	Yellowish	<i>Knebelite</i> *	Sil.	—	$50^\circ \pm$	$Y = \text{yellow. } X \perp \text{oro cleav.}$	193
1.877	Gr.-yellow	Gr.-yellow	<i>Fayalite</i> *	Sil.	—	50°	$Y = \text{orange. } X \perp \text{oro cl.}$	192
(f) Birefringence extreme: $N_0 - N_p > 0.0545$								
1.525	Colorless	Amber-yellow	<i>Sideronatrite</i>	Sul.	+	58°	$Y = \text{yellow. } X \perp \text{oro cl.}$	115
1.54 $\pm$	Yellow	Gr.-yellow	<i>Mono. copiapite</i>	Sul.	+	Lg.	$Y = \text{colorless. } Z \wedge c = 50^\circ$	108
1.580	Yellowish	Orange	<i>Cacoxenite</i>	Phos.	+	0°	$Z \parallel \text{fib. } G = 3.38$	143
1.605	Colorless $\pm$	Orange	<i>Amaranite</i>	Sul.	—	28°	$Y = \text{orange. } 100, \text{oro cl.}$	109
1.66	Colorless	Yellow	<i>Stewartite</i>	Phos.	—	Lg.	$Y = \text{yellow. } \text{oro cleav.}$	128
1.672	Yellow	Golden	<i>Parisite</i> *	Carb.	+	0°	$\text{ooo cleav. } G = 4.4$	85
1.680	Colorless $\pm$	Yellow	<i>Zippelite</i>	Sul.	—	Lg.	$Y = \text{yellow. } X \perp \text{oro cleav.}$	110
1.703	Golden	Lemon yellow	<i>Astrophyllite</i>	Sil.	+	$75^\circ \pm$	$Y = \text{orange. } X \perp \text{oro cl.}$	417
1.734		Yellow: $X < Y < Z$	<i>Curtisite</i>	$\text{C}_{60}\text{H}_{40}\text{O}$	+	83°	$Z \perp \text{ooo cleav.}$	18
1.755	Yellow	Br. yellow	<i>Vegasite</i>	Sul.	+	0°	$Z \perp \text{ooo plates}$	116
1.76 $\pm$	Clear yellow	Gray-yellow	<i>Ferrimolybdate</i>	Molyb.	+	28°	$Y = X. \ X = b. \ Z \parallel \text{fib.}$	108
1.760	Br.-yellow	Gr.-yellow	<i>Condyite</i> *	Carb.	—	0°	$\text{ooo cleav. } G = 4.3$	86
1.820	Colorless	Yellow	<i>Jarosite</i>	Sul.	—	0°	$\text{ooo cleav. } G = 3.2$	114
1.832	Colorless	Yellow	<i>Natrojarosite</i>	Sul.	—	0°	$\text{ooo cleav. } G = 3.18$	114
1.9 $\pm$	Gray-yellow	Yellow	<i>Carnotite</i>	Van.	—	45°	$Y = Z. \ X \perp \text{ooo cleav.}$	148
1.9 $\pm$	Colorless $\pm$	Yellow	<i>Tuyamunite</i>	Van.	—	45°	$Y = Z. \ X \perp \text{ooo cleav.}$	147
1.905	Br. yellow	Yellow	<i>Titanite</i> *	Sil.	+	28°	$Y = X. \ \text{Str. disp.}$	204

Colorless Br.-yellow Yellow	Yellow Golden Br.-yellow Yellow: X > Y > Z	Durdenite Cassiterite Lepidocrocite Tungstite Goethite Vanadinite Crocoite Wulfenite Ochalcadrite Brookite Massicotite Rutile † Orpiment *	Tel. SnO ₂ FeO(OH) WO ₃ ·H ₂ O FeO(OH) Van. PbCrO ₄ PbMoO ₄ TiO ₂ TiO ₂ PbO TiO ₂ As ₂ S ₃	23° 0° 83° Sm. Var. 0° 57° 0° 0° Var. Lg. 0° Sm.	Y = yellow, X = c G. = 7±. Zonal. Y = orange. X ⊥ oro cl. X ⊥ oor cleav. Sol. KOH Y = br.-yellow. Extr. disp. Hex. Prism. Dec. HCl Y = ? Y = b. Z ∧ c = 6° Tet. 111 cleav. G. = 6.9 oor cleav. G. = 3.9. Insol. Y = X. Abn. int. colors Y (or X?) ⊥ 100 cleav. Tet. Prism. G. = 4.2 X ⊥ oro cleav. Z = a ±	118 52 48 60 47 131 101 98 53 59 41 50 25
1.95± 1.997 2.20 2.24 2.30 2.354 2.37 2.402 2.56 2.58 2.61 Li 2.61 2.72+						

V. MINERALS PLEOCHROIC IN YELLOW AND BROWN

(a) Birefringence very weak to moderate: $N_g - N_p < 0.0185$

Yellow Yellow Yellow Olive-yellow Yellow Br.-yellow	Yellow Yellow Yellow Olive-yellow Yellow Br.-yellow	Cordierite * Nontronite Goyazite * Axinite * Vesuvianite *	Sil. Sil. Phos. Sil. Sil.	60°± Var. 0° 75° 0°	Y = brown. Ps. Hex. twin. Y = ? X ⊥ oor cleav. oor cleav. Y = violet. X ⊥ 011 ± Poor cleav. G. = 3.4	307 415 153 425 207
1.543 1.62 1.620 1.685 1.72						

(b) Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$

Brown Yellow Yellow Brown Brown Yellow	Yellow Brown Brown Yellow Brown Brown	Anthophyllite * Tourmaline Barkevikite Pigeonite Wurtzite	Sil. Sil. Sil. Sil. ZnS	Lg. 0° 40°± Sm. 0°	Y = X. Z = c. 110 cleav. Max. abs. ⊥ elong. Y = red-brown. Z ∧ c = 12° Y = X. Y = b. Z ∧ c = 30° ± 100 cleav. G. = 4 ±	240 301 254 222 20
1.64 1.65 1.69 1.70 2.36						

* Usually colorless in sections of standard thickness (0.2-0.3 mm.); pleochroic in thicker sections.

† Often opaque in standard sections; colored in extremely thin sections.

TABLE III.—COLOR OF MINERALS
V. MINERALS PLEOCHROIC IN YELLOW AND BROWN—continued

N_o or N_m	X	Z	Mineral	Chem.	$\pm$	$2V$	Other Characters	Page
(c) Birefringence strong to very strong: $N_o - N_p > 0.0275 < 0.0545$								
1.625	Yellow	Brown	<i>Roscherite</i>	Phos.	—	Lg.	Y = yel.-brown. oor cl.	156
1.63±	Yellow	Red-brown	BIOTITE	Sil.	—	Sm.	Y = Z. X ⊥ oor cleav.	227
1.63±	Yellow	Brown	Anomite	Sil.	—	Sm.	Y = Z. X ⊥ oor cleav.	276
1.63±	Yellow	Brown	<i>Protolithionite</i>	Sil.	—	Sm.	Y = Z. X ⊥ oor cleav.	270
1.65	Colorless	Yellow	<i>Reddingite</i>	Phos.	+	40°	Y = brown; Y ⊥ oor cl.	124
1.70±	Yellow	Green, brown	HORNBLÉNDE	Sil.	—	80°±	Y = brown; Z ∧ c = 20°±	247
1.722	Brown	Yellowish	Diaspore *	AlO(OH)	+	84°	Y = ? Y ⊥ oor cleav.	46
1.734	Rose-red	Yellow	<i>Adamite</i>	Phos.	+	83°	Y = yel.-brown, X = a	133
1.75	Green	Yellow	EPIDOTE †	Sil.	—	70°±	Y = brown. Z ∧ a = 25°	314
1.776	Red-brown	Br.-yellow	<i>Orientite</i>	Sil.	+	67°	Y = yellow. X = a. Y = c	432
1.79	Br.-yellow	Br.-yellow	Monazite *	Phos.	+	12°	Y = red-brown. X = b	138
1.81	X or Z = Gr.-yellow	Br.-yellow	<i>Hancockite</i>	Sil.	—	50°	Y = yel.-brown. oor cl.	316
1.845	Yellow	Red-Brown	<i>Kraurite</i>	Phos.	—	Sm.	Y = Z. X = a. Y = c	142
1.9±	Br.-yellow	Green	Ilvaite †	Sil.	—	Sm.	Y = brown. Z = c	431
(d) Birefringence extreme: $N_o - N_p > 0.0545$								
1.685	Gr.-yellow	Brown	<i>Roscoelite</i>	Sil.	—	Sm.	Y = Z. X ⊥ oor cleav.	270
1.69	Yellowish	Brown	<i>Stilpnomelane</i>	Sil.	—	Sm.	Y = Z. X ⊥ oor cleav.	435
1.77	Yellow	Red-brown	<i>Chalcodite</i>	Sil.	—	Sm.	Y = Z. X ⊥ oor cleav.	435
1.87	Yellow	Red-brown	<i>Arseniosiderite</i>	Arsen.	—	0°	oor cleav. G. = 3.7±	153
1.879	Br.-yellow	Gr.-yellow	<i>Uvanite</i>	Van.	+	52°	Y = brown. 2 cleav.	148
2.19	Brown	Brown	<i>Baddeleyite</i>	ZrO ₂	—	30°	Y = gr.-yellow. X ∧ c = 12°	60
2.22 Li	Golden	Gr.-yellow	Huebnerite	MnWO ₄	—	73°	Y = yel.-brown. Z ∧ c = 20°	101
2.25	Br.-yellow: X < Z	Br.-yellow	<i>Manganite</i> †	MnO(OH)	+	Sm.	Y = X. Y ⊥ oor cleav. Z = c	48
2.3±	Brown	Orange	<i>Goethite</i>	FeO(OH)	—	Var.	Y = br.-yellow. Ext. disp.	47

VI. MINERALS PLEOCHROIC IN YELLOW AND RED

(a) Birefringence very weak: $N_g - N_p < 0.0095$

	Golden	Carmine							
1.328	Golden	Carmine	Villiaumite	NaF	?	100 cleav.	X ⊥ ool	30	
1.61 ±	Golden	Carmine	Eudialite §	Sil.	+	0°	ool cleav.	417	
1.63 ±	Carmine	Yellow	Eucrite §	Sil.	-	0°	ool cleav.	417	
1.70	Pink	Yellow	Thulite	Sil.	+	Sm.	Y = pink, X ⊥ ool cl.	311	

(b) Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$

	Yellow	Violet pink							
1.62	Yellow	Violet pink	Topaz §	Sil.	+	60° ±	Y = pink, Z ⊥ ool cleav.	198	
1.64	Red	Yellow	Andalusite §	Sil.	-	84°	Y = Z, X = c, Z = a, 110 cl.	201	
1.67 ±	Pink	Pink	Lithiophilite	Phos.	+	63° ±	Y = gr.-yellow, Y ⊥ ool cl.	149	
1.70 ±	Red	Blue	Hypersthene	Sil.	-	70° ±	Y = yellow, X = a, Z = c	219	
1.73 ±		Red-yellow: X > Z	Rhodonite §	Sil.	-	76°	Y = pink, 110, 110 cl.	403	

(c) Birefringence rather strong to strong: $N_g - N_p > 0.0185 < 0.0365$

	Yellow	Orange-red							
1.548	Yellow	Orange-red	Botryogen	Sul.	+	41°	Y = red, X ⊥ ool cleav.	116	
1.660	Yellowish	Colorless	Eosphorite	Phos.	-	40°	Y = pink, Y ⊥ 100 cleav.	156	
1.678	Blood-red	Orange	Tilandinohumile	Sil.	+	60° ±	Y = Z, X ∧ ool cleav. = 8°, Z = b	198	
1.70	Gr.-yellow	Gr.-yellow	AUGITE (Ti)	Sil.	+	60°	Y = red, X ∧ c = 45° ±, Y = b	228	
1.735	Orange-red	Yellow	Sicklerite	Phos.	-	Lg.	Y = orange, Z ⊥ cleav.	158	
1.75	Wine yellow	Orange-red	Laaverite	Sil.	-	80°	Y = gr.-yellow, X ∧ c = 20°	420	
1.852	Gr.-yellow	Pink	Törnebohmlite	Sil.	+	26°	Y = bl.-green. Rare	414	

(d) Birefringence very strong: $N_g - N_p > 0.0365 < 0.0545$

	Yellowish-red	Yellowish-red							
1.70	Yellow	Yellowish-red	Neptunite	Sil.	+	49°	Y = Z, Y = b, Z ∧ c = 20°	418	
1.722	Blue	Violet	Diaspore §	AlO(OH)	+	84°	Y = yellow, Y ⊥ ool cl.	46	

* Usually colorless in sections of standard thickness (0.2-0.3 mm.); pleochroic in thicker sections.

† Usually pleochroic greenish to golden yellow in sections of standard thickness; colored as given above in thicker sections.

‡ Usually opaque in sections of standard thickness (0.2-0.3 mm.); pleochroic in extremely thin flakes or on thin edges.

§ Usually colorless in sections of standard thickness (0.2-0.3 mm.); colored in thicker sections.

TABLE III.—COLOR OF MINERALS
VI. MINERALS PLEOCHROIC IN YELLOW AND RED—continued

N_o or N_m	X	Z	Mineral	Chem.	$\pm$	$2V$	Other Characters	Page
(d) Birefringence very strong: $N_o - N_p > 0.0365 < 0.0545$ —continued								
1.734	Rose-red	Yellow	<i>Adamite</i>	Arsen.	+	83°	$Y = \text{yel. brown. } X = a$	133
1.74	Yellow	Red	<i>Piedmontite</i>	Sil.	+	$70^\circ \pm$	$Y = \text{violet. } Z \wedge ooi \text{ cleav. } = 32^\circ$	315
1.75 $\pm$	Yellow	Pink	EPIDOTE *	Sil.	—	$70^\circ \pm$	$Y = \text{green. } Z \wedge ooi \text{ cleav. } = 25^\circ$	314
2.10	Orange	Red	<i>Metahelvite</i>	Van.	—	52°	$Y = \text{red. } Z \parallel \text{ elong.}$	160
(e) Birefringence extreme: $N_o - N_p > 0.0545$								
1.550	Purple-red	Yellow	<i>Rhombochase</i>	Sul.	+	Sm.	$Y = Z. X \perp ooi \text{ cleav.}$	108
1.721	Pink	Br.-yellow	<i>Xenotime</i>	Phos.	+	0°	Tet. Prism. 110 cleav.	138
1.875	Golden	Br.-red	<i>Plumbiujarosite</i>	Sul.	—	Sm.	$Y = ? \ 1011 \text{ cleav. } G. = 3.67$	115
1.905	Yellow	Pink	Titanite †	Sil.	+	28°	$Y = \text{gr.-pink. } Y = b$	204
2.18	Orange	Red	<i>Hewettite</i>	Van.	—	Mod.	$Y = X. Z \parallel \text{ elong.}$	160
2.20	Yellow	Orange-red	<i>Lepidocrocite</i>	FeO(OH)	+	83°	$Y = \text{orange. } X \perp ooi \text{ cl.}$	48
2.354	Yellow	Br.-red	Vanadinite	Phos.	—	0°	Hex. Prism. $G. = 7.0$	131
2.59	Orange-red	Gold-yellow	Realgar	AsS	—	40°	$Y = Z. Y \perp ooi \text{ cl. } X \wedge c = 11^\circ$	22

VII. BROWN MINERALS, NOT PLEOCHROIC AND ISOTROPIC

N	Color	Mineral	Chem.	Cleav.	Other Characters	Page
1.434	Purple, brown, etc.	Fluorite	CaF ₂	III	$G. = 3.18. \text{ Sol. } H_2SO_4$	31
1.49 $\pm$	Blue, brown	Noselite	Sil.	110 poor	$G. = 2.3. \text{ Gel. HCl}$	290
1.5 $\pm$	Golden brown	<i>Hisingerite</i>	Sil.	None	$G. = 3. \text{ Dec. HCl}$	415

1.50±	Blue, brown	Haunite	Sil.	110 poor	G.=2.4. Gel. HCl	290
1.54±	Brown	<i>Neotocite</i>	Sil.	None	G.=2.7. Coal-like	298
1.54±	Green, brown	<i>Cornuile</i>	Sil.	None	G.=2±. Conch. frac.	413
1.635±	Reddish brown	<i>Piticite</i>	Sil.	None	G.=2.4±. Sol. HCl	121
1.652	Green, brown	<i>Greenalite</i> †	Sil.	None	G.=2.8±. Sol. HCl	413
1.7±	Brown, yellow	<i>Thorite</i>	Ox.	?	G.=5.3. Also aniso.	185
1.70±	<i>Red, brown</i>	Pyrope	Sil.	None	G.=3.5. No cleav.	178
1.70	Clear brown	<i>Polycrase</i>	Colum.	None	G.=5.0. Dec. H ₂ SO ₄	167
1.73±	Red, brown, etc.	Spinel	MgAl ₂ O ₄	111 poor	G.=3.6. Oct.	61
1.74±	Yellowish brown	Caryocrite	Sil.	None	G.=4.3. Dec. HCl	420
1.75±	Yellow, brown	<i>Trilomite</i>	Sil.	Poor	G.=4.2. Dec. HCl	420
1.75±	<i>Brown</i>	Grossularite	Sil.	None	G.=3.5. No cleav.	180
1.8±	Brown	<i>Manganspinel</i>	MnAl ₂ O ₄	None	G.=4. Oct.	62
1.81±	Brown	<i>Gahnite</i>	ZnAl ₂ O ₄	111 poor	G.=4.5. Oct.	63
1.82±	<i>Brown, red</i>	Almandite	Sil.	None	G.=4±. No cleav.	178
1.87±	Red, brown	Andradite	Sil.	None	G.=3.7. No cleav.	180
1.9±	Red-brown	<i>Cherkinite</i>	Sil.	None	G.=4.4. Gel. HCl	423
2.0±	Brown, yellow	<i>Pyrochlore</i>	Tit.	111	G.=4.3. Color zonal	163
2.0±	Brownish	Limonite †	Ox.	None	G.=3.8. Sol. HCl	47
2.0±	Brown	<i>Wikkite</i>	Colum.	?	G.=4.3±. H.=6	167
2.05	Red-brown	Risoerite	Tant.	?	G.=4.2. Sol. H ₂ SO ₄	165
2.13	Brown	<i>Ampangabéite</i> ‡	Colum.	?	G.=4.1±. H.=4	166
2.14	Brown-black	<i>Blomstrandinite</i> *	Tit.	010 poor	G.=4.9. H.=5.5	167
2.15±	Brown	<i>Samaraskite</i> †	Colum.	010 poor	G.=5.7. Insol.	166
2.15±	Red-brown	<i>Euxenite</i>	Tit.	None	G.=4.8. Insol.	167
2.15±	Brown	<i>Fergusonite</i>	Colum.	111 poor	G.=5.8. Also biref.	164
2.15	Red-brown	<i>Yttrialite</i>	Tant.	010 poor	G.=5.7. Insol.	166

* Usually pleochroic, greenish to golden yellow in sections of standard thickness.

† Usually colorless in sections of standard thickness (0.2–0.3 mm.); pleochroic in thicker sections.

‡ Usually opaque in standard sections; colored in extremely thin sections.

TABLE III.—COLOR OF MINERALS

VII. BROWN MINERALS, NOT PLEOCHROIC AND ISOTROPIC—continued

N	Color	Mineral	Chem.	Clev.	Other Characters	Page
2.19	Reddish brown	<i>Zirkelite</i>	Ox.	None	G. = 4.72. Oct.	164
2.20	Red-brown	<i>Thorianite</i>	(Th, U)O ₂	?	G. = 9.3. Radioactive	50
2.215	Brown	<i>Polymignite</i>	Tit.	100 poor	G. = 4.8. Insol.	167
2.23 ±	Red-brown	<i>Eschynite</i>	Colum.	?	G. = 5 ±. Insol.	167
2.30	Brownish	<i>Knopite</i>	Tit.	?	G. = 4.2. Also biref.	163
2.33	Brown	<i>Dysandite</i> *	Tit.	100	G. = 4.13. Dec. HCl	163
2.38	Brown, gray, etc.	Perovskite	CaTiO ₃	100 poor	G. = 4. Also biref.	163
2.4 ±	Brown, reddish	Sphalerite	ZnS	110	G. = 4.1. Sol. HCl	19
Very high	Brown	<i>Blomstrandite</i> *	Tit.	?	G. = 4.2. H. = 5.5	167

VIII. BROWN MINERALS, NOT PLEOCHROIC, BUT ANISOTROPIC

N _o or N _m	Color	Mineral	Chem.	±	2V	Other Characters	Page
(a) Birefringence very weak to moderate: N _o - N _p < 0.0185							
1.65 ±	Brown, red	<i>Hellandite</i>	Sil.	+	80°	X = b. ZΛc = 44°	425
1.75 ±	Brown, yellow, etc.	<i>Grossularite</i>	Sil.	±	Var.	No cleav. G. = 3.5	180
1.78 ±	Green, brown	<i>Gadolinite</i>	Sil.	+	85°	No cleav. ZΛc = 10° ±	424
1.87 ±	Red, brown	<i>Andradite</i>	Sil.	±	Var.	No cleav. G. = 3.7	180
(b) Birefringence rather strong to strong: N _o - N _p > 0.0185 < 0.0365							
1.58 ±	Brown	<i>Canbyite</i>	Sil.	-	Sm.	ZΛc cleav.	415
1.65	Yellow-brown	<i>Ferri-symplectite</i>	Arsen.	?	?	Fibrous. G. = 2.89	126

1.733	Brown, yellow	<i>Hematolite</i>	Arsen.	—	0°	0001 cleav.	G.=3.4	153
1.780	Nut brown	<i>Caryinite</i>	Arsen.	+	41°	110, 010 cleav.	X=c	122
2.36±	Brown, yellow	<i>Wurizite</i>	ZnS	+	0°	1010 cleav.	G.=4±	20
(c) Birefringence very strong: $N_g - N_p > 0.0365 < 0.0545$								
1.87	Red-brown	<i>Synadelphite</i>	Arsen.	+	Sm.	X∧c=45°	Z=b	155
1.95±	Brown, etc.	Zircon	Ox.	+	0°	Tet. Prism.	G.=4.7	183
(d) Birefringence extreme: $N_g - N_p > 0.0545$								
1.88	Red-brown	<i>Hemafibrite</i>	Arsen.	+	35°	X⊥ 010 cleav.	Y=a	136
2.4±	Brown	<i>Sibiontantalite</i>	Tant.	+	75°	X⊥ 100 cleav.	Z=c	167
2.45	Brown	<i>Derbyite</i>	Tit.	+	0°	Twin.	G.=4.5	162
2.46	Red-brown	<i>Hausmannite</i> †	Ox.	—	0°	001 cleav.	G.=4.8	64

IX. BROWN MINERALS, PLEOCHROIC IN BROWN

N_o or N_m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
(a) Birefringence very weak to weak: $N_g - N_p < 0.0095$								
1.55±	Brown	Clear brown	<i>Cordierite</i> †	Sil.	—	60°±	Y=brown. Ps. Hex. twin.	307
1.64±	Brown	Brown	<i>Apatite</i> †	Phos.	—	0°	Hex. Prism. G.=3.2	129
1.80±	Red-brown	Brown	<i>Enigmatite</i>	Sil.	+	32°	Y=brown. Z∧c=45°±	428
2.40 Li	Red-brown	Colorless±	<i>Minium</i>	Pb ₃ O ₄	?	0°	Abn. int. colors	65
(b) Birefringence moderate to rather strong: $N_g - N_p > 0.0095 < 0.0275$								
1.58±	Colorless	Brown	<i>Vermiculite</i>	Sil.	—	Sm.	Y=Z. X⊥ 001 cl. G.=2.4	434
1.64	Colorless±	Brownish	<i>Bemelite</i>	Sil.	—	0°±	Y=Z. X⊥ 001 cleav.	409

* Usually opaque in standard sections; colored in extremely thin sections.

† Usually opaque in sections of standard thickness (0.2–0.3 mm.); colored in extremely thin flakes or on thin edges.

‡ Usually colorless in standard sections; may be colored in thicker sections.

TABLE III.—COLOR OF MINERALS

IX. BROWN MINERALS, PLEOCHROIC IN BROWN—continued

N_o or N_m	X	Z	Mineral	Chem.	$\pm$	$2V$	Other Characters	Page
(b) Birefringence moderate to rather strong: $N_g - N_p > 0.0095 < 0.0275$ —continued								
			HORNBLÉNDE					
1.67±	Clear brown	<i>Green</i>	<i>Triplite</i>	Sil.	—	80°	$Y = \text{brown}$. $Z \wedge c = 20^\circ \pm$	247
1.67±	Red-brown	<i>Red-brown</i>	<i>Dumortierite</i>	Phos.	+	Lg.	$Y = \text{colorless}$. $Z \wedge a = 42^\circ$	134
1.685	Gr.-brown	Colorless		Sil.	—	30°	$Y = Z$. $Z \perp 100$ cleav. $X = c$	422
1.69±	Brownish	Brown	<i>Barvikite</i>	Sil.	—	40°±	$Y = \text{red-brown}$. $Z \wedge c = 12^\circ$	254
1.7±	Brown	Red-brown	<i>Rhoenite</i>	Sil.	—	?	$Y = Z$. $Z \wedge c = 40^\circ$. 110 cl.	429
1.725	Yel.-brown	Colorless	<i>Ganophyllite</i>	Sil.	—	Sm.	$Y = Z$. 001 cleav. $Z = b$	436
1.788	Colorless	Red-brown	<i>Relzianite</i>	Arsen.	+	Lg.	$Y = \text{yel.-brown}$. $Z = a$	154
1.809	Yel.-brown	Brown	<i>Warwickite</i>	Bor.	+	59°	$Y = \text{red-brown}$. $X = c$	95
1.9±	Colorless	Brown	<i>Chekinite</i>	Sil.	±	Var.	$Y = \text{brown}$. No cl.	423
(c) Birefringence strong to very strong: $N_g - N_p > 0.0275 < 0.0545$								
1.535	Colorless	Brown	<i>Quedenite</i>	Sul.	+	34°	$Y = X$. 110 cleav. $G. = 2.12$	116
1.6±	Colorless	Brown	Fe-muscovite *	Sil.	—	Sm.	$Y = Z$. $X \perp 001$ cleav.	268
1.60±	Colorless	Brown	<i>Leverrierite</i>	Sil.	—	Sm.	$Y = \text{brown}$. $X \perp 001$ cleav.	433
1.62±	Red-brown	<i>Brown</i>	<i>Chondrodite</i>	Sil.	+	Lg.	$Y = X$. $X \wedge a = 28^\circ$. $Z = b$	196
1.7±	Red-brown: $X < Y < Z$		<i>Iddingsite</i>	Sil.	±	Var.	$X \perp 100$ cl. $Z \perp 001$ cl.	437
1.70±	Colorless	<i>Brownish</i>	<i>Grunerite</i>	Sil.	—	82°	$Y = X$. $Y = b$. $Z \wedge c = 12^\circ \pm$	242
1.73	Colorless	Brown	<i>Pyrochroite</i>	$Mn(OH)_2$	—	0°	001 cleav. $G. = 3.26$	42
1.74	Yel.-brown	Red-brown	<i>Melanovanadite</i>	Van.	—	Sm.	$Y = Z$. $X \perp 010$ cleav.	102
1.75+	<i>Red-brown</i>	Red-brown	<i>Fourmarierite</i>	Ox.	—	Lg.	$X \perp 100$ cleav. $Z = b$	103
1.77	Brown	<i>Yel.-brown</i>	Acmite	Sil.	—	60°	$Y = \text{brown}$. $X \wedge c = 5^\circ \pm$	234
1.79	Red-brown	Red-brown	<i>Monazite</i>	Phos.	+	12°	$Y = \text{red-brown}$	138
1.85±	<i>Yel.-brown</i>	Brown	<i>Högbomite</i>	Ox.	—	0°	No cleav. $G. = 3.81$	65

1.95	Red-brown	Opaque±	Manganostibite	Antim.	Sm.	155
2.36	Red-brown: X < Z		Langbanite	Ox.?	°	66
2.39	Red-brown: X < Y > Z		Pseudobrookite	Ox.?	50°	165
(d) Birefringence extreme: $N_g - N_p > 0.0545$						
1.571	Brown	Brown	Roemerite	Sul.	51°	117
1.637	Colorless	Gr.-brown	Ekmanite	Sil.	0°±	281
1.703	Red-brown	Yel.-brown	Astrophyllite	Sil.	75°	417
1.72	Yel. brown	Gray-brown	Xenotime	Phos.	0°	138
1.73±	Brown	Brown	OXYHORNBLÉNDE	Sil.	Lg.	252
1.898	Colorless±	Red-brown	Mazapilite	Arsen.	0°±	156
2.05	Red-brown: Y > X > Z		Pinakolite	Bor.	32°	94
2.17	Colorless	Red-brown	Melanokite	Sil.	67°	427
2.20	Red-brown: X < Y < Z		Kentrolite	Sil.	88°	427
2.2±	Yel. brown	Brown	Huebnerite	Tung.	Lg.	101
2.27	Brown	Opaque±	Tapiolite	Tant.	0°	164
2.3	Colorless	Red-brown	Cuprodesclizite	Van.	60°±	133
2.30	Yel.-brown	Opaque±	Hjelmite	Tant.	0°±	166
2.34	Red-brown: X > Z weak		Heterolite	Ox.	0°	65
2.36	Colorless±	Red-brown	Brackebuschite	Van.	Lg.	125
2.4±	Red-brown	Opaque±	Columbite †	Colum.	Lg.	165
2.56	Brown	Brown	Ocladrite	TiO ₂	0°	53
2.59	Cin. brown	Clove brown	Brookite	TiO ₂	Var.	59

X. MINERALS PLEOCHROIC IN BROWN AND RED

(a) Birefringence very weak to moderate: $N_g - N_p > 0.0185$

1.654	Colorless	Red-brown	Hureulite	Phos.	74°	124
1.70±	Red	Green	HYPERSTHENE	Sil.	70°±	219

* Usually colorless in standard sections; may be colored in thicker sections.

† Usually opaque in standard sections; may be colored in extremely thin portions.

TABLE III.—COLOR OF MINERALS

X. MINERALS PLEOCHROIC IN BROWN AND RED—continued

N_o or N_m	X	Z	Mineral	Chem.	$\pm$	$2V$	Other Characters	Page
(b) Birefringence rather strong to very strong: $N_g - N_p > 0.0185 < 0.0545$								
1.57±	Reddish	Brown	Zinnwaldite	Sil.	—	Sm.	Y=Z. X⊥oor cleav.	270
1.734	Rose	Yellow	<i>Adamite</i>	Arsen.	+	83°	Y=brown. X=a. Z=b	133
1.81	X or Z=rose		<i>Hancockite</i>	Sil.	—	50°	Y=yel.-brown. oor cl.	316
1.89±	Red-brown	Red	<i>Heterosite</i>	Phos.	—	Lg.	Y=carmine. X⊥oor cl.	141
(c) Birefringence extreme: $N_g - N_p > 0.0545$								
1.774	Flesh red	Brown	<i>Taramellite</i>	Sil.	+	40°	Y=X. Z || fib. G.=3.9	427
1.997	<i>Brown</i>	Red	Cassiterite	SnO ₂	+	0°	Tet. Prism. G.=7±	52
2.2	Red	Blood red	Huebnerite	Tung.	+	Lg.	X=brown. X⊥oor cl.	101

XI. RED MINERALS, NOT PLEOCHROIC AND ISOTROPIC

N	Color	Mineral	Chem.	Cleav.	Other Characters	Page
1.485	Yellow, pink	Sodalite	Sil.	110 poor	G.=2.3. Gel. HCl	289
1.49±	Blue, pink, etc.	Noselite	Sil.	110 poor	G.=2.3. Gel. HCl	290
1.50±	Blue, pink, etc.	Hauynite	Sil.	110 poor	G.=2.4. Gel. HCl	290
1.72±	<i>Red, brown</i>	Pyrope	Sil.	None	G.=3.6±. Insol.	178
1.73±	Red, blue, etc.	Spinel	MgAl ₂ O ₄	111 poor	G.=3.6. Oct.	62
1.737	Pink	<i>Danailite</i>	Sil.	111 poor	G.=3.43. Gel. HCl	291
1.74±	Pink	<i>Trilomite</i>	Sil.	Poor	G.=4.2. Dec. HCl	420
1.80±	Pink, etc.	Spessartite	Sil.	None	G.=4.2±. Insol.	178

N_0 or N_m	Color	Mineral	Chem.	$\pm$	2V	Other Characters	Page
1.82±	Red, brown	Almandine	Sil.		None	G. = 4.2±. Insol.	178
1.89±	Red, brown	Andradite	Sil.		None	G. = 3.75±. Insol.	180
2.13	Brown-red	<i>Ampungabéite</i> *	Colum.		?	Prism. G. = 4.2	166
2.15±	Red	<i>Koppite</i>	Tant.			Dodec. G. = 4.5	164
2.35 Li	Red	<i>Magnesioferrite</i>	MgFe ₂ O ₄		None	G. = 4.6. Oct.	61
2.38	Gray, brown, etc.	Perovskite	CaTiO ₃		100 poor	G. = 4. Also biref.	163
2.4±	Brown, red	Sphalerite	ZnS		110 perf.	G. = 4.1. Sol. HCl	19
2.69 Li	Red	<i>Hauerite</i>	MnS ₂		100 poor	G. = 3.46. Sol. HCl	24
2.72 Li	Bright red	Tetrahedrite	Cu, Sb, S		None	G. = 5±. Luster!	26
2.849	Cochineal red	Cuprite	Cu ₂ O		111 poor	G. = 6±. Sol. H ₂ SO ₄	40

XII. RED MINERALS, NOT PLEOCHROIC, BUT ANISOTROPIC

N_0 or N_m	Color	Mineral	Chem.	$\pm$	2V	Other Characters	Page
(a) Birefringence very weak to moderate: $N_g - N_p < 0.0185$							
1.65±	Brown, red	<i>Hellandite</i>	Sil.	+	80°	X = b; Z $\wedge$ c = 44°	425
1.794	Blood red	<i>Arsenophelite</i>	Arsen.	+	0°	101 cleav. Sol. HCl	153
1.89	Red, brown	Andradite	Sil.	±	Var.	No cleav. G. = 3.75	180
2.38	Gray, red, etc.	Perovskite	CaTiO ₃	+	90°±	X = c. Y = b. Poor cleav.	163
(b) Birefringence rather strong to very strong: $N_g - N_p > 0.0185 < 0.0545$							
1.508	(Violet±) Red	<i>Ussingite</i>	Sil.	+	39°	Z $\wedge$ 1001 = 33°±	439
1.8±	Red	<i>Glockertite</i>	Sul.	?	?	Fibrous	108
2.008	Red	Zincite	ZnO	+	0°	0001 cleav. G. = 5.6	41

* Usually opaque in sections of standard thickness (.02-.03 mm.); colored in extremely thin sections.

TABLE III.—COLOR OF MINERALS
XII. RED MINERALS, NOT PLEOCHROIC, BUT ANISOTROPIC—continued

N_o or N_m	Color	Mineral	Chem.	$\pm$	2V	Other Characters	Page
(c) Birefringence extreme: $N_g - N_p > 0.0545$							
1.683	<i>Pink</i>	<i>Koettigite</i>	Arsen.	+	77°	X ⊥ oro cl. $Z \wedge c = 37^\circ$	127
1.997	Red, brown, etc.	Cassiterite	SnO ₂	+	0°	Tet. Prism. $G = 7 \pm$	52
2.31	Red-purple	<i>Geikielite</i>	MgTiO ₃	—	0°	1011 cleav. $G = 3.9$	67
2.44	Yellow-red	<i>Pyrophanite</i>	MnTiO ₃	—	0°	021 cleav. $G = 4.5$	67
2.58	Vermilion	<i>Smilite</i>	AgAsS ₂	—	Mod.	100 cleav. $Y = b$	27
2.6±	Orange-red	<i>Hydrohematite</i>	Ox.	—	0°?	Fibrous. $G = 4.5-5$	45
2.6±	Brown-red	<i>Rutile *</i>	TiO ₂	+	0°	Tet. Prism. $G = 4.2$	50
2.65	Yellowish red	<i>Lithargite</i>	PbO	—	0°	Tet. 110 cleav. $G = 9.1$	41
> 2.72	Red	<i>Lorandite</i>	TlAsS ₂	+	Lg.	Z || 100 and 001 cl.	28
> 2.72	Red	<i>Miargyrite *</i>	AgSbS ₂	+	Mod.	Poor cleav. $G = 5.2$	27
2.91	Bright red	Cinnabar	HgS	+	0°	1010 cleav. $G = 8.2$	21
3.0±	Cherry red	<i>Polybasite</i>	Ag, Sb, S	—	22°	X = c. $Z = b$. $G = 6.1$	27
3.084	Red	<i>Pyroargyrite</i>	Ag ₃ SbS ₃	—	0°	1011 cleav. $G = 5.8$	27
3.176	Scarlet	<i>Hutchinsonite</i>	Tl, As, S	—	38°	X = b. Y ⊥ 100 cleav.	28
3.22	Blood red	HEMATITE *	Fe ₂ O ₃	—	0°	0001 part. $G = 5.2$	44

XIII. RED MINERALS, PLEOCHROIC IN RED

N_o or N_m	X	Z	Mineral	Chem.	$\pm$	2V	Other Characters	Page
(a) Birefringence very weak to weak: $N_g - N_p < 0.0095$								
1.58±	<i>Pink</i>	Colorless	Beryl †	Sil.	—	0°	Hex. Prism. Poor cleav.	212
1.59±	<i>Purple</i>	Red-purple	<i>Kaemmererite</i>	Sil.	—	Sm.	Y = Z. X ⊥ 001 cleav.	286

1.60±	Colorless	Pink	Delessite	Sil.	—	Sm.	Y=Z. X ⊥ 001 cleav.	282
1.621	Rose-red	Pink	<i>Gillespie</i>	Sil.	—	0°	0001 cleav. G.=3.33	401
1.72	Pink	Colorless	Vesuvianite	Sil.	—	0°	Tet. Poor 110 cleav.	207
1.77	Colorless±	Red	<i>Ruby</i>	Al ₂ O ₃	—	0°	0001 part. H.=9. G.=4	43
1.81±	Colorless±	Reddish	<i>Cerite</i> †	Sil.	+	25°	Y=? No cleav. G.=4.9	422

(b) Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$

1.565	Colorless	Yel.-red	<i>Pyroaurite</i>	Carb.	—	0°	0001 cleav. Sol. HCl	87
1.62	Br.-yellow	Violet pink	Topaz †	Sil.	+	60°±	Y=yel.-pink. Z ⊥ 001 cl.	198
1.64	Pink	Colorless	Andalusite †	Sil.	—	84°	Y=Z. X=c. Z=a. 110 cl.	201
1.65	Colorless	Pink	Mullite	Sil.	+	50°	Y=X. Y ⊥ 010 cl. Z=c	201
1.725	Rose-red	Colorless	<i>Roselite</i>	Arsen.	+	Mod.	X ⊥ 100 cleav.± G.=3.5	127
2.62	Blood-red: X<Z		<i>Arizonaite</i> *	Ox.	?	Mod.	G.=4.2. Dec. H ₂ SO ₄	68

(c) Birefringence rather strong to strong: $N_g - N_p > 0.0185 < 0.0365$

1.57±	Colorless	Pink	Lepidolite †	Sil.	—	30°	Y=Z. X ⊥ 001 cleav.	270
1.64	Red	Red	BIOTITE	Sil.	—	Sm.	Y=Z. X ⊥ 001 cleav.	272
1.73	Colorless	Pink	<i>Siregite</i>	Phos.	±	Sm.	Y=X. Z ⊥ 001 cleav.	140
1.735	Red	Red	<i>Sicklerite</i>	Phos.	—	Lg.	Y=red. Z ⊥ cleav.	158
1.775	Pink (|| cl.) to colorless		<i>Leucopheniche</i>	Sil.	—	74°	X ⊥ cleav. G.=3.85	412
2.16	Pink: X<Z		<i>Ballite</i> †	Arsen.	—	0°	Hex. needles. G.=5.5	119

(d) Birefringence very strong: $N_g - N_p > 0.0365 < 0.0545$

1.59±	Purple-red	Purple-red	<i>Alurgite</i>	Sil.	—	0°±	Y=br.-red. X ⊥ 001 cl.	†
1.723	Colorless	Yel.-red	<i>Pyrochroite</i>	Mn(OH) ₂	—	0°	0001 cleav. Sol. HCl	42
1.73	Pink	Colorless±	<i>Phosphosiderite</i> †	Phos.	—	62°	Y=carmine. Y ⊥ 010 cl.	142

* Usually opaque in sections of standard thickness (0.02-.03 mm.); colored in extremely thin flakes.

† Usually colorless in sections of standard thickness (0.02-.03 mm.); colored in thicker sections.

‡ S. L. Penfield: *Am. Jour. Sci.*, XLVI, 1893, p. 288.

TABLE III.—COLOR OF MINERALS

XIII. RED MINERALS, PLEOCHROIC IN RED—continued

N_o or N_m	X	Z	Mineral	Chem.	$\pm$	$2V$	Other Characters	Page
(d). Birefringence very strong: $N_g - N_p > 0.0365 < 0.0545$ —continued								
1.734	Carmine	Colorless $\pm$	<i>Adamite</i>	Arsen.	—	$90^\circ \pm$	$X = a$. $Y = c$. $G = 4.35$	133
1.75	Br.-red: $X < Y < Z$		Iddingsite	Sil.	$\pm$	Var.	$X \perp$ roo cl. $Z \perp$ oor cl.	437
1.786	<i>Pink</i> $\pm$	Red	<i>Beraunite</i>	Phos.	+	Mod.	$Y = X$. $X \wedge c = 89^\circ$. $Z = b$	144
1.9 $\pm$	Br.-gray	Red	<i>Purpurite</i>	Phos.	+	38°	$Y = Z$. $X \perp$ oor cl. $Z = b$	141
(e). Birefringence extreme: $N_g - N_p > 0.0545$								
1.898	Colorless $\pm$	Br.-red	<i>Mazapilite</i>	Arsen.	—	$0^\circ \pm$	$Y = Z$. Orth. Prism. $X = c$	156
2.25	Red	Red	<i>Manguntantalite</i>	Tant.	+	Lg.	$Y =$ blood red. $G = 5$	165
2.59	Orange-red	Vermilion	Realgar	AsS	—	40°	$Y = Z$. $X \wedge c = 11^\circ$. $Y = b$	22
2.6 $\pm$	Colorless $\pm$	Red	<i>Treichmannite</i>	AgAsS ₂	—	0°	$10\bar{1}1$, oor cleav.	27
2.6 $\pm$	Br.-red	Blood red	Rutile *	TiO ₂	+	0°	Tet. Prism. $G = 4.2$	50
> 2.72	Red: $X > Y > Z$		<i>Kermesite</i>	Sb ₂ S ₂ O	+	Sm.	100, 101 cleav. $G = 4.5$	28
> 2.72	Deep red	Opaque $\pm$	<i>Chalcofanite</i>	Ox.	—	0°	oor cleav. $G = 3.91$	66
3.0 $\pm$	Red: $X > Z$		Livingstonite	HgSb ₂ S ₇	—	?	Prism. cleav. $Z = c$	28
3.087	Red	Blood red	Proustite	Ag ₂ AsS ₃	—	0°	$10\bar{1}1$ cleav. $G = 5.6$	27
3.22	Yel.-red	Br.-red	HEMATITE *	Fe ₂ O ₃	—	0°	Hex. oor part. $G = 5.2$	44

XIV. MINERALS PLEOCHROIC IN RED AND BLUE

(a) Birefringence very weak to moderate: $N_g - N_p > 0.0185$

1.55 $\pm$	Reddish	Clear blue	<i>Cordierite</i> †	Sil.	—	$60^\circ \pm$	$Y =$ violet. Ps. Hex. twin.	307
1.665	Purple	Colorless	<i>Kunzite</i>	Sil.	+	69°	$Y =$ pink. $Z \wedge c = 25^\circ$	236
1.685	Blue	Colorless	Dumortierite	Sil.	—	$30^\circ \pm$	$Y =$ red. $Z \perp$ 100 cleav.	422
1.69	Red-gray	Gr. blue	<i>Kataphorite</i>	Sil.	—	$35^\circ \pm$	$Y =$ br.-red. $Z \wedge c = 45^\circ \pm$	254
1.70 $\pm$	Red	Blue	HYPERSTHENE	Sil.	—	$70^\circ \pm$	$Y =$ yellow. $X = a$. $Z = c$	219

(b) Birefringence rather strong to strong: $N_g - N_p > 0.0185 < 0.0365$

1.70±	Reddish	Violet	AUGITE (Ti)	Sil.	—	60°	Y=Z.	Y=b.	Z∧c=45°±
1.79±	Br.-red	Gr.-blue	Tephroite †	Sil.	—	65°	Y=red.	X⊥oro cleav.	194
1.87±	Br.-red	Violet	Heterosite	Phos.	—	Lg.	Y=carmine.	X⊥oor cl.	141
2.146	Violet red	Violet red	Rufellite	Hal.	?	?	Y=violet.	oor cleav.	39

(c) Birefringence very strong to extreme: $N_g - N_p > 0.0365$

1.663	Pinkish	Red	Erythrite	Arsen.	±	90°±	Y=violet.	X⊥oro cl.	127
1.734	Magenta	Rose	Adamite	Arsen.	±	83°	Y=purple.	X=a.	Z=b
1.75±	Greenish	Pink	EPIDOTE †	Sil.	—	70°±	Y=blue.	Z∧oor cl.=25°	314
1.75±	Yellow	Red	Piedmontite	Sil.	+	70°±	Y=blue.	Z∧oor cl.=32°	315

XV. MINERALS PLEOCHROIC IN BROWN AND BLUE

(a) Birefringence very weak to moderate: $N_g - N_p < 0.0185$

1.685	Brown	Yellow	Axinite †	Sil.	—	73°	Y=violet.	X⊥oor±	425
1.69±	Red-gray	Gr.-blue	Kataphorite	Sil.	—	35°±	Y=gr.-brown.	Z∧c=45°±	254
1.695	Blue	Brown	Riebeckite	Sil.	—	Lg.	Y=blue.	X∧c=3°±.	Z=b
1.72±	Brown	Blue	Sapphirine †	Sil.	—	69°	Y=Z.	Y=b.	Z∧c=10°±
1.73±	Br.-green±	Gr.-brown	Chloritoid	Sil.	+	50°±	Y=blue.	oor cleav.	438

(b) Birefringence very strong to extreme: $N_g - N_p > 0.0365$

1.60	Blue	Brownish	Vivianite	Phos.	+	Lg.	Y=colorless.	X⊥oro cl.	126
1.762	Gr.-blue	Yel.-brown	Dihydrite	Phos.	±	90°±	Y=yel.-green.	Z || fib.±	135

* Usually opaque in standard sections; colored in extremely thin portions.

† Usually colorless in sections of standard thickness (.02-.03 mm.); colored in thicker sections.

‡ Usually yellowish green to golden in thin section.

TABLE III.—COLOR OF MINERALS
XVI. BLUE MINERALS, NOT PLEOCHROIC AND ISOTROPIC

N	Color	Mineral	Chem.	Cleav.	Other Characters	Page
1.434	Blue, purple, etc.	Fluorite	CaF ₂	111 perf.	Colored in spots	31
1.435	Violet	<i>Yttrocrite</i>	Hal.	111 perf.	Colored in spots	36
1.485±	Yellow, blue, pink	Sodalite	Sil.	110 poor	G.=2.3. Gel. HCl	289
1.49±	Blue, yellow, etc.	Noselite	Sil.	110 poor	G.=2.3. Gel. HCl	290
1.50±	Blue	Lazurite	Sil.	110 poor	G.=2.4. Gel. HCl	290
1.54±	Blue-green, blue	<i>Cornuite</i>	Sil.	None	G.=2±. Opaline	413
1.73±	Red, blue, etc.	Spinel	MgAl ₂ O ₄	111 poor	H.=8. G.=3.6	62
1.81±	Green, blue, etc.	<i>Gahnite</i>	ZnAl ₂ O ₄	111 fair	G.=4.5. Oct.	63
2.05	Sky-blue	<i>Percyite</i>	Hal.	100	Sol. HNO ₃	37

XVII. BLUE MINERALS, NOT PLEOCHROIC BUT ANISOTROPIC

N ₀ or N _m	Color	Mineral	Chem.	±	2V	Other Characters	Page
(a) Birefringence very weak to very strong: N _g —N _p <0.0545							
1.434	Blue, purple, etc.	Fluorite *	CaF ₂	?	?	111 cleav. G.=3.2	31
1.73±	Gr.-blue	<i>Connellite</i>	Sul.	+	0°	Hex. Acic. G.=3.4	118
1.731	<i>Gr.-blue</i>	<i>Chalcomenite</i>	Sel.	—	Var.	Mon. Y=b. G.=3.76	118
2.03	Blue	<i>Pseudobolite</i>	Hal.	—	0°	001, 101 cleav. G.=4.9	37
2.06	Gr.-blue	<i>Bolite</i>	Hal.	—	0°	001, 101 cleav. G.=5	37
(b) Birefringence extreme: N _g —N _p >0.0545							
1.658	<i>Gr.-blue</i>	<i>Veselyite</i>	Phos.	+	71°	No cleav. G.=3.5	138
1.8±	Gr.-blue	<i>Cornelite</i>	Phos.	—	33°	X=a. Z=b. G.=4.1	132

XVIII. BLUE MINERALS PLEOCHROIC IN BLUE

N_o or N_m	X	Z	Mineral	Chem.	$\pm$	$2V$	Other Characters	Page
(a) Birefringence very weak to weak: $N_g - N_p < 0.0095$								
1.58	Blue	Bluish $\pm$	Beryl $\dagger$	Sil.	—	0°	Hex. Prism. $G = 2.75 \pm$	212
1.6 $\pm$	Colorless	Blue	<i>Aerinite</i>	Sil.	—	Sm.	$Y = Z$. $X \perp$ oor cleav.	285
1.634	Blue: $X > Z$ or $X < Z$		Apatite $\dagger$	Phos.	—	0°	Hex. Prism. $G = 3.2$	129
1.66 $\pm$	Colorless	Violet	<i>Crossite</i>	Sil.	—	Sm.	$Y = \text{blue}$. $X \wedge c = 70^\circ \pm$	259
1.71 $\pm$	Colorless	Blue	Vesuvianite $\dagger$	Sil.	—	0°	Tet. Poor 110 cleav.	207
1.72 $\pm$	Colorless	Blue	<i>Sapphirine</i>	Sil.	—	69°	$Y = Z$. $Y = b$. $Z \wedge c = 10^\circ \pm$	427
1.769	Bluish	Blue	<i>Sapphire</i>	Al_2O_3	—	0°	Hex. $H = 9$. $G = 4 \pm$	43
(b) Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$								
1.555	Colorless	Colorless	<i>Vauxite</i>	Phos.	+	Sm.	$Y = \text{blue}$. Tric. No cl.	157
1.665	Purple	Colorless	<i>Kunzite</i>	Sil.	+	69°	$Y = \text{amethystine}$. $Z \wedge c = 25^\circ$	236
1.685	Blue	Colorless $\pm$	Dumortierite	Sil.	—	30°	$Y = Z$. $X = c$. $Z \perp$ 100 cleav.	422
1.722	Colorless	Blue	<i>Kyanite</i>	Sil.	—	82°	$Y = \text{blue}$. 100, 010 cleav.	205
(c) Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$								
1.530	Blue	Colorless	<i>Minasragite</i>	Sul.	—	Lg.	$Y = \text{blue}$. $X \perp$ 010 cl.	110
1.542	Lilac	Lilac	<i>Slichtite</i>	Carb.	—	0°	oor cleav. $G = 2.16$	87
1.638	Colorless	Blue	Glaucophane	Sil.	—	Mod.	$Y = \text{violet}$. $Z \wedge c = 5^\circ \pm$	258
1.65 $\pm$	Colorless	Blue	<i>Tourmaline</i>	Sil.	—	0°	Max. abs. $\perp$ elong.	301
(d) Birefringence strong: $N_g - N_p > 0.0275 < 0.0365$								
1.56	Colorless	Violet	<i>Lepidolite</i> $\dagger$	Sil.	—	$50^\circ \pm$	$Y = Z$. $X \perp$ oor cleav.	270
1.632	Colorless	Blue	Lazulite	Phos.	—	69°	Inclusions common	154
1.73	Colorless $\pm$	Blue	<i>Srèngite</i>	Phos.	$\pm$	Sm.	$Y = \text{violet}$. $Z \perp$ oor cl.	140

* Usually isotropic.

 $\dagger$ Usually colorless in standard sections; colored in thicker sections.

TABLE III.—COLOR OF MINERALS

XVIII. BLUE MINERALS PLEOCHROIC IN BLUE—continued

N_g or N_m	X	Z	Mineral	Chem.	$\pm$	$2V$	Other Characters	Page
(c) Birefringence very strong: $N_g - N_p > 0.0365 < 0.0545$								
1.62	Colorless to blue		<i>Turquois</i>	Phos.	+	40°	Two cleav. $G = 2.84$	157
1.722	Colorless	Blue	Diaspore	AlO(OH)	+	84°	$Y = X$. $Y \perp$ o to cleav. $Z = a$	46
1.75	Colorless	Colorless	EPIDOTE *	Sil.	—	$70^\circ \pm$	$Y = blue$. $Z \wedge$ o to cl. $= 25^\circ$	314
1.757	Colorless	Blue	<i>Benitoite</i>	Sil.	+	0°	Rhom. Color varies	212
1.838	Blue	Prus. blue	<i>Linarite</i>	Sul.	—	80°	$Y = blue$. $X \wedge$ 100 cl. $= 24^\circ$	104
2.654	Blue	Blue	<i>Moissanite</i>	SiC	+	0°	H. $= 9.5$. $G = 3.2$	17
(1) Birefringence extreme: $N_g - N_p > 0.0545$								
1.617	Colorless	Blue	<i>Kyanotrichite</i>	Sul.	+	83°	$Y = blue$. $X = a$. $Z = c$	116
1.660	Colorless	Blue	<i>Planchéite</i>	Sil.	+	Mod.	$Y = X$. $X \perp$ cl. $Z \parallel$ fib.	411
1.748	Gr.-blue	Gr.-blue	<i>Freirinite</i>	Arsen.	—	0°	o to cleav. Sol. HCl	151
1.758	Clear blue	Blue	Azurite	Carb.	+	68°	$Y = b$. $Z \wedge c = -13^\circ$	82
1.782	Blue	Blue	<i>Shattuckite</i>	Sil.	+	Lg.	$Y = gr.-blue$. $Z \parallel$ fib. $\pm$	411
1.866	Blue: X and Z > Y	Blue	<i>Caledonite</i>	Sul.	—	85°	$X \perp$ 100 cl. $Z \perp$ o to cl.	120
2.04	Clear blue	Blue	<i>Cumengite</i>	Hal.	—	0°	101, 110 cleav. $G = 4.8$	37
2.55	Blue	Blue	<i>Octahedrite</i>	TiO ₂	—	0°	o to 1, 111 cleav. $G = 3.9$	53

XIX. MINERALS PLEOCHROIC IN BLUE AND GREEN

(a) Birefringence very weak or weak: $N_g - N_p < 0.0095$

1.585	Bluish	Green	<i>Metazeunerite</i>	Arsen.	—	0°	o to 1 cleav. $G = 3.28$	146
1.624	Blue	Green	<i>Metatorbernite</i>	Phos.	+	$0^\circ \pm$	o to 1 cleav. $G = 3.7$	145

1.69±	Blue	Green	Arfvedsonite	Sil.	—	Lg.	Y=blue. X∧c=Sm.	257
1.695±	Indigo	Green	Riebeckite	Sil.	—	Lg.	Y=blue. X∧c=3°±	257
1.703	Green	Blue	Serendibite	Sil.	+	90°±	Y=X. No cleav. G.=3.4	425
1.769	Green	Blue	Sapphire	Al ₂ O ₃	—	0°	oor part. H.=9. G.=4±	43
(b). Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$								
1.68±	Yellow±	Green±	Axinite	Sil.	—	75°	Y=blue. X∧oor±	425
1.73±	Olive green	Yellow±	Chloritoid	Sil.	+	Mod.	Y=blue. oor cleav.	438
(c) Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$								
1.63±	Gr.-yellow	Gr.-blue	Pargasite	Sil.	+	60°±	Y=green. Z∧c=25°±	248
1.655	Blue	Blue	Euclase †	Sil.	+	50°±	Y=yel.-green. Y∧oor cl.	432
1.665	Yellow	Blue	Sillimanite †	Sil.	+	27°±	Y=green. Y∧oor cleav.	200
1.67±	Yellow	Gr.-blue	HORNBLÉNDE	Sil.	—	80°±	Y=bl.-green. Z∧c=20°±	247
1.713	Green	Blue	Gerhardtite	Nit.	+	Lg.	Y=green. Z∧oor cl.	89
(d) Birefringence very strong: $N_g - N_p > 0.365 < 0.545$								
1.60±	Blue	Olive green	Vivianite	Phos.	+	Lg.	Y=colorless. X∧oor cl.	126
1.75±	Greenish	Pink	EPIDOTE *	Sil.	—	70°±	Y=blue. X∧oor cl.=25°	314
2.654	Olive green	Gr.-blue	Moissanite	SIC	+	0°	Poor oor cleav. H.=9.5	17
(e) Birefringence extreme: $N_g - N_p > 0.545$								
1.642	Green	Gr.-blue	Serpierite	Sul.	—	35°	Y=Z. X∧oor cleav.	102
1.668	Blue	Yel.-green	Symplectite	Arsen.	—	87°	Y=yellow. X∧oor cl.	126
1.745	Bluish	Bluish	Libehenite	Phos.	—	83°	Y=yel.-green. X=b. Z=a	132
1.762	Gr.-blue	Yel.-brown	Dithyrite	Phos.	±	90°±	Y=yel.-green. Z=b±	135

* Usually yellowish green to golden in thin section.

† Usually colorless in standard sections; colored in thicker sections.

TABLE III.—COLOR OF MINERALS
 XX. GREEN MINERALS, NOT PLEOCHROIC AND ISOTROPIC

N	Color	Mineral	Chem.	Cleav.	Other Characters	Page
1.434	Red, green, etc.	Fluorite *	CaF ₂	111 perf.	G. = 3.18. Cubic	31
1.50±	Blue, green, etc.	Hauynite	Sil.	110 poor	G. = 2.4. Gel. HCl	290
1.54±	Green, blue, etc.	Cornuile	Sil.	None	G. = 2±. Sol. HCl	413
1.585	Green	<i>Volchonskoite</i>	Sil.	None	G. = 2.3. Gel. HCl	416
1.59±	Emerald green	<i>Zaratite</i>	Carb.	None	G. = 2.6. Sol. HCl	85
1.59	Bright green	<i>Garnierite</i>	Sil.	None	Fibrous. Dec. HCl	261
1.60±	Oil-green	<i>Voltaite</i>	Sul.	?	G. = 2.79. Sol. H ₂ O	115
1.65	Green, brown, etc.	<i>Greenalite</i> †	Sil.	None	G. = 2.8+. Sol. HCl	413
1.725	<i>Green</i>	<i>Roselandite</i>	Sil.	None	G. = 4.5. Gel. HCl	420
1.758	<i>Green</i>	<i>Yttrialite</i>	Sil.	None	G. = 4.58. Sol. HCl	414
1.77±	Green	<i>Ceylonite</i>	MgAl ₂ O ₄	111 poor	G. = 3.6. Oct.	62
1.77±	Grass-green	<i>Chlorospinel</i>	MgAl ₂ O ₄	111 poor	G. = 3.6. Oct.	62
1.8±	Green, blue, etc.	<i>Gahnite</i>	ZnAl ₂ O ₄	111 fair	G. 4.5. Oct.	63
1.87±	Green	<i>Uvarovite</i>	Sil.	None	G. = 3.7±. Insol.	263
1.9±	Green	<i>Hercynite</i>	FeAl ₂ O ₄	?	G. = 3.9. Insol.	62
2.16 Li	Emerald green	<i>Manganosile</i>	MnO	100	G. = 5.18. Oct.	41
2.23	Green, brown	<i>Bunsenite</i>	NiO	?	G. = 6.4. Oct.	41

XXI. GREEN MINERALS, NOT PLEOCHROIC, BUT ANISOTROPIC

N _o or N _m	Color	Mineral	Chem.	±	2V	Other Characters	Page
(a) Birefringence very weak to weak: $N_g - N_p < 0.0095$							
1.483	<i>Blue-green</i>	<i>Zn-Cu-melanterite</i>	Sul.	+	Lg.	Y ∧ fib. = Lg. Z = b	106
1.556	<i>Blue-green</i>	<i>Miloschite</i>	Sil.	-	90° ±	oot cleav. G. = 2.1	416
1.69	<i>Green</i>	<i>Pharmacosiderite</i>	Phos.	-	Sm.	Cubic. G. = 3	143

(b) Birefringence rather strong to very strong: $N_g - N_p > 0.0185 < 0.0545$

1.59	Yellow-green	<i>Connarite</i>	Sil.	—	$0^{\circ} \pm$	$X \perp \text{oor cl.}$	$G = 2.5$	280
1.686	<i>Blue-green</i>	<i>Trichalcite</i>	Arsen.	—	Lg.	$X \perp \text{plates.}$	Sol. HCl	124
1.698	Bluish green	<i>Euchroite</i>	Arsen.	+	29°	$X = b.$	$Z \parallel \text{prism.}$	136
1.77	<i>Green</i>	<i>Conicalchalcite</i>	Arsen.	—	25°	$X = c.$	$Z \parallel a = \text{fib.}$	136
1.774	Yellow-green	<i>Barthite</i>	Arsen.	+	Mod.	No cleav.	$G = 4.19$	160
2.01	<i>Green</i>	<i>Volborhlite</i>	Van.	$\pm$	Var.	$Bx. \perp \text{cleav.}$	$G = 3.5$	137
2.05	Dull green	<i>Fernandinite</i>	Van.	?	?	Fibrous.	Sol. HCl	148
2.15	Green	<i>Cuprolungstite</i>	Tung.	?	?	One cleav.	$G = 3.95$	105

(c) Birefringence extreme: $N_g - N_p > 0.0545$

1.652	Greenish	<i>Liroconite</i>	Arsen.	—	67°	$X = b.$	$Z \wedge c = -25^\circ$	157
1.70	Green	<i>Ancylite</i>	Carb.	—	66°	No cleav.	$G = 3.95$	87
1.745	Green	<i>Libelhenite</i>	Phos.	—	83°	$X = b.$	$Z = a.$	132
1.745	Green	<i>Mixite</i>	Arsen.	+	Sm.	$Z \parallel \text{fib.}$	$G = 3.8$	156
1.90	Bluish green	<i>Trippkeite</i>	Arsen.	+	0°	100 cleav.	Sol. HCl	159

XXII. GREEN MINERALS PLEOCHROIC IN GREEN

N_o or N_m	X	Z	Mineral	Chem.	$\pm$	2V	Other Characters	Page
(a) Birefringence very weak: $N_g - N_p < 0.0035$								
1.57 $\pm$	Colorless	Green	Penninite	Sil.	—	Sm.	$Y = Z.$	281
1.59 $\pm$	Green	Colorless	Penninite	Sil.	+	Sm.	$Y = X.$	281
1.60 $\pm$	Colorless	Green	Delessite	Sil.	—	Sm.	$Y = Z.$	282
1.62 $\pm$	Colorless	Green	Diabantite	Sil.	—	Sm.	$Y = Z.$	283

* Usually colorless or purple in standard sections; may be colored red or green in thicker sections.

† Often opaque in standard sections; colored in extremely thin portions.

TABLE III.—COLOR OF MINERALS

VII. GREEN MINERALS PLEOCHROIC IN GREEN—continued

N_o or N_m	X	Z	Mineral	Chem.	$\pm$	$2V$	Other Characters	Page
(a) Birefringence very weak: $N_g - N_p < 0.0035$ —continued								
1.62±	Green	Colorless±	Ripidolite	Sil.	+	Sm.	Y=X. Z⊥oor cl. G.=2.9±	284
1.64±	Colorless±	Green	Aphrosiderite	Sil.	—	Sm.	Y=Z. X⊥oor cl. G.=2.96	284
1.66±	Colorless±	Green	Daphnite	Sil.	—	Sm.	Y=Z. X⊥oor cl. G.=3.0	285
(b). Birefringence weak: $N_g - N_p > 0.0035 < 0.0095$								
1.58±	Green	Yel.-green	Beryl *	Sil.	—	0°	Hex. Prism. G.=2.75±	212
1.58±	Green	Colorless±	Clinocllore	Sil.	+	Sm.	Y=X. Z⊥oor cl. G.=2.7±	283
1.60±	Green	Colorless±	Prochlorite	Sil.	+	Sm.	Y=X. Z⊥oor cl. G.=3.07	284
1.66±	Colorless±	Green	Thuringite	Sil.	—	Sm.	Y=Z. X⊥oor cl. G.=3.07	285
1.69±	Bl.-green	Br.-green	Arvedsonite	Sil.	—	Lg.	Y=X. X∧c=Sm. Z=b	257
2.33	Gray-green: X<Z		Dysandite †	Tit.	+	90°±	Y=? Y=c. Z=b. G.=4.1	163
(c) Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$								
Chrysotile								
1.55±	Colorless	Green	Corundophillite	Sil.	+	30°	Y=X. Z||fib. G.=2.5	260
1.59±	Bl.-green	Br.-green	Chrysocolia	Sil.	+	Sm.	Y=X. Z⊥oor cl.± G.=2.9±	283
1.6±	Green	Colorless	Celadonite	Sil.	±	Sm.	Fibrous. G.=2.4±	411
1.63±	Yel.-green	Green	Chamosite	Sil.	—	Sm.	Y=Z. X⊥oor cleav.	436
1.64±	Colorless±	Green	Dickinsonite	Sil.	+	Sm.	Y=b. Y⊥oor cleav.±	286
1.66±	Olive green: X>Y>Z		Hiddenite	Phos.	—	Mod.	X=b. Y⊥oor cleav.±	122
1.671	Green	Colorless	Dumortierite	Sil.	+	56°	Y=greenish. Z∧c=27°	236
1.69±	Green	Colorless	Pumpellyite	Sil.	—	30°	Y=X. Z⊥100 cleav.	422
1.700	Colorless	Colorless		Sil.	+	Lg.	Y=green. X⊥oor cl.	432

1.701	Yel.-green	Colorless	<i>Tinzenite</i>	Sil.	—	63°	Y = greenish. X ⊥ 100 cl. ±	428
1.73 ±	Greenish	Green	Clinzoisite	Sil.	+	85° ±	Y = X. Z ∧ oor cl. = 20° ±	312
1.74 ±	Green	Green	Hedenbergite	Sil.	+	60°	Y = yel.-green. Z ∧ c = 48°	224
1.78	Olive green	Green	<i>Gadolinite</i>	Sil.	+	85°	Y = Z. Y = b. X ∧ c = 10° ±	424
1.84	Yel.-green: X < Z	Yel.-green: X < Z	<i>Dusserite</i>	Arsen.	—	0°	Hex. Lam. G. = 3.75. Sol. HCl	153

(d) Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$

1.594	Colorless	Green	<i>Astroile</i>	Sil.	—	30°	Y = Z. X ⊥ cleav. G. = 2.8	429
1.61 ±	Yel.-green	Olive green	<i>Nontronite</i>	Sil.	—	Var.	Y = X. X ⊥ oor cleav.	415
1.63 ±	Yel.-green: X < Y = Z	Yel.-green: X < Y = Z	Glauconite †	Sil.	—	Sm.	X ⊥ oor cleav. G. = 2.5 ±	436
1.643	Green: X < Z	Green: X < Z	<i>Zinnerite</i>	Arsen.	—	0° ±	X ⊥ oor cleav. G. = 3.2	146
1.646	Colorless	Green	Tourmaline	Sil.	—	0°	Max. abs. ⊥ elong.	301
1.67 ±	Yel.-green	Green	HORNBLENDE	Sil.	—	80° ±	Y = olive. X ∧ c = 20° ±	247
1.67 ±	Green	Opaque ±	<i>Sirigone</i>	Sil.	—	Sm.	Y = Z. X ⊥ oor cleav.	437
1.68 ±	Colorless	Gray-green	<i>Sincosite</i>	Phos.	—	0°	X ⊥ oor cleav. G. = 2.8	147
1.786	Sea green	Yel.-green	<i>actue</i>	Arsen.	—	Sm.	Y = Z. X ∧ c = 50°. G. = 3.8	155

(e) Birefringence strong: $N_g - N_p > 0.0275 < 0.0365$

1.558	Colorless	Green	<i>Metavariscite</i>	Phos.	+	55°	Y = Z. X = a (elong.). Y = b	141
1.62 ±	Green	Yel.-green	<i>Nepouite</i>	Sil.	—	Sm.	Y = Z. X ⊥ oor cleav.	279
1.726	Grass green	Grass green	<i>Tyrolite</i>	Arsen.	—	36°	Y = yel.-green. X ⊥ oor cl.	161
1.77 ±	Colorless	Bl.-green	<i>Conicalcite</i>	Arsen.	±	25°	Y = greenish. Z || fib.	136
1.78 ±	Colorless	Green	<i>Allanite</i>	Sil.	—	Lg.	Y = ? G. = 4.1. Gel. HCl	316
1.78 ±	Colorless	Green	<i>Scordite †</i>	Arsen.	+	62°	Y = ? X = b. Z = c. G. = 3.2	139

(f) Birefringence very strong: $N_g - N_p > 0.0365 < 0.0545$

1.595	Colorless	Bl.-green	<i>Fuchsite</i>	Sil.	—	40° ±	Y = yel.-green. X ⊥ oor cl.	269
1.636	Bl.-green	Green	<i>Grandierite</i>	Sil.	—	30°	Y = colorless. X ⊥ 100 cl.	421

* Usually colorless in standard sections; colored in thicker sections.

† Usually opaque in standard sections; may be colored in extremely thin portions.

‡ Pleochroic colors transposed on page 138.

TABLE III.—COLOR OF MINERALS
XXII. GREEN MINERALS PLEOCHROIC IN GREEN—continued

N_g or N_m	X	Z	Mineral	Chem.	$\pm$	2V	Other Characters	Page
(f) Birefringence very strong: $N_g - N_p > 0.0365 < 0.0545$ —continued								
	<i>Green: X > Z</i>		<i>Diopase*</i>	Sil.	+	0°	1011 cleav. Gel. HCl	186
1.657	Bl. green	Green	<i>Spangolite</i>	Sul.	—	0°	0001 cleav. G. = 3.14	119
1.694	Colorless	<i>Greenish</i>	<i>Grunerite</i>	Sil.	—	80°	Y = X. Y = b. Z $\wedge$ c = 12° $\pm$	242
1.697	Green	Opaque $\pm$	<i>Cronstedtite</i>	Sil.	—	Sm.	Y = Z. X $\perp$ 001 cleav.	285
1.80 $\pm$	Green	Bl.-green	<i>Higginsite</i>	Arsen.	—	90° $\pm$	Y = yel.-green. X = a. Y = b	132
1.831	<i>Green</i>	Grass green	<i>Atacamite</i>	Hal.	—	75°	Y = yel.-green. X $\perp$ 010 cl.	38
(g) Birefringence extreme: $N_g - N_p > 0.0565$								
1.618	<i>Green</i>	Bl.-green	<i>Chalcophyllite</i>	Arsen.	—	0°	0001 cleav. G. = 2.5	136
1.649	<i>Green</i>	Bl.-green	<i>Herrngundite</i>	Sul.	—	39°	Y = green. X $\perp$ 001 cl. $\pm$	104
1.67 $\pm$	Colorless	<i>Green</i>	<i>Ekmannite</i>	Sil.	—	Sm.	Y = Z. X $\perp$ 001 cl. G. = 2.79	281
1.737	<i>Yel.-green</i>	Green	<i>Anderite</i>	Sul.	—	35°	Y = Z. X $\perp$ 010 cl. G. = 3.9	102
1.74 $\pm$	Colorless $\pm$	<i>Green</i>	<i>Aurichalcite</i>	Carb.	—	Sm.	Y = Z. Y $\perp$ 100 cleav. $\pm$	84
1.745	<i>Green</i>	<i>Green</i>	<i>Libethenite</i>	Phos.	—	83°	Y = green. X = b. Y = c	132
1.760	Bl.-green	Bl.-green	<i>Langite</i>	Sul.	—	81°	Y = yel.-green. X $\perp$ 001 cl.	102
1.778	<i>Green: X and Y < Z</i>		<i>Brochantite</i>	Sul.	—	72°	X $\perp$ 010 cleav. Z = c	102
1.840	Colorless	<i>Green</i>	<i>Chalcociderite</i>	Phos.	—	24°	Y = ? X $\perp$ 010 cleav. $\pm$	157
1.87	<i>Bl.-green</i>	Benzol green	<i>Clinodasite</i>	Arsen.	—	53°	Y = bl.-green. X $\perp$ 001 cl. $\pm$	135
1.875	Colorless $\pm$	Green	<i>Malachite</i>	Carb.	—	43°	Y = yel.-green. X $\wedge$ c = 23°	85
2.2 $\pm$	<i>Yel.-green</i>	Grass-green	<i>Huebnerite</i>	Tung.	+	Lg.	Y = green. X $\perp$ 010 cl.	101
XXIII. MINERALS PLEOCHROIC IN GREEN AND YELLOW								
(a) Birefringence very weak to weak: $N_g - N_p < 0.0095$								
1.57 $\pm$	<i>Yellow</i>	<i>Green</i>	<i>Antigorite</i>	Sil.	—	Sm.	Y = Z. X $\perp$ 001 cl. G. = 2.6 $\pm$	280
1.60 $\pm$	<i>Yellow</i>	Green	<i>Delessite</i>	Sil.	—	Sm.	Y = Z. X $\perp$ 001 cl. G. = 2.8 $\pm$	282
1.60 $\pm$	Green	<i>Gr.-yellow</i>	<i>Prochlorite</i>	Sil.	+	Sm.	Y = X. Z $\perp$ 001 cl. G. = 2.85	284

1.655	Yel.-green	Gr.-yellow	Uranochalcite	Sul.	+	Sm.	Y=X. Z || fib. Sol. HCl	117
1.66±	Yellow	Green	Daphnite	Sil.	-	Sm.	Y=Z. X ⊥ ool cl. G.=3.0	381
1.695	Blue	Green	Riebeckite	Sil.	-	Lg.	Y=gr.-yellow. X ∧ c=3°	257
1.72±	Green	Gr.-yellow	Vesuvianite *	Sil.	-	o°	Tet. G.=3.4. Contacts	207
(b) Birefringence moderate: $N_g - N_p > 0.0095 < 0.0185$								
1.545	Gr.-yellow	Green	Chrysotile *	Sil.	+	30°	Y=Z. Z || fib. G.=2.4	260
1.592	Green	Gr.-yellow	Torbernite	Phos.	-	o°±	X ⊥ ool cleav. G.=3.2	145
1.64±	Yellow	Gr.-yellow	Andalusite *	Sil.	-	84°	Y=green. X || 110 cleav.	201
1.660	Orange	Green	Brandisite	Sil.	-	57°	Y=Z. X ⊥ ool cl. G.=3.1	286
1.675	Red.-yellow	Green	Kornerupine *	Sil.	-	20°	Y=yellow. X || 110 cl.	421
1.681	Yellow	Greenish	Prismatine *	Sil.	-	30°	Y=br.-yellow. X=c	421
1.685	Yellow	Green	Aznite	Sil.	-	75°	Y=blue. X ⊥ 011±	425
1.70±	Red.-yellow	Green	HYPERSTHENE	Sil.	-	70°±	Y=yellow. X=a. Z=c	219
1.72±	Olive green	Yellow	Chloritoid	Sil.	+	50°±	Y=blue. ool cleav.	438
2.061	Yellow	Green	Pyromorphite	Phos.	-	o°	Hex. Prism. G.=7.0	131
(c) Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$								
1.547	Bl.-green	Yellow±	Voglite	Carb.	+	60°	Y=X. X nearly ⊥ scales	88
1.6±	Gr.-yellow	Green	Bowlingite	Sil.	-	Sm.	Y=Z. X ⊥ ool cleav.±	437
1.62±	Yellow	Green	Natronite	Sil.	-	Var.	Y=olive. X ⊥ ool cl.	415
1.63±	Gr.-yellow	Gr.-blue	Pargasite	Sil.	+	60°	Y=green. X ∧ c=25°±	248
1.63±	Yellow	Green	Actinolite	Sil.	-	80°	Y=gr.-yellow. Z ∧ c=15°±	245
1.63±	Yellow	Green	Glauconite †	Sil.	-	Sm.	Y=Z. X ⊥ ool cleav.	436
1.66±	Yellow	Blue	Sillimanite *	Sil.	+	30°	Y=green. Y ⊥ 010 cl.	200
1.67±	Yellow	Blue, green	HORNBLende	Sil.	-	80°	Y=green, yellow. 110 cl.	247
1.680	Colorless±	Green	Sincsite	Phos.	-	o°±	X ⊥ ool cleav. G.=2.8	147
1.725	Bl.-green	Br.-yellow	Homilite *	Sil.	+	80°	Y=br.-gray. Y=c±	424
1.786	Sea green	Yellow	Allacite	Arsen	-	Sm.	Y=Z. X ∧ c=50°±. G.=3.8	155

* Usually colorless in standard sections; colored in thicker sections.

† Usually opaque in standard sections; may be colored in extremely thin portions.

TABLE III.—COLOR OF MINERALS
 XXIII. MINERALS PLEOCHROIC IN GREEN AND YELLOW—continued

N_g or N_m	X	Z	Mineral	Chem.	$\pm$	$2V$	Other Characters	Page
(d) Birefringence strong: $N_g - N_p > 0.0375 < 0.0365$								
1.619	Br.-yellow	Yel.-green	Chondrodite	Sil.	+	Lg.	$Y = Z$, $X \wedge a = 28^\circ \pm$	196
1.670	Br.-yellow	Yel.-green	Clinohumite	Sil.	+	76°	$Y = Z$, $X \wedge a = 10^\circ \pm$	197
1.671	Yellow	Yellow	<i>Manganodulsite</i>	Sil.	+	71°	$Y = \text{green}$, 110° cleav. $X = a$	202
1.69 $\pm$	Green	Yellow	Aegirinaugite	Sil.	+	65°	$Y = \text{gr.-yellow}$, $Z \wedge c = 70^\circ \pm$	232
1.77 $\pm$	Yellowish	Bl.-green	<i>Conichalcite</i>	Arsen.	-?	25°	$Y = \text{greenish}$, $Z \parallel \text{fib.}$	136
1.78 $\pm$	Yellow	Green	Scorodite	Arsen.	+	62°	$Y = ?$ $X = b$, $Y = a$, $G = 3.2$	139
1.85	Gr.-yellow	Pink	<i>Törebomite</i>	Sil.	+	26°	$Y = \text{bl.-green}$, $G = 4.9$	414
1.9 $\pm$	Br.-yellow	Green	Ilvaite	Sil.	-	Sm.	$Y = \text{brown}$, $Z = c$	431
(e) Birefringence very strong: $N_g - N_p > 0.0365 < 0.0345$								
1.63 $\pm$	Yellow	Green	BIOTITE	Sil.	-	$0^\circ \pm$	$Y = Z$, $X \perp \text{oor cleav.}$	272
1.687	Yellow	Green	Tourmaline	Sil.	-	0°	Max. abs. $\perp$ elong.	301
1.70 $\pm$	Yellow	Blue, green	HORNBLLENDE	Sil.	-	80°	$Y = \text{green, yellow}$, 110° cl.	247
1.75 $\pm$	Yellow	Yel.-green	EPIDOTE	Sil.	-	$70^\circ \pm$	$Y = \text{golden}$, $Z \wedge \text{oor cl.} = 25^\circ$	314
1.793	Green	Yellow	<i>Thornite</i>	Sil.	-	66°	$Y = Z$, $X \wedge c = +5^\circ$, $G = 3.5$	211
1.80	Green	Yellow	Acmite	Sil.	-	60°	$Y = \text{yel.-green}$, 110° cl.	234
1.845	Yellow	Green	<i>Kraurite</i>	Phos.	+	Sm.	$Y = Z$, $X = a$, $Y = c$	142
(f) Birefringence extreme: $N_g - N_p > 0.0345$								
1.54 $\pm$	Yel.-green	Yellow	<i>Copiapite</i>	Sul.	+	$60^\circ \pm$	$Y = \text{yellow}$, $X \perp \text{oor cl.}$	108
1.561	Yel.-green	Yellow	Humboldtite	Oxal.	+	Lg.	$Y = \text{gr. yellow}$, $X = a$, $Z = c$	88
1.569	Yellow	Br.-green	<i>Griffithite</i>	Sil.	-	Sm.	$Y = \text{olive}$, $X \perp \text{oor cl.}$	434
1.668	Bl.-green	Yellowish	<i>Symplectite</i>	Arsen.	-	87°	$Y = \text{colorless}$, $X \perp \text{oor cl.}$	126
1.69 $\pm$	Yellowish	Br.-green	<i>Stilpnomelane</i>	Sil.	-	Sm.	$Y = Z$, $X \perp \text{oor cleav.}$	435

1.745	Yellow	Yellow	Libellulite	Phos.	83°	Y = yel.-green. X = b. Y = c	132
1.810	Greenish	Yellow	Olivinite	Arsen.	82°	Y = X. X = a. Y = c	132
1.840	Golden	Green	Dufrenite	Phos.	90° ±	Y = br.-yellow. Z ⊥ oio cl.	142

XXXIV. MINERALS PLEOCHROIC IN GREEN AND BROWN

(a) Birefringence very weak to moderate: $N_g - N_p < 0.0185$

1.55 ±	Green	Clear brown	Cordierite *	Sil.	60° ±	Y = green. Ps. Hex. twin.	307
1.60 ±	Yel.-green	Brownish	Prochlorite	Sil.	Sm.	Y = X. Z ⊥ ooi cleav. G = 2.8	284
1.66 ±	Red-brown	Green	Xanthophyllite	Sil.	Sm.	Y = Z. X ⊥ ooi cl. G = 3.1	286
1.69 ±	Green	Gr.-brown	Arfvedsonite	Sil.	Lg.	Y = yel.-brown. X ∧ c = Sm.	257
1.70 ±	Red	Green	HYPERSTHENE	Sil.	70° ±	Y = yel.-brown. X = a. Z = c	219
1.73 ±	Br.-green	Gr.-brown	Chloritoid	Sil.	Mod.	Y = blue. ooi cleav.	438

(b) Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$

1.625	Olive green	Brown	Roscherite	Phos.	Lg.	Y = yel.-brown. Y ∧ c = 15°	156
1.64 ±	Brown	Green	Anthophyllite *	Sil.	Lg.	Y = X. X = a. Z = c. 110 cl.	240
1.67 ±	Brownish	Green	HORNBLende	Sil.	80° ±	Y = brown, green. 110 cl.	247
1.68 ±	Greenish	Greenish	Diallage *	Sil.	60°	Y = brownish. 100 part.	228
1.70 ±	Greenish	Greenish	AUGITE *	Sil.	60°	Y = brownish. Z ∧ c = 45° ±	228

(c). Birefringence strong: $N_g - N_p > 0.0275 < 0.0365$

1.66 ±	Brownish	Green	Tourmaline	Sil.	0°	Max. abs. ⊥ elong.	301
1.70 ±	Green	Brownish	Aegirinaugite	Sil.	65° ±	Y = X. Z ∧ c = 70° ±. 110 cl.	232
1.726	Green	Brown	Babingtonite	Sil.	60°	Y = brown. 110 cl.	428
1.80 ±	Red-brown	Olive green	Cronstedtite	Sil.	0° ±	Y = Z. X ⊥ ooi cleav.	285
1.89 ±	Brown	Green	Ilvaite	Sil.	Sm.	Y = brown. Z ⊥ ooi cleav.	431

* Often colorless in standard sections: colored in thicker sections.

TABLE III.—COLOR OF MINERALS
 XXIV. MINERALS PLEOCHROIC IN GREEN AND BROWN—continued

N_0 or N_m	X	Z	Mineral	Chem.	$\pm$	$2V$	Other Characters	Page
(d) Birefringence very strong: $N_g - N_p > 0.0365 < 0.0345$								
1.70±	Colorless	Greenish	Grunerite *	Sil.	—	82°	$Y = brown$. $Z \wedge c = 12^\circ \pm$	242
1.75±	Green	Green, yellow	EPIDOTE †	Sil.	—	70°±	$Y = brown$. $Z \wedge ool\ cl. = 25^\circ$	314
1.77±	Brown	Br.-green	Acmite	Sil.	—	66°	$Y = Z$. $X \wedge c = 5^\circ$. $Y = b$	234
1.801	Yel.-green	Or.-brown	Finkite	Arsen.	+	Lg.	$Y = X$. No cleav. $Y = c$. $Z = a$	154
(e) Birefringence extreme: $N_g - N_p > 0.0345$								
1.625	Brown	Green	Bisbeeite *	Sil.	+	Sm.	$Y = X$. $X \perp laths$	411
1.685	Olive green	Gr.-brown	Roscoelite	Sil.	—	Sm.	$Y = X$. $X \perp ool$ cleav.	270
1.762	Gr.-blue	Yel.-brown	Diktyrite	Phos.	±	90°±	$Y = yel.-green$. $X \wedge c = 22^\circ$	135
1.84	Red-brown	Green	Dufrenite	Phos.	±	90°±	$Y = yellow$. $Z \perp ool\ cl.$	142
1.85±	Green	Red-brown	Ludwigite	Bor.	+	Sm.	$Y = X$. $Z \parallel fib$. $G = 4$	94
2.19	Red-brown	Red-brown	Baddeleyite *	ZrO ₂	—	30°	$Y = oil\ green$. $X \wedge c = 12^\circ$	60
2.22	Green	Brown	Vauquelinite	Chrom.	—	0°±	$Y = Z$. No cleav. $X \parallel fib$.	121
2.50	Brown	Green	Struversite	Tit.	—?	0°	Tet. Prism. $G = 5.56$	164
?	(a=) Yel.-brown	Green	Chlorosulphite	Hal.	—	?	$X \perp ool$ cleav.±. $G = 6.8$	39
XXV. MINERALS PLEOCHROIC IN GREEN AND RED								
(a) Birefringence very weak to rather strong: $N_g - N_p < 0.0275$								
1.64±	Red	Olive green	Andalusite *	Sil.	—	85°	$Y = green$. $X = c$. $Z = a$. $110\ cl.$	201
1.70±	Red	Green	HYPERSTHENE *	Sil.	—	75°±	$Y = brown$. $X = a$. $Z = c$	219
1.71±	Yel.-green	Greenish	Pigeonite *	Sil.	+	Sm.	$Y = pink$. $Z \wedge c = 35^\circ \pm$	222
1.725	Green	Smoky	Hornblende *	Sil.	+	80°	$Y = red$. $Y \wedge c = -1^\circ$. $X = b$	424
1.73±	Green	Red	Clinzoisite *	Sil.	+	80°±	$Y = pink$. $Z \wedge ool\ cl. = 20^\circ \pm$	312
(b) Birefringence strong to very strong: $N_g - N_p > 0.0275 < 0.0345$								
1.57±	Yellow	Br.-red	Phlogopite *	Sil.	—	Sm.	$Y = br.-green$. $X \perp ool\ cl.$	272

1.58±	Green	Br.-red	<i>Cryptophyllite</i>	Sil.	—	Sm.	Y=Z. X⊥oor cleav.	271
1.726	Bl.-green	Green	Babingtonite	Sil.	+	62°	Y=clarel. 110 cleav.	428
1.75±	Greenish	Pink	EPIDOTE	Sil.	—	70°±	Y=yellow. Z∧oor cl.=25°±	314
1.78±	Pink	Green	Scorodite	Arsen.	+	62°	Y=? X=b. Z=c. G.=3.2	139
1.85±	Pink	Pink	<i>Törnebohmit</i>	Sil.	+	26°	Y=bl.-green. G.=4.9	414
(c) Birefringence extreme: $N_g - N_p > 0.0545$								
1.997	Red	Green	Cassiterite *	SnO ₂	+	0°	Tet. Prism. G.=7±	52
1.997	Yel.-green	Reddish	Cassiterite *	SnO ₂	+	0°	Tet. Prism. G.=7±	52
2.61	Red	Green	Rutile †	TiO ₂	+	0°	Tet. Prism. G.=4.2	50
XXVI. GRAY MINERALS								
(a) Birefringence very weak or weak: $N_g - N_p < 0.0095$								
1.64±	Gray, etc.: X<Z (or X>Z)		Apatite *	Phos.	—	0°	Hex. Prism. G.=3.2	129
1.72±	Br.-gray	Yel.-green	Vesuvianite *	Sil.	±	0°	Tet. Poor cl. G.=3.4	207
2.38	Gray	Gray	Perovskite	CaTiO ₃	+	90°±	Cubic. Poor cleav. G.=4	163
(b) Birefringence moderate or rather strong: $N_g - N_p > 0.0095 < 0.0275$								
1.725	Bl.-green	Smoky gray	<i>Hornblende *</i>	Sil.	+	80°	Y=brownish gray. Y∧c=1°	424
2.38	Gray	Gray	Perovskite	CaTiO ₃	+	90°±	Cubic. Poor cleav. G.=4	163
(c) Birefringence strong or very strong: $N_g - N_p > 0.0275 < 0.0545$								
1.57±	Yellowish	Br.-gray	Zinnwaldite	Sil.	—	Sm.	Y=Z. X⊥oor cleav.	270
1.86±	Br.-gray	Purple	<i>Purpurite</i>	Phos.	+	38°	Y=scarlet. X=c. Z=b	141
1.95±		Gray: X<Z	Zircon *	ZrSiO ₄	+	0°	Tet. Prism. G.=4.7	183
(d) Birefringence extreme: $N_g - N_p > 0.0545$								
1.87±	Colorless	Ash gray	Siderite	FeCO ₃	—	0°	1011 cleav. G.=3.89	76
1.95±		Gray: X<Z	Zircon *	ZrSiO ₄	+	0°	Tet. Prism. G.=4.7	183

* Often colorless in standard sections; colored in thicker sections.

† Usually pleochroic in golden yellow in standard sections; may be colored as above in thicker sections.

‡ Often opaque in standard sections; colored in extremely thin portions.

SUPPLEMENTARY TABLE III.—COLOR OF MINERALS

I. MINERALS PLEOCHROIC IN YELLOW AND BLUE

N_0 or N_m	X	Z	Mineral	Chem.	$\pm$	$2V$	Other Characters	Page
1.692	Yellow	Blue	(d) Birefringence strong to extreme: $N_0 - N_p > 0.0275$ <i>Bandyite</i>	Bor.	—	0°	$X \perp \text{oor cl.}$	*
III. YELLOW MINERALS, NOT PLEOCHROIC, BUT ANISOTROPIC								
(c) Birefringence extreme: $N_0 - N_p > 0.0545$								
2.07	Yellow		<i>Curite</i>	Uran.	?	?	G. = 7.19	103
IV. YELLOW MINERALS, PLEOCHROIC IN YELLOW (INCLUDING ORANGE TO COLORLESS)								
(c) Birefringence rather strong. $N_0 - N_p > 0.0185 < 0.0275$								
1.736	Colorless	Yellow	<i>Renardite</i>	Phos.	—	70°	Y = yellow. X = a	148
1.89	Yellow	?	<i>Dumontite</i>	Phos.	+	Lg.	Y = dark yellow	148
(d) Birefringence strong. $N_0 - N_p > 0.0275 < 0.0365$								
1.686	Colorless	Yellow	β - <i>Uranotile</i>	Sil.	—	65°	Y = deep yellow. $Z \wedge c = 41^\circ$	**
(e) Birefringence very strong: $N_0 - N_p > 0.0365 < 0.0545$								
1.542	Yellow	Gr.-yellow	<i>Dakeite</i>	Sul.	—	5°	oor cl.	***
(f) Birefringence extreme: $N_0 - N_p > 0.0545$								
1.575	Colorless	Br.-yellow	<i>Melastodonatrite</i>	Sul.	+	60°	Y = yellow. Z = c	*4
1.630	Yellow	Gr.-yellow	<i>Guildite</i>	Sul.	+	Sm.	oor and 100 cl.	117
1.690	Colorless	Yellow	<i>Krasite</i>	Sul.	+	Lg.	$X \wedge c = 35^\circ$	115
1.663	Yellow	Br.-yellow	<i>Parabulterite</i>	Sul.	+	87°	Y = gr.-yellow. G. = 2.55	*4
1.674	Br.-yellow	Canary-yellow	<i>Bulterite</i>	Sul.	—	Lg.	oor cl.	108

1.600	?	Yellow	<i>Legrandite</i>	Phos.	+	27°	Y = colorless	137
1.732	Red-yellow	Gr.-yellow	<i>Lopezite</i>	Chrom.	+	50°	Y = yellow. oio cl.	*5
2.098	Light to dark orange		<i>Clarkite</i>	Uran.	-	40° ±	G. = 6.4	111

V. MINERALS PLEOCHROIC IN YELLOW AND BROWN

(a) Birefringence very weak to moderate. $N_g - N_p < 0.0185$

1.728	Brown	Yellow	<i>Landesite</i>	Phos.	-	Lg.	Y = brown. X = c	156
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(c) Birefringence strong to very strong. $N_g - N_p > 0.0275 < 0.0545$

1.78 ±	Yellow	Red-brown	<i>Taosite</i>	Ox.	-	o°	Assoc. with spinel	*6
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(d) Birefringence extreme: $N_g - N_p > 0.0545$

1.643	Yellow	Gr.-brown	<i>Hohmanite</i>	Sul.	-	40°	oio cl. Y = gr. yellow	*7
1.718	Yellow	Red-brown	<i>Madahmanite</i>	Sul.	+	70°	Y = red-yellow	*7
1.905	Yellow	Brown	<i>Argentojarosite</i>	Sul.	-	o°	oioi cl.	114

VI. MINERALS PLEOCHROIC IN YELLOW AND RED

(e) Birefringence extreme: $N_g - N_p > 0.0545$

1.643	?	Br.-red	<i>Castanite</i>	Sul.	-	Mod.	Y = yellow. X Λ c = 22° in oio	110
1.725	Red	Red	<i>Bermanite</i>	Phos.	-	74°	Y = yellow. X = c	*8

* C. Palache and W. F. Foshag: *Am. Mineral.*, XXIII, 1938, p. 85.** R. Nováček: *Mineral. Abst.*, VI, 1935, p. 149.*** E. S. Larsen and F. A. Gonyer: *Am. Mineral.*, XXII, 1937, p. 561.*4 M. C. Bandy: *Am. Mineral.*, XXIII, 1938, p. 714.*5 M. C. Bandy: *Am. Mineral.*, XXII, 1937, p. 929.*6 J. de Lapparent: *Comp. Rend.*, CCI, 1935, p. 154.*7 M. C. Bandy: *Am. Mineral.*, XXIII, 1938, p. 714.*8 C. S. Hurlbut: *Am. Mineral.*, XXI, 1936, p. 656.

SUPPLEMENTARY TABLE III.—COLOR OF MINERALS

VIII. BROWN MINERALS, NOT PLEOCHROIC, BUT ANISOTROPIC

N _o or N _m	X	Z	Mineral	Chem.	±	2V	Other Characters	Page
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(b) Birefringence rather strong to strong. $N_g - N_p > 0.0185 < 0.0365$

1.749		Brown	<i>Allodelphite</i>	Arsen.	—	0°±	G. = 3.57	440
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IX. BROWN MINERALS PLEOCHROIC IN BROWN

(c) Birefringence strong to very strong: $N_g - N_p > 0.0275 < 0.0545$

1.864	<i>Brown</i>	Red-brown	<i>Plumbosynadelphite</i>	Arsen.	+	40°	Y = brown	*
1.930	Brown, weakly pleochroic		<i>Fersmanite</i>	Tit.	—	3°±	Y = b. G. = 3.44	168

X. MINERALS PLEOCHROIC IN BROWN AND RED

(c) Birefringence extreme: $N_g - N_p > 0.0545$

1.765	Pink	Brown	<i>Murmanite</i>	Sil.	—	64°	Y = clear brown. G. = 2.84	**
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XVII. BLUE MINERALS, NOT PLEOCHROIC BUT ANISOTROPIC

(a) Birefringence very weak to very strong: $N_g - N_p < 0.0545$

1.512		Pale blue	<i>Mg-Chalcantinite</i>	Sul.	—	55°	G. = 1.72	***
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XVIII. BLUE MINERALS, PLEOCHROIC IN BLUE

(c) Birefringence rather strong: $N_g - N_p > 0.0185 < 0.0275$

1.735	Lavender	Lavender	<i>Hodgkinsonite</i>	Sil.	—	Mod.	Y = colorless	412
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(f) Birefringence extreme: $N_g - N_p > 0.0545$

1.90	Colorless	Violet	<i>Ianthinite</i>	Oxal.	—	Sm.	Y = violet. X ⊥ 100 cl.	60
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XIX. MINERALS PLEOCHROIC IN BLUE AND GREEN

(c) Birefringence rather strong. $N_g - N_p > 0.0185 < 0.0275$

1.636	Grass green	Sky blue	<i>Mitscherlichite</i>	Hal.	—	0°	G. = 2.42	34
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(e) Birefringence extreme: $N_g - N_p > 0.0545$

1.685	Green	Blue	<i>Antofagastite</i>	Hal.	+	75°	Y = olive green. 110, 001 cl.	*4
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XXI. GREEN MINERALS, NOT PLEOCHROIC BUT ANISOTROPIC

2.002	Green	Green	<i>Lindgrenite</i>	Molyb.	—	71°	Z ⊥ 001 cl. G. = 4.26	*5
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XXII. GREEN MINERALS, PLEOCHROIC IN GREEN

(b) Birefringence weak. $N_g - N_p > 0.0035 < 0.0095$

1.622	Bluish green	Bluish green	<i>Garnierite</i>	Sil.	+	0° ±	Fibrous	*6
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(e) Birefringence strong: $N_g - N_p > 0.0275 < 0.0365$

1.78 ±	Green to colorless	Green to colorless	<i>Vandenbergite</i>	Uran.	?	?	Abn. int. colors	*7
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XXIII. MINERALS PLEOCHROIC IN GREEN AND YELLOW

(a) Birefringence very weak to weak: $N_g - N_p < 0.0095$

1.71 ±	Olive green	Green	<i>Taenmawite</i>	Sil.	—	50°	Y = yellow to brown	*8
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* C. S. Hurlbut: *Am. Mineral.*, XXII, 1937, p. 526.** A. E. Fersman: *Mineral. Abst.*, II, p. 263; also V, 1933, p. 198.*** J. J. Glass in Charles Milton and W. D. Johnston: *Econ. Geol.*, XXXIII, 1938, p. 761.*4 C. Palache and W. F. Foshag: *Am. Mineral.*, XXIII, 1938, p. 85.*5 C. Palache: *Am. Mineral.*, XX, 1935, p. 484.*6 K. Spangenberg: *Zent. Mineral.*, 1938, A, p. 360.*7 A. Schoep: *N. Jahrb. Mineral.*, 1933, I, p. 250.*8 P. Eskola: *C. R. Soc. Géol. Finlande*, 7, 1933, p. 26.

TABLE IV.—REFRINGENCE OF MINERALS

THE refringence of minerals in thin section can be estimated or measured by the methods described in Part I of this work on pages 76-79 and 83-85. Accordingly, the following table can be used to good advantage in the study of thin sections in some cases. It is still more useful in the study of powdered minerals, since the refringence of such material can be measured much more accurately by the immersion methods described on pages 79-82, 228-239, and 244-253.

The table of refringence of minerals is divided into two parts, namely, one part including the isotropic minerals, and a second part including the anisotropic minerals. In each part the minerals are arranged in the order of increasing refringence as determined by N , the single index of refraction of the isotropic minerals, and by N_o or N_m for the anisotropic minerals. In the second part of the table (dealing with anisotropic minerals) the indices of refraction are arranged in the first column with indices of positive minerals at the extreme left side and indices of negative minerals indented two spaces to the right. The indices of a few minerals of variable or uncertain sign are in an intermediate position, indented one space to the right.

Many minerals vary more or less in chemical composition and therefore in their physical properties, including their refringence. Such variations are shown by entering each mineral in its proper place as determined by the lowest known value for the refringence (N , N_o or N_m), and entering it again for the highest known value, and connecting these two entries by a vertical line (to the right of the column of indices of refraction) expressing the entire range of variation. Furthermore, when the range of variation of any mineral carries it beyond one page, the mineral is repeated with its minimum index at the head of the next page, so that all minerals having an index within a certain range are listed on any page.

In the second part of the table devoted to anisotropic minerals, the second and third columns give the greatest and least indices of refraction of each mineral, or, if they are unknown, the birefringence ($N_o - N_p$) of the mineral. The fifth column gives the chemical

formula of each mineral when that formula is very short; in other cases it gives the chemical nature of the mineral usually by naming the class of chemical salts to which it belongs, such as carbonate, halide, or silicate. The sixth column gives the crystallographic direction of the cleavage of each mineral and expresses the optic orientation as related to that cleavage; in case the mineral has no cleavage its optic orientation is expressed in relation to its crystal axes. The seventh column gives such other characters as seem most important in each case. The last column gives the page in Part II of this work where a more complete description may be found.

For methods of estimating or measuring the birefringence, see Part I, pages 119-123 and 136-138.

For a discussion of cleavage, see Part I, pages 29-32.

For methods of determining pleochroic formulas, see Part I, pages 170, 171, 204, and 211.

For definitions of X, Y and Z, see Part I, pages 117 and 160.

For methods of distinguishing between X, Y and Z, see Part I, pages 124, 130, and 211.

For methods of determining the optic sign, see Part I, pages 129-135, 138, 148-152, 169, and 206-213.

For methods of estimating or measuring the optic axial angle, see Part I, pages 186-189, 210, 226-227, and 239-244.

For methods of determining the optic orientation of a mineral, see Part I, pages 170, 171, 205, and 212.

For methods of measuring extinction angles, see Part I, pages 126, 137, 173, 174, and 178.

For a list of abbreviations used in the table, see page xiii.

TABLE IV A.—REFRACTANCE OF ISOTROPIC MINERALS

N	Mineral	Chem.	Cleav.	Other Characters	Page
1.339	↑ <i>Hieratite</i>	K_2SiF_6	111	G.=2.75. Also hex.	36
1.3395	↑ <i>Cryolithionite</i>	Hal.	110	G.=2.78. Oct.	34
1.39	↓ <i>Hieratite</i>	K_2SiF_6	111	G.=2.75. Also hex.	36
1.403	<i>Termierite</i>	Sil.	None	Clay-like. Also biref.	115
1.406	↑ <i>Opal</i>	Ox.	None	G.=2.1. Sol. HF	57
1.427	↑ <i>Ralstonite</i>	Hal.	None	G.=2.61. Also biref.	36
1.434	↑ <i>Fluorite</i>	CaF_2	111	White or tinted	31
1.435	↑ <i>Yttrocerite</i>	Hal.	111	G.=3.5. Violet	36
1.439	↑ <i>Sodalumite</i>	Sul.	?	G.=1.69. Also biref.	113
1.44-5	↑ <i>Yttrfluorite</i>	Hal.	111	Yellow or green	35
1.45	↑ <i>Hisingerite</i>	Sil.	None	Data vary. Brown	415
1.45	↑ <i>Melanophlogite</i>	Ox.	None	Cubic. Yellow±	54
1.453	↑ <i>Potassalumite</i>	Sul.	None	G.=1.76. Also biref.	113
1.454	↑ <i>Sulfohalite</i>	Sul.	None	G.=2.49. Dodec.	118
1.458	↑ <i>Lechatelierite</i>	SiO_2	None	G.=2.19. Sol. HF	57
1.458	↑ <i>Tschermigite</i>	Sul.	None	G.=1.64. Sol. H_2O	113
1.46	↑ <i>Opal</i>	Ox.	None	G.=2.1. Sol. HF	57
1.461	↑ <i>Melanophlogite</i>	Ox.	None	Cubic. Yellow±	54
1.47	↑ <i>Hisingerite</i>	Sil.	None	Data vary. Brown	415
1.47	↑ <i>Allophane</i>	Sil.	None	G.=1.87. Sol. HCl	415
1.47	↑ <i>Halloysite</i>	Sil.	None	G.=2.1. Data vary	415
1.47±	↑ <i>Neotocite</i>	Sil.	None	G.=2.7. Brown	413
1.479	↑ <i>Analcite</i>	Sil.	None	G.=2.25. Also biref.	293
1.48	↑ <i>Faujasite</i>	Sil.	111	G.=1.92. Also biref.	382
1.48	↑ <i>Noselite</i>	Sil.	None	White or tinted	290
1.483	↑ <i>Sodalite</i>	Sil.	None	White or tinted	289
1.485	↑ <i>Evansite</i>	Phos.	None	G.=1.94. Concretions	145
1.486	↑ <i>Metacristobalite</i>	SiO_2	?	G.=2.27. Metastable	54
1.487	↑ <i>Sodalite</i>	Sil.	None	White or tinted	289
1.487	↑ <i>Hackmanite</i>	Sil.	None	Color fades	290
1.489	↑ <i>Analcite</i>	Sil.	None	G.=2.25. Also biref.	293
1.49	↑ <i>Allophane</i>	Sil.	None	G.=1.87. Sol. HCl	415
1.49	↑ <i>Vashegyite</i>	Phos.	None	G.=1.96. Sol. HCl	144
1.49	↑ <i>Succinite</i>	$C_{12}H_{20}O$	None	G.=1.07. Yellow	89
1.49	↑ <i>Sylvite</i>	KCl	100	G.=1.98. Cubes	30
1.495	↑ <i>Noselite</i>	Sil.	None	White or tinted	290
1.496	↑ <i>Hauynite</i>	Sil.	None	Blue, green, etc.	290
1.5	↑ <i>Rosièresite</i>	Phos.	None	G.=2.2. Yellow *	145
1.50±	↑ <i>Lazurite</i>	Sil.	None	G.=2.4±. Blue	290
1.50	↑ <i>Stevensite</i>	Sil.	None	Like talc	419
1.50±	↑ <i>Montmorillonite</i>	Sil.	None	G.=2±. Sol. HF	434
1.504	↑ <i>Vashegyite</i>	Phos.	None	G.=1.96. Sol. HCl	144
1.508	↑ LEUCITE	Sil.	None	G.=2.47. Also biref.	291
1.508	↑ <i>Tycheite</i>	Carb.	None	G.=2.46. Sol. HCl	118
1.51	↑ <i>Hauynite</i>	Sil.	None	Blue, green, etc.	290

TABLE IV A.—REFRACTANCE OF ISOTROPIC MINERALS—continued

N	Mineral	Chem.	Cleav.	Other Characters	Page
1.47	Halloysite	Sil.	None	G.=2.1. Data vary	415
1.49	<i>Succinite</i>	C ₁₂ H ₂₀ O	None	G.=1.07. Yellow	89
1.50	<i>Montmorillonite</i>	Sil.	None	G.=2±. Sol. HF	434
1.514	<i>Northupite</i>	Carb.	None	G.=2.38. Also biref.	85
1.517	<i>β-Sepiolite</i>	Sil.	None	White or yellow	410
1.517	<i>Planerite</i>	Phos.	None	G.=2.65. Green	145
1.52	<i>Kehoeite</i>	Phos.	None	G.=2.34. Chalky	158
1.525	<i>Pollucite</i>	Sil.	None	G.=2.9. Sol. HCl	293
1.525	<i>Cornuile</i>	Sil.	None	Green, blue, brown	413
1.53	<i>Spudaite</i>	Sil.	None	Red in mass	413
1.53	Allanite	Sil.	?	Alteration product	316
1.53	<i>Neotocite</i>	Sil.	None	G.=2.7. Brown	413
1.535	<i>Langbeinite</i>	Sul.	None	G.=2.83. Hygros.	110
1.538	<i>Indianaite</i>	Sil.	None	G.=2.3-2.5	415
1.54	<i>Kehoeite</i>	Phos.	None	G.=2.34. Chalky	158
1.543	<i>Succinite</i>	C ₁₂ H ₂₀ O	None	G.=1.07. Yellow	89
1.544	Halite	NaCl	100	G.=2.17. Sol. H ₂ O	29
1.55	<i>Montmorillonite</i>	Sil.	None	G.=2±. Sol. HF	434
1.55	<i>Cornuile</i>	Sil.	None	Green, blue, brown	413
1.555	<i>Collyrite</i>	Sil.	None	G.=2±. Sol. HF	435
1.56	<i>Neotocite</i>	Sil.	None	G.=2.7. Brown	413
1.56	<i>Zaraitite</i>	Carb.	None	Green. Also biref.	85
1.56±	Bauxite	Ox.	None	G.=2.55. Sol. KOH	49
1.569	Collophane	Phos.	None	Also biref. In sediments	161
1.57	Halloysite	Sil.	None	G.=2.1. Data vary	415
1.57	<i>Borickite</i>	Phos.	None	G.=2.7. Brown	157
1.584	<i>Schroetterite</i>	Sil.	None	White, green, brown	415
1.589	<i>Zunyite</i>	Sil.	111	G.=2.87. Sol. HF	414
1.59±	<i>Hisingerite</i>	Sil.	None	G.=3. Brown	415
1.59	<i>Garnierite</i>	Sil.	None	Green. Sol. HCl	261
1.59	<i>Kochite</i>	Sil.	?	G.=2.93	414
1.60±	<i>Stibiconite</i>	Ox.	None	G.=5.2. Also biref.	68
1.602	<i>Zunyite</i>	Sil.	111	G.=2.87. Sol. HF	414
1.602	<i>Voltaite</i>	Sul.	None	G.=2.79. Oil-green	115
1.61	<i>Zaraitite</i>	Carb.	None	Green. Also biref.	85
1.61	Bauxite	Ox.	None	G.=2.55. Sol. KOH	49
1.61±	<i>Gummite</i>	Ox.	None	G.=4±. Sol. HCl	68
1.618	<i>Diadochite</i>	Sul.	None	White or yellow	121
1.625	Collophane	Phos.	None	Also biref. In sediments	161
1.63	<i>Griphite</i>	Phos.	None	G.=3.4. Brown	155
1.635±	<i>Pitticite</i>	Sul.	None	Brown to white	121
1.64	<i>Picite</i>	Phos.	None	G.=2.83. Yellow	145
1.64±	<i>Lagonite</i>	Bor.	None	Yellow. Rare	94
1.640	<i>Homilite</i>	Sil.	Poor	Also biref. with N _m =1.72±	424
1.642	<i>Salammoniac</i>	NH ₄ Cl	111	G.=1.53. Sol. H ₂ O	30

TABLE IV A.—REFRACTANCE OF ISOTROPIC MINERALS—continued

N	Mineral	Chem.	Cleav.	Other Characters	Page
1.53	Allanite	Sil.	?	Alteration product	316
1.57	<i>Borickite</i>	Phos.	None	G.=2.7. Brown	157
1.60	<i>Stibiconite</i>	Ox.	None	G.=5.2. Also biref.	68
1.618	<i>Diadochite</i>	Sul.	None	White or yellow	121
1.63	<i>Griphite</i>	Phos.	None	G.=3.4. Brown	155
1.65	<i>Griphite</i>	Phos.	None	G.=3.4. Brown	155
1.652±	<i>Greenalite</i>	Sil.	None	G.=2.8+. Green, brown	413
1.67	<i>Borickite</i>	Phos.	None	G.=2.7. Brown	157
1.67	<i>Hibschite</i>	Sil.	None	G.=3.05. Sol. HCl	429
1.675	<i>Plazolite</i> ¹	Sil.	None	G.=3.13. Dodec.	183
1.676	<i>Pharmacosiderite</i>	Phos.	100	G.=3.0. Green, yellow	143
1.68	<i>Thorite</i>	ThSiO ₄	110	G.=5.3±. Yellow	185
1.69	<i>Rhodizite</i>	Bor.	111	Biref. very weak	94
1.70	Allanite	Sil.	?	Alteration product	316
1.70	<i>Diadochite</i>	Sul.	None	White or yellow	121
1.70	<i>Polycrase</i>	Colum.	None	G.=5. Brown	167
1.70	Pyralspite	Sil.	None	Red±. Dodec.	178
1.705	Pyrope	Sil.	None	Red±. Dodec.	178
1.72	<i>Thorite</i>	ThSiO ₄	110	G.=5.3±. Yellow	185
1.72	<i>Delvauxite</i>	Phos.	None	G.=1.9±. Brown	145
1.723	Spinel	MgAl ₂ O ₄	111	Red, blue, yellow, etc.	62
1.725	<i>Rowlandite</i>	Sil.	None	G.=4.5. Green	420
1.727	<i>Berzelite</i>	Arsen.	None	G.=4. Yellow	122
1.73	<i>Tritomite</i>	Sil.	Poor	G.=4.2. Brown	420
1.73	Ugrandite	Sil.	None	Green, yellow, red	180
1.735	Grossularite	Sil.	None	White to brown	180
1.736±	<i>Periclase</i>	MgO	100	G.=3.65. Sol. HCl	41
1.737	<i>Danalite</i>	Sil.	111	G.=3.43. Pink±	291
1.739	<i>Helvite</i>	Sil.	111	G.=3.2. Yellow±	291
1.74	<i>Pilbarite</i>	Ox.	None?	G.=4.6. Yellow	185
1.74	<i>Caryocerite</i>	Sil.	None	G.=4.29. Brown	420
1.755	<i>Arsenolite</i>	As ₂ O ₃	?	G.=3.71. Oct.	43
1.758	<i>Yttrialite</i>	Sil.	?	G.=4.58. Green	414
1.76	<i>Tritomite</i>	Sil.	Poor	G.=4.2. Brown	420
1.77	Pyrope	Sil.	None	Red±. Dodec.	178
1.77	<i>Mackintoshite</i>	Ox.	?	G.=5.44. Cloudy	185
1.77	<i>Melanocerite</i>	Sil.	None	Reddish brown	420
1.77	Almandite	Sil.	None	Red±. Dodec.	178
1.77	<i>Hercynite</i>	FeAl ₂ O ₄	None?	G.=3.9. Green	62
1.78±	<i>Gadolinite</i>	Sil.	None	G.=4±. Green	424
1.79	<i>Gahnite</i>	ZnAl ₂ O ₄	111	G.=4.5. Green	63
1.79	Spessartite	Sil.	None	G.=4±. Red±	178
1.80	Spinel	MgAl ₂ O ₄	111	G.=3.6. Red, blue, etc.	62
1.8±	<i>Manganspinel</i>	MnAl ₂ O ₄	None	G.=4.05. Brown	62
1.81	<i>Gahnite</i>	ZnAl ₂ O ₄	111	G.=4.5. Green	63

1. N as corrected in *Am. Mineral.*, IX, 1924, p. 94.

TABLE IV A.—REFRACTANCE OF ISOTROPIC MINERALS—continued

N	Mineral	Chem.	Cleav.	Other Characters	Page
1.60	<i>Stibiconite</i>	Ox.	None	G.=5.2. Also biref.	68
1.70	<i>Pyralspite</i>	Sil.	None	Red±. Dodec.	178
1.73	<i>Ugrandite</i>	Sil.	None	Green, yellow, red	180
1.735	<i>Grossularite</i>	Sil.	None	White to brown	180
1.77	<i>Almandite</i>	Sil.	None	Red±. Dodec.	178
1.77	<i>Hercynite</i>	FeAl ₂ O ₄	None?	G.=3.9. Green	62
1.79	<i>Spessartite</i>	Sil.	None	G.=4±. Red±	178
1.81	<i>Grossularite</i>	Sil.	None	White to brown	180
1.81	<i>Spessartite</i>	Sil.	None	G.=4±. Red	178
1.812	<i>Beckelite</i>	Sil.	100	Yellow. Also biref.	420
1.818	<i>Naegite</i>	Ox.	?	Green or brown	65
1.82	<i>Andradite</i>	Sil.	None	Yellow to red	180
1.82	<i>Malacon</i>	Ox.	None	G.=4-4.3. Also biref.	184
1.82	<i>Roméite</i>	Antim.	111	Yellow. Also biref.	159
1.83	<i>Pyralspite</i>	Sil.	None	Red±. Dodec.	178
1.83	<i>Almandite</i>	Sil.	Poor	Red±. Dodec.	178
1.83	<i>Uvarovite</i>	Sil.	None	Green. Dodec.	180
1.84	<i>Bindheimite</i>	Antim.	111	Yellow. Also biref.	160
1.86	<i>Schorlomite</i>	Sil.	None	Has TiO ₂ . Brown	183
1.87	<i>Uvarovite</i>	Sil.	None	Green. Dodec.	180
1.87	<i>Bindheimite</i>	Antim.	111	Yellow. Also biref.	160
1.87	<i>Stibiconite</i>	Ox.	None	G.=5.2. Also biref.	68
1.87	<i>Roméite</i>	Antim.	111	Yellow. Also biref.	159
1.87	<i>Chalcocamprite</i>	Colum.	?	G.=3.77. Brown	164
1.90	<i>Ugrandite</i>	Sil.	None	Green, yellow, red	180
1.90	<i>Hercynite</i>	FeAl ₂ O ₄	None?	G.=3.9. Green	62
1.90	<i>Andradite</i>	Sil.	None	Yellow to red	180
1.91	<i>Cervantite</i>	Ox.	None?	G.=4. Sol. HCl	67
1.92±	<i>Betafite</i>	Titan.	?	G.=4. Green	164
1.92	<i>Samirésite</i>	Colum.	?	G.=5.24. Yellow	164
1.93	<i>Microlite</i>	Tant.	?	G.=5.5. Yellow	164
1.93	<i>Malacon</i>	Ox.	None	G.=4-4.3. Also biref.	184
1.93	<i>Nantokite</i>	CuCl	100	G.=3.93. Sol. H ₂ O	30
1.95	<i>Neotantalite</i>	Tant.	?	G.=5.19. Yellow	164
1.96	<i>Samirésite</i>	Colum.	?	G.=5.24. Yellow	164
1.96±	<i>Pyrochlore</i>	Titan.	111	G.=4.3. Yellow	163
1.98±	<i>Hatchettolite</i>	Colum.	?	G.=4.8±. Yellow±	164
1.99	<i>Neotantalite</i>	Tant.	?	G.=5.19. Yellow	164
1.998	<i>Sulfur (fused)</i>	S	None	G.=2. Yellow	14
2.00	<i>Winkite</i>	Colum.	?	Yellow. Also biref.	167
2.0	<i>Limonite</i>	Ox.	None	G.=3.8. Yellow	47
2.01	<i>Schorlomite</i>	Sil.	None	Has TiO ₂ . Brown	183
2.05±	<i>Picotite</i>	Ox.	111	G.=4.1. Brown	62
2.05	<i>Risoerite</i>	Tant.	?	G.=4.18. Brown	165
2.05	<i>Eulytite</i>	Sil.	110	G.=6.1. Yellow	414

TABLE IV A.—REFRACTANCE OF ISOTROPIC MINERALS—*continued*

N	Mineral	Chem.	Cleav.	Other characters	Page
1.91	↑ <i>Cervantite</i>	Ox.	None?	G.=4. Sol. HCl	67
2.0	↑ <i>Limonite</i>	Ox.	None	G.=3.8. Yellow	47
2.05-6	↓ <i>Percylite</i>	Hal.	100	G.=2.25. Blue	37
2.06	↓ <i>Cervantite</i>	Ox.	None?	G.=4. Sol. HCl	67
2.06	↑ <i>Euxenite</i>	Titan.	None	G.=4.8. Brown	167
2.06	↑ <i>Cerargyrite</i>	Hal.	None	G.=5.4-6. Horny	30
2.065	↓ <i>Mosesite</i>	Hal.	None	Yellow. Also biref.	34
2.07	↑ <i>Chromite</i>	FeCr ₂ O ₄	None	Opaque to brown	62
2.087	↓ <i>Senarmontite</i>	Sb ₂ O ₃	111	G.=5.2. Also biref.	43
2.09	↓ <i>Schneebergite</i>	Antim.	111	G.=5.4. Yellow	160
2.10	↑ <i>Samarskite</i>	Colum.	010	Brown. Also biref.	166
2.10	↑ <i>Fergusonite</i>	Colum.	111	Brown. Also biref.	164
2.12	↑ <i>Yttracrasite</i>	Titan.	None?	Yellow. Also biref.	167
2.12	↑ <i>Koppite</i>	Tant.	None	G.=4.5. Red	164
2.13	↑ <i>Amfangabéite</i>	Colum.	None?	G.=4.2±. Red	166
2.14	↑ <i>Blomstrandinite</i>	Titan.	010	G.=4.9±. Brown	167
2.15	↑ <i>Yttracrasite</i>	Titan.	None?	Yellow. Also biref.	167
2.15±	↑ <i>Embolite</i>	Hal.	None	G.=5.8. Yellow	30
2.15	↑ <i>Ytrotantalite</i>	Tant.	010	G.=5.7±. Brown	166
2.15	↑ <i>Bismutite</i>	Carb.	None	G.=7.0. Efferv. HCl	86
2.16	↓ <i>Chromite</i>	FeCr ₂ O ₄	None	Opaque to brown	62
2.16	↓ <i>Manganosile</i>	MnO	100	G.=5.18. Green	41
2.16	↓ <i>Pyrrhite</i>	Tant.	None?	G.=4.5±. Red	164
2.18	↓ <i>Koppite</i>	Tant.	None?	G.=4.5. Red	164
2.19	↓ <i>Fergusonite</i>	Colum.	111	Brown. Also biref.	164
2.19	↓ <i>Zirkelite</i>	Ox.	None	G.=4.72. Brown	164
2.20±	↓ <i>Iodembolite</i>	Hal.	None	G.=5.7. Yellow	30
2.20	↓ <i>Thorianite</i>	Ox.	None?	G.=9.32. Brown	50
2.20	↓ <i>Lewisite</i>	Antim.	111	G.=4.95. Yellow	162
2.20	↓ <i>Miersite</i>	Hal.	110	G.=5.64. Yellow	30
2.20	↑ <i>Eschynite</i>	Titan.	None?	G.=5.0±. Brown	167
2.21	↑ <i>Weslicenite</i>	Antim.	None	Yellow. Also biref.	160
2.215	↑ <i>Polymignite</i>	Titan.	Poor	G.=4.8. Brown	167
2.23	↑ <i>Bunsenite</i>	NiO	?	G.=6.4. Green, brown	41
2.25	↑ <i>Samarskite</i>	Colum.	010	Brown. Also biref.	166
2.25±	↑ <i>Bromyrite</i>	AgBr	None	G.=6.0. Yellow	30
2.26±	↑ <i>Cerargyrite</i>	Hal.	None	G.=5.4-6. Horny	30
2.26	↑ <i>Euxenite</i>	Titan.	None	G.=4.8. Brown	167
2.26	↑ <i>Bismutite</i>	Carb.	None	G.=7.0. Also biref.	86
2.26	↑ <i>Eschynite</i>	Titan.	None	G.=5.0±. Brown	167
2.27	↑ <i>Iron</i>	Fe	100	Opaque. Sol. HCl	16
2.30	↑ <i>Limonite</i>	Ox.	None	G.=3.8. Yellow, red	47
2.30	↑ <i>Brannerite</i>	Ox.	None	G.=5.1. Green, brown	69

TABLE IV A.—REFRINGENCE OF ISOTROPIC MINERALS—*continued*

N	Mineral	Chem.	Cleav.	Other Characters	Page
2.30±	<i>Jacobsite</i>	MnFe ₂ O ₄	?	G.=4.75. Brown	63
2.30	<i>Knopite</i>	Titan.	100	Brown. Also biref.	163
2.33	<i>Dysanalite</i>	Titan.	100	Green. Also biref.	163
2.346	<i>Marshite</i>	CuI	110	G.=5.59. Yellow	30
2.35	<i>Magnesioferrite</i>	MgFe ₂ O ₄	None	Opaque to red	61
2.36	Franklinite	Ox.	111	Opaque to brown	63
2.37	↑ Sphalerite	ZnS	110	G.=4.09. Brown±	19
2.38	Perovskite	CaTiO ₃	100	Gray, etc. Also biref.	163
2.419	↓ Diamond	C	111	G.=3.5. H.=10	13
2.42	MAGNETITE	Fe ₃ O ₄	110	Opaque. G.=5.17	63
2.47	Sphalerite	ZnS	110	G.=3.94. Brown	19
2.49	<i>Eglestonite</i>	Hal.	None	G.=8.33. Yellow	37
2.69	<i>Haucerite</i>	MnS ₂	100	G.=3.46. Red	24
2.70	<i>Alabandite</i>	MnS	100	G.=4.0. Green	20
>2.72	<i>Tennantite</i>	Cu ₆ As ₂ S ₆	None	Red to opaque	26
>2.72	Tetrahedrite	Cu ₆ Sb ₂ S ₆	None	G.=4.4. Red	26
2.849	Cuprite	Cu ₂ O	111	G.=6. Red	40
2.92	<i>Selenium</i> (fused)	Se	None	G.=4.7±. Red	15
Extreme	<i>Blomstrandite</i>	Titan.	None	G.=4.2. Brown	167

SUPPLEMENTARY TABLE IV A.—REFRINGENCE OF ISOTROPIC MINERALS

N	Mineral	Chem.	Cleav.	Other Characters	Page
1.369	Cryptohalite	Hal.	111	G.=2.00. Sol. in H ₂ O	36

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS

N_o or N_m + —	N_o or $N_g - N_p$	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.309	1.313	Ice	H ₂ O	0001 $\perp$ Z	Hex. G. = 0.92	40
1.312	1.309	<i>Malladrite</i>	Hal.	X = c	Ps.Hex. twin. G. = 2.75	37
1.326	Very weak	<i>Anogadrite</i>	Hal.	X = c	Y = b. 2V = Lg. G. = 2.62	34
1.328	Very weak	<i>Villiaumite</i>	NaF	100	X = yellow, Z = red	30
1.339	.001	<i>Cryolite</i>	Na ₄ AlF ₆	001, 110	X = b. Z $\wedge$ c = -44°; 2V = 43°	34
1.349	1.343	<i>Chiolite</i>	Na ₂ AlF ₅	001 $\perp$ X	Tet. G. = 3.0	34
1.378	1.390	<i>Sellaite</i>	MgF ₂	100, 110	Tet. G. = 3.17	32
1.396	1.398	Mirabilite	Sul.	100	Z $\wedge$ c = +29°. 2V = 80°. Sol. H ₂ O	97
1.40?	Mod.	Chrysocolla	Sil.	Z = c	Green or brown	44
1.403	.002	<i>Termierite</i>	Sil.	?	G. = 1.2?	415
1.413	.008	<i>Pachnolite</i>	Hal.	Z $\wedge$ c = +68°	X = b; 2V = 76°	36
1.414	1.415	<i>Thomsonolite</i>	Hal.	001; Z = b	X $\wedge$ c = -52°; 2V = 50°	36
1.44	1.432	<i>Eriomite</i>	Sil.	Z = c	Orth. G. = 2.0	389
1.448	1.450	<i>Variscite</i> (-H ₂ O)	Phos.	?	Z = a = lavender; c = violet	140
1.448	1.459	<i>Taylorite</i>	Sul.	?	2V = 36°. Orth.?	96
1.45±	Very weak	<i>Yttracalcite</i>	Hal.	1010	G. = 3.19	36
1.45	Weak	<i>Conellite</i>	CuS	0001 $\perp$ Z	Green to opaque	20
1.452	1.458	Kalinite	Sul.	Y $\wedge$ c = 13°	Z = b; 2V = 52°	113
1.452	1.453	<i>Leconite</i>	Sul.	110 at 76°	X = a. Y = c. 2V = 40°	97
1.454	1.456	<i>Gearksuite</i>	Hal.	Y $\wedge$ c = Lg.	X = b. 2V = Mod.	35
1.455	1.461	Epsomite	Sul.	010 $\perp$ X	Y = c. 2V = 51°	103
1.455	1.459	<i>Wallerite</i>	Sul.	X $\wedge$ fib. = 0° - Lg.	2V = 48°	112
1.455	1.456	<i>Mendozite</i>	Sul.	X || fib.	2V = Sm. G. = 1.73	113
1.456	1.459	<i>Sassolite</i>	B(OH) ₃	001 $\perp$ X $\pm$	2V = 7°. G. = 1.48	59
1.459	1.459	<i>Mendozite</i>	Sul.	X || fib.	2V = 0°. Sol. H ₂ O	113
1.46	1.54	Chrysocolla	Sil.	Z || fib.	Green or brown	411
1.462	1.475	<i>Picromerite</i>	Sul.	201; Y = b	X $\wedge$ c = +14°; 2V = 48°	112
1.464	1.470	<i>Aluminite</i>	Sul.	X = c	2V = Lg. G. = 1.66	109

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—continued

N_o or N_m + —	N_o or $N_o - N_p$	N_p	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.466	1.466	1.461	<i>Etringite</i>	Sul.	100. $X=c$	$G=1.70$. Sol. HCl	115
1.476	1.485	1.473	Natrolite	Sil.	110. $X=c$	$Y=b$. $2V=62^\circ$	390
1.478	1.525	1.478	<i>Paraffin</i>	C, H	$Z=c$	$G=0.9$. $F=50^\circ \pm$	17
1.48	Weak	Weak	Phillipsite	Sil.	100, 010	$X=b$; $Z \wedge c=10^\circ-30^\circ$. $2V=70^\circ \pm$	393
1.481	Weak	Weak	Chabazite	Sil.	101	$2V=Sm$. Ps. Hex.	384
1.481	1.486	1.391	<i>Darapskite</i>	Sul.	100. 010 $\perp$ X	$Z \wedge c=12^\circ$. $2V=27^\circ$	120
1.481	1.481	1.461	<i>Hanksite</i>	Sul.	0001 $\perp$ X	$G=2.56$. Sol. H_2O	119
1.482	1.493	1.480	Natrolite	Sil.	100 at 89°	$X=c$. $Y=b$. $2V=62^\circ$	390
1.482	1.482	1.478	<i>Apjohnite</i>	Sul.	$Z \wedge c=29^\circ$	$Y=b$. $2V=Sm$.	117
1.483	1.488	1.479	<i>Zn-Cu-Melanterite</i>	Sul.	$Y \wedge fib.=Lg.$	$Z=b$. $2V=Lg.$	106
1.484	1.487	1.483	<i>Bloedite</i>	Sul.	$X \wedge c=43^\circ$	$Y=b$. $2V=71^\circ$	112
1.485	Weak	Weak	Chabazite	Sil.	101	$Z=c$? $2V=Sm$. Ps. Hex.	384
1.487	1.487	1.484	<i>Cristobalite</i>	SiO_2	$X=c$	Tet.? $G=2.27$	53
1.487	1.490	1.483	<i>Leonite</i>	Sul.	$Z \wedge c=Sm$.	$Y=b$. $2V=86^\circ$. Sol. H_2O	112
1.487 $\pm$	.001	.001	Analcite	Sil.	Diff.	$2V=varies$. Gel. HCl	293
1.487	1.496	1.484	<i>Tamarugite</i>	Sul.	$Y \wedge c=30^\circ \pm$	$Z=b \pm$. $2V=60^\circ$	115
1.487	1.492	1.487	<i>Aphthalite</i>	Sul.	100. $Z=c$	$G=2.7$. Sol. H_2O	96
1.488	1.489	1.486	<i>Bloedite</i>	Sul.	$X \wedge c=43^\circ$	$Y=b$. $2V=71^\circ$. Sol. H_2O	112
1.488	1.542	1.470	<i>Bechite</i>	Bor.	?	$2V=62^\circ$	92
1.488	1.500	1.488	<i>Douglasite</i>	Hal.	$Z=c$?	Mon.? Green	34
1.488	1.489	1.485	<i>Vanthoffite</i>	Sul.	?	$2V=84^\circ$. Mono.?	111
1.489	1.492	1.467	<i>Morenosite</i>	Sul.	010 $\perp$ X	$Y=c$. $2V=42^\circ$	103
1.490	1.490	1.471	<i>Loewite</i>	Sul.	001 $\perp$ X	$G=2.37$. Sol. H_2O	111
1.490	1.511	1.473	<i>Fluellite</i>	Hal.	$Y=a$. $Z=c$	$2V=85^\circ$. $G=2.17$	33
1.49	.005	.005	<i>Halotrichite</i>	Sul.	$Z \wedge c=30^\circ \pm$	$G=1.9 \pm$. Sol. H_2O	116
1.49	1.49	1.48	<i>Etringite</i>	Sul.	100. $X=c$	$G=1.79$. Sol. HCl	115

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—continued

N_o or N_m + —	N_o or $N_o - N_p$	N_p	Mineral	Chem.	Cleavage Opt. Orient.	Other Characters	Page
1.48	Weak		Phillipsite	Sil.	100, 010	$X=b$, $Z\wedge c=10^\circ-30^\circ$, $2V=70^\circ\pm$	393
1.505	.01	1.495	<i>Deweyite</i>	Sil.	Z || fib.	$2V=Sm$, $G=2.3$	261
1.507		1.504	<i>Bischofite</i>	Hal.	$Y\wedge c=+10^\circ$	$X=b$, $2V=79^\circ$	32
1.508		1.509	<i>Ussingite</i>	Sil.	001, 110	Tr. $2V=39^\circ$	439
1.508		1.508	LEUCITE	Sil.	Poor	$2V=0^\circ\pm$, Ps. Isom.	291
1.509		1.575	<i>Pirssonite</i>	Carb.	$Y=c$, $Z=b$	$2V=33^\circ$, $G=2.35$	87
1.509		1.509	<i>Nocerite</i>	Hal.	$X=c$	Hex. $G=2.96$	38
1.509		1.486	Cancrinite	Sil.	1010, $X=c$	Efferv. Gel. HCl.	301
1.51	.010	1.500	Phillipsite	Sil.	0101, X	$Z\wedge c=20^\circ\pm$, $2V=70^\circ\pm$	393
1.510		1.504	<i>Petalite</i>	Sil.	0011, Y	$Z=b$, $2V=84^\circ$, Mono.	309
1.510		1.512	<i>Epistilbite</i>	Sil.	0011, Y	$Z\wedge c=-10^\circ$, $2V=44^\circ$	396
1.510		1.521	<i>Uranospatheite</i>	Phos.	0011, X	$Y=b$, $2V=69^\circ$, Ps. Tet.	146
1.51	.01±	1.488	<i>Racemite</i>	Sil.	None	$G=1.96\pm$	433
1.51		1.520	<i>Inyoite</i>	Bor.	001, $Y=b$	$X\wedge c=+37^\circ$, $2V=70^\circ$	92
1.51		1.495	<i>Nocerite</i>	Hal.	$X=c$	Hex. $G=2.96$	38
1.512		1.517	<i>Brewsterite</i>	Sil.	0101, Z	$X\wedge c=+22^\circ$, $2V=65^\circ$	397
1.512		1.522	Chrysotile?	Sil.	Z || fib.	$Y=b$, $2V=Lg$.	260
1.512		1.508	<i>Flagstaffite</i>	H, C, O	$Y=b$, $Z=a$	$2V=77^\circ$, $G=1.1$	88
1.512		1.505	<i>Hydrocalcite</i>	Carb.	0001, X	Efferv. HCl. $G=2.06$	87
1.512		1.498	Thomsonite	Sil.	0101, Z	$Y=c$, $2V=54^\circ\pm$	387
1.513		1.512	Carnegieite	Sil.	?	$2V=13^\circ\pm$, Tr.	299
1.514		1.509	<i>Gonnardite</i>	Sil.	Z || fib.	$2V=52^\circ$, Gel. HCl	387
1.515		1.514	<i>Ozocerite</i>	H, C	?	$2V=0^\circ\pm$, Burns	18
1.515		1.515	<i>Gaylussite</i>	Carb.	110 at 69°	$X=b$, $Z\wedge c=-14^\circ$, $2V=34^\circ$	87
1.516		1.443	<i>Syngentite</i>	Sul.	110, 100	$Z=b$, $Y\wedge c=3^\circ$, $2V=28^\circ$	111
1.517		1.501	<i>Neuberyite</i>	Phos.	0101, Y	$Z=c$, $2V=45^\circ$	123
1.518		1.533	<i>Fibrolferrite</i>	Sul.	Z || fib.	$2V=0^\circ$, Yellow; $X<Z$	109
1.518		1.561	<i>Felsöbanyite</i>	Sul.	0011, Z	$2V=48^\circ$, $G=2.33$	109

I. 534	I. 534	Zincaluminite	Sul.	X = c 111, 113	G. = 2.26	115
I. 535	I. 586	Kieserite	Sul.	110	Z $\wedge$ c = +76°. 2V = 55°	104
I. 535	I. 582	Quetinite	Sul.	oor $\perp$ Z	2V = 34°. Brown; X < Z	116
I. 535	I. 537	Apophyllite	Sil.	?	Abn. int. colors	262
I. 535	I. 538	Kaliophyllite?	Sil.	oor $\perp$ Z	2V = 39°. Twin.	300
I. 535	I. 500	Meyerhoferite	Bor.	oor	2V = 79°. G. = 2.12	93
I. 535	Weak	Brugnatellite	Carb.	oor $\perp$ X	Efferv. HCl	87
I. 536	I. 541	ALBITE	Sil.	oor, oio	Z $\wedge$ b = 15° $\pm$. 2V = 75°	369
I. 536	.001 $\pm$	Milarite	Sil.	X = c	2V = 0° $\pm$. G. = 2.57	429
I. 536	I. 517	Fe-Cu-Chalcantinite	Sil.	?	2V = 60° $\pm$. Sol. H ₂ O	107
I. 536	I. 532	Cordierite	Sil.	oor $\perp$ Z	X = c. 2V = 60° $\pm$. Twins	307
I. 536	I. 532	OLIGOCLASE	Sil.	oor, oio	Z = b $\pm$. 2V = 90° $\pm$	371
I. 536	I. 532	NEPHELITE	Sil.	X = c	G. = 2.6. Gel. HCl	298
I. 537	I. 533	Kaliophyllite	Sil.	X = c	G. = 2.56. Gel. HCl	300
I. 537	I. 528	Siderolite	Sul.	?	2V = Mod. Sol. H ₂ O	107
I. 537 $\pm$	I. 541	Okenite	Sil.	oor	2V = Lg. Gel. HCl	413
I. 539	I. 539	Chalcedonite	SiO ₂	Fibers	G. = 2.6	57
I. 539	I. 516	Chalcantinite	Sul.	Poor	2V = 56°. Sol. H ₂ O	106
I. 539	I. 511	Mellite	Al, C, O, H	Poor	Tet. G. = 1.6	88
I. 540	I. 510	Brugnatellite	Carb.	oor $\perp$ X	Efferv. HCl	87
I. 54 $\pm$	I. 531	Gismondite	Phos.	oor, X = b	Z = a $\pm$. 2V = 84° $\pm$	373
I. 54	I. 545	Lueneburgite	Sul.	110 at 73°	X $\wedge$ c = 45°. Y = b. 2V = Mod.	161
I. 540	I. 527	Sulfoborite	Sil.	110 at 64°	X = c. Y = b. 2V = 70°	120
I. 540	.01	Gyrolite	Sil.	oor $\perp$ X	Also biax. Sol. HCl	408
I. 542	I. 516	Stichtite	Carb.	oor $\perp$ X	Efferv. HCl. Lilac	87
I. 542	I. 466	Dawsonite	Carb.	110 at 66°	X = a. Y = c. 2V = 77°. Efferv. HCl	87
I. 543	Very weak	Apophyllite	Sil.	oor $\perp$ X	Abn. int. colors	262
I. 543 $\pm$	I. 555	Chrysotile	Sil.	Z || fib.	Y = b. 2V = 32° $\pm$	260
I. 544	I. 553	QUARTZ	SiO ₂	Z = c	G. = 2.05. Sol. HF	54
I. 544	I. 544	Epidiymite	Sil.	oor $\perp$ Y; oio $\perp$ Z	2V = 22°. Ps. Hex. twin.	418
I. 545	I. 547	Hyalophane	Sil.	oor, oio	Z = b. 2V = 78°	360

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—continued

N_o or N_m + —	N_o or $N_g - N_p$	N_p	Mineral	Chem.	Cleavage, Opt. Orient.	Other Characters	Page
1.528	1.575	1.506	<i>Copiapite</i>	Sul.	oor $\perp$ X; Y = b	$2V = 60^\circ \pm$. X = green, Z = yellow	108
1.53	.005 $\pm$		Marialite	Sil.	110	$2V = 0^\circ$. G. = 2.6	296
1.536	1.539	1.532	Cordierite	Sil.	oro $\perp$ Z; X = c	$2V = 60^\circ \pm$. Twins	307
1.536	1.541	1.532	OLIGOCLASE	Sil.	oor, oro	Z = b $\pm$. $2V = 90^\circ \pm$	371
1.536	1.536	1.532	NEPHELITE	Sil.	X = c	G. = 2.6. Gel. HCl	298
1.540	.01		<i>Gyrolite</i>	Sil.	ooo $\perp$ X	Also biax. Sol. HCl	408
1.540	Weak		<i>Eucryptite</i>	Sil.	ooo $\perp$ X	Hex. G. = 2.67	300
1.545	1.545	1.503	<i>Pholidolite</i>	Sil.	oor $\perp$ X	$2V = 10^\circ \pm$. G. = 2.41	435
1.545	1.545	1.525	Vermiculite *	Sil.	oor $\perp$ X	$2V = \text{Sm}$. Yellow; X < Y	434
1.545	1.546	1.540	Marialite	Sil.	$\perp$ 10 at 90°	G. = 2.6	296
1.546	1.551	1.539	<i>Brushite</i>	Phos.	oro $\perp$ Z	X $\wedge$ c = -72° . $2V = 84^\circ$	123
1.546	1.551	1.545	<i>Eudidymite</i>	Sil.	oor. Y = b	Z $\wedge$ c = 59° . $2V = 30^\circ$	418
1.546	1.546	1.540	Dipyrite	Sil.	100	Inclusions common	296
1.547	1.595	1.438	<i>Oxammitte</i>	Oxal.	X = c. Y = a	$2V = 62^\circ$	89
1.547	1.564	1.541	<i>Voglite</i>	Carb.	One $\perp$ X $\pm$	$2V = 60^\circ$. Efferv. HCl	88
1.548	1.548	1.540	<i>Gyrolite</i>	Sil.	ooo $\perp$ X	Also biax. Sol. HCl	408
1.548	1.549	1.535	<i>Centrallastite</i>	Sil.	One $\perp$ X	$2V = \text{Sm}$. Fibers	409
1.548	1.550	1.530	<i>Co-Chalcantinite</i>	Sul.	Poor	$2V = \text{Mod}$. Pink	107
1.548	1.572	1.544	<i>Botryogen</i>	Sul.	oro $\perp$ X	$2V = 41^\circ$. X = yellow, Z = red	116
1.549	1.553	1.545	OLIGOCLASE	Sil.	oor, oro	$2V = 90^\circ \pm$. Lam. twin	371
1.549	1.549	1.544	NEPHELITE	Sil.	Poor	Hex. G. = 2.6. Gel. HCl	298
1.549	1.554	1.539	<i>Edingtonite</i>	Sil.	110 at $90^\circ \pm$	X = c. Y = b. $2V = 50^\circ \pm$	389
1.549	1.553	1.545	ANDESINE	Sil.	oor, oro	$2V = 90^\circ \pm$. Lam. twin.	372
1.550	1.600	1.540	<i>Criopite</i>	Sul.	oor $\perp$ X. Y = b	$2V = 60^\circ \pm$. X = green, Z = yellow	108
1.550	1.635	1.533	<i>Rhomboclase</i>	Sul.	oor $\perp$ X. Y = a	$2V = \text{Sm}$. X = red, Z = yellow	108
1.55	.02		<i>Zepharovitchite</i>	Phos.	Z || fib.	G. = 2.37. Sol. HCl	141
1.55	.01?		<i>Pyroaurite</i>	Carb.	ooo $\perp$ X	Efferv. HCl	87

	I. 55	I. 56	I. 57	I. 58	I. 59	Bor.	X || fib.	2V = Sm.	93
	I. 55	I. 55	I. 53	.01 ±		Sil.	oor ⊥ X	X = yellow, Z = green	280
	I. 55	I. 55	I. 53			Sil.	oor ⊥ X	Z = b. 2V = 40° ±. Pink	270
	I. 552	I. 557	I. 552			Sul.	Poor	Z = c. Rhom.	107
	I. 553	I. 584	I. 553			Sil.	110 at 90°	Z = c. Tet. Yellow; X < Z	429
	I. 554	.016				Sil.	X = b. Y = c	2V = Mod.	432
	I. 554	I. 554	I. 554			Ox.	oor	2V = Sm. G. = 2.35	48
	I. 555	Mod.				Phos.	p	Tet. Also biax.	151
	I. 555	I. 562	I. 551			Phos.	Z Loro ±	2E = 32°. Blue: X < Y	157
	I. 555	I. 650	I. 490			Oxal.	oor; oro ⊥ X	Z ∧ c = +29°. 2V = 84°	37
	I. 555	.01 ±				Sil.	One ⊥ X	2V = o°. G. = 2.26	837
	I. 555	.01				Phos.	100. Y = b	X ∧ c = +30°. 2E = 40°	158
	I. 555	I. 559	I. 552			Sil.	oor ⊥ X ±	2V = 90° ±. G. = 2.1	416
	I. 556	I. 562	I. 555			Sil.	oor, oro	2V = 90° ±. Lam. twin.	372
	I. 557	I. 562	I. 555			Sil.	oor, oro	2V = 80° ±. Lam. twin.	374
	I. 558	I. 573	I. 554			Phos.	oro. Tric.	2V = 35°. Sol. HCl	151
	I. 558	I. 582	I. 551			Phos.	X = a. Y = b	2V = 55°. Sol. HCl	147
	I. 558	I. 562	I. 552			Phos.	oor ⊥ X	2V = 68°. Ps. Hex. twin.	149
	I. 559	I. 627	I. 559			Sul.	1010, Z = c	G. = 2.56. Sol. H ₂ O	114
	I. 56 ±	.04				Sil.	X || fib.	G. = 2.69	420
	I. 560	I. 560	I. 495			Sul.	X = c	G. = 1.93	119
	I. 56	Very weak				Sil.	oor ⊥ X ±	Green: X < Z	281
	I. 56	.03 ±				Sil.	oor ⊥ X ±	Z = b. 2V = 35° ±. Brown: X < Z	270
	I. 56	Weak				Phos	oor ⊥ X ±	2V = o° ±. Yellow, green	156
	I. 56	I. 56	I. 53			Sil.	oor ⊥ X ±	2V = o° ±. X = green, Z = yellow	279
	I. 56	.02 ±				Sil.	oor ⊥ X ±	Yellow	416
	I. 561	I. 692	I. 494			Oxal.	110 at 75°. Y = b	Z = c. 2V = Lg. X = green, Z = yel.	88
	I. 562	I. 57	I. 552			Sil.	oro ⊥ Z	X = c. 2V = 60° ±. Ps. Hex.	307
	I. 562	I. 567	I. 548			Sul.	100. Tric.	Lam. twin. G. = 2.78	113
	I. 564	.019				Ox.	oor ⊥ Z	Rhom. G. = 2.4	42

* E. V. Shannon; *Am. Jour. Sci.* CCXV, 1928, p. 20.

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—continued

N_o or N_m +	N_o or $N_o - N_p$	N_p or $N_o - N_p$	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.545	1.545	1.525	Vermiculite	Sil.	001 $\perp$ X	2V = Sm. Yellow: X < Y	434
1.546	1.546	1.540	Dipyre	Sil.	100	Inclusions common	296
1.55	.01 $\pm$		Antigorite	Sil.	001 $\perp$ X	X = yellow, Z = green	280
1.55	1.55	1.53	Lepidolite	Sil.	001 $\perp$ X	Z = b. 2V = 40° $\pm$. Pink	270
1.554	1.576	1.554	Gibbsite	Ox.	001	2V = Sm. G. = 2.35	48
1.557	1.562	1.555	LABRADORITE	Sil.	001, 010	2V = 80° $\pm$. Lam. Twin.	374
1.56	Very weak		Penninite	Sil.	001 $\perp$ X $\pm$	2V = Sm. Green: X < Z	281
1.56	.03 $\pm$		Zinnwaldite	Sil.	001 $\perp$ X $\pm$	Z = b. 2V = 35° $\pm$. Brown: X < Z	270
1.56	Weak		Calcioferite	Phos.	001 $\perp$ X $\pm$	2V = 0° $\pm$. Yellow, green	156
1.56	1.56	1.53	Nepotite	Sil.	001 $\perp$ X $\pm$	2V = 0° $\pm$. X = green, Z = yellow	279
1.564	1.565	1.535	Phlogopite	Sil.	001 $\perp$ X	Y = b. 2V = 10° $\pm$. G. = 2.75	272
1.565	.025 $\pm$		Lepidolite	Sil.	001 $\perp$ X	2V = Sm. Pink	270
1.565	1.574	1.560	Elpidite	Sil.	110 at 54°	Y = b. Z = a. 2V = 75° $\pm$	400
1.565	1.575	1.565	Pinnoite	Bor.	Z = c	Tet. G. = 2.29	92
1.565	1.565	1.559	Reyerite	Sil.	001 $\perp$ X	Rhom. G. = 2.52	408
1.565	1.567	1.561	Kaolinite	Sil.	001 $\perp$ X $\pm$	Z = b. 2V = 60°. Ps. Hex.	264
1.565	1.565	1.560	Zeophyllite	Sil.	001 $\perp$ X	Also biax.	408
1.565	.01		Pyroaurite	Carb.	0001 $\perp$ X	Efferv. HCl. Red: X < Z	87
1.565	Weak		Zaratite	Carb.	Paral. Ext.	Efferv. HCl. Green	85
1.565	1.570	1.550	Variscite	Phos.	?	G. = 2.54. Sol. HCl	140
1.567	1.589	1.567	Gibbsite	Ox.	001	2V = Sm. G. = 2.35	48
1.567	1.572	1.564	LABRADORITE	Sil.	001, 010	2V = 80° $\pm$. Lam. twin.	374
1.567	1.590	1.563	Norbergite	Sil.	?	2V = 49°. G. = 3.14. Gel. HCl	196
1.567	1.572	1.564	BYTOWNITE	Sil.	001, 010	2V = 80° $\pm$. Lam. twin.	376
1.568	.01		Natroalunite	Sul.	0001 $\perp$ Z	G. = 2.6	114
1.568	1.580	1.565	Isoclasite	Phos.	010 $\perp$ Y	Z $\wedge$ c = Sm. 2V = 50° $\pm$	137

1.568	1.568	1.564	Beryl	Sil.	$X=c$	Also biax. Pneumat.	212
1.569	1.572	1.485	Griffithite	Sil.	oor $\perp X$	$2V=Sm$. X = yellow, Z = green	434
1.570	1.570	1.545	Dipyre	Sil.	100. $X=c$	Tet. Incl. common	296
1.571	1.576	1.568	Jurupaite	Sil.	$Z \wedge fib. = 31^\circ$	G. = 2.75. Sol. HCl	412
1.572	1.585	1.555	Tengerite	Carb.	X $\parallel$ fib.	$2V=Lg$.	86
1.573	.026±		Xylotile	Sil.	Z $\parallel$ fib.	$2V=Sm$. Yellow: X < Z	261
1.574	1.582	1.569	Wagnerite	Phos.	Y = b	$Z \wedge c = 22^\circ$. $2V = 26^\circ$	134
1.575	.016±		Barrandite	Phos.	Z $\parallel$ fib.	$2V=Mod$. G. = 2.6	140
1.576	Very weak		Penninite	Sil.	oor $\perp Z$	$2V=Sm$. Green: X < Z	281
1.577	.006±		Clinchlore	Sil.	oor $\perp Z$	$2V=Sm$. Green: X > Z	283
1.578	1.570	1.545	Mizzonite	Sil.	100. $X=c$	Tet. Incl. common	297
1.579	1.596	1.563	Hoernesite	Phos.	100. $X=b$	$Z \wedge c = +32^\circ$. $2V = 60^\circ$	125
1.580	1.583	1.524	Roemerite	Sul.	oor?	$2V = 51^\circ$. Brown: X = Z < Y	117
1.581	1.592	1.572	Alunite	Sul.	oor $\perp Z$	Rhom. G. = 2.60	113
1.582	1.575	1.555	Hannayite	Phos.	oor $\perp X$	$Y \wedge c = 33^\circ$. $2V = 42^\circ$	151
1.583	1.580	1.558	Basselite	Phos.	oor $\perp X$	$Z \wedge c = 4^\circ$. $2E = 110^\circ$	146
1.584	.01		Loewigite	Sul.	oor?	G. = 2.58	114
1.585	1.575	1.547	Errite	Sil.	oor $\perp X$	Brown; pleo.	407
1.586	1.577	1.553	Autunite	Phos.	oor $\perp X$. Y = b	$2V = 33^\circ$. Yellow: X < Z	146
1.587	.04±		Talc	Sil.	oor $\perp X$. Z = b	$2V = 20^\circ \pm$. Insol.	262
1.588	1.614	1.570	Anhydrite	Sul.	oor $\perp X$	oor $\perp Y$. $2V = 42^\circ$	98
1.589	1.588	1.574	Augelite	Phos.	110 at 67°	Y = b. $Z \wedge c = -34^\circ$. $2V = 51^\circ$	143
1.590	1.588	1.562	Sphrite	Phos.	Fibers	$2V=Lg$.	144
1.591	1.576	1.546	Parcelensite	Sil.	oor $\perp X$	Yellow: X > Z	407
1.592	1.582	1.571	BYTOWNITE	Sil.	oor, oio	$2V = 80^\circ \pm$. Lam. twin.	376
1.593	1.60	1.54	Fichtelite	Sil.	oor, Y = b	$Z \wedge c = +13^\circ$. $2V = 87^\circ$	18
1.594	1.601	1.544	Krochokite	Sul.	oor $\perp Y$	$X \wedge c = -49^\circ$; $2V = 79^\circ$. Blue	112
1.595	1.582	1.571	ANORTHITE	Sil.	oor, oio	$2V = 80^\circ \pm$. Lam. twin.	378
1.596	1.583	1.578	Baenite	Sil.	oor $\perp Z$	$X \wedge a = 2^\circ$. $2V = 47^\circ$	438
1.597	.016±		Barrandite	Phos.	Z $\parallel$ fib.	$2V=Mod$.	140
1.598	Weak		Calcioferite	Phos.	oor $\perp X \pm$	$2V = 0^\circ \pm$. Yellow, green	156

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—continued

N_o or N_m +	N_o or $N_g - N_p$	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.545	1.545 | 1.525	Vermiculite	Sil.	oor $\perp$ X	2V = Sm. Yellow: X < Y	434
1.55	.01 $\pm$	Antigorite	Sil.	oor $\perp$ X	X = yellow, Z = green	280
1.56	Very weak	Penninite	Sil.	oor $\perp$ X	2V = Sm. Green: X < Z	281
1.56	.03 $\pm$	Zinnwaldite	Sil.	oor $\perp$ X $\pm$	Z = b. 2V = 35° $\pm$. Brown: X < Z	270
1.56	1.56 | 1.53	Nepouite	Sil.	oor $\perp$ X $\pm$	2V = o° $\pm$. X = green, Z = yellow	279
1.564	1.565 | 1.535	Phlogopite	Sil.	oor $\perp$ X $\pm$	Y = b. 2V = 10° $\pm$. G. = 2.75	272
1.565	1.570 | 1.550	Variscite	Phos.	oor $\perp$ X $\pm$	G. = 2.54. Sol. HCl	140
1.568	1.568 | 1.564	Beryl	Sil.	?	Also biax. Pneumat.	212
1.57	1.570 | 1.545	Mizzonite	Sil.	X = c	Tet. Incl. common	297
1.57	Very weak	Penninite	Sil.	100. X = c	2V = Sm. Green: X > Z	281
1.57	.006 $\pm$	Clinocllore	Sil.	oor $\perp$ Z	2V = Sm. Green: X > Z	379
1.575	1.577 | 1.553	Autunite	Phos.	oor $\perp$ X. Y = b	2V = 33°. Yellow: X < Z	146
1.575	.04 $\pm$	Talc	Sil.	oor $\perp$ X. Z = b	2V = 20° $\pm$. Insol.	262
1.578	1.582 | 1.571	ANORTHITE	Sil.	oor $\perp$ X. Z = b	2V = 86° $\pm$. Lam. twin.	378
1.58	1.015 | 1.540	Hambergite	Bor.	010 $\perp$ Y. X = a	G. = 2.35. H. = 7.5	91
1.58	.01 $\pm$	Antigorite	Sil.	oor $\perp$ X	X = yellow, Z = green	280
1.58	1.59 | 1.55	Jeszkite	Phos.	100. Y = b	X $\wedge$ c = +29°. 2V = Mod.	158
1.58	1.582 | 1.562	Canbyite	Sil.	One $\perp$ Z	2V = Sm.	415
1.580	1.588 | 1.580	Ceruleolacite	Phos.	Z || fib.	2V = o°. Sol. HCl	143
1.58	1.597 | 1.576	Cookeite	Sil.	oor $\perp$ Z	2V = 40° $\pm$. G. = 2.67	435
1.58	.015 $\pm$	Amesite	Sil.	oor $\perp$ Z	2V = Sm. Ps. Hex.	285
1.580	1.640 | 1.580	Cacoxenite	Phos.	Z = c	2V = o°. Yellow: X < Z	143
1.58	.01 $\pm$	Corundophilite	Sil.	oor $\perp$ X	2V = Sm. Green: X < Z	283
1.582	1.587 | 1.56	Uranospinite	Phos.	oor $\perp$ X	2V = 46°. Also biax. Yel: X < Z	147
1.582 $\pm$	.008	Hopite	Phos.	100 $\perp$ Z?	2V = o° $\pm$. G. = 3	124

1.582	1.588	1.552	MUSCOVITE	Sil.	oor $\perp$ X	Z = b. $2V = 47^\circ$	267
1.583	1.602	1.583	<i>Alumianite</i>	Sul.	?	Rhom. Sol. HCl	107
1.583	1.593	1.583	<i>Xonolite</i>	Sil.	Z || fib.	X = b. $2V = \text{Sm.}$	409
1.584	1.589	1.576	ANORTHITE	Sil.	oor, oro	$2V = 80^\circ \pm$. Lam. twin.	378
1.585	1.606	1.585	<i>Cacoxenite</i>	Phos.	Z = c	$2V = 0^\circ$. Yellow: X < Z	143
1.585	1.585	1.585	<i>Natrodonite</i>	Sul.	oor $\perp$ Z	G. = 2.6	114
1.585	1.585	1.576	<i>Metazeunerite</i>	Phos.	oor $\perp$ X	$2V = 0^\circ \pm$. Green: X < Z	146
1.585	1.585	1.337	<i>Nitratite</i>	NaNO ₃	toir, X = c	Rhom. G. = 2.27. Sol. H ₂ O	89
1.585	Mod.		<i>Volchonskoite</i>	Sil.	oor $\perp$ X $\pm$	Green. Gel. HCl	416
1.585	1.560		<i>Nontronite</i>	Sil.	oor $\perp$ X $\pm$	Z || fib. X = yellow, Z = green	415
1.586	1.586	1.560	<i>Uranospinite</i>	Phos.	oor $\perp$ X	Ps. Tet. Yellow: X < Z	147
1.586	1.613	1.582	<i>Colemanite</i>	Bor.	oro $\perp$ X	Z $\wedge$ c = 83° . $2V = 55^\circ$	93
1.587	1.600	1.52	<i>Lanhanite</i>	Carb.	oor $\perp$ X	Y = a. $2V = 62^\circ$	86
1.587	1.588	1.552	<i>Pyrophyllite</i>	Sil.	oor $\perp$ X	$2V = 55^\circ \pm$	263
1.588	1.594	1.578	<i>Metavoltine</i>	Sul.	oor $\perp$ X?	Hex. Yellow: X < Z	114
1.588	Very weak	1.583	<i>Celsian</i>	Sil.	oor, oro	Y = b. Z $\wedge$ a = 28° . $2V = 86^\circ$	359
1.589	1.594	1.583	<i>Rinneite</i>	Hal.	oro	Z = c. G. = 2.35. Sol. H ₂ O	33
1.589	Weak		<i>Pharmacolite</i>	Phos.	oro $\perp$ Z	X $\wedge$ c = $+70^\circ$. $2V = 79^\circ$	123
1.59	Weak		<i>Clinocllore</i>	Sil.	oor $\perp$ Z	Y = b. $2E = \text{Sm.}$ Green: X > Z	283
1.59	.01 $\pm$		<i>Corundophilite</i>	Sil.	oor $\perp$ Z	Y = b. $2E = 50^\circ \pm$. Green: X > Z	283
1.59	1.59	1.56	<i>Vermiculite</i>	Sil.	oor $\perp$ X	$2V = \text{Sm.}$ Brown: X < Z	434
1.59	1.590	1.545	<i>Talc</i>	Sil.	oor $\perp$ X. Z = b	$2V = 20^\circ \pm$. Insol.	262
1.59	1.59	1.555	<i>Phlogopite</i>	Sil.	oor $\perp$ X; Y = b	$2V = 10^\circ \pm$. Yellow: X < Z	366
1.59	.03 $\pm$		<i>Zinnwaldite</i>	Sil.	oor $\perp$ X; Z = b	$2V = 35^\circ \pm$. Brown: X < Z	270
1.59	Very weak		<i>Penninite</i>	Sil.	oor $\perp$ X; Y = b	$2V = 0^\circ \pm$. Green: X < Z	281
1.59	Weak		<i>Noumélite</i>	Sil.	Z || fib.	$2E = \text{Sm.}$ Green	261
1.59 $\pm$	1.598	1.586	<i>Custerite</i>	Sil.	oor	X = b. Z $\wedge$ c = 6° . $2E = 105^\circ$	412
1.59	Very weak		<i>Chlormankalite</i>	Hal.	X = c	Rhom. Yellow. Sol. H ₂ O	33
1.59	1.605	1.575	<i>Cataplette</i>	Sil.	Z = c	$2V = 1g$.	400
1.59	1.59	1.56	<i>Connarite</i>	Sil.	oor $\perp$ X	$2V = 0^\circ \pm$. Green; pleo.	280
1.59 $\pm$	1.59	1.56	<i>Jenkinsite</i>	Sil.	oor $\perp$ X	$2V = \text{Mod.}$ Green	281

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—continued

N_o or N_m +	N_o or N_p or $N_o - N_p$	Mineral	Chem.	Cleavage, Opt. Orient.	Other Characters	Page
1.56	1.56	<i>Nepouite</i>	Sil.	oor $\perp$ X $\pm$	$2V = 0^\circ \pm$. X = green, Z = yel.	279
1.565	1.550	<i>Variscite</i>	Phos.	?	G. = 2.54. Sol. HCl	140
1.568	1.564	Beryl	Sil.	X = c	Also biax. Pneumat.	212
1.57	1.545	Mizzonite	Sil.	100. X = c	Tet. Incl. common	297
1.57	Very weak	Penninite	Sil.	oor $\perp$ X	$2V = \text{Sm}$. Green: X > Z	281
1.575	1.553	<i>Autunite</i>	Phos.	oor $\perp$ X. Y = b	$2V = 33^\circ$. Yellow: X < Z	146
1.58	.015 $\pm$	Amesite	Sil.	oor $\perp$ Z	$2V = \text{Sm}$. Ps. Hex.	285
1.58	1.615	<i>Hambergite</i>	Bor.	010 $\perp$ Y. X = a	G. = 2.35. H. = 7.5	91
1.582	1.540	MUSCOVITE	Bor.	oor $\perp$ X	Z = b. $2V = 47^\circ$	267
1.585	1.552	<i>Noutronite</i>	Sil.	oor $\perp$ X $\pm$	Z || fib. X = yellow, Z = green	415
1.587	1.560	<i>Colmanite</i>	Sil.	oor $\perp$ X	Z $\wedge$ c = 83° . $2V = 55^\circ$	93
1.588	1.610	Celsian	Bor.	oor $\perp$ X	Y = b, Z $\wedge$ a = 28° . $2V = 86^\circ \pm$	359
1.59	1.594	<i>Kaemmererite</i>	Sil.	oor; 010	$2V = \text{Sm}$. Purple: X < Z	286
1.59	1.590	Anthophyllite	Sil.	oor $\perp$ X	Y = b. Z = c. $2V = 85^\circ \pm$	240
1.59	1.597	<i>Kupfferite</i>	Sil.	110 at 56°	Y = b. Z $\wedge$ c = 11° . $2V = 85^\circ \pm$. Green	244
1.59	1.584	<i>Prochlorite</i>	Sil.	110 at 56°	Y = b. $2V = \text{Sm}$. Green: X > Z	284
1.59	Weak	<i>Marinite</i>	Phos.	Y = b; Z = a	$2V = \text{Lg}$. Sol. HCl	124
1.59	.02	BIOTITE	Phos.	oor $\perp$ X; Y = b	$2V = 0^\circ \pm$. Brown or green: X < Z	272
1.59	1.555	<i>Levernietite</i>	Sil.	oor $\perp$ X $\pm$	Y = b; $2V = 50^\circ \pm$	433
1.59	1.54	<i>Protolithionite</i>	Sil.	oor $\perp$ X $\pm$	$2V = 0^\circ \pm$. X = yel. Z = brown	270
1.59	.04 $\pm$	Phengite	Sil.	oor $\perp$ X $\pm$	$2V = \text{Sm}$.	267
1.59	.04 $\pm$	Delessite	Sil.	oor $\perp$ X	$2V = \text{Sm}$. Green: X < Z	282
1.59	Very weak	<i>Hambergite</i>	Bor.	010 $\perp$ Y; X = a	$2V = 87^\circ$. G. = 2.35	91
1.591	1.631	<i>Hopeite</i>	Phos.	100 $\perp$ Z; X = b	$2V = 36^\circ$	124
1.591	1.591	<i>Melanollite</i>	Sul.	ooo $\perp$ X?	$2V = 0^\circ$. Yellow; X < Z	114
1.591	1.591	<i>Priceite</i>	Bor.	oor, 110	$2V = 32^\circ$	93

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—continued

N_o or N_m +	N_o or N_p or $N_o - N_p$	Mineral	Chem.	Cleavage Opt. Orient.	Other Characters	Page
1.56	1.56	<i>Nepouite</i>	Sil.	001 $\perp$ X $\pm$	2V = 0° $\pm$. X = green, Z = yel.	279
1.568	1.564	Beryl	Sil.	X = c	Also biax. Pneumat.	212
1.57	Very weak	Penninite	Sil.	001 $\perp$ Z	2V = Sm. Green: X > Z	281
1.58	.015 $\pm$	Amesite	Sil.	001 $\perp$ Z	2V = Sm. Ps. Hex.	285
1.582	1.552	MUSCOVITE	Sil.	001 $\perp$ X	Z = b. 2V = 47°	267
1.585	1.560	<i>Nontronite</i>	Sil.	001 $\perp$ X $\pm$	Z $\parallel$ fib. X = yellow, Z = green	415
1.59	1.584	Anthophyllite	Sil.	110 at 56°	Y = b. Z = c. 2V = 85° $\pm$	240
1.59	1.584	<i>Kupfferite</i>	Sil.	110 at 56° Y = b	Z $\wedge$ c = 11°. 2V = 85° $\pm$. Green	244
1.59	Weak	Prochlorite	Sil.	001 $\perp$ Z	Y = b. 2V = Sm. Green: X > Z	284
1.59	.02	<i>Martinite</i>	Phos.	Y = b; Z = a $\pm$	2V = Lg. Sol. HCl	124
1.59	1.555	BIOTITE	Sil.	001 $\perp$ X. Y = b	2V = 0° $\pm$. Br. or gr.: X < Z	272
1.59	.04 $\pm$	<i>Protolithionite</i>	Sil.	001 $\perp$ X $\pm$	2V = 0° $\pm$. X = yel., Z = br.	270
1.59	.04 $\pm$	Phengite	Sil.	001 $\perp$ X $\pm$	2V = Sm.	267
1.59	Very weak	Gelesite	Sil.	001 $\perp$ X $\pm$	2V = Sm. Green: X < Z	282
1.593	1.563	<i>Ganophyllite</i>	Sil.	001 $\perp$ X	Z = b. 2V = Sm.	436
1.598	1.580	Vivianite	Phos.	010 $\perp$ X	Z $\wedge$ c = 28°. X = blue, Z = olive	126
1.60	1.592	<i>Dahlite</i>	Phos.	Z $\parallel$ fib.	X = c. Sol. HCl	161
1.60	1.56	Meionite	Sil.	100. X = c	Tet. Dec. HCl	297
1.602	1.595	Beryl	Sil.	X = c	G. = 2.9. Insol.	212
1.602	1.590	<i>Haidingerite</i>	Phos.	010 $\perp$ X	2V = 58°. G. = 2.85	123
1.603	1.594	<i>Fremontite</i>	Phos.	001 $\perp$ X $\pm$	Tr.? 2V = Lg.	152
1.603	1.593	<i>Crestmorite</i>	Sil.	100? Z $\wedge$ c = 12°	2V = Lg.	409
1.603	1.584	<i>Bertrandite</i>	Sil.	001 $\perp$ Z. X = a	2V = 74°	410
1.604	1.582	Vivianite	Phos.	010 $\perp$ X	Z $\wedge$ b = 28°. X = blue, Z = olive	126
1.605	1.51	<i>Amarantite</i>	Sul.	100 $\perp$ X $\pm$; 010	Y = b. 2E = 60°. Yel. X < Z	109
1.606	.02	<i>Martinite</i>	Phos.	Y = b. Z = a $\pm$	Mon.? 2V = Lg.	124
1.606 $\pm$	1.606	<i>Endite</i>	Sil.	001 $\perp$ Z	Yellow, etc. X < Z	417

1.606±	1.633	1.595	Pectolite	Sil.	100 L X±; 001	Y = c. 2V = 60°	419
1.606	1.622	1.593	Chondrodite ¹	Sil.	X∧a = 26°±	Z = b. 2V = 80°±	196
1.607	Weak		Euclite	Sil.	001 L X	Yellow, etc. X>Z	417
1.608	.03		Ganophyllite	Sil.	001 L X±; 010	Z = b. 2V = Sm. Yel.: X>Z	436
1.609	.025±		Glauconite	Sil.	001 L X±	2V = Sm. Green: X<Z	436
1.61	Very weak		Penninite	Sil.	001 L Z±	2V = Sm. Green: X>Z	281
1.61	.015±		Amesite	Sil.	001 L Z±	2V = Sm. G. = 2.8	285
1.61	1.613	1.610	Eudalite	Sil.	001 L Z	Yellow, etc. X<Z	417
1.61	.04±		MUSCOVITE	Sil.	001 L X±	2V = 45°±	267
1.61	.04±		Phengite	Sil.	001 L X±	2V = Sm.	267
1.61	Very weak		Delessite	Sil.	001 L X±	2V = Sm. Green: X<Z	282
1.61	1.612	1.605	Hillebrandite	Sil.	110	Z = c. 2E = 70°±. Sol. HCl.	408
1.61	Very weak		Ripidolite	Sil.	001 L Z±	2V = Sm. Green: X>Z	284
1.61	1.617	1.607	Topaz	Sil.	001 L Z	2V = 65±°. G. = 3.5	198
1.61	Very weak		Metatorbernite	Phos.	001 L Z±	2V = Sm. X = blue, Z = green	145
1.61	Weak		Diabantite	Sil.	001 L X±	2V = Sm. Green: X<Z	283
1.611	1.651	1.610	Pseudowollast.	Sil.	001 L Z±	2V = Sm. G. = 2.905	402
1.612	1.621	1.592	Herderite	Phos.	Z∧c = -3°	Y = b. 2V = 74°	134
1.612	1.612	1.607	Fluocerite	Hal.	001 L X	G. = 6. Yellow	33
1.613	1.619	1.609	Stokesite	Sil.	110 at 38°	X = a. Y = b. 2V = 70°	409
1.613	1.649	1.602	Anapaite	Phos.	101, 010	Tr. 2V = 53°	128
1.613	1.613	1.593	Meliphanite	Sil.	001 L X	Tet. Yellow: X<Z	210
1.613	1.624	1.600	Tremolite	Sil.	110 at 56°	Y = b. Z∧c = 17°. 2V = 85°	245
1.614	1.630	1.607	Montebrazite	Phos.	001, 100	2V = 80±°. G. = 3±	152
1.614	Weak		Francolite	Phos.	X = c	Also biax. G. = 3.1	161
1.614	1.616	1.594	Phosphophyllite	Phos.	100, 010	Y∧a = 50°. Z = b. 2V = 50°±	125
1.615	1.615	1.575	Meionite	Sil.	100. X = c	G. = 2.8	297
1.615	1.636	1.614	Hemimorphite	Sil.	110 at 76°	X = b. Z = c. 2V = 46°	211
1.617	1.655	1.588	Kyanotrichite	Sul.	X = a; Z = c	2V = 83°. Blue: X<Z	116
1.617	.02		Fremontite	Phos.	001 L X±	Tr.? 2V = Lg.	152
1.618	1.618	1.611	Fluocerite	Hal.	001 L X	G. = 6. Yellow	33

¹ E. S. Larsen: *Am. Mineral.*, XIII, 1928, p. 354.

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—continued

N_o or N_m +	N_o or N_p or $N_o - N_p$	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.56	1.56	<i>Nepouite</i>	Sil.	001 $\perp$ X $\pm$	$2V = 0^\circ \pm$. X = gr., Z = yel.	279
1.585	1.585	<i>Nontronite</i>	Sil.	001 $\perp$ X $\pm$	Z $\parallel$ fib. X = yel., Z = green	415
1.59	1.597	<i>Anthophyllite</i>	Sil.	110 at 56°	Y = b. Z = c. $2V = 85^\circ \pm$	240
1.59	1.597	<i>Kupfferite</i>	Sil.	110 at 56° . Y = b	Z $\wedge$ c = 11° . $2V = 85^\circ \pm$. Gr.	244
1.59	Weak	Prochlorite	Sil.	001 $\perp$ Z. Y = b	$2V = \text{Sm}$. Green: X > Z	284
1.59	1.555	BIOTITE	Sil.	001 $\perp$ X. Y = b	$2V = 0^\circ \pm$. Br. or gr.: X < Z	272
1.59	.04 $\pm$	<i>Protolithionite</i>	Sil.	001 $\perp$ X $\pm$	$2V = 0^\circ \pm$. X = yel., Z = br.	270
1.598	1.592	<i>Dahlite</i>	Phos.	Z $\parallel$ fib.	X = c. Sol. HCl	161
1.622	1.593	Chondrodite	Sil.	X $\wedge$ a = $26^\circ \pm$	Z = b. $2V = 80^\circ \pm$	196
1.607	Weak	<i>Euclite</i>	Sil.	0001 $\perp$ X	Yellow, etc.: X > Z	417
1.609	.025 $\pm$	Glauconite	Sil.	001 $\perp$ X $\pm$	$2V = \text{Sm}$. Green: X < Z	436
1.61	Very weak	Ripidolite	Sil.	001 $\perp$ Z $\pm$	$2V = \text{Sm}$. Green: X > Z	284
1.61	1.617	Topaz	Sil.	001 $\perp$ Z	$2V = 65^\circ$. G. = 3.5	198
1.61	Very weak	<i>Metatorbernite</i>	Phos.	001 $\perp$ Z $\pm$	$2V = \text{Sm}$. X = blue, Z = green	145
1.613	Very weak	Diabantite	Sil.	001 $\perp$ X $\pm$	$2V = \text{Sm}$. Green: X < Z	283
1.614	1.624	Tremolite	Sil.	110 at 56° . Y = b	Z $\wedge$ c = 17° . $2V = 85^\circ \pm$	245
1.618	Weak	<i>Francolite</i>	Phos.	X = c	Also biax. G. = 3.1	161
1.618	1.613	Pargasite	Sil.	110 at 56°	Y = b. Z $\wedge$ c = $25^\circ \pm$. $2V = 60^\circ \pm$	248
1.618	1.618	<i>Chalcophylite</i>	Phos.	0001 $\perp$ X	Yellow, green: X < Z	136
1.62	Weak	Prochlorite	Sil.	001 $\perp$ Z $\pm$	G. = 2.5. Green	284
1.62	1.61	<i>Kupfferite</i>	Sil.	110 at 56°	$2V = \text{Sm}$. Green: X > Z	244
1.62	1.65	<i>Turquois</i>	Phos.	110. Tric.	Z $\wedge$ c = $12^\circ \pm$. $2V = 80^\circ \pm$. Yel., green: X < Z	157
1.62	1.654	<i>Churchite</i>	Phos.	One $\perp$ Z	$2V = 40^\circ$. Blue; pleo.	156
1.62	1.649	<i>Camselite</i>	Bor.	X $\parallel$ elong.	$2V = 0^\circ \pm$. Sol. HCl	91
1.620	1.637	<i>Afuillite</i>	Sil.	001; Y = b	$2V = \text{Lg}$.	412
1.62	.02 $\pm$	<i>Kreuzbergite</i>	Phos.	oro?	X $\wedge$ c = 30° . $2V = 55^\circ$ Y = c? $2V = 90^\circ \pm$	141

1.620	1.630	1.620	Goyazite	Phos.	0001 $\perp$ Z	Brown: $X > Z$	153
1.62	1.63	1.61	Cumingtonite	Sil.	110 at 55°	$Y = b$, $Z \wedge c = 15^\circ \pm$, $2V = 90^\circ \pm$	243
1.620	.015 $\pm$		Wollastonite	Sil.	100, 001	Yellow: $X < Z$	401
1.621	1.621	1.619	Gillespite	Sil.	0001 $\perp$ X	Hex.? Red: $X > Z$	401
1.622	1.638	1.618	Arakawaite	Phos.	$Z \wedge c = -36^\circ$	$2V = 38^\circ$. Green	138
1.623	1.631	1.622	Celestine	Sul.	001, 110, 010	$X = c$. $2V = 51^\circ$. $G = 4.0$	99
1.623	1.631	1.621	Uranopilite	Sul.	$X \perp$ lath. $\pm$	$2V = Sm$, Yellow	117
1.623	1.623	1.610	Uranocircite	Phos.	001 $\perp$ X	$2V = 10^\circ$. Yellow: $X < Z$	147
1.623	1.623	1.620	Merrillite	Phos.	1010. $X = c$	Also biax. +?	149
1.623	1.623	1.602	Bazzite	Sil.	$X = c$	Hex. $X = blue$, $Z = yellow$	414
1.624	1.645	1.615	Prehnite	Sil.	001 $\perp$ Z	$X = a$, $2V = 66^\circ \pm$. Sol. HCl	430
1.624	1.652	1.617	Humite	Sil.	$X = a$; $Z = b$	$2V = 68^\circ$. Yellow: $X > Z$	197
1.625	1.71	1.615	Bisbeeite	Sil.	$Z \parallel$ elong.	$2V = Sm$. Colorless or $X = brown$, $Z = green$	411
1.625	Weak		Gorceixite	Phos.	Rhom.?	$G = 3.1$	153
1.625	1.665	1.615	Destinezite	Sul.	$Z \wedge$ elong. $= 16^\circ$	$2V = Sm$.	121
1.625	1.637	1.614	Parahopeite	Phos.	010; $X = a \pm$	Tr. $2V = 90^\circ \pm$	128
1.625	.025 $\pm$		Tremolite	Sil.	110 at 56°	$Y = b$, $Z \wedge c = 15^\circ$. $2V = 85^\circ \pm$	245
1.625	Strong		Actinolite	Phos.	001; 010 $\perp$ X	$2V = Lg$. $X = green$, $Z = br$.	156
1.626	.025 $\pm$		Roscherite	Sil.	110 at 56°	$Y = b$, $Z \wedge c = 15^\circ$. $2V = 85^\circ \pm$. $X = yellow$, $Z = green$	245
1.626	1.626	1.608	Bazzite	Sil.	$X = c$	Hex. $X = blue$, $Z = yellow$	414
1.627	Weak		Francolite	Phos.	$X = c$	Also biax. Sol. HCl	161
1.627	1.627	1.582	Troegerite	Phos.	001 $\perp$ X	Also biax. Yellow	147
1.628	Weak		Metatorbernite	Phos.	001 $\perp$ Z	Abn. int. colors	145
1.629	1.639	1.629	Goyazite	Phos.	0001 $\perp$ Z	Colorless or brown: $X > Z$	153
1.63	1.630	1.620	Margarite	Sil.	001 $\perp$ X $\pm$	$2V = Sm$. -67° . $G = 3$	288
1.63	Very weak		Ripidolite	Sil.	001 $\perp$ Z $\pm$	$2V = Sm$. Green: $X > Z$	284
1.63	Very weak		Diabantite	Sil.	001 $\perp$ X $\pm$	$2V = Sm$. Green: $X < Z$	283
1.63 $\pm$	.037		Nepontite	Sil.	001 $\perp$ X $\pm$	$2V = Sm$. Green: $X < Z$	279
1.63 $\pm$	1.635	1.629	Fibrolite	Sil.	010 $\perp$ X	$2V = 30^\circ \pm$. Fibrous	200

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—continued

N_o or N_m +	N_o or $N_o - N_p$	N_p	Mineral	Chem.	Cleavage, Opt. Orient.	Other Characters	Page
1.585	1.585	1.560	<i>Nontronite</i>	Sil.	oor $\perp$ X $\pm$	Z $\parallel$ fib. X = yel., Z = green	415
1.59	1.597	1.584	<i>Anthophyllite</i>	Sil.	110 at 56°	Y = b, Z = c. $2V = 85^\circ \pm$	240
1.59	1.59	1.555	BIOTITE	Sil.	oor $\perp$ X. Y = b	$2V = 0^\circ \pm$. Br. or gr.: X < Z	272
1.598	.04 $\pm$		<i>Protolithionite</i>	Sil.	oor $\perp$ X $\pm$	$2V = 0^\circ \pm$. X = yel., Z = br.	270
1.606	1.598	1.592	<i>Dahlite</i>	Phos.	Z $\parallel$ fib.	X = c. Sol. HCl	161
1.607	1.622	1.593	<i>Chondrodite</i>	Sil.	X $\wedge$ a = $26^\circ \pm$	Z = b. $2V = 80^\circ \pm$	196
1.609	Weak		<i>Eucolite</i>	Sil.	oor $\perp$ X	Yellow, etc. X > Z	417
1.61	.025 $\pm$		<i>Glauconite</i>	Sil.	oor $\perp$ X $\pm$	$2V = \text{Sm. Green: X} < \text{Z}$	436
1.618	1.617	1.607	<i>Topaz</i>	Sil.	oor $\perp$ Z	$2V = 65^\circ$. G. = 3.5	198
1.618	1.633	1.613	Pargasite	Sil.	110 at 56°	$2V = 25^\circ \pm$. $2V = 60^\circ \pm$. Yellow, green: X < Z	248
1.62	1.618	1.552	<i>Chalcophyllite</i>	Phos.	oor $\perp$ X	G. = 2.5. Green	136
1.62	1.63	1.61	<i>Cummingtonite</i>	Sil.	110 at 55°	Y = b. $2V = 15^\circ \pm$. $2V = 90^\circ \pm$. Yellow: X < Z	243
1.620	.015 $\pm$		Wollastonite	Sil.	100, 001	X $\wedge$ c = 32° . Y = b. $2V = 40^\circ$	401
1.624	1.645	1.615	<i>Phehnite</i>	Sil.	oor $\perp$ Z	X = a. $2V = 66^\circ \pm$. Sol. HCl	430
1.624	1.652	1.617	<i>Humite</i>	Sil.	X = a. Z = b 110 at 56°	$2V = 68^\circ$. Yellow: X > Z	197
1.625	.025 $\pm$		Actinolite	Sil.	oor $\perp$ X $\pm$	$2V = 15^\circ$. $2V = 80^\circ \pm$. X = yellow, Z = green	245
1.629	1.630	1.620	<i>Margarite</i>	Sil.	oor $\perp$ X $\pm$	$2V = \text{Sm. } -67^\circ$. G. = 3	288
1.630	1.630	1.585	<i>Troegerite</i>	Phos.	oor $\perp$ X	$2V = \text{Sm. Yellow}$	147
1.63	1.638	1.625	<i>Celadonite</i>	Sil.	oor $\perp$ X $\pm$	$2V = \text{Sm. Green: X} < \text{Z}$	436
1.63	.02 $\pm$		<i>Bityte</i>	Sil.	oor $\perp$ X	Ps. Hex. $2V = \text{Sm.}$	427
1.63	1.64	1.62	<i>Carpholite</i>	Sil.	oor $\perp$ X	Z = c. $2V = 60^\circ \pm$. Yellow: X > Z	431
1.63	.09 $\pm$		<i>Stilpnomelane</i>	Sil.	oor $\perp$ X $\pm$	$2V = \text{Sm. Gr. or br.: X} < \text{Z}$	435
1.63	.02 $\pm$		Tourmaline (Mg)	Sil.	X = c	Colorless or brown: X < Z. Insol.	301
1.63	Very weak		<i>Aphrosiderite</i>	Sil.	oor $\perp$ X $\pm$	$2V = \text{Sm. Green: X} < \text{Z}$	284
1.631	1.638	1.629	<i>Topaz</i>	Sil.	oor $\perp$ Z	$2V = 48^\circ$. G. = 3.55	198
1.632	1.632	1.575	<i>Chalcophyllite</i>	Phos.	oor $\perp$ X	G. = 2.5. Green	136

1.632	1.640	1.631	<i>Picropharmacolite</i>	Phos.	oto $\perp$ Y; 100	X $\wedge$ c = 37°. 2V = 40°	125
1.632	1.639	1.603	<i>Lazulite</i>	Phos.	X $\wedge$ c = -9°	Y = b. 2V = 60°. Blue: X < Z	154
1.632	1.632	1.630	<i>Apatite (F)</i>	Phos.	X = c	White or tinted: X > Z	129
1.632	1.632	1.602	<i>Beminite</i>	Sil.	oo1 $\perp$ X	Y = b. 2V = 0°. Yellow: X < Z	409
1.633	1.635	1.621	<i>Wollastonite</i>	Sil.	100, oo1	X $\wedge$ c = 32°. Y = b. 2V = 40° ±	401
1.633	1.639	1.629	<i>Andalusite</i>	Sil.	110 at 89°	X = c. 2V = 84°. Red ±: X > Z	201
1.633	1.639	1.633	<i>Akermanite</i>	Sil.	110 at 90°	Z = c. Tet. Gel. HCl	209
1.633	1.636	1.630	<i>Danburite</i>	Sil.	X = b, Y = c	2V = 88° ±	210
1.633	1.634	1.627	<i>Daktilite</i>	Phos.	Z $\parallel$ fib.	X = c. Sol. HCl	161
1.633	1.657	1.613	<i>Protolithonite</i>	Sil.	oo1 $\perp$ X ±	2V = 0° ±. Brown: X < Z	270
1.634	1.635	1.615	<i>Sklodowskite</i>	Sil.	oo1 $\perp$ Y	2V = Ig. Yellow: X < Z	441
1.635	1.644	1.623	<i>Tourmaline (Li)</i>	Sil.	X = c	Colorless or X < Z. Insol.	301
1.635	1.660	1.631	<i>Gedrite</i>	Sil.	110 at 56°	X = a; Z = c. 2V = 79°. Insol.	240
1.636	1.639	1.602	<i>Schizolite</i>	Sil.	100 $\perp$ Y ±; oo1	Tr. 2E = 83°	420
1.636	1.639	1.602	<i>Grandidierite</i>	Sil.	100 $\perp$ X; oo1 $\perp$ Z	2V = 30°. Blue: Y < Z	421
1.637	1.644	1.609	<i>Inesite</i>	Sil.	oto $\perp$ X ±; 100	2V = 60°. Pink; pleo.	413
1.637	1.648	1.636	<i>Danburite</i>	Sil.	X = b; Y = c	2V = 88° ±	210
1.637	1.637	1.581	<i>Barite</i>	Sul.	oo1, 110	X = c. 2V = 38°. Insol.	100
1.638 ±	1.639	1.621	<i>Ekmannite</i>	Sil.	X $\perp$ oo1 ±	Brown: X < Z	281
1.64	1.65	1.625	<i>Glaucophanite</i>	Sil.	110 at 56°	Z $\parallel$ fib. 2V = 48° ±	258
1.640	1.645	1.640	<i>Actinolite</i>	Sil.	110 at 56°	Z $\wedge$ c = 15°. 2V = 80° ±.	245
1.64	1.66	1.64	<i>Akermanite</i>	Sil.	110 at 90°	X = yellow, Z = green	209
1.64	1.66	1.64	<i>Spanbergite</i>	Sul.	oo1 $\perp$ Z	Z = c. Tet. Gel. HCl	119
1.64	1.697	1.640	<i>Rooblingite</i>	Sil.	X $\parallel$ fib.	Rhom. Also biax.	440
1.64	1.697	1.640	<i>Barrandite</i>	Phos.	Z $\parallel$ fib.	2V = Sm. G. = 3.43	140
1.640	1.697	1.640	<i>Planchéite</i>	Sil.	Z $\parallel$ fib.	2V = 0°. Blue: X < Z	411
1.64 ±	Mod.?	1.640	<i>Chamosite</i>	Sil.	oo1 $\perp$ X	2V = Sm. Green: X < Z	286
1.64	1.62 ±	1.640	<i>Ermeyevite</i>	Bor.	Ps. Hex.	2V = Sm. G. = 3.28	94
1.64	1.63 ±	1.640	HORNBLLENDE	Sil.	110 at 56°	Y = b. Z $\wedge$ c = 20° ±. 2V = 80° ±.	247
1.64	1.63 ±	1.640	<i>Tourmaline (Fe)</i>	Sil.	X = c	X = yellow, Z = green	301
1.64	Weak	1.640	<i>Mellite</i>	Sil.	X or Z = c	Brown, green, blue: X < Z	208

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—continued

N_o or N_m +	N_o or $N_o - N_p$	N_p	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.585	1.585	1.560	<i>Nontzonite</i>	Sil.	$ooi \perp X \pm$	$Z \parallel \text{fib. } X = \text{yel.}, Z = \text{green}$	415
1.59	1.597	1.584	<i>Anthophyllite</i>	Sil.	110 at 56°	$Y = b, Z = c, 2V = 85^\circ \pm$	240
1.59	1.59	1.555	BIOTITE	Sil.	$ooi \perp X, Y = b$	$2V = 0^\circ \pm, \text{Br. or gr.: } X < Z$	272
1.606	1.622	1.593	<i>Chondrodite</i>	Sil.	$X \wedge a = 26^\circ \pm$	$Z = b, 2V = 80^\circ \pm$	196
1.607	Weak		<i>Euclite</i>	Sil.	$oooi \perp X$	Yellow, etc.: $X > Z$	417
1.609	.025 $\pm$		<i>Glauconite</i>	Sil.	$ooi \perp X \pm$	$2V = \text{Sm. Green: } X < Z$	436
1.618	1.633	1.613	Pargasite	Sil.	110 at 56°	$Z \wedge c = 25^\circ \pm, 2V = 90^\circ \pm,$ Yellow, green: $X < Z$	248
1.62	1.63	1.61	<i>Cummingtonite</i>	Sil.	110 at 55°	$Z \wedge c = 15^\circ \pm, 2V = 90^\circ \pm,$ Yellow: $X < Z$	243
1.624	1.645	1.615	<i>Prehnite</i>	Sil.	$ooi \perp Z$	$X = a, 2V = 66^\circ \pm, \text{Sol. HCl}$	430
1.624	1.652	1.617	<i>Humite</i>	Sil.	$X = a, Z = b$	$2V = 68^\circ, \text{Yellow: } X > Z$	197
1.629	1.630	1.620	<i>Margarite</i>	Sil.	$ooi \perp X \pm$	$2V = \text{Sm. } -67^\circ, G. = 3$	288
1.63	.09 $\pm$		<i>Stilpnomelane</i>	Sil.	$ooi \perp X \pm$	$2V = \text{Sm. Gr. or br.: } X < Z$	435
1.63	.02 $\pm$		Tourmaline (Mg)	Sil.	$X = c$	Colorless or brown: $X < Z,$ Insol.	301
1.63	Very weak		<i>Aphrosiderite</i>	Sil.	$ooi \perp X \pm$	$2V = \text{Sm. Green: } X < Z$	284
1.632	1.632	1.630	Apatite (F)	Phos.	$X = c$	Colorless or tinted: $X < Z$	128
1.632	1.632	1.602	<i>Bementite</i>	Sil.	$ooi \perp X$	$Y = b, 2V = 0^\circ \pm,$ Yellow: $X < Z$	409
1.633	1.639	1.629	<i>Andalusite</i>	Sil.	110 at 89°	$X = c, 2V = 84^\circ, \text{Red } \pm: X > Z$	201
1.635	1.635	1.615	Tourmaline (Li)	Sil.	$X = c$	Colorless or tinted: $X < Z$	301
1.64	.02 $\pm$		HORNBLende	Sil.	110 at 56°	$Y = b, Z \wedge c = 20^\circ \pm, 2V = 80^\circ \pm,$ $X = \text{yellow}, Z = \text{green}$	247
1.64	.03 $\pm$		Tourmaline (Fe)	Sil.	$X = c$	Brown, green, blue: $X < Z$	301
1.64	Weak		Melilite	Sil.	X or $Z = c$	Abnor. int. colors	208
1.64	.02		<i>Barrandite</i>	Phos.	$Z \parallel \text{fib.}$	$2V = \text{Lg. } G. = 2.6 \pm$	140
1.641	1.652	1.633	<i>Fairfeldite</i>	Phos.	010, 100	Tr Sol. HCl	127
1.642	1.647	1.584	<i>Serpierite</i>	Sul.	$ooi \perp X$	$2V = 35^\circ, \text{Green: } X < Z$	102
1.642	1.665	1.632	<i>Prehnite</i>	Sil.	$ooi \perp Z$	$X = a, 2V = 65^\circ \pm, G. = 2.9$	430
1.643	1.645	1.632	<i>Margarite</i>	Sil.	$ooi \perp X$	$2V = \text{Sm. } G. = 3.0-3.1$	288

1.643	1.643	1.634	<i>Eucrite</i>	Sil.	001 $\perp$ X	Colorless or X > Z	417
1.643	.035 $\pm$		Humite	Sil.	X = a; Z = b	2V = 68° $\pm$. Yel. $\pm$: X > Z	197
1.643	1.623	1.643	<i>Zennerite</i>	Phos.	001 $\perp$ X	2V = 0° $\pm$. Green: X < Z	146
1.644	1.640	1.647	<i>Andalusite</i>	Sil.	110 at 89°	X = c; Z = a. 2V = 85°.	201
1.644	1.636	1.654	<i>Fairfieldite</i>	Phos.	010, 100	Tr. G. = 3.1. Sol. HCl	127
1.644	1.642	1.697	<i>Diopase</i>	Sil.	010, 100	Also biax. Green: X > Z	186
1.645	1.644	1.654	Mullite	Sil.	010, 100	2V = 50° $\pm$. Pink $\pm$: X < Z	235
1.645	1.635	1.663	Chondrodite	Sil.	X $\wedge$ a = 26°; Z = b	2V = 80° $\pm$. Yellow: X < Z	196
1.646	1.612	1.645	Glauconite	Sil.	001 $\perp$ X $\pm$	2V = Sm. Green: X < Z	436
1.648	1.630	1.649	<i>Gastaldite</i>	Sil.	110 at 56°	$\lambda_{\text{D}} = 64\frac{1}{2}\mu$. 2V = 43° $\pm$.	259
1.648	1.643	1.648	<i>Apatite (F)</i>	Phos.	X = c	Colorless or X > Z	128
1.648	1.643	1.674	<i>Reddingite</i>	Phos.	010 $\perp$ Y; Z = c	2V = 41°. Brown: X < Y	124
1.649	1.646	1.658	<i>Mosandrite</i>	Sil.	100 $\perp$ Z $\pm$	2V = 74°. Brown	423
1.649	1.585	1.660	<i>Herengrundite</i>	Sul.	001, 110	X = c $\pm$. Z = b. 2V = 39	104
1.65	Very weak		Aphrosiderite	Sil.	001 $\perp$ X $\pm$	2V = Sm. Green: X < Z	284
1.65	1.63	1.65	Tourmaline (Li)	Sil.	X = c	Colorless or X > Z	301
1.65 $\pm$	.03 $\pm$		<i>Barrandite</i>	Phos.	Z $\parallel$ fib.	2V = Sm. G. = 3.43	140
1.65 $\pm$	.01 $\pm$		<i>Hollandite</i>	Sil.	Z $\wedge$ c = -44°	X = b. 2V = 80° $\pm$. Brown	425
1.65	1.625	1.655	<i>Nontzonite</i>	Sil.	001 $\perp$ X $\pm$	Z $\parallel$ fib. X = yel., Z = green	415
1.65	1.624	1.65	<i>Bementite</i>	Sil.	001 $\perp$ Z	X = b. 2V = 0° $\pm$.	409
1.65	1.628	1.655	Iddingsite	Sil.	001 $\perp$ Z	Yellow: X < Z.	437
1.65	1.575	1.65	<i>Seabelyite</i>	Bor.	100 $\perp$ X; 001 $\perp$ Z	2V = 40° $\pm$. Brown: X < Z	92
1.650	1.610	1.682	<i>Epistiotite</i>	Sil.	Acicular	G. = 2.76-3.0	442
1.65	1.645	1.656	<i>Koninkite</i>	Phos.	001 $\perp$ Z $\pm$	Y = b. 2V = 80°. G. = 2.89	142
1.65	.01		<i>Aurilit</i>	Ox.	X $\parallel$ fib.	Tet. Yellow	185
1.65	1.62	1.65	<i>Friedelite</i>	Sil.	Z = c	2V = 0° $\pm$. Pink $\pm$	408
1.65	1.64	1.66	<i>Allanite</i>	Sil.	001 $\perp$ X	2V = Ig. Green: X < Z	316
1.65	Very weak		<i>Apatite (Cl)</i>	Phos.	Y = b	Colorless or X > Z	128
1.65	Very weak		Daphnite	Sil.	X = c	2V = 0° $\pm$. Green: X < Z	285
1.65	.01 $\pm$		Thuringite	Sil.	001 $\perp$ X $\pm$	2V = 0° $\pm$. Green: X < Z	285

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—continued

N_o or N_m + —	N_o | N_p or $N_o - N_p$	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.59	1.597	Anthophyllite	Sil.	110 at 56°	$Y = b$, $Z = c$, $2V = 85^\circ \pm$	240
1.59	1.59	BIOTITE	Sil.	oor $\perp$ X, $Y = b$	$2V = 0^\circ \pm$, Brown or green: $X < Z$	272
1.618	1.555	Pargasite	Sil.	110 at 56°	$2V = 25^\circ$, $2V = 60^\circ \pm$, Yellow, green, $X < Z$	248
1.62	1.613	Cummingtonite	Sil.	110 at 55°	$Z \wedge c = 90^\circ$, $2V = 80^\circ \pm$, Yellow, $X < Z$	243
1.63	1.61	Stilpnomelane	Sil.	oor $\perp$ X $\pm$	$2V = 8m$, Green or brown: $X < Z$	435
1.63	.00 $\pm$	Tourmaline (Mg)	Sil.	$X = c$	Colorless or brown: $X < Z$	301
1.63	.02 $\pm$	HORNBLende	Sil.	110 at 56°	Insol. $Z \wedge c = 20^\circ \pm$, $2V = 80^\circ \pm$, $X = \text{yellow}$, $Z = \text{green}$	247
1.64	.03 $\pm$	Tourmaline (Fe)	Sil.	$X = c$	Brown, green, blue: $X < Z$	301
1.64	Weak	Meliite	Sil.	X or $Z = c$	Abnor. int. colors	208
1.644	1.654	Mullite	Sil.	oor $\perp$ Y, $Z = c$	$2V = 50^\circ \pm$, Pink $\pm$: $X < Z$	201
1.646	1.630	Gastaldite	Sil.	110 at 56°	$Z \wedge c = 0^\circ \pm$, $2V = 43^\circ \pm$	259
1.648	1.674	Reddingite	Phos.	oor $\perp$ Y, $Z = c$	$2V = 41^\circ$, Brown: $X < Z$	124
1.65	1.643	Friedelite	Sil.	oor $\perp$ X	$2V = 0^\circ \pm$, Pink $\pm$	408
1.65	1.62	Allanite	Sil.	$Y = b$	$2V = 1g$, Green: $X < Z$	316
1.65	1.64	Apatite (Cl)	Phos.	$X = c$	Colorless or $X > Z$	128
1.65	Very weak	Daphnite	Sil.	oor $\perp$ X $\pm$	$2V = 0^\circ \pm$, Green: $X < Z$	285
1.65	Very weak	Thuringite	Sil.	oor $\perp$ X $\pm$	$2V = 0^\circ \pm$, Green: $X < Z$	285
1.65	.01 $\pm$	Eosphorite	Phos.	oor $\perp$ Y	$2V = 40^\circ$, Pleo. $X > Z$	156
1.651	1.629	Forsterite	Sil.	oor $\perp$ X	$2V = 85^\circ$, Gel. HCl	188
1.652	1.670	Liroconite	Phos.	$Z \wedge c = -25^\circ$	$X = b$, $2V = 67^\circ$, Blue	157
1.653	1.675	Plumbogummite	Phos.	Gumlike	$2V = 0^\circ$, Yellow: $X < Z$	153
1.653	1.650	Messelite	Phos.	One	$2V = \text{Mod.}$, $G = 3$	128
1.653	1.644	ENSTATITE	Sil.	110 at 88°	$X = a$; $Z = c$, $2V = 31^\circ - 90^\circ$	217
1.653	1.658	Datolite	Sil.	$Z \wedge c = 4^\circ$; $Y = b$	$2V = 74^\circ$, Gel. HCl	424
1.654	1.670	Phenakite	Sil.	1120; $Z = c$	$G = 3.0$, Insol.	185
1.654	1.654	Rhabdophamite	Phos.	$Z \parallel \text{fib.}$	$2V = 0^\circ$, Sol. HCl	139

1.654	1.660	1.651	Clinoenstatite	Sil.	110 at 88°	Y = b. Z $\wedge$ c = 22°. 2V = 54°	220
1.654	1.659	1.62	Cabrerite	Phos.	oro $\perp$ X	Z $\wedge$ c = 33°. 2V = 90° $\pm$	127
1.654	1.660	1.647	Huraulite	Phos.	100; X = b	Z $\wedge$ c = +75°. 2V = 74°	124
1.655	.015 $\pm$		Jadeite	Sil.	110 at 87°	Y = b. Z $\wedge$ c = 35°. 2V = 70°	235
1.655	1.655	1.650	Wilhelite	Sil.	X = c	Hex. G. = 3.23	440
1.655	1.655	1.63	Tourmaline (Mg)	Sil.	X = c	Colorless or brown: X < Z.	301
1.655	1.671	1.651	Euclase	Sil.	oro $\perp$ Y	Z $\wedge$ c = +41°. 2V = 50°	432
1.656	1.662	1.655	Uranocalcite	Sul.	Z $\parallel$ fib.	2V = Sm. Green: X < Z	117
1.656	1.660	1.652	Paluite	Phos.	Mono.	2V = Lg. G. = 3.2	124
1.657	1.683	1.651	Reddingite	Phos.	oro $\perp$ Y	Z = c. 2V = 41°	124
1.657	.02 $\pm$		Gastaldite	Sil.	110 at 56°	Z $\wedge$ c = 8°. 2V = 43° $\pm$.	259
1.657	1.714	1.649	Natrochalcite	Sul.	oor; Y = b	Z $\wedge$ c = 12°. 2V = 37°. Gr.	112
1.657	1.658	1.646	Scyberite	Sil.	oor $\perp$ X $\pm$	2V = Sm. Yellow: X < Z	286
1.658	1.684	1.640	Leucosphenite	Sil.	oro $\perp$ Z	Y $\wedge$ c = 3°. 2V = 77°	418
1.658	1.695	1.640	Veselyite	Phos.	Tric.?	2V = 71°. Blue	138
1.658	1.687	1.622	Annabergite	Phos.	oro $\perp$ X	Z $\wedge$ c = 36°. 2V = 84°	127
1.658	1.658	1.486	CALCITE	Carb.	101; X = c	Eferv. HCl. G. = 2.72	71
1.657	1.677	1.657	Sillimanite	Sil.	oro $\perp$ Y; Z = c	2V = 30°. Colorless or X < Z	200
1.66 $\pm$	.02 $\pm$		Pargasite	Sil.	110 at 56°	Y = b. Z $\wedge$ c = 25°. 2V = 70°.	248
1.66 $\pm$	.015 $\pm$		Jadeite	Sil.	110 at 87°	Colorless or X < Z.	235
1.66	1.670	1.655	Salmonsite	Phos.	Two. Z $\parallel$ fib.	2V = Lg. Yellow: X < Z	156
1.660	1.672	1.650	Triphite	Phos.	100. Z $\wedge$ a = 42°	2V = Lg. Pink: X > Z	134
1.660	1.715	1.645	Planchéite	Sil.	Z $\parallel$ fib.	2V = Mod. Blue: X < Z	411
1.66	Weak		Ferromite	Phos.	X = c	G. = 3.5. Sol. HCl	130
1.66	1.69	1.63	Sicavartite	Phos.	oro	2V = Lg. Yellow: X < Z	128
1.660	1.675	1.640	Tilasite	Phos.	Z $\wedge$ c = -30°	X = b. 2V = 82°	134
1.660	1.601	1.649	Xanthophyllite	Sil.	oor $\perp$ X $\pm$	2V = Sm. X = br., Z = gr.	286
1.66	.02 $\pm$		Pigeonite	Sil.	110 at 87°	Z $\wedge$ c = 35° $\pm$. 2V = 8m.	222
1.66	Weak		Crossite	Sil.	110 at 56°	X = 70°. 2V = 8m.	259
1.661	1.688	1.645	Leucosphenite	Sil.	oro $\perp$ Z	Y $\wedge$ c = 3°. 2V = 77°	418

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—continued

N_o or N_m + —	N_o or $N_o - N_p$	N_p	Mineral	Chem.	Cleavage Opt. Orient.	Other Characters	Page
1.59	1.597	1.584	Anthophyllite	Sil.	110 at 56°	$Y=b$. $Z=c$. $2V=85^\circ \pm$	240
1.59	1.59	1.555	BIOTITE	Sil.	oor $\perp$ X. $Y=b$	$2V=0^\circ$. Br. or gr.; $X<Z$	272
1.62	1.63	1.61	Cummingtonite	Sil.	110 at 55°	$Z/\Delta c=15^\circ \pm$. $2V=90^\circ \pm$. Yellow: $X<Z$.	243
1.63	.09 $\pm$		Stilpnomelane	Sil.	oor $\perp$ X $\pm$	$2V=8$ Sm. Green or brown:	435
1.64	.02 $\pm$		HORNBLLENDE	Sil.	110 at 56°	$X/\Delta c=20^\circ \pm$. $2V=80^\circ \pm$	247
1.64	.03 $\pm$		Tourmaline (Fe)	Sil.	X=c	$X/\Delta c=20^\circ \pm$. $2V=80^\circ \pm$ $X=b$ yellow. Z = green	301
1.64	Weak		Melilite	Sil.	X or Z=c	Brown, green, blue: $X<Z$	208
1.65	1.654	1.642	Mullite	Sil.	oor $\perp$ Y. $Z=c$	$2V=50^\circ \pm$. Pink $\pm$: $X<Z$	201
1.65	1.65	1.62	Friedelite	Sil.	oor $\perp$ X	$2V=0^\circ \pm$. Pink $\pm$	408
1.65	1.66	1.64	Allanite	Sil.	Y=b	$2V=Lg$. Green: $X<Z$	316
1.65	Very weak		Apatite (Cl)	Phos.	X=c	Colorless or $X>Z$	128
1.65	Very weak		Daphnite	Sil.	X=c	$2V=0^\circ \pm$. Green: $X<Z$	285
1.65	.01 $\pm$		Thuringite	Sil.	oor $\perp$ X $\pm$	$2V=0^\circ \pm$. Green: $X<Z$	285
1.651	1.658	1.629	Eosphorite	Phos.	oor $\perp$ Y	$2V=40^\circ$. Pleo.: $X>Z$	156
1.653	1.670	1.635	Forsterite	Sil.	oor $\perp$ X	$2V=85^\circ \pm$. Gel. HCl	188
1.654	1.658	1.650	ENSTATITE	Sil.	110 at 88°	$X=a$. $Z=c$. $2V=31^\circ-90^\circ$	217
1.654	1.660	1.651	Clinoenstatite	Sil.	110 at 88°	$Y=b$. $Z/\Delta c=22^\circ$. $2V=54^\circ$	220
1.658	1.658	1.486	CALCITE	Carb.	1011. $X=c$	Efferv. HCl. G. = 2.72	71
1.66	1.677	1.657	Sillimanite	Sil.	oor $\perp$ Y. $Z=c$	$2V=30^\circ$. Colorless or $X<Z$	200
1.66	.02 $\pm$		Pigeonite	Sil.	110 at 87°	$Z/\Delta c=35^\circ \pm$. $2V=8$ Sm. Tinted $\pm$.	222
1.662	1.671	1.658	Crossite	Sil.	110 at 56°	$X/\Delta c=70^\circ \pm$. $2V=8$ Sm. Blue: $X<Z$	259
1.662	1.727	1.629	Dickinsonite	Phos.	oor $\perp$ Y $\pm$	$X=b$. $2V=Mod$. Green: $X>Z$	122
1.662	?	1.645	Lindackerite	Sul.	oor $\perp$ Y	$X/\Delta c=26^\circ$. $2V=73^\circ$. Gr.	121
1.662	1.669	1.626	Soddiite	Ox.	Y=b. $Z=c$	$2V=?$. Yellow	61
1.662	1.668	1.651	Erythrite	Arsen.	oor $\perp$ X	$Z/\Delta c=32^\circ$. $2V=90^\circ \pm$	127
1.662	1.668	1.651	Monticellite	Sil.	X=b. $Y=a$	$2V=75^\circ$. Gel. HCl	187
1.663	?	1.632	Clinohumite ¹	Sil.	oor; $Z=b$	$2V=76^\circ$. Yellow: $X<Y$	197
1.664	1.664	1.629	Friedelite	Sil.	oor $\perp$ X	Also biax. Pink: $X<Z$	408

1.664	1.666	1.516	Strontianite	Carb.	110 at 63°	X = c, Z = a, 2V = 11°	81
1.665	Weak		Mellite	Sil.	X or Z = c	Abn. int. colors	208
1.665	1.669	1.642	Eosphorite	Phos.	100 ⊥ Y	x = b 2V = 40°. Pink: X < Z	156
1.665	.035		Forsterite	Sil.	010 ⊥ X	2V = 85° ±. Gel. HCl	188
1.665	1.676	1.660	Spodumene	Sil.	110 at 87°	ZΛc = +28° ±. 2V = 60° ±. Green or lilac: X > Z	236
1.666	.035+		CHRYSOI. (Olivine)	Sil.	010 ⊥ X; 100 ⊥ Z	2V = 90° ±. Gel. HCl	189
1.666	1.673	1.661	<i>Johnstrupite</i>	Sil.	100 ⊥ Z ±	2V = 70°. Lam. twin.	423
1.666	1.669	1.643	<i>Uranophane</i>	Sil.	One ⊥ X	ZΛb = 2V = 40°. Yellow: X < Z. Abn. int. colors	441
1.666	1.673	1.663	Lithiophilite	Phos.	001 ⊥ Y; 010 ⊥ Z	2V = 60° ±. Pink: X > Z	149
1.667	.001 ±		Apatite (Cl)	Phos.	X = c	Colorless or X > Z	128
1.667	1.673	1.662	Boracite	Bor.	III	2V = 83°. Comp. twin.	94
1.668	1.681	1.665	<i>Rinkite</i>	Sil.	100, X = b	YΛc = -8°. 2V = 43°. Yellow: X < Z	423
1.667	1.667	1.490	<i>Plumbocalcite</i>	Carb.	1011	X = c	72
1.668	1.702	1.635	<i>Symplectite</i>	Arsen.	010 ⊥ X	ZΛc = +32°. 2V = 87°. Green: X > Z	126
1.669	1.689	1.650	<i>Luclumite</i>	Phos.	001, Y = b	ZΛc = 67°. 2V = 82°. Green	137
1.669	1.669	1.658	<i>Gehlenite</i>	Sil.	X = c	G. = 3. Gel. HCl	209
1.67	1.682	1.661	Mullite	Sil.	010 ⊥ Y, Z = c	2V = 50°. Pink ±: X < Z	201
1.67 ±	.01 ±		Clinostatite	Sil.	110 at 87°	ZΛc = 25° ±. 2V = 50° ±. G. = 3.19	220
1.67	1.684	1.661	Sillimanite	Sil.	010 ⊥ Y; Z = c	2V = 30°. Colorless or X < Z	200
1.67	Weak		<i>Crossite</i>	Sil.	110 at 56°	XΛc = 70° ±. 2V = 8m. Blue: X < Z	259
1.67	.014		<i>Lothrite</i>	Sil.	One; Y = b?	2V = 18° ±. Green in mass	433
1.670	1.689	1.670	<i>Hinsdalite</i>	Sul.	0001 ⊥ Z	Also biax. G. = 4.65	119
1.670	.01		<i>Clinohedrite</i>	Sil.	010 ⊥ Z	YΛc = -28°. 2V = Lg.	413
1.670	1.670	1.582	<i>Ekmannite</i>	Sil.	001 ⊥ X ±	G. = 2.79. Green: X < Z	281
1.67 ±	1.67	1.65	<i>Strigovite</i>	Sil.	001 ⊥ X ±	2V = 0° ±. Green: X < Z	437
1.670	1.670	1.657	<i>Justite</i>	Sil.	X = c	Tet. In slags	209
1.671	1.694	1.664	DIOPSIDE	Sil.	110 at 87°	ZΛc = 39°. 2V = 60°. Insol.	224
1.671	1.691	1.662	<i>Manganandalusite</i>	Sil.	110 at 89°	X = a, Z = c, 2V = 71°. X = yellow, Y = green	202
1.671	?	?	<i>Uranotile</i>	Sil.	100 ⊥ X	2V = ? Yellow	441
1.671	1.672	1.526	<i>Alstonite</i>	Carb.	010 ⊥ Y?	2V = 7°	79

¹ E. S. Larsen: *Am. Mineral.*, XIII, 1928, p. 354, gives N_m as low as 1.638 for clinohumite.

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—continued

N_o or N_m +	N_o or $N_o - N_p$	N_p or $N_p - N_p$	Mineral	Chem.	Cleavage, Opt. Orient.	Other Characters	Page
1.59	↑ 1.597	1.584	Anthophyllite	Sil.	110 at 56°	$Y = b$, $Z = c$, $2V = 85^\circ \pm$	240
1.59	1.59	1.555	BIOTITE	Sil.	oor $\perp$ X.	$Y = b$, $2V = 0^\circ$. Brown or green: $X < Z$.	272
1.62	1.63	1.61	Cumingtonite	Sil.	110 at 55°	$Z/\Delta c = 15^\circ \pm$, $2V = 90^\circ \pm$.	243
1.63	.09 $\pm$		<i>Stilpnomelane</i>	Sil.	oor $\perp$ X $\pm$	$2V = 84^\circ$. Green or brown: $X < Z$.	435
1.64	.02 $\pm$		HORNBLende	Sil.	110 at 56°	$Y = b$, $Z/\Delta c = 20^\circ \pm$, $2V = 80^\circ \pm$.	247
1.65	.03 $\pm$		Tourmaline (Fe)	Sil.	$X = c$	$X = \text{yellow}$, $Z = \text{green}$.	301
1.65	1.66	1.64	Allanite	Sil.	$Y = b$	Brown, green, blue: $X < Z$.	316
1.65	Very weak		Daphnite	Sil.	oor $\perp$ X $\pm$	$2V = 0^\circ \pm$. Green: $X < Z$.	285
1.65	.01 $\pm$		Thuringite	Sil.	oor $\perp$ X $\pm$	$2V = 0^\circ \pm$. Green: $X < Z$.	285
1.653	1.658	1.650	ENSTATITE	Sil.	110 at 88°	$X = a$, $Z = c$, $2V = 31^\circ - 90^\circ$.	217
1.658	1.658	1.486	CALCITE	Carb.	10 $\bar{1}$ 1. $X = c$	Efferv. HCl. G. = 2.72	71
1.66	.02 $\pm$		Pigeonite	Sil.	110 at 87°	$Z/\Delta c = 35^\circ \pm$, $2V = 8m$.	222
1.663	? 1.652		Clinohumite	Sil.	oor. $Z = b$	$2V = 76^\circ$. Yellow: $X < Y$.	197
1.665	.035 $\pm$		CHRYSol. (Olivine)	Sil.	oio $\perp$ X; 100 $\perp$ Z	$2V = 90^\circ \pm$. Gel. HCl	189
1.666	1.673	1.663	Lithiophilite	Phos.	oor $\perp$ Y; oio $\perp$ Z	$2V = 60^\circ \pm$. Pink: $X > Z$.	149
1.669	1.689	1.650	Ludlumite	Phos.	oor. $Y = b$	$Z/\Delta c = -67^\circ$, $2V = 82^\circ$.	137
1.67	1.694	1.664	DIOPSIDE	Phos.	oor. $Y = b$	Green	224
1.672	1.676	1.672	Fillowite	Sil.	110 at 87°	$Z/\Delta c = 39^\circ$, $2V = 60^\circ$. Insol.	123
1.672	1.771	1.672	Parisite	Phos.	oor	$2V = Sm$. Sol. HCl	85
1.673	1.672	1.661	Hardystonite	Carb.	oor $\perp$ Z	Colorless or yellow: $X < Z$.	209
1.673	1.682	1.665	Triplite	Sil.	oor $\perp$ X	G. = 3.4. Gel. HCl	134
1.673	1.698	1.664	Clinohumite	Phos.	100; $Y = b$	$Z/\Delta c = 42^\circ$, $2V = 1g$.	197
1.673	1.685	1.631	Dunungite	Sil.	oor; $Z = b$	$2V = 70^\circ$. Yellow: $X > Y$.	151
1.674	1.685	1.664	Kornerupine	Arsen.	110 at 70°	$X/\Delta c = -25^\circ$, $Z = b$, $2V = 57^\circ$.	421
1.674	1.674	1.631	Lawsonite	Sil.	110 at 81°	Yellow: $X > Z$.	430
1.674	1.684	1.665	Jadinite-diopside	Sil.	oio $\perp$ Y; oor $\perp$ Z	or $X = \text{yellow}$, $Z = \text{green}$.	421
1.674 $\pm$	1.688	1.666		Sil.	110 at 87°	$2V = 84^\circ$. Blue $\pm$: $X > Z$.	235

1.674	1.684	1.671	<i>Natrophilite</i>	Phos.	001 $\perp$ Y; 010 $\perp$ Z	2V = 72°. Yellow	150
1.674	1.699	1.663	<i>Spodiosite</i>	Phos.	010	2V = 69°. Sol. HCl	135
1.674	1.676	1.662	<i>Bustamite</i>	Sil.	010, 110, 110	X $\perp$ 010 $\pm$. 2V = 44°	406
1.674	1.679	1.640	<i>Spurrite</i>	Sil.	001 $\perp$ Y $\pm$	2V = 40°. Lam. twin.	442
1.675	1.684	1.665	HORNBLLENDE	Sil.	110 at 56°	Y = b. Z = 20° $\pm$. 2V = 80° $\pm$.	247
1.675	1.697	1.653	<i>Ludlamite</i>	Phos.	001. Y = b	X = yellow, Z = green.	442
1.675	1.689	1.661	<i>Liskeardite</i>	Arsen.	010 $\perp$ X	ZAc = -87°. 2V = 82° $\pm$. Green	137
1.675	1.675	1.59	<i>Chloromagnesite</i>	Hal.	0001 $\perp$ X	2V = Lg. G. = 3. Insol.	142
1.675	1.675	1.636	<i>Pyrosmalite</i>	Sil.	0001 $\perp$ X	Deliques.	32
1.676	1.677	1.529	<i>Witherite</i>	Carb.	010 $\perp$ V. X = c	Green $\pm$; X < Z	408
1.677	1.677	1.665	<i>Kornerupine</i>	Sil.	110 at 81°	2V = 16°. Ps. Hex. twin.	81
1.678	1.702	1.669	<i>Tiandinhumite</i>	Sil.	X $\wedge$ a = -8°	X = c. Y = a. 2V = 20°. Colorless or X = yellow, Z = green.	421
1.678	1.684	1.643	<i>Childrenite</i>	Sil.	X = b; Y = a	Z = b. 2E = 120°. Gel. HCl	198
1.679	1.679	1.502	DOLOMITE (Mg)	Phos.	1011. X = c	2V = 45°. G. = 3.2. Sol. HCl	155
1.68	1.70	1.66	ENSTATITE	Carb.	110 at 88°	G. = 2.87. Efferv. HCl	73
1.68	Very weak	1.66	<i>Cumingtonite</i>	Sil.	110 at 55°	X = a; Z = c. 2V = 90° $\pm$	217
1.68	01 $\pm$	1.678	<i>Daphnite</i>	Sil.	001 $\perp$ X $\pm$	Y = b. ZAc = 15°. 2V = 80° $\pm$	243
1.68	1.683	1.678	<i>Thuringite</i>	Sil.	001 $\perp$ X $\pm$	2V = Sm. Green: X < Z	285
1.680	1.685	1.680	<i>Harsigite</i>	Sil.	X = c; Y = b	2V = Sm. Green: X < Z	285
1.680	Strong	1.620	<i>Florencite</i>	Phos.	0001 $\perp$ Z	2V = 52°. G. = 3.05	432
1.680	Strong	1.620	<i>Erythrosiderite</i>	Hal.	X = a. Y = c	Yellow $\pm$. G. = 3.59	142
1.680	Strong	012 $\pm$	ZIPPEITE	Sil.	010 $\perp$ X	Yellow. Deliques.	35
1.68	1.70	1.66	OXHOENBLLENDE	Sil.	110 at 56°	ZAc = 35° $\pm$. 2V = Lg.	110
1.68	1.683	1.667	HYPERSTHENE	Sil.	110 at 88°	Yellow: X < Z. 2V = 80° $\pm$.	252
1.68	1.684	1.671	<i>Grunerite</i>	Sil.	110 at 56°	Brown: X < Z. 2V = 80° $\pm$.	219
1.68	1.70	1.66	<i>Cenosite</i>	Sil.	One	X = a; Z = c. 2V = 80° $\pm$.	242
1.681	1.685	1.530	<i>Aragonite</i>	Carb.	010, 110	ZAc = 15° $\pm$. 2V = 80° $\pm$.	440
1.681	1.684	1.671	<i>Prismatine</i>	Sil.	110 at 81°	X = reddish, Z = greenish.	79
1.682 $\pm$	1.717	1.662	<i>Koeditzite</i>	Arsen.	010 $\perp$ X	Yellow: X < Z	421
1.683	1.70	1.61	<i>Roscolite</i>	Sil.	001 $\perp$ X $\pm$	2V = Mod. Yellow	127
1.684	1.686	1.525	<i>Baryocalcite</i>	Carb.	110 at 73°	X = c. Z = b. 2V = 18°. Efferv. HCl	270

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—continued

N_o or N_m +	N_o or N_p or $N_o - N_p$	Mineral	Chem.	Cleavage, Opt. Orient.	Other Characters	Page
1.59	1.597	Anthophyllite	Sil.	110 at 56°	$Y=b, Z=c. 2V=85^\circ \pm$	240
1.59	1.59	BIOTITE	Sil.	oor $\perp X$	$Y=b. 2V=0.$	272
1.63	1.555	<i>Stilpnomelane</i>	Sil.	oor $\perp X \pm$	Brown or green: $X < Z$ $2V=Sm.$ Green or brown: $X < Z$	435
1.64	.09 $\pm$	Tourmaline (Fe)	Sil.	$X=c$	Brown, green, blue: $X < Z$	301
1.65	.03 $\pm$	Allanite	Sil.	$Y=b$	$2V=Lg.$ Green: $X < Z$	316
1.658	1.64	CALCITE	Carb.	1011. $X=c$	Efferv. HCl. $G=2.72$	71
1.66	1.658	Pigeonite	Sil.	110 at 87°	$Z/\Delta c=35^\circ \pm. 2V=Sm.$ Tinted $\pm$	222
1.665	.02 $\pm$	CHRYSOI. (Olivine)	Sil.	oor $\perp X; 100 \perp Z$	$2V=90^\circ \pm.$ Gel. HCl	189
1.666	.035 $\pm$	Lithiophilite	Phos.	oor $\perp Y; 100 \perp Z$	$2V=60^\circ \pm.$ Pink: $X > Z$	149
1.671	1.673	DIOPSIDE	Sil.	110 at 87°	$Y=b. Z/\Delta c=39^\circ. 2V=80^\circ$	224
1.679	1.694	DOLOMITE (Mg)	Carb.	1011. $X=c$	Efferv. HCl. $G=2.87$	73
1.680	1.502	<i>Zippelite</i>	Sul.	oor $\perp X$	$Z/\Delta c=35^\circ \pm. 2V=Lg.$ X yellow: $X < Z$	110
1.68	1.720	OXYHORNBLEND	Sil.	110 at 56°	Brown: $X < Z. 2V=80^\circ \pm.$	252
1.68	Strong	HYPERSTHENE	Sil.	110 at 88°	$X=a. Z=c. 2V=80^\circ \pm.$ X = reddish, Z = greenish	219
1.68	.012 $\pm$	Grunerite	Sil.	110 at 56°	$Z/\Delta c=15^\circ \pm. 2V=80^\circ \pm.$ Brown: $X < Z$	242
1.684	1.70	Dumortierite	Sil.	100 $\perp Z$	$2V=30^\circ \pm.$ Blue, etc. $X > Z$	422
1.685	.01 $\pm$	Lithiophilite	Phos.	oor $\perp Y; 100 \perp Z$	$2V=40^\circ \pm.$ Pink: $X > Z$	149
1.685	1.689	Aznite	Sil.	112, 010	$2V=73^\circ \pm. X, Z$ = yellow, Y = violet	425
1.685	1.695	Barylite	Sil.	oor $\perp Z$	$2V=65^\circ. G=4$	401
1.686	.01 $\pm$	Triphylite	Phos.	oor $\perp Y$ or X	$2V=Var.$ Sol. HCl	149
1.687	1.698	<i>Tilano-elpidite</i>	Sil.	110	$X=b, Y=c. 2V=Mod.$	400
1.687	1.698	<i>Trichalcite</i>	Arsen.	$Y \parallel$ elong.	$X=b, Z/\Delta c=-13^\circ. 2V=60^\circ.$	124
1.687	1.711	<i>Rosenbuschite</i>	Sil.	oor	Yellow: $X < Z. 2V=60^\circ.$	419
1.687	1.709	Aegirinaugite	Sil.	110 at 87°	$Z/\Delta c=65^\circ \pm. 2V=65^\circ \pm.$ X = green, Y = yellow	232
1.687 $\pm$	Weak	Riebeckite	Sil.	110 at 56°	X = blue, Z = green	257
1.687	1.690	<i>Shrooekingierite</i>	Carb.	oor $\perp X$	$2V=40^\circ.$ Yellow: $X < Z$	86

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—continued

N_o or N_m + —	N_o or N_p or $N_o - N_p$	Mineral	Chem.	Cleavage, Opt. Orient.	Other Characters	Page
1.65	1.66	Allanite	Sil.	$Y = b$	$2V = Lg.$ Green: $X < Z$	316
1.68	Strong	OXYHORNBLÉNDE	Sil.	110 at 56°	$Z\Delta c = Sm.$ $2V = 80^\circ \pm$. Brown: $X < Z$	252
1.68	.012 $\pm$	HYPERSTHENE	Sil.	110 at 88°	$X = a$, $Z = c$. $2V = 90^\circ \pm$. $X = reddish$, $Z = greenish$	219
1.68	1.70 | 1.66	Grunerite	Sil.	110 at 56°	$Z\Delta c = 15^\circ \pm$. $2V = 80^\circ \pm$. Brown: $X < Z$	242
1.685	.01 $\pm$	Triphylite	Phos.	001 $\perp$ Y or X	$2V = Var.$ Sol. HCl	149
1.687	1.709 | 1.680	Aegirinaugite	Sil.	110 at 87°	$Z\Delta c = 65^\circ \pm$. $2V = 65^\circ \pm$. $X = green$, $Z = yellow$	232
1.69	1.71 | 1.685	AUGITE	Sil.	110 at 87°	$Z\Delta c = 45^\circ \pm$. $2V = 60^\circ$. Tinted $\pm$	228
1.69	.005 $\pm$	Arfvedsonite	Sil.	110 at 56°	$X = Sm.$ $Z = b$. $2V = Lg.$ $X = blue-green$, $Z = gray$	257
1.696	1.702 | 1.696	Zoisite	Sil.	010 $\perp$ Y or X	$2V = Sm.$ Abn. int. colors	311
1.7 $\pm$	.012	Hainite	Sil.	010 $\perp$ Z $\pm$	$2V = Lg.$ Yellow: $X < Z$	406
1.700	1.708 | 1.698	Pumpellyite	Sil.	010 $\perp$ X	$Y = b$. Green: $X < Y$	432
1.700	1.735 | 1.629	Ancylite	Carb.	$X = a$; $Z = c$	$2V = 66^\circ$. Green, etc.	87
1.70+	1.712 | 1.635	Sussexite	Bor.	$X \parallel fib.$	$2V = Sm.$ $G. = 3.1$	91
1.70	1.700 | 1.599	Magnesite	Carb.	1011, $X = c$	Efferv. HCl. $G. = 2.96$	75
1.70	1.72 | 1.695	Saite	Sil.	110 at 87°	$Z\Delta c = 42^\circ \pm$. $2V = 60^\circ \pm$. Insol.	227
1.70	1.70 | 1.52	Ankerite	Carb.	1011, $X = c$	Efferv. HCl. $G. = 3 \pm$	73
1.70	1.72 | 1.68	Hyalosiderite	Sil.	010 $\perp$ X; 100 $\perp$ Z	$2V = 80^\circ \pm$. Gel. HCl	189
1.701	1.704 | 1.693	Tizzenite	Sil.	100 $\perp$ X $\pm$	$2V = 63^\circ$. Green: $X > Z$	428
1.702	1.706 | 1.700	Zoisite	Sil.	010 $\perp$ Y or X	$2V = Sm.$ Colorless or $X = pink$, $Z = yellow$	311
1.703	1.733 | 1.678	Asrophyllite	Sil.	010 $\perp$ X	$2V = 75^\circ$. Yellow: $X > Z$	417
1.703	1.706 | 1.701	Serendibite	Sil.	None	$2V = 90^\circ \pm$. $X = yellow$, $Z = blue$	425
1.704	1.704 | 1.679	Schallerite	Sil. +	One $\perp$ X	$2V = 0^\circ$. $G. = 3.37$	440
1.705	1.705 | 1.701	Vesuvianite	Sil.	110 at 90°	$2V = 0^\circ$. Colored $\pm$	207
1.705	1.724 | 1.700	Graftonite	Phos.	$X = b$	$2V = 55^\circ \pm$. $G. = 3.67$	122
1.705	1.713 | 1.660	Tarbutite	Phos.	001	$2V = 50^\circ$. Sol. HCl	135
1.706	1.706 | 1.698	Swabite	Arsen.	$X = c$	$2V = 0^\circ$. Sol. HCl	129
1.707	1.708 | 1.704	Sapphirine	Sil.	$Z\Delta c = 10^\circ \pm$	$Y = b$. $2V = 69^\circ$. Blue: $X < Z$	427

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—*continued*

N_o or N_m +	N_a or $N_g - N_p$	Mineral	Chem.	Cleavage Opt. Orient.	Other Characters	Page
1.65	1.66	Allanite	Sil.	$Y = b$	$2V = Lg.$ Green: $X < Z$	316
1.68	Strong	OXYHORNBLÉNDE	Sil.	110 at 56°	$Z \wedge c = 8m.$ $2V = 80^\circ \pm.$	252
1.687	1.709	Aegirinaugite	Sil.	110 at 87°	Brown: $X < Z.$	232
1.70	1.70	Ankerite	Carb.	1011. $X = c$	$Z \wedge c = 65^\circ \pm.$ $2V = 65^\circ \pm.$	73
1.70	1.72	Hyalosiderite	Sil.	1011. $X = c$	Efferv. HCl. $G = 3 \pm$	189
1.705	1.705	Vesuvianite	Sil.	0101X. 1001Z	$2V = 85^\circ \pm.$ Colored $\pm$	207
1.707	1.708	Sapphirine	Sil.	110 at 90°	$Y = b.$ $2V = 69^\circ.$ Blue: $X < Z$	427
1.707	1.707	Breunnerite	Carb.	$Z \wedge c = 10^\circ \pm$	Efferv. HCl	75
1.708	1.745	Strengite	Phos.	1011. $X = c$	$2V = Sm.$ Pink $\pm:$ $X < Z$	140
1.71	.01 $\pm$	Allanite?	Sil.	0011Z	$2V = Lg.$ Brown: $X < Z$	316
1.71	Weak	Sibiconite	Ox.	?	$G = 5.2.$ Insol.	68
1.715	1.718	Clinozoisite	Sil.	001. $X \wedge c = Sm.$	$2V = Lg.$ Tinted $\pm:$ $X < Z$	312
1.719	1.719	Iddingsite	Sil.	1001X; 0011Z	$2V = Var.$ Brown: $X < Z$	437
1.72	1.72	Mesitite	Carb.	1011. $X = c$	Efferv. HCl	75
1.722	1.824	Mangandolomite	Carb.	1011. $X = c$	Efferv. HCl. $G = 3.3 \pm$	73
1.722	1.750	Bastnäsité	Carb.	$Z = c.$ Hex.	$G = 5.0.$ Efferv. HCl	85
1.722	1.729	Diaspore	Ox.	0101Y	$2V = 84^\circ.$ Colorless or red $\pm:$	46
1.722	1.729	Kyanite	Sil.	0101X	$X > Z.$	205
1.722	1.731	Chloritoid	Sil.	0011Z $\pm$	$2V = 83^\circ.$ $H = 4$ to 7.5	438
1.723	1.723	Pyrochroite	Ox.	0011X	$2V = Mod.$ $X = gr., Y = bl.$	42
1.724	1.746	Connellite	Sul.	0001X	Brown $\pm:$ $X < Z$	118
1.725	1.738	Homilité	Sil.	$Z = c$	$G = 3.38.$ Blue	424
1.725	.01	Roselite	Arsen.	$Z = b.$ $Y = c \pm$	$2V = 80^\circ.$ Brown: $Y > Z$	127
1.725	Very weak	Sarcopside	Phos.	0011X $\pm$	Tr. $2V = Mod.$ Red: $X > Z$	134
1.725	1.738	Phosphosiderite	Phos.	001, 010	Mon. ? $G = 3.64$	142
1.726	1.746	Babingtonite	Sil.	0101Y	$X \wedge c = 4^\circ.$ $2V = 68^\circ.$	428
				110, 110	Red $\pm:$ $Y > Z.$	
					$2V = 60^\circ.$ $X = gr., Y = br.$	

Phos.	Triphloidiite	1.730	1.725	1.730	1.726	1.737
Arsen.	Tyrolite	1.730	1.694	1.730	1.726	1.738
Sil.	Rhodonite	1.730	1.721	1.730	1.726	1.738
Sil.	Picrotephroite	1.740	1.711	1.740	1.728	1.736
Arsen.	Adamite	.05				
Sil.	Gaioophyllite	1.730	1.705	1.730	1.729	1.735
Sil.	OXYHORNBLLENDE	1.76	1.69	1.76	1.73	1.735
Sil.	Ottrelite	.01				
Arsen.	Mixite	1.810	1.730	1.810	1.730	1.738
Sil.	Melanocerite	1.73	1.72	1.73	1.73	1.738
Sil.	Hedenbergite	1.745	1.725	1.745	1.733	1.738
Sil.	Piedmontite	1.75	1.72	1.75	1.733	1.738
Sil.	Jeffersonite	1.748	1.720	1.748	1.731	1.738
Sel.	Chalcocite	1.732	1.710	1.732	1.732	1.738
Phos.	Phosphidite	.05				
Phos.	Strengite	1.762	1.730	1.762	1.732	1.738
Sil.	Sapphirine	1.734	1.729	1.734	1.733	1.738
Ox.	Pyrochroite	.04				
Phos.	Hematite	1.733	1.714	1.733	1.733	1.738
Molyb.	Ferrimolybdate	1.87	1.72	1.87	1.733	1.738
C ₂ H ₂ O	Curite	2.07	1.557	2.07	1.734	1.738
Arsen.	Adamite	1.758	1.708	1.758	1.734	1.738
Sil.	Clinzoisite	.01				
Sul.	Conellite	1.758	1.735	1.758	1.735	1.738
Sil.	Hodgkinsonite	1.75	1.715	1.75	1.735	1.738
Phos.	Sicklerite	1.745	1.715	1.745	1.735	1.738
Sil.	PISTAC. (Epidote)	.03				
Sil.	Vesuvianite	1.736	1.732	1.736	1.736	1.738
Carb.	Hydrozincite	1.750	1.640	1.750	1.736	1.738
Sil.	Andlerite	1.785	1.730	1.785	1.738	1.738
Sil.	Shannonite	1.746	1.718	1.746	1.738	1.738

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—continued

N_o or N_m +	N_o or $N_o - N_p$	N_p or $N_p - N_p$	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.65	1.66	1.64	Allanite	Sil.	$Y = b$	$2V = \text{Lg.}$ Green: $X < Z$	316
1.687	1.709	1.680	Aegirinaugite	Sil.	110 at 87°	$Z \wedge c = 65^\circ \pm$. $2V = 65^\circ \pm$. $X = \text{green.}$ $Z = \text{yellow}$	232
1.70	1.70	1.52	Ankerite	Carb.	1011, $X = c$	Efferv. HCl. $G = 3 \pm$	73
1.70	1.72	1.68	Hyalosiderite	Sil.	010 $\perp$ X; 100 $\perp$ Z	$2V = 85^\circ \pm$. Gel. HCl	189
1.707	1.707	1.517	Breunnerite	Carb.	1011, $X = c$	Efferv. HCl	75
1.71	.01 $\pm$		Allanite?	Sil.	?	$2V = \text{Lg.}$ Brown: $X < Z$	316
1.71	.01 $\pm$		Stibiconite	Ox.	?	$G = 5.2$. Insol.	68
1.715	1.718	1.674	Iddingsite	Sil.	100 $\perp$ X; 001 $\perp$ Z	$2V = \text{Var.}$ Brown: $X < Z$	437
1.719	1.719	1.527	Mesitile	Carb.	1011, $X = c$	Efferv. HCl	75
1.72	1.72	1.53	Mangandolomite	Carb.	1011, $X = c$	Efferv. HCl. $G = 3.3 \pm$	73
1.722	1.731	1.720	Chloritoid	Sil.	001 $\perp$ Z $\pm$	$2V = \text{Mod.}$ $X = \text{green,}$ $Y = \text{blue}$	438
1.726	1.730	1.721	Rhodonite	Sil.	110, 110, 001	$2V = 76^\circ$. $G = 3.5 \pm$	403
1.730	1.810	1.730	Mixite	Arsen.	$Z = c$	$2V = \text{Sm.}$ Green	156
1.73	1.745	1.725	Hedenbergite	Sil.	110 at 87°	$Z \wedge c = 45^\circ \pm$. $2V = 60^\circ$. Green: $X < Z$	224
1.73	1.75	1.72	Piedmontite	Sil.	001, $Y = b$	$2V = 70^\circ$. $X = \text{yel.}, Z = \text{red}$	315
1.733	1.87	1.72	Ferrimolybdate	Molyb.	001 $\perp$ Z	$2V = 28^\circ$. Yellow: $X < Z$	108
1.735	.03 $\pm$		PISTAC. (Epidote)	Sil.	001, $Y = b$	$2V = \text{Lg.}$ Yellow: $X < Y$	314
1.738	1.744	1.731	Thalénite	Sil.	$Y = c \pm$; $Z = b$	$2V = 70^\circ \pm$. $G = 4.3 \pm$	414
1.74	.03 $\pm$		Aegirinaugite	Sil.	110 at 87°	$X \wedge c = 40^\circ \pm$. $2V = \text{Lg.}$ Green: $X > Z$	232
1.74	1.74	1.54	Ankerite	Carb.	1011, $X = c$	$G = 3.1$. Efferv. HCl	73
1.74	1.744	1.733	Rhodonite	Sil.	110, 110, 001	$2V = 76^\circ$. $G = 3.5$	403
1.74 $\pm$	1.775	1.735	Jadette-acmite	Sil.	110 at 87°	$X \wedge c = 5^\circ$. $2V = \text{Lg.}$	193
1.74 $\pm$	.01		Sismondine	Sil.	001 $\perp$ Z $\pm$	$2V = 50^\circ \pm$. $X = \text{green,}$ $Y = \text{blue}$	438
1.74	1.770	1.735	Molengraafite	Sil.	100 $\perp$ Y $\pm$	$2V = 28^\circ$. Yellow: $Y < Z$	244
1.74 $\pm$	Strong		Vilatite	Phos.	$Z = c?$	$2V = \text{Mod.}$ Pink: $X < Z$	140
1.740	1.744	1.655	Aurichalcite	Carb.	100 $\perp$ Y $\pm$	$2V = \text{Sm.}$ Green: $X < Z$	84

	Strong	<i>Melanovanadite</i>		Sul.	oio $\perp$ X ioi $\perp$, X=c	2V=Sm. Brown: X<Z Efferv. HCl	102
1.74+	1.74	<i>Ferrodolomite</i>		Carb.	ioi $\perp$, X=c		73
1.741	1.746	<i>Staurolite</i>		Sil.	oio $\perp$ X	2V=88°. Yellow: X<Z	202
1.742	1.765	<i>Scorodite</i>		Arsen.	X=b; Y=a	2V=Mod. Green, pleo.	139
1.745	1.757	<i>Hedenbergite</i>		Sil.	110 at 87°	2V=48°. 2V=60°. Green: X<Z	224
1.745	1.830	<i>Mixite</i>		Arsen.	Z=c	2V=Sm. Green	155
1.745	1.789	<i>Libellenite</i>		Phos.	X=b; Y=c	2V=83°. Green: Y>Z	132
1.748±	1.755	<i>Chrysoberyl</i>		Ox.	Y=b; Z=c	2V=60°±. G.=3.64	65
1.748	1.748	<i>Freirite</i>		Phos.	oio $\perp$ X	2V=0°. Blue: X<Z	151
1.75	1.77	<i>Hyalosiderite</i>		Sil.	oio $\perp$ X	2V=80°. Gel. HCl	189
1.75	1.75	<i>Mangandolomite</i>		Carb.	ioi $\perp$, X=c	Efferv. HCl. G.=3.3	73
1.75	1.75	<i>Brunnerite</i>		Carb.	ioi $\perp$, X=c	Efferv. HCl	75
1.750	1.75	<i>Laurenite</i>		Sil.	100	X $\wedge$ c=20°. 2V=80°. Yellow±: X<Z	420
1.75	1.788	<i>Lorenzenite</i>		Sil.	120. Z=b	2V=39°. Insol.	400
1.75	1.80	<i>Rutherfordite</i>		Carb.	?	G.=4.8. Yellow±	86
1.75	1.87±	<i>Hoelite</i>		H, C	X=c; Y=a	2V=Sm. G.=1.43	18
1.754	1.762	<i>Staurolite</i>		Sil.	oio $\perp$ X	2V=Lg. Golden: X<Z	202
1.754	1.764	<i>Caracolite</i>		Sul.	None	2V=Lg. Ps. Hex. twin.	120
1.755±	1.82	<i>Pyroxmangite</i>		Sul.	110 at 88°	Z $\wedge$ c=45°. 2V=30°. Yellowish	406
1.755	1.804	<i>Vegasite</i>		Sil.	101 $\perp$, Z=c	Yellow: X<Z	116
1.757	1.838	<i>Bemite</i>		Sil.	Z=c	Blue, etc. X<Z	212
1.758	1.730	<i>Azurite</i>		Carb.	100 $\perp$ Y±	2V=68°. Blue: X<Z	82
1.76	1.82	<i>Allanite?</i>		Sil.	?	Brown: X<Z	316
1.76	1.81	<i>Gloekerie</i>		Sul.	?	Brown, green	108
1.76	1.76	<i>Chalcodite</i>		Sil.	oio $\perp$ X±	2V=Sm. X=yel, Z=br.	435
1.76	1.63	<i>Cappelenite</i>		Sil.	X=c	Brown. Sol. HCl	420
1.760	1.760	<i>Cordylite</i>		Carb.	oio $\perp$ X	Colorless or yellow: X>Z	86
1.760	1.798	<i>Langite</i>		Sul.	oio $\perp$ X	2V=81°. Blue-gr.: X<Z	102
1.762	1.805	<i>Diktyrdite</i>		Phos.	X $\wedge$ c=+22°	2V=90°±. Green: X>Z	135
1.763	?	<i>Dewindtite</i>		Phos.	100 $\perp$ X	2V=Lg. Yellow	148
1.763	1.768	<i>Iddingsite</i>		Sil.	100 $\perp$ X; oio $\perp$ Z	2V=40°±. Brown: X<Z	437

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—continued

N_o or N_m + —	N_o or $N_o - N_p$	N_p	Mineral	Chem.	Cleavage, Opt. Orient.	Other Characters	Page
1.65	1.66	1.64	Allanite	Sil.	$Y=b$	$2V=Lg.$ Green: $X<Z$	316
1.71	.01±		Stibiconite	Ox.	?	$G=5.2.$ Insol.	68
1.719	1.719	1.527	Mesite	Carb.	$10\bar{1}1, X=c$	Efferv. HCl	75
1.722	1.731	1.720	Chloritoid	Sil.	$oor \perp Z \pm$	$2V=Mod.$ $X=green,$ $Y=blue$	438
1.73	1.75	1.72	Piedmontite	Sil.	$oor.$ $Y=b$	$2V=70.$ $X=yel., Z=red$	315
1.733	1.87	1.72	Ferrimolybdate	Molyb.	$oor \perp Z$	$2V=28°.$ Yellow: $X<Z$	108
1.735	.03±		PISTAC. (Epidote)	Sil.	$oor.$ $Y=b$	$2V=Lg.$ Yellow: $X<Y$	314
1.74	1.74	1.54	Ferrodolomite	Carb.	$10\bar{1}1, X=c$	Efferv. HCl	73
1.742	1.765	1.738	Scorodite	Arsen.	$X=b, Y=a,$ $oor \perp X \pm$	$2V=Mod.$ Green: pleo.	139
1.76	1.76	1.63	Chalcodite	Sil.	None, $X=c$	$2V=Sm.$ $X=yel., Z=br.$	435
1.768	1.768	1.760	Corundum	Ox.	$oor \perp Z \pm$	Tinted±: $X<Z$	43
1.77	.016±		Chloritoid	Sil.	$oor; Y=b$	$2V=50° \pm.$ $X=green,$ $Y=blue$	438
1.77	1.82	1.76	Piedmontite	Sil.	$Z=c$	$2V=55° \pm.$ Brown: $X<Z$	315
1.77	.01		Stibiconite	Ox.	$Z=c$	$G=5.2.$ Insol.	68
1.77	1.78	1.73	PISTAC. (Epidote)	Sil.	$oor.$ $Y=b$	$2V=75° \pm.$ $X, Z=greenish,$ $Y=golden$	314
1.77	Strong		Nordenskiöldite	Bor.	$oor \perp X$	Yellow±	95
1.770	1.785	1.698	Holdenite	Phos.	$Y=b, Z=a$	$2V=30°.$ $G=4$	136
1.77	1.79	1.765	Conichalcite	Arsen.	$Z \parallel fib.$	$2V=25°.$ $X=yel., Z=gr.$ $X\Delta c=5° \pm.$ $2V=69° \pm.$	136
1.77	1.782	1.745	Acmite	Sil.	110 at $87°$	Brown or green: $X>Z$	234
1.771	1.782	1.751	Leucophenicite	Sil.	One $\perp X$	$2V=74°.$ Pink±	412
1.772	1.772	1.763	Corundum	Ox.	$X=c$	Tinted±: $X<Z$	43
1.772	1.772	1.770	Swedenborgite	Antim.	$oor \perp X$	$G=4.29.$ Insol.	149
1.773	1.807	1.729	Margarosanite	Sil.	oro. Tric.	$2V=83°.$ $G=4.0$	406
1.774	1.783	1.770	Barthite	Arsen.	None	$2V=Mod.$ $G=4.2$	160
1.774	1.83	1.770	Taramallite	Sil.	$Z \parallel fib.$	$2E=76°.$ Brown: $X<Z$	427
1.776	1.795	1.758	Orientite	Sil.	$X=a; Y=c$	$2V=67°.$ Brown: $X>Z$	432
1.778	1.790	1.760	Leucophenicite	Sil.	One $\perp X$	$2V=74°.$ Pink±	412

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—continued

N_o or N_m + —	N_o | N_p or $N_o - N_p$	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.77	1.782	Acmite	Sil.	110 at 87°	$X \wedge c = 5^\circ \pm$. $2V = 69^\circ \pm$. Br. or gr. $X < Z$	234
1.785	1.747	<i>Olivenite</i>	Arsen.	$X = a$; $Y = c$	$2V = \text{Lg.}$ Green	132
1.785	1.57	<i>Pistomesite</i>	Carb.	1011. $X = c$	Efferv. HCl. $G. = 3.4$	75
1.788	1.787	Monazite	Phos.	001 $\perp$ $Z \pm$	$2V = \text{Sm.}$ Yellow: $X < Y$	138
1.79	.015 $\pm$	<i>Ardennite</i>	Sil.	010 $\perp$ Y	$2V = \text{Var.}$ Yellow: $X > Z$	440
1.8 $\pm$	.01	<i>Thorite</i>	Ox.	110 at 90°	$Z = c$. $G. = 5.3$. Yellow	185
1.80 $\pm$	Strong	<i>Cronstedtite</i>	Sil.	001 $\perp$ $X \pm$	$2V = 0^\circ \pm$. $X = \text{brown}$, $Z = \text{green}$	285
1.80	1.72	<i>Ferriungstite</i>	Tung.	$Z \parallel \text{fib.}$	Hex. Yellow $\pm$	107
1.80	1.765	<i>Cornelite</i>	Phos.	$X = a$; $Y = c$	$2V = 30^\circ \pm$. Blue	132
1.80	1.585	<i>Rhodochrosite</i>	Carb.	1011. $X = c$	$G. = 3.7 \pm$. Efferv. HCl	77
1.801	1.800	Monazite	Phos.	001 $\perp$ $Z \pm$	$2V = \text{Sm.}$ Yellow: $X < Y$	138
1.801	1.783	<i>Flintkile</i>	Arsen.	$Y = c$; $Z = a$	$2V = \text{Lg.}$ $X = \text{green}$, $Z = \text{brown}$	154
1.807	1.79	<i>Leucochalcite</i>	Arsen.	$Z = c?$	$2V = \text{Lg.}$ Rare	136
1.809	1.806	<i>Warwickite</i>	Bor.	100 $\perp$ Z	$2V = 59^\circ$. Brown: $X > Z$	95
1.81	1.772	<i>Olivinite</i>	Arsen.	$X = a$; $Y = c$	$2V = 82^\circ$. Green	132
1.81 $\pm$	.030	<i>Törnebohmite</i>	Sil.	?	$2V = 30^\circ$. Olive; pleo.	414
1.81	1.788	<i>Hancockite</i>	Sil.	001	$2V = 50^\circ \pm$. $X = \text{pink}$, $Y = \text{brown}$	316
1.81	1.74	<i>Carphosiderite</i>	Sul.	0001 $\perp$ X	$G. = 2.6 \pm$. Yellow $\pm$	107
1.81	1.78	<i>Knebelite</i>	Sil.	010 $\perp$ X	$2V = 55^\circ \pm$. Gel. HCl	193
1.815 $\pm$	1.81 $\pm$	<i>Cornwallite</i>	Arsen.	$Y \parallel \text{fib.}$	$2V = \text{Sm.}$ Green	136
1.85	1.775	<i>Pascoite</i>	Van.	010 $\perp$ X	$2V = 50^\circ$. $X = \text{yellow}$, $Z = \text{orange}$	160
1.815	1.761	<i>Molybdophyllite</i>	Sil.	0001 $\perp$ X	$G. = 4.72$. Rare	407
1.817	1.715	<i>Jarosite</i>	Sul.	0001 $\perp$ X	Also biax. Yellow	114
1.818	1.821	<i>Cerite</i>	Sil.	None	$2V = 25^\circ$. Reddish $\pm$	422
1.82	1.84	Acmite	Sil.	110 at 87°	$X \wedge c = +5^\circ \pm$. $2V = 60^\circ$. Gr. or br. $X > Z$	234
1.82	1.78	<i>Pistomesite</i>	Carb.	1011. $X = c$	$G. = 3.4 \pm$. Efferv. HCl	75

1.82	Jarosite	Sul.	0001 X	G. = 3.2. Yellow	114
1.82	Carphosiderite	Sul.	0001 X	G. = 2.6±. Yellow	107
1.82	Sideroplesite	Carb.	1011. X = c	G. = 3.7±. Efferv. HCl	75
1.827	Iddingsite	Sil.	1001 X	2V = 80°. Brown: X < Z	437
1.83	Rhodochrosite	Carb.	1011. X = c	G. = 3.7±. Efferv. HCl	77
Strong	Carminite	Arsen.	110. Z = c?	G. = 4.1. Red	154
1.83	Oligonite	Carb.	1011. X = c	G. = 3.8±. Efferv. HCl	154
1.83	Beaverite	Sul.	X = c	G. = 4.36. Yellow	115
1.831	Higginsite	Arsen.	X = a; Z = c	2V = 90°±. Green; pleo.	132
1.832	Natrojarosite	Sul.	0001 X	G. = 3.18. Yellow: X < Z	114
1.838	Linarite	Sul.	100, 001	2V = 80°. Blue: X < Z	104
1.84	Knebelite	Sil.	0101 X	2V = 55°±. Gel. HCl	193
1.840	Laurarite	Iod.	011; Y = b	2V = 90°±. Sol. HCl	89
1.840	Dufrenite	Phos.	0101 X	2V = 90°±. X = brown, Z = green	142
1.845	Tagilite	Phos.	010; X = c±	2V = Sm. Green	137
0.03	Chalcosiderite	Phos.	0101 X±	2V = 24°. Green: X < Z	157
1.857	Heterosite	Chrom.	001 X	2V = Lg. X = brown, Z = violet	141
1.849	Dietzite	Carb.	1001 X±	2V = 86°. Yellow	121
1.840	Smithsonite	Phos.	1011. X = c	G. = 4.3. Efferv. HCl	78
1.846	Kraurite	Sil.	0101 X	2V = 28°. X = yellow, Z = brown or gr.	142
1.848	Iddingsite	Ox.	1001 X	2V = 75°±. Brown: X < Z	437
1.848	Högbomite	Bor.	X = c	G. = 3.8. Brown: X < Z	65
1.98	Ludwigite	Ox.	Z || fib.	2V = Sm. X = green, Z = brown	94
1.86	Zircon (alt.)	Sil.	Poor	Tet. G. = 4.2. Gray	183
1.86	Fayalite	Ox.	0101 X	2V = 50°±. Gel. HCl	192
1.853	Högbomite	Carb.	X = c	G. = 3.8. Brown: X < Z	65
1.855	Spherochalcite	Carb.	1011. X = c	G. = 4.1. Efferv. HCl	78
1.86	Sideroplesite	Carb.	1011. X = c	G. = 3.7±. Efferv. HCl	75
1.86	Oligonite	Arsen.	One 1 Z	G. = 3.8±. Efferv. HCl	76
1.88	Erinite	Carb.	0101 X	2V = Mod. Green	133
1.880	Atacamite	Cu, OH, Cl	0101 X	2V = 75°. Green: X < Z	38

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—continued

N_o or N_m + —	N_o | N_p or $N_o - N_p$	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.79	1.83 | 1.79	<i>Ardennite</i>	Sil.	010 $\perp$ Y	2V = Var. Yellow: X > Z	440
1.83	1.86 | 1.82	<i>Beaverite</i>	Sul.	X = c	G. = 4.36. Yellow	115
1.84	1.92 $\pm$ 1.85 $\pm$	<i>Heterosite</i>	Phos.	001 $\perp$ X	2V = Lg. X = brown, Z = violet	141
1.85	1.86 | 1.62	<i>Fayalite</i>	Sil.	010 $\perp$ X	2V = 50°. Gel. HCl	192
1.86	1.87 | 1.83 $\pm$	<i>Purpurite</i>	Phos.	001 $\perp$ X	2V = 38°. X = gray, Z = red	141
1.866	1.909 | 1.818	<i>Siderite</i>	Carb.	101 $\bar{1}$. X = c	G. = 3.85. Efferv. HCl	76
1.87	1.87 | 1.83 $\pm$	<i>Caledonite</i>	Sul.	001 $\perp$ Z	2V = 85°. Green: Y < Z	120
1.87	1.88 | 1.750	<i>Beaverite</i>	Sul.	X = c	G. = 4.36. Yellow $\pm$	115
1.87	1.90 | 1.86	<i>Becquerelite</i> *	Ox.	001 $\perp$ X	2V = Sm. Yellow: X < Z	60
1.870	1.870 | 1.792	<i>Synadelphite</i>	Arsen.	X $\wedge$ c = 45°	2V = Sm. Brown	155
1.87	1.91 | 1.73	<i>Arseniosiderite</i>	Arsen.	001 $\perp$ X	Also biax. X = yellow, Z = brown	153
1.870	1.805 | 1.670	<i>Clinoclase</i>	Arsen.	001 $\perp$ X $\pm$	2V = 53°. Green; pleo.	135
1.875	1.875 | 1.633	<i>Tynunamite</i>	Van.	001 $\perp$ X	2V = 45° $\pm$. Yellow: X < Z	147
1.875	1.909 | 1.655	<i>Siderite</i>	Carb.	101 $\bar{1}$. X = c	G. = 3.89. Efferv. HCl	76
1.875 $\pm$	1.875 | 1.785	<i>Malachite</i>	Carb.	001 $\perp$ X $\pm$	2V = 43°. Green: X < Z	83
1.879	2.057 | 1.817	<i>Plumbojarosite</i>	Sul.	101 $\bar{1}$. X = c	Also biax. X = yellow, Z = red	115
1.88	1.89 | 1.84	<i>Uvanite</i>	Van.	Two pinac.	2V = 52°. Y = brown, Z = yellow	148
1.88	1.93 | 1.87	<i>Fayalite</i>	Sil.	010 $\perp$ X	2V = 47°. Gel. HCl	192
1.88	1.88 | 1.87	<i>Hemaphysite</i>	Arsen.	010 $\perp$ X	2V = 35°. Red-brown	135
1.88	1.88 | 1.87	<i>Chenervite</i>	Arsen.	?	Green, yellow	156
1.883	1.805 | 1.878	<i>Chenkinite</i>	Sil.	Z = b	2V = Mod. Brown: X < Z	423
1.89 $\pm$	1.91 | 1.86	<i>Anglesite</i>	Sul.	001 $\perp$ X	2V = 70° $\pm$. G. = 6.3	99
1.89	1.996 | 1.888	<i>Heterosite</i>	Phos.	001 $\perp$ X	2V = Lg. X = brown, Z = red	136
1.894	1.92 | ?	<i>Ilvaite</i>	Sil.	001 $\perp$ Z	2V = Sm. X = brown, Z = green	141
1.895	1.92 | ?	<i>Titanite</i>	Sil.	110 at 66°	Y = b. 2V = Sm. $\rho > v$, strong	204
1.895	1.92 | ?	<i>Carnotite</i>	Van.	001 $\perp$ X	2V = 40° $\pm$. Yellow $\pm$	148

[illegible]

* Indices as given by V. Billiet: *Bull. Soc. Fr. Min.*, XLIX, 1926, p. 136.

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—continued

N_o or N_m + —	N_o or N_p or $N_o - N_p$	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.79	.015+	<i>Ardennite</i>	Sil.	010 $\perp$ Y	2V = Var. Yellow: X > Z	440
1.805	1.92 | ?	<i>Carnotite</i>	Van.	001 $\perp$ X	2V = 40° $\pm$. Yellow	148
1.91	Strong	<i>Cervantite</i>	Ox.	Z || fib.	G. = 4	67
1.963	1.966 1.963	<i>Hyalokite</i>	Sil.	Two at 90°	2V = Sm. G. = 3.8	422
1.967	1.978 1.967	<i>Powellite</i>	Molyb.	III. Z = c	Tet. G. = 4.4	98
1.97	1.99 1.95	<i>Bayldonite</i>	Arsen.	Z $\wedge$ c = 45°	2V = Lg. Green	137
1.973	2.656 1.973	<i>Calomel</i>	Hal.	100	G. = 6.48. Extr. biref.	30
1.975	2.005 1.871	<i>Walpurgite</i>	Arsen.	010?	2V = 52°. Yellow $\pm$	148
1.98	1.98 ?	<i>Diabolite</i>	Hal.	001 $\perp$ X	G. = 6.4. Blue: X < Z	37
1.985	2.05 1.935	<i>Uranospherite</i>	Uran.	100 $\perp$ X	2V = Lg. Yellow $\pm$	109
1.99	2.01 1.93	<i>Lanarkite</i>	Sul.	001 $\perp$ X $\pm$	2V = 47°. G. = 6.6 $\pm$	102
1.99	Weak	<i>Pursonite</i>	Phos.	Z $\wedge$ c = 12°	G. = 6.23. Brown $\pm$	148
1.99	Weak	<i>Agricolite</i>	Sil.	Fibers	2V = Lg. Yellow $\pm$	414
1.997	2.003 | 1.997	<i>Cassiterite</i>	SnO ₂	110 at 90°	Z = c. Tet. Brown $\pm$, etc.	52
2.0	.02 $\pm$	<i>Ardennite</i>	Sil. +	010, 110	2V = Var. Yellow: X > Z	440
2 $\pm$	Strong	<i>Pseudocolunnite</i>	Hal.	Z = c	Sol. H ₂ O. Yellow $\pm$	33
2 $\pm$	Mod.	<i>Graphite</i>	C	001 $\perp$ X	G. = 2.25. Opaque	14
2.00	2.00 1.82	<i>Bismite</i>	Ox.	001 $\perp$ X	G. = 4.36. Sol. HNO ₃	43
2.00	2.01 1.87	<i>Leadhillite</i>	Sul.	001 $\perp$ X $\pm$	2V = 10°. Ps. Hex. twin.	120
2.008	2.029 2.008	<i>Zincite</i>	ZnO	001 $\perp$ Z	G. = 5.5 $\pm$. Red	41
2.01	2.03 1.9 $\pm$	<i>Walpurgite</i>	Arsen.	010?	2V = 52°. Yellow $\pm$	148
2.01	2.02 2.00	<i>Volborthite</i>	Van.	One $\perp$ Bx.	2V = Var. Green $\pm$	137
2.03	Weak	<i>Agricolite</i>	Sil.	Fibers	2V = Lg. Yellow	414
2.03	Mod.	<i>Volzite</i>	Zn ₃ OS ₄	Z = c	G. = 3.7. Yellow $\pm$, etc.	28
2.03	2.03 2.00	<i>Pseudobolite</i>	Hal.	001 $\perp$ X	G. = 4.85. Blue	37
2.038	2.245 1.958	<i>Sulfur</i>	S	X = a; Z = c	2V = 69°. Yellow $\pm$	14

2.04	↑	0.02±	<i>Bolite</i>	Hal.	001 X	G. = 4.9±. Blue	37
2.041	↑	2.041	<i>Cumengeite</i>	Hal.	101. X = c	G. = 4.8. Blue	37
2.05	↑	2.10	<i>Calcivobolite</i>	Van.	?	2V = 83°. Green±. Extr. disp.	135
2.05	↑	Strong	<i>Fernandinite</i>	Van.	Fibers	Green; not pleo.	148
2.06	↑	2.065	<i>Pinakioite</i>	Bor.	010 X	2V = 32°. Brown: X > Z	94
2.061	↑	Weak	<i>Cervantite</i>	Ox.	Fibers	Data vary. G. = 4	67
2.07	↑	2.061	<i>Pyromorphite</i>	Phos.	X = c	2V = 0°±. Colorless or X = yel., Z = gr.	131
2.07	↑	2.08	<i>Carnotite</i>	Phos.	001 X	2V = 50°±. Yellow±	148
2.07	↑	2.07	<i>Barysite</i>	Sil.	001 X	G. = 6.7. Gel. HNO ₃	401
2.074	↑	2.076	<i>Cerussite</i>	Carb.	110 at 63°	X = c. 2V = 9°. G. = 6.57. Efferv. HCl	80
2.08	↑	2.08	<i>Bindheimite</i>	Antim.	Prism.	2V = 0°. G. = 4.8±	160
2.09	↑	2.09	<i>Bolite</i>	Hal.	001 X	G. = 4.9±. Blue	37
2.09	↑	2.10	<i>Emmonsite</i>	Tel.	010 Y	2V = 20°. Sol. HCl	118
2.09	↑	2.09	<i>Hydrocerussite</i>	Carb.	001 X	G. = 6.8. Efferv. HCl	82
2.09	↑	0.01±	<i>Montanite</i>	Tel.	One? 1 X	2V = Lg. G. = 7.1	109
2.1±	↑	Dist.	<i>Georgiadessite</i>	Arsen.	X = b; Z = c	Ext. in oro at 45°	133
2.1±	↑	2.16	<i>Trigonite</i>	Arsen.	010 Y	2V = 52°. X = yellow, Z = red	159
2.10	↑	2.23	<i>Metahevelite</i>	Van.	Z || elong.	2V = Sm. Yellow: a > b	160
2.10	↑	2.11	<i>Goethite</i>	Ox.	010 X	Z = b. G. = 5.88	47
2.102	↑	2.126?	<i>Fiedlerite</i>	Hal.	100 X±	2V = 82°. G. = 6.24	39
2.116	↑	2.158	<i>Laurionite</i>	Hal.	100 X	G. = 6.1±. Sol. HNO ₃	38
2.118	↑	2.145	<i>Phosgenite</i>	Carb.	110, 100	Sol. HNO ₃	85
2.13	↑	2.21	<i>Penfieldite</i>	Hal.	001 Z	G. = 7.3. Efferv. HCl	38
2.13	↑	2.13	<i>Bismutospherite</i>	Carb.	One? 1 X	Also biax. Yellow: X < Z	86
2.135	↑	2.135	<i>Mimetite</i>	Arsen.	X = c	Also biax. Violet±: Y > Z	132
2.146	↑	Strong	<i>Paralaurionite</i>	Hal.	001; Y = b	2V = 44°. Colorless or yellow: X < Z	39
2.15	↑	2.15	<i>Mimetite</i>	Arsen.	X = c	Also biax. Colorless or yellow: X < Z	132
2.15	↑	2.18	<i>Alesterite</i>	Arsen.	001	Green. Dec. HCl	143
2.15	↑	Strong	<i>Cuprotungstite</i>	Tung.	One	Also biax. G. = 7.2	105
2.15	↑	2.15	<i>Mallockite</i>	Hal.	001 X		37

TABLE IVB.—REFRINGENCE OF ANISTROPIC MINERALS—continued

N_o or N_m + —	N_o or $N_o - N_p$	N_p	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
2.10	2.11	2.05	Goethite	Ox.	010 $\perp$ X	2V = Sm. Yellow: $a > b$	47
2.15		.05 $\pm$	Bismutite	Carb.	Z $\parallel$ fib.	2V = Mod. Efferv. HCl	86
2.16	2.16	2.14	Bellite	Arsen. +	X $\parallel$ fib.	Yellow: X < Z	119
2.17	2.31	2.12	Melanokite	Sil.	Two	2V = 67°. Brown: X < Z	427
2.18 Li	2.35	2.00	Tellurite	Ox.	010 $\perp$ X	2V = 90° $\pm$. G. = 5.9	59
2.18	2.35	1.77	Hewellite	Van.	Z $\parallel$ elong.	2V = Mod. Red: X < Z	160
2.18	2.18	2.16	Kleinite	Hal.	Tr.?	2V = Sm. Sol. HCl	38
2.18		.01 $\pm$	Iodyrite	Hal.	001 $\perp$ Z	Abn. int. colors	30
2.19	2.21	2.19	Kleinite	Hal.	001 $\perp$ Z	G. = 7.98. Sol. HCl	38
2.19	2.20	2.13	Buddleyite	Ox.	001 $\perp$ X $\pm$	2V = 30°. Brown: X > Z	60
2.20	2.31	2.10	Kentrolite	Sil.	110 at 65°	X = a. 2V = 88°. Brown: X < Z	427
2.20	2.51	1.94	Lepidocrocite	Ox.	010 $\perp$ X	2V = 83°. Red: X < Z	48
2.20	2.33	2.19	Triphuyite	Antim.	?	2V = Sm. Yellow	160
2.21	2.22	2.21	Iodyrite	Hal.	001 $\perp$ Z	Abn. int. colors	30
2.217	2.260	2.109	Cotunnite	Hal.	001 $\perp$ Z	2V = 67°. G. = 5.84	32
2.22	2.32	2.17	Huebnerite	Tung.	010 $\perp$ X	2V = 73°. Green or brown: X < Z	101
	2.22	2.11	Vauquelinite	Chrom.	X $\parallel$ fib. $\pm$	2V = Sm. Colorless or X = gr., Z = br.	121
2.22	2.26	2.09	Tungstite	Ox.	001 $\perp$ X	2V = Sm. Yellow	60
2.25	2.53	2.25	Manganite	Ox.	010 $\perp$ Y	2V = Sm. Brown: X < Z	48
2.25	2.25	2.20	Endichite	Arsen.	X = c	Yellow $\pm$	132
2.25 $\pm$	2.34	2.19	Manganantianite	Tan.	100	2V = Lg. Red: X < Z	165
2.26		.13 $\pm$	Cuprodesclousite	Van.	X $\parallel$ fib.	2V = 60°. Brown: X < Z	133
2.26	2.26	2.10	Heterolite	Ox.	001 $\perp$ X	G. = 4.8. Brown: X > Z	65
2.265	2.35	2.185	Desclousite	Van.	X = c; Z = a	2V = Lg. Yellow: X < Z	133
2.269	2.269	2.182	Stolzite	Tung.	001 $\perp$ X	G. = 8 $\pm$. Dec. HNO ₃	98
2.27 Li	2.42	2.27	Tapialite	Tant.	Z = c	G. = 7.5 $\pm$. Brown: X < Z	164

2.27	2.30	2.27	Raspite	Tung.	100; Y=b	2V=Sm. Yellow: X<Z	101
2.27	2.31	2.24	Mendipite	Hal.	110; o10	X=a, 2V=90°±. Z||elong.	38
	.05±		Bismutite	Carb.	Z||fib.	2V=Mod. Efferv. HCl	86
2.28	2.295	2.285	Finnemanite	Arsen.	1011	G.=7.26. Olive	159
2.30 Li	2.40	2.30	Hjelmite	Tant.	?	2V=Sm. Brown: X<Z	166
2.3 Li	2.3	?	Platnerite	Ox.	X=c	G.=8.5. Brown	53
2.31	2.33	2.21	Cuprodesclonite	Van.	X||fib.	2V=60°. Brown: X<Z	133
2.31	2.31	1.95	Geikielite	Ox.	1011. X=c	G.=3.9. Purple	67
2.32± Li	2.42	2.26	Wolframite	Tung.	o101X	Often opaque	101
2.32±	2.43	2.26	Tantalite	Tant.	100	2V=Lg. Red: X<Z	165
2.32 Li	2.32	2.25	Ecdemite	Arsen.	o011X	Also biax. Yellow±	159
2.34	2.34	2.14	Hegroliite	Ox.	o011X	G.=4.85. Brown: X>Z	65
2.35	2.35	2.31	Endlichite	Van.	X=c	Also biax. Yellow±	132
2.35 Li	2.40	2.30	Nadorite	Antim.	1001X	2V=Lg. Yellow±	159
2.35 Li	2.36	2.25	Schwarzembergite	Hal.	o011X	2V=Sm. Yellow±	38
2.35	2.35	2.18	Valentinite	Ox.	o101Z	2V=Sm. Sol. HCl	45
2.35	2.35	2.33	Lorettoite	Hal.	o011X	G.=7.5. Yellow±	38
2.354	2.354	2.299	Vanadinite	Van.	X=c	Yellow±: X<Z	131
2.356	2.378	2.356	Wurtsite	ZnS	X||fib.	G.=4.0. Yellow: X>Z	20
2.36 Li	2.48	2.28	Brackebuschite	Van.	?	2V=Lg. Brown: X<Z	125
2.36 Li	2.36	2.31	Langbanite	Ox.?	X=c	G.=4.7. Brown: X<Z	66
2.36± Li	2.375	2.35	Pseudobrookite	Ox.	o011X	2V=50°. Brown: Y>Z	165
2.37 Li	2.66	2.31	Crocoite	Chrom.	110 at 86°	Y=b, Z∧c= -6°. 2V=57°. Orange±	101
2.38 Li	2.65	2.34	Phenicochroite	Chrom.	One	2V=Mod. Red	100
2.39 Li	2.42	2.38	Pseudobrookite	Ox.	o011X	2V=50°. Brown: Y>Z	165
2.394	2.400	2.260	Goethite	Ox.	o101X	2V=Sm. Yellow: a>b	47
2.40	2.40	2.37	Loretoite	Hal.	o011X	G.=7.5. Yellow±	38
2.40± Li.	Extr.		Columbite	Colum.	100	2V=Lg. Opaque±	165
2.40 Li	Weak		Minium	Ox.	X||elong.	Red: X>Z. Abn. int. colors	65
2.40 Li	Strong		Ferberite	Tung.	o101X	Nearly opaque	101

TABLE IVB.—REFRACTANCE OF ANISTROPIC MINERALS—continued

N_o or N_m +	N_o or N_p or $N_o - N_p$	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
2.356	2.378	<i>Wurtzite</i>	ZnS	X || fib.	G. = 4.0. Yellow: X > Z	20
2.402 Li	2.356	<i>Wulfenite</i>	Molyb.	111; X = c	Also biax. G. = 6.9	98
2.404	2.402	<i>Stibioantinite</i>	Tant.	100 ⊥ X	2V = 75°. Yellow ±	167
2.419	2.457	<i>Stibicolumbite</i>	Colum.	100 ⊥ X	2V = 73°. Yellow ±	167
2.45 Li	2.459	<i>Derbylite</i>	Titan.	?	2V = 0° ±. G. = 4.5. Brown	162
2.45 ± Li	2.51	<i>Mangancolumbite</i>	Colum.	100	2V = Lg. Opaque ±	165
2.46	2.48	<i>Wurtzite</i>	ZnS	X || fib.	G. = 4.0. Yellow: X > Z	20
2.46 Li	2.46	<i>Hausmannite</i>	Ox.	001 ⊥ X	G. = 4.8. Dark brown	64
2.481	2.46	<i>Pyrophanite</i>	Ox.	0221. X = c	G. = 4.5. Red	67
2.50 Li	2.481	<i>Mogrovydite</i>	Ox.	010 ⊥ Z	2V = Lg. Yellow ±	41
2.50 Li	2.65	<i>Struenerite</i>	Tit.	?	G. = 5.56. O = brown, E = green	164
2.50 Li	Mod.	<i>Senaite</i>	Ox.	?	G. = 5 ±. Opaque ±	67
2.50 Li	2.51	<i>Pucherite</i>	Van.	001 ⊥ X	2V = 19°. Brown ±	138
2.5	2.5	<i>Hydrohematite</i>	Ox.	X || fib.	G. = 4.5-5. Red ±	45
2.506	2.529	<i>Greenockite</i>	CdS	1010	G. = 4.8. Yellow ±	21
2.534	2.534	<i>Octahedrite</i>	TiO ₂	001 ⊥ X	Yellow or blue: X < Z	53
2.55 Li	2.534	<i>Koehnite</i>	Molyb.	100 ⊥ Z	2V = Lg. Yellow ±	107
2.564	Strong	<i>Octahedrite</i>	TiO ₂	001 ⊥ X	Yellow or blue: X < Z	53
2.582	2.564	<i>Greenockite</i>	CdS	1010	Also. biax. G. = 4.8. Yellow ±	21
2.585	2.705	<i>Brookite</i>	TiO ₂	Z = a	2V = 30°. Brown: X < Z	59
2.59 Li	2.61	<i>Realgar</i>	AsS	010 ⊥ Y	2V = 40°. Red; pleo.	22
2.6 Li	Extreme	<i>Treichmannite</i>	AgAsS ₂	1011; 0001 ⊥ X	Red: X < Z	27

2.603	2.889	2.603	Rutile	TiO ₂	110 at 90°	Z=c. G.=4.2. Brown: X<Z	50
2.61 Li	2.71	2.51	<i>Massicotite</i>	PbO	100 ⊥ Y	2V=Lg. Yellow: X<Z	41
2.616	2.903	2.616	Rutile	TiO ₂	110 at 90°	Z=c. G.=4.2. Brown: X<Z	50
2.62 Li	Mod.		<i>Arizona</i>	Tit.	?	Nearly opaque red	68
2.64 Li	2.64	2.51±	<i>Lithargite</i>	PbO	110 at 90°	X=c. G.=9.1. Yellow±	41
2.64 Li	2.66	2.35	<i>Tetragonite</i>	Hg ₂ OCl	101	2V=20°. G.=8.7	39
2.654	2.607	2.654	<i>Moissanite</i>	SiC	Z=c	Tinted±. Str. dispersion	17
2.665	2.665	2.535	<i>Lithargite</i>	PbO	110 at 90°	X=c. G.=9.1. Yellow±	41
2.7 Li	2.7	2.6	<i>Hydrokematite</i>	Ox.	X || fib.	G.=4.5-5. Red±	45
2.72+ Li	Extreme		Orpiment	As ₂ S ₃	oro ⊥ X	2E=70°. Yellow±: X>Z	25
2.72+ Li	Extreme		<i>Lorandite</i>	TlAsS ₂	oro ⊥ X±	Y=a±. 2F=Lg. Red; pleo.	28
2.72+ Li	Strong		<i>Miargyrite</i>	AgSbS ₂	oro	Nearly opaque red	27
2.74+ Li	Extreme		<i>Chalcofanite</i>	Ox.	ooo ⊥ X	G.=3.9. X=red, Z=opaque	66
2.84	Extreme		<i>Kermesite</i>	Sb ₂ S ₂ O	100, 101	2V=Sm. Red: X>Z	28
2.913	3.272	2.913	<i>Tenorite</i>	CuO	111, 111, 001	X=brown, Z=opaque±	41
3±	Extreme		Cinnabar	HgS	101	G.=8.17. Red. Extr. disp.	21
3±	Strong		<i>Livingstonite</i>	HgSb ₂ S ₇	110 at 90°	Z=c. Nearly opaque red	28
3.084 Li	3.084	2.881	<i>Polybasite</i>	Ag ₂ Sb ₂ S	X=c±. Y=a±	2E=70°. Red. G.=6.1	27
3.087 Li	3.087	2.792	Pyrrargyrite	Ag ₂ Sb ₂ S	101. X=c	G.=5.8. Red	27
3.176	3.188	3.078	Proustite	Ag ₂ As ₂	101. X=c	G.=5.7. Red; pleo.	27
3.22	3.22	2.94	<i>Hutchinsonite</i>	Tl ₂ Pb ₂ As ₂ S	100 ⊥ Y	G.=4.6. Red; pleo.	28
3.27?	?	?	HEMATITE	Fe ₂ O ₃	X=c	G.=5.2. Red to opaque	44
4.046 Li	4.303	3.194	<i>Smithite</i>	AgAsS ₂	100; Y=b	G.=4.9. Red	27
4.7±	?	?	Stibnite	Sb ₂ S ₃	oro ⊥ Z	Red to opaque	25
Extr.	Extreme		Molybdenite	MoS ₂	ooo ⊥ X	G.=4.7±. Opaque	26
Extr.	Extreme		Ilmenite	FeTiO ₃	?	G.=4.8±. Opaque	66
	Extreme		<i>Chloroziphrine</i>	Hal.	ooo ⊥ X±	Y=brown; Z=green	39

SUPPLEMENTARY TABLE IV B.—REFRINGENCE OF ANISOTROPIC MINERALS

N_o or N_m +	N_g or $N_g - N_p$	N_p	Mineral	Chem.	Cleavage, Opt. Orient.	Other Characters	Page
1.301	1.307	1.301	<i>Ferrucite</i>	NaBF ₄	X = c	G. = 2.50. Sol. H ₂ O	*
1.348	1.350	1.346	<i>Bakerite</i>	Hal.	Two cleav.	G. = 2.96	**
1.406	1.406	1.391	<i>Cryophallite</i>	Hal.	0001 $\perp$ X	G. = 2.15	36
1.432	1.435	1.427	<i>Jarlite</i>	Hal.	X $\wedge$ $\perp$ 100 = -16°	G. = 3.93. 2V = 79°	***
1.454	1.491	1.445	<i>Mercallite</i>	Sul.	?	G. = 2.31	*4
1.461	1.474	1.461	<i>Tincalconite</i>	Bor.	Rhom.	G. = 1.88	90
1.470	1.484	1.461	<i>Lapparentite</i>	Sul.	Mono.	2V = 80° calc.	*5
1.482	1.486	1.481	<i>Ashtonite</i>	Sil.	001, 110?	Fibrous	432
1.486	1.488	1.465	<i>Burkeite</i>	Carb.-Sul.	X = c. Y = a	G. = 2.57	*6
1.487	1.540	1.470	<i>Ammionoborite</i>	Bor.	Ext. Ang. = 10° $\pm$	2V = 60° $\pm$ 10°	91
1.488	1.504	1.47 $\pm$	<i>Inderite</i>	Bor.	X = b. Z $\wedge$ c = 5°	G. = 1.79	*7
1.489	1.489	1.486	<i>Wischnevitte</i>	Sil.	10 $\overline{1}0$. X = c	May show twinning	30
1.492	1.504	1.490	<i>Lapparentite</i>	Sul.	Y = b. X $\wedge$ c = -5°	2V = 55°	*5
1.495	1.497	1.445	<i>Burkeite</i>	Carb.-Sul.	X = c. Y = a	No cleavage	*6
1.500	1.586	1.380	<i>Nahcolite</i>	Carb.	101, 111	X $\wedge$ c = +27.5°	*8
1.502	1.502	1.449	<i>Ungemachite</i>	Sul.	0001 $\perp$ X	G. = 2.29	*9
1.506	1.529	1.423	<i>Nesquehonite</i>	Carb.	110. Y = c	G. = 1.85	84
1.52	1.526	1.501	<i>Ledovicitte</i>	Sul.	X $\wedge$ c = 17 $\frac{1}{2}$ °. Z = b	G. = 1.81	97
1.524	1.577	1.517	<i>Ginorite</i>	Bor.	010 $\perp$ Y	2V = 42°. X $\wedge$ elong. = 51°	*10
1.530	1.580	1.515	<i>Earlandite</i>	Cit.	?	2V = 60° calc. G. = 1.95	*11
1.534	1.538	1.531	<i>Minyulite</i>	Phos.	110. X = c	G. = 2.45	*12
1.536	1.545	1.536	<i>Ashcroftine</i>	Sil.	100, 001	G. = 2.61	*13
1.542	1.544	1.535	<i>Foshallasite</i>	Sil.	X $\perp$ cleav.	G. = 2.5	*14

1.542	1.542	Dakette	Sul.-Carb.	001 $\perp$ X	G. = 2.51. Yellow: X < Y = Z	*15
1.543	1.534	Gordonite	Phos.	010, 100	Z $\wedge$ c = -26°	157
1.548	1.518	Fluorborite	Bor.	Hex.	G. = 2.9	92
1.553	1.551	Veatchite	Bor.	010 $\perp$ Y	2V = 37° . Z $\wedge$ c = -38°	*16
1.553	1.485	Alumohydrocalcite	Carb.	100, 010	Ext. Ang. = 10° on fibers	88
1.553	1.535	Hydrocalumite	Ox.	001 $\perp$ X $\pm$	2V = 24°	*17
1.556	1.645	Julienite	CSN +	Tetrag.	G. = 1.65	*18
1.558	1.544	Louderbackite	Sul.	Two good cleav.	G. = 2.19. Sol. in H ₂ O	116
1.566	1.528	Fluorborite	Bor.	Hex.	G. = 2.9	92

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SUPPLEMENTARY TABLE IV B.—REFRACTANCE OF ANISOTROPIC MINERALS—continued

N_o or N_m +	N_g or $N_g - N_p$	N_p	Mineral	Chem.	Cleavage, Opt. Orient.	Other Characters	Page
1.570	1.574	1.559	<i>Sulite</i>	Phos.	001 $\perp$ X. 010	$2V = 61^\circ$. $G = 3.1$	*
1.572	1.572	1.570	<i>Engishite</i>	Phos.	001 $\perp$ X	$G = 2.65$	158
1.575	1.634	1.543	<i>Metastideronatrite</i>	Sul.	001, 010, 100	$Y = b$; $Z = c$. Yellow: $X < Y < Z$	**
1.575	1.575	1.547	<i>Porlandite</i>	$Ca(OH)_2$	0001 $\perp$ X	$G = 2.23$	***
1.581	1.586	1.559	<i>Skolite</i>	Sil.	001 $\perp$ X $\pm$	$2V = 0^\circ - 85^\circ$	*4
1.581	1.581	1.565	<i>Schuchardite</i>	Sil.	001 $\perp$ X	$X = bluish\ green$, $Z = olive\ green$	*5
1.587	1.595	1.578	<i>Leightonite</i>	Sul.	$X \wedge b = 3^\circ - 5^\circ$	$G = 2.95$	*6
1.590	1.599	1.590	<i>Wardite</i>	Phos.	001 $\perp$ Z	$G = 2.81$	158
1.590	1.597	1.587	<i>Bullfonteinite</i>	Sil.	100	$Z' \wedge c$ on 010 = 28°	*7
1.598	1.602	1.584	<i>Millisite</i>	Phos.	X $\parallel$ Elong.	$G = 2.83$	158
1.600	1.600	1.586	<i>Dekrinite</i>	Phos.	0001 $\perp$ X	$G = 3.0$	151
1.601	1.601	1.591	<i>Dennisonite</i>	Phos.	0001 $\perp$ X	$G = 2.85$	155
1.605	1.607	1.601	<i>Tuhualite</i>	Sil.	001, 100, 010	$X = a$. $Y = b$	*8
1.605	1.613	1.600	<i>Hydrophilite</i>	Hal.	110	Lam. twinning	32
1.606	1.621	1.597	<i>Scawite</i>	Sil.	$Z \wedge a = 29^\circ$	$G = 2.77$	442
1.607	1.607	1.588	<i>Schuchardite</i>	Sil.	001 $\perp$ X	$X = bluish\ green$, $Z = olive\ green$	*5
1.614	1.631	1.600	<i>Monetite</i>	Phos.	001, 110	$G = 2.92$	123
1.615	1.629	1.600	<i>Lehnite</i>	Phos.	Lg. Ext. Ang.	$G = 2.89$	158
1.622	1.630	1.622	<i>Garnierite</i>	Sil.	Z $\parallel$ Elong.	$2V = 0^\circ - 10^\circ$	*9
1.623	1.663	1.591	<i>Saomohokite</i>	Sul.	$X \wedge c = +26^\circ$	$Y = b$. $G = 3.05$	*10
1.623	1.624	1.613	<i>Lewisstonite</i>	Phos.	0001 $\perp$ X	$G = 3.06$	151
1.630	1.684	1.623	<i>Guildite</i>	Sul.	001, 100	$G = 2.72$	117
1.631	1.633	1.620	<i>Parawollastonite</i>	Sil.	100, $\bar{1}02$, 001	$Z \wedge c = -34^\circ$	*11

1.635	1.632	Tilleyite	Sil.	100. $X \wedge c = 18^\circ$	$G = 2.84$	*12
1.636	1.647	Woodhouseite	Sul.	$0001 \perp Z$	$G = 3.01$	*13
1.636	1.636	Hilgardite	Bor.	$010 \perp Y$	$Z \wedge c = 1.5^\circ$ $G = 2.71$	*14
1.636	1.630	Mitscherlichite	Hal.	$X = c$	$G = 1.4$	34
1.636	1.615	Boehmite	Ox.	$010 \perp Z$	$110 \wedge 1\bar{1}0 = 63^\circ$	46
1.64±	0.01±	Juanite	Sil.	$Z \parallel$ Elong.	Fibrous	*15
1.641	1.647	Deltaite	Phos.	$Z = c$	$G = 2.95$	155
1.641	1.650	Collinsite	Phos.	Four cleav.	$G = 2.95$	128
1.642	1.657	β -Ascharite	Bor.	$X \parallel$ Elong.	$G = 2.65$	*16
1.642	1.646					

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SUPPLEMENTARY TABLE IV B.—REFRACTANCE OF ANISOTROPIC MINERALS—continued

N_o or N_m +	N_g or $N_g - N_p$	N_p	Mineral	Chem.	Cleavage. Opt. Orient.	Other Characters	Page
1.643	1.657	1.553	<i>Castanite</i>	Sul.	oto $\perp$ X $\pm$	Y = yellow, Z = brownish red	110
1.643	1.695	1.631	<i>Ransomite</i>	Sul.	Perf. cleav.	G. = 2.63	116
1.647	1.647	1.637	<i>Aminofite</i>	Sil.	oo1 $\perp$ X	G. = 2.94	*
1.648	1.676	1.637	<i>Loseyite</i>	Carb.	Y $\parallel$ Elong.	2V = 64°	84
1.655	1.655	1.650	<i>Ellestadite</i>	Sil. etc.	X $\parallel$ Elong.	G. = 3.07	**
1.660	1.663	1.648	<i>Roweite</i>	Bor.	X = a; Y = c	2V = 15°. G. = 2.92	***
1.662	1.663	1.662	<i>Cahnite</i>	Arsen.	Tetrag.	G. = 3.16	161
1.663	1.665	1.640	<i>Seamanite</i>	Phos.	Y = b; Z = c	G. = 3.13	161
1.663	1.737	1.598	<i>Parabulterite</i>	Sul.	Y = c; Z = a	X = yellow; Z = greenish yellow	* 4
1.664	1.688	1.660	<i>Serandite</i>	Sil.	oo1, 100	X $\wedge$ a = -57°	418
1.667	1.667	1.655	<i>Cyprosklodowskite</i>	Sil.	oo1 $\perp$ Y	Gel. with HCl	* 5
1.674	1.731	1.604	<i>Bullerite</i>	Sul.	010	X = brown-yellow, Z = canary yellow	108
1.676	1.683	1.672	<i>Acrochordite</i>	Arsen.	Y $\wedge$ c = 40° - 45°	X = b. G. = 3.19	137
1.685	1.745	1.646	<i>Antofagastite</i>	Hal.	110, oo1	2V = 75°. X = green, Z = blue	* 6
1.686	1.696	1.665	β - <i>Uranotile</i>	Sil.	Z $\wedge$ c = 41°	Yellow; X < Y = Z	* 7
1.690	1.735	1.675	<i>Legrandite</i>	Arsen.	Z $\wedge$ c = -38°	X = b. G. = 4.01	137
1.692	1.692	1.640	<i>Bandyllite</i>	Bor.	oo1 $\perp$ X	O = deep blue, E = yellow	* 8
1.70 $\pm$	1.73 $\pm$	1.70 $\pm$	<i>Erikite</i>	Phos.	?	G. = 3.78	* 9
1.70 $\pm$	0.008		<i>Taumarite</i>	Sil.	oo1, 100	X = green, Y = yellow, Z = green	* 10
1.704	1.719	1.604	<i>Roselite</i>	Phos.	010 $\perp$ Y; X $\wedge$ a = 1°	Pink: X = Y > Z	127
1.713	1.724	1.708	<i>Reposkite</i>	Phos.	?	G. = 3.74	* 11
1.715	1.730	1.707	<i>Larnite</i>	Sil.	X $\wedge$ c = 13°	Z = b	194
1.718	1.734	1.709	<i>Metaholmanite</i>	Sul.	?	X = yellow; Z = brown	* 12

SUPPLEMENTARY TABLE IV B.—REFRACTANCE OF ANISOTROPIC MINERALS—continued

N_o or N_m +	N_o or N_g	N_p	Mineral	Chem.	Cleavage, Opt. Orient.	Other Characters	Page
1.749	1.749	1.724	<i>Allodelphite</i>	Sil.	?	Brown	440
1.750	1.752	1.750	<i>Abukumalite</i>	Phos.	Poor cleav.	G. = 4.35	*
1.751	1.761	1.750	<i>Synadelphite</i>	Arsen.	$X \wedge c = 45^\circ$	Brown: X = Y < Z	155
1.76	1.76	1.72	<i>β-Uranopilite</i>	Sul.	Y || Elong.	2V = Sm.	**
1.763	1.783	1.759	<i>Austinite</i>	Arsen.	110; Z = b	Y = a G. = 4.12	***
1.764	1.794	1.763	<i>Clingferrosilite</i>	Sil.	110	Z $\wedge$ c = 33°	*4
1.765±	1.775	1.760	<i>Alluaudite</i>	Phos.	Z $\perp$ best cl.	G. = 3.58	*5
1.765	1.839	1.735	<i>Murmanite</i>	Sil.	001 $\perp$ X $\pm$	X = pink; Y = brown; Z = brown	*6
1.767	1.823	1.748	<i>Joaquinile</i>	Sil.	Y = b; Z = c	G. = 5.80	417
1.769	1.769	1.760	<i>Ca-Larsenite</i>	Sil.	?	G. = 4.42	187
1.770	1.840	1.710	<i>Roselite</i>	Van.	010	G. = 2.45	158
1.775	1.777	1.772	<i>Britholite</i>	Sil.	X = c; Y = a	Ps. Hex.	441
1.78±	1.80±	?	<i>Vandenbrandeite</i>	Uran.	001, 110	G. = 4.96. Abn. interf. col.	*7
1.78±	0.035		<i>Taositte</i>	Ox.	?	X = yellow. Z = red-brown	*8
1.78±	1.792	1.756	<i>Alleganyite</i>	Sil.	X $\wedge$ a = -35°	G. = 4.02	*9
1.780	1.80	1.75	<i>Ammoniojarosite</i>	Sul.	0001 $\perp$ X	Soluble in HCl	114
1.80	1.816	1.787	<i>Arsenoclastite</i>	Arsen.	010; X = b	Y = a. G. = 4.16	133
1.810	1.894	1.851	<i>Plumbosynadelphite</i>	Arsen.	?	Brown. X < Y < Z	*10
1.864	1.90	1.88	<i>Dumortite</i>	Phos.	Y = c; Z = a	Yellow: X < Y	148
1.89	1.92	1.674	<i>Ianthinite</i>	Ox.	100 $\perp$ X	Y = c	60
1.90	1.908	1.870	<i>Talasskite</i>	Sil.	001 $\perp$ Y	X = b	*11
1.902	1.910	1.873	<i>Yeatmanite</i>	Sil.	100 $\perp$ X $\pm$	G. = 4.8	*12
1.905	1.905	1.785	<i>Argentojarosite</i>	Sul.	0001 $\perp$ X	Yellow: O > E	114

	I. 939	I. 886	Fersmanite	Tit.	Y = b. X $\perp$ 001 $\pm$	Brown. G. = 3.44	168
I. 930	I. 96	I. 92	Larsenite	Sil.	X = a; Y = c.	G. = 5.9	187
I. 95	2. 02	I. 93	Lindgrenite	Molyb.	010 $\perp$ Z	$2V = 71^\circ$. G. = 4.26	*13
2. 002	2. 08	2. 03	Dufite	Arsen.	Orth.?	G. = 6.19	132
2. 06	2. 12	?	Curite	Uran.	Z = c	G. = 7.19	103
2. 07	2. 108	I. 997	Clarkeite	Uran.	?	$2V = 45^\circ \pm$. G. = 6.39	111
2. 098	2. 224	2. 186	Fervanite	Van.	Incl. Ext.	$2V = \text{Sm.}$	142

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TABLE V.—DISPERSION OF MINERALS

The new methods of studying powdered minerals lead naturally, not only to a knowledge of their indices of refraction in ordinary light, but also and simultaneously to a knowledge of the variation in their indices with variation in the wave-length (or color) of light; that is, the new methods lead to a knowledge of the dispersion of the minerals. Of course the dispersion of a mineral is as definite a physical property as its refringence or birefringence and may therefore be used to identify it. At present, data regarding the dispersion of minerals are remarkably scanty and in some cases not very accurate.

The dispersion given is always the difference between the index in light of 4861 Å wave-length (=the Fraunhofer line *F* or the β line of hydrogen) and the index in light of 6563 Å wave-length (=the Fraunhofer line *C* or the α line of hydrogen). In the tables this dispersion is meant by the expression $F-C$.

In anisotropic crystals the dispersion of the substance is, in general, not the same for light vibrating in directions which are crystallographically unlike. Therefore the dispersion for N_o is not the same as for N_p , and the dispersion for N_m is not equal to that for N_o nor to that for N_p . However, these differences are usually small, and the only dispersion given in the table is that for N of isotropic substances, N_o of uniaxial substances and N_m of biaxial substances.

In the literature¹ the dispersion is very rarely given directly and the indices measured for different wave-lengths do not always include the wave-lengths of the *F* and *C* lines here used as standards. Therefore it has been necessary to obtain the dispersion given in the table by calculation or graphic solution in many cases. In cases in which this involves notable extrapolation the result is given as a $\pm$ value and the extrapolation involved is indicated in footnotes.

In the following table minerals are classified first on the basis of their dispersion, and in each group thus established they are arranged

¹ For references to the literature see A. N. Winchell: Dispersion of Minerals, *Am. Mineral*, XIV, 1929, p. 125.

in the order of increasing refringence. This table is remarkably incomplete even though it includes all available data.

For methods of measuring the index of refraction with different wave-lengths of light and thus obtaining the dispersion, see Part I, pages 228-239 and 244-248.

For methods of estimating or measuring the birefringence of minerals, see Part I, pages 119-123, 136-138, and 244-246.

For methods of determining the optic sign, see Part I, pages 129-135, 138, 148-152, 169, 206-213, and 228-239.

For methods of estimating or measuring the optic axial angle, see Part I, pages 186-189, 210, 226-227, and 239-244.

' For a discussion of cleavage in minerals, see Part I, pages 29-32.

For a list of abbreviations and symbols, see page xiii.

TABLE V.—DISPERSION OF MINERALS

N _D , N _F or N _m		Mineral	Chem.	Sign	2V	Other Characters	Page
F—C	D						
Section 1. N _F —N _C = .000 to .0075							
.0062	1.309	Ice	H ₂ O	+	0°	Index extremely low	40
.0039	1.328	<i>Williamite</i>	NaF	—	0°	Red. Sol. hot H ₂ O	30
.004± ^a	1.340	<i>Cryolithionite</i>	Hal.	..	.....	110 cleav.	34
.0045	1.434	Fluorite	CaF ₂	..	.....	111 cleav. Tinted ±	31
.0049	1.443	<i>Yttriofluorite</i>	Hal.	..	.....	Poor cleav. Rare	35
.007	1.462	<i>Picromerite</i>	Sul.	+	48°	201 cleav. Sol. H ₂ O	112
.006± ^b	1.503	<i>Prosopite</i>	Hal.	+	63°	211 cleav. Rare	34
.006	1.509	<i>Nocerite</i>	Hal.	—	0°	Hex. 0001 cleav.	38
.0065± ^c	1.535	<i>Langbeinite</i>	Sul.	..	.....	Sol. H ₂ O	110
.005± ^d	1.546	<i>Eudidymite</i>	Sil.	+	30°	Lam. twin.	418
.007± ^e	1.581	Scapolite	Sil.	—	0°	100 cleav. Tet.	293
.006± ^f	1.622	Tremolite	Sil.	—	82°	110 cleav. at 56°	245
Section 2. N _F —N _C = .0075 to .0085							
.0079	1.455	Epsomite	Sul.	—	51°	010 cleav. H.=2	103
.0081	1.469	Borax	Por.	—	40°	100 cleav. Sol. H ₂ O	90
.0081	1.472	<i>Boussingaultite</i>	Sul.	+	51°	201 cleav. Sol. H ₂ O	113
.0084	1.48	<i>Goslarite</i>	Sul.	—	46°	010 cleav. Sol. H ₂ O	104
.008± ^g	1.489	<i>Morenosite</i>	Sul.	—	42°	010 cleav. Sol. H ₂ O	103
.008	1.508	LEUCITE	Sil.	+	Sm.	Trapezohedrons	291
.008	1.509	<i>Pirssonite</i>	Carb.	+	33°	No cleav. Efferv. HCl	87
.008± ^h	1.512	<i>Flagstaffite</i>	H, C, O	+	77°	Sol. alcohol	301
.008	1.518	Cancrinite	Sil.	—	0°	1010 cleav. H.=2	301
.0079	1.523	Gypsum	Sul.	+	58° •	010 cleav.	104
.008	1.523	ADULARIA	Sil.	—	70° ±	001, 010 cleav.	361

.008	1.53	.01	ALBITE	Sil.	+	75°±	001, 010 cleav.	369
.0084	1.537	.004	NEPHELITE	Sil.	-	0°	Gel. HCl	298
.0084	1.537	.01±	Cordierite	Sil.	-	60°±	Ps. Hex. twin	307
.0083	1.543	.008	OLIGOCASE	Sil.	±	90°±	001, 010 cleav.	371
.0078	1.544	.009	QUARTZ	SiO ₂	+	0°	No cleav. Insol.	54
.008± ⁶	1.544	.002	Epididymite	Sil.	+	23°	001, 010 cleav. Ps. Hex.	418
.0084	1.549	.015	Edingtonite	Sil.	-	50°	110 cleav. Gel. HCl	389
.008	1.554	.016	Grothine	Sil.	+	Mod.	X=b; Y=c	432
.008± ^h	1.558	.010	Beryllonite	Phos.	-	68°	001, 100 cleav.	149
.0078	1.575	.044	Anhydrite	CaSO ₄	+	42°	001, 010 cleav.	98
.008	1.593	.013	Celsian	Sil.	+	80°±	001, 010 cleav.	359
.008± ^j	1.599	.04±	MUSCOVITE	Sil.	+	40°±	001 cleav.	267
.0078	1.618	.01	Topaz	Sil.	-	60°±	001 cleav. H.=8	198
.0084	1.623	.009	Celestite	SrSO ₄	+	51°	001, 110, 010 cleav.	99
.008± ^k	1.635	.021	ANTHOPHYLLITE	Sil.	+	88°±	110 cleav. at 55°	240
.008± ^l	1.65±	.005±	Mellilite	Sil.	-	0°	Tet. Gel. HCl	208
.008± ^m	1.66±	.03±	Eosphorite	Phos.	-	40°	100 cleav. Sol. HCl	156
Section 3. $N_F - N_G = .0085$ to $.0095$								
.009 ^b	1.478	.015	Melanterite	Sul.	+	82°	Sol. H ₂ O	106
.009± ⁿ	1.479	.012	Natrolite	Sil.	+	62°	110 cleav. Acic.	390
.009± ^o	1.483	.000	Sodalite	Sil.	..	.....	Poor cleav. Gel. HCl	289
.0091	1.52	.025	Cancrinite	Sil.	-	0°	1010 cleav.	301
.009± ^p	1.525	.000	Pollucite	Sil.	..	.....	Contains Cs	293

^a From Tl-Li = .0026.

^b From "blue" + "red".

^c From $N_L = 1.5281$, $N_T = 1.5343$
^d From Tl-red = .0032.

^e From Tl-Li = .0047.

⁶ From F-D = .0061.

^h From Tl-Li = .0055.

ⁱ From "green" - "red" = .0049.

^j From Tl-Li = .0064.

^k From "blue" - "red" = .008.

^l From Na-"red" = .0027.

^m From Tl-Li = .0059 for N_G and .0052 for N_F .

ⁿ From Tl-Li = .0054.

^o From Tl-Li = .0059.

^p From Tl-Li = .0038.

TABLE V.—DISPERSION OF MINERALS

TABLE V.—DISPERSION OF MINERALS—Continued

N, N _o or N _m		N _D -N _p	Mineral	Chem.	Sign	2V	Other Characters	Page
F-C	D							
Section 3. N _F -N _C = .0085 to .0095—Continued								
.009± ^a	1.528±	.006	ANORTHOCLASE	Sil.	—	50°±	001, 010 cleav.	366
.0089	1.535	.002±	Apophyllite	Sil.	±	0°	Abn. int. colors	262
.0087	1.538±	.004	NEPHELITE	Sil.	—	0°	Gel. HCl	298
.009± ^b	1.54	.017	<i>Gismondite</i>	Sil.	—	84°	Gel. HCl	373
.009±	1.55	.01±	Cordierite	Sil.	—	Lg.	Ps. Hex. twin.	307
.0086	1.553±	.007	ANDESINE	Sil.	±	90°±	001, 010 cleav.	372
.0087	1.558	.010	<i>Beryllonite</i>	Phos.	±	68°	001, 100 cleav.	149
.009	1.562±	.008	LABRADORITE	Sil.	+	80°±	001, 010 cleav.	374
.009 ^c	1.572±	.006	Beryl	Sil.	—	0°	Colorless or tinted	212
.0093	1.572±	.009	BYTOWNITE	Sil.	—	85°±	001, 010 cleav.	376
.0095	1.58±	.012	ANORTHITE	Sil.	—	77°	001, 010 cleav.	378
.009	1.586	.074	<i>Hambergite</i>	Bor.	+	87°	010, 100 cleav.	91
.009± ^d	1.587±	.03±	Scapolite	Sil.	—	0°	100 cleav. Tet.	293
.009	1.592	.028	<i>Colemanite</i>	Bor.	+	55°	010 cleav. Sol. HCl	93
.0094	1.602	.000	<i>Zunyite</i>	Sil.	..	.....	111 cleav. Insol.	414
.009	1.637	.012	Barite	BaSO ₄ .	+	37°	001, 110 cleav.	100
.009	1.645±	.025±	Tourmaline	Sil.	—	0°	Max. absorp. ⊥ c	301
.009	1.654	.016	Phenakite	Sil.	+	0°	1120 cleav.	185
.009	1.655	.015	<i>Euclase</i>	Sil.	+	50°	010 cleav.	432
.009± ^e	1.66	.02±	Sillimanite	Sil.	+	30°±	010 cleav. Acic.	200
Section 4. N _F -N _C = .0095 to .0105								
.010± ^f	1.484	.000	Sodalite	Sil.	..	.....	Poor cleav. Gel. HCl	289
.010± ^g	1.510	.012	<i>Petalite</i>	Sil.	+	84°	001 cleav.	309
.01± ^h	1.514	.000	<i>Northupite</i>	Carb.	..	.....	No cleav. Efferv. HCl	85

.010 ± ^f	1.572 ±	.005 ±	Beryl	Sil.	—	0°	Tinted ±	212
.0095	1.58 ±	.012	ANORTHITE	Sil.	—	80° ±	oor, oro cleav.	378
.01 ± ^j	1.587 ±	.04	MUSCOVITE	Sil.	—	40° ±	oor cleav.	267
.010 ± ^k	1.592	.028	Colemanite	Bor.	+	55°	oro cleav. Sol. HCl	93
.01 ± ^l	1.617	.022	Hemimorphite	Sil.	+	46°	oro cleav. Gel. HCl	211
.010 ±	1.634	.006	<i>Danburite</i>	Sil.	—	87°	Poor cleav. Disp.	210
.010 ±	1.638 ±	.004	Apatite	Phos.	—	0°	Hex. Prism.	129
.01 ± ^m	1.64 ±	.025 ±	Tourmaline	Sil.	—	0°	Max. absorp. ⊥ c	301
.01 ± ⁿ	1.658	.02 ±	Sillimanite	Sil.	+	30° ±	oro cleav. Acic.	200
.010 ±	1.665	.015	Spodumene	Sil.	+	60° ±	oro cleav. at 87°	236
.010	1.672	.009	<i>Parisite</i>	Carb.	+	0°	oor cleav. Efferv. HCl	85
.01 ± ^o	1.722	.048	Diaspore	Ox.	+	84°	Y ⊥ oro cleav	46
.01 ± ^p	1.72 ±	.000	Spinel	Mg-Al ₂ O ₄	..	.....	Oct. H. = 8	62
.01 ±	1.729	.025	<i>Ganophyllite</i>	Sil.	—	24°	oor cleav.	436

Section 5. $N_F - N_G = .0105 \text{ to } .0115$

.011	1.490	.000	Sylvite	KCl	..	.....	Sol. H ₂ O	30
.011 ± ^q	1.522	.007	MICROCLINE	Sil.	—	83°	oor, oro cleav.	364
.0115	1.566	.02 ±	Brucite	Mg(OH) ₂	+	0°	oor cleav.	42
.011 ±	1.575 ±	.006 ±	Beryl	Sil.	—	0°	Colorless or tinted	212
.0113 ± ^r	1.590	.035 ±	Scapolite	Sil.	—	0°	Tet.	293
.011	1.645 ±	.025 ±	Tourmaline	Sil.	—	0°	Max. absorp. ⊥ c	301
.0106	1.678	.028	DIOPSIDE	Sil.	+	59°	oro cleav. at 87°	224

^q From Na-Li = .003.

^r From Tl-Li = .0061.

^s From Cd-green-Li = .0074.

^t From Tl-Li = .0063.

^u From Tl-Li = .0068

^v From Tl-Li = .0061.

^g From "blue"- "red" = .010.

^h From Tl-Li = .0063.

ⁱ From E-B = .0068.

^j From Tl-Li = .0071.

^k From Tl-Li = .006.

^l From Tl-Li = .0063.

^m From Tl-Li = .0069.

ⁿ From Tl-Li = .0063.

^o From "blue"- "red" = .010.

^p From Na-Li = .0037.

^q From Tl-Li = .0063.

^r From Tl-Li = .0068.

TABLE V.—DISPERSION OF MINERALS—Continued

N, N _o or N _m		N _p —N _p	Mineral	Chem.	Sign	2V	Other Characters	Page
F—C	D							
Section 5. N _F —N _C = .0105 to .0115—Continued								
.0114	1.722	.012	Kyanite	Al ₂ SiO ₅	—	82°	100, 010 cleav.	205
.0115 ^a	1.747	.009	<i>Chrysoberyl</i>	BeAl ₂ O ₄	+	65°±	H.=8.5. G.=3.64	65
.0106	1.77	.008	Corundum	Al ₂ O ₃	—	0°	H.=9. G.=4.1	43
.0115 ^b	1.814	.000	Spessartite	Sil.	..	.....	H.=7. G.=4±. Insol.	178
Section 6. N _F —N _C = .0115 to .0125								
.0125 ^c	1.534	.027	Wavellite	Phos.	+	72°	101, 010 cleav.	144
.0125 ^d	1.539	.028	<i>Mellite</i>	Al, C, O, H	—	0°	Yellow±. Tet.	88
.0115	1.564	.02	Brucite	Mg(OH) ₂	+	0°	0001 cleav.	42
.0125 ^e	1.570±	.006	Beryl	Sil.	—	0°	Colorless or tinted	212
.0125	1.59±	.010±	Clinocllore	Sil.	+	0°±	001 cleav.	283
.0125 ^f	1.595	.027	<i>Leucophane</i>	Sil.	—	39°	001, 100, 010 cleav.	210
.0125 ^g	1.613	.019	<i>Meliphanite</i>	Sil.	—	0°	001 cleav. Tet.	210
.0123	1.639	.004	Akermanite	Sil.	+	0°	110 cleav. Tet.	209
.0125 ^h	1.652	.025±	Tourmaline	Sil.	—	0°	Max. absorp. ⊥ elong.	301
.0117± ^e	1.66	.02±	Sillimanite	Sil.	+	30°±	010 cleav. Acic.	200
.0125 ^h	1.662	.017	Monticellite	Sil.	—	75°	Poor cleav. Gel. HCl	187
.0125	1.667	.011	<i>Boracite</i>	Bor.	+	83°	Ps. Isom. twin.	94
.0123	1.681	.155	Aragonite	CaCO ₃	—	18°	Ps. Hex. twin.	79
.0125 ⁱ	1.682	.035	<i>Pyrosomaliite</i>	Sil.	—	0°	0001 cleav. Gel. HCl	408
.0125 ^j	1.688	.004	Triphylite	Phos.	+	0°±	001, 010 cleav. Gel. HCl	149
.0125 ^j	1.694	.002	<i>Rhodizite</i>	Bor.	?	?	Ps. Isom. Insol.	94
.0124	1.713±	.039	Olivine	Sil.	+	84°±	Poor cleav. Gel. HCl	189
.0125 ^k	1.719	.000	Spinel	MgAl ₂ O ₄	..	.....	Oct. H.=8	62

TABLE V.—DISPERSION OF MINERALS—Continued

N, N _o or N _m		N _p —N _p	Mineral	Chem.	Sign	2V	Other Characters	Page
F—C	D							
Section 7. N _F —N _C = .0125 to .0135—Continued								
.0127	1.75±	.012	Staurolite	Sil.	+	85°±	010 cleav. Golden	202
.013± ^a	1.793	.053	Thortveitite	Sil.	—	66°	110 cleav. Green	211
.013± ^b	1.804±	.000	Spessartite	Sil.	..	.....	G.=4.2. Insol.	178
Section 8. N _F —N _C = .0135 to .0155								
W ^h ewellite								
.0138 ^c	1.555	.160	Vivianite	Oxal.	+	84°	001, 010 cleav. Organic	89
.014± ^d	1.60±	.05±	Tourmaline	Phos.	+	85°±	010 cleav. Blue-green	126
.014± ^e	1.654	.025	CALCITE	CaCO ₃	—	0°	Max. absorp. 1.6	301
.0136	1.658	.172	HORNBLÉNDE		—	0°	101 cleav. Efferv. HCl	71
.014± ^f	1.658	.015	Rinkite	Sil.	—	80°±	110 cleav. at 56°	247
.014± ^g	1.668	.016	Justite	Sil.	+	43°	100 cleav. Yellow	423
.0137	1.670	.013	Hardystonite	Sil.	—	0°	Tet. Gel. HCl	209
.0142	1.672	.011	Axinite	Sil.	—	0°	Tet. Gel. HCl	209
.014± ^h	1.685±	.010	DOLOMITE	Sil.	—	75°±	Wedge-shaped. Pleo.	425
.014± ⁱ	1.692	.18±	Clinozoisite	Carb.	—	0°	101 cleav. Efferv. HCl	73
.0145	1.717±	.005±	Xenotime	Sil.	+	70°±	001 cleav.	312
.015± ^j	1.721	.095	PYROXENE	Phos.	+	0°	110 cleav. Tet.	138
.014± ^k	1.726	.023	Periclase	MgO	+	60°±	110 cleav. at 87°	213
.014	1.737	.000	Pyrope	Sil.	..	.....	100 cleav. Sol. HCl	41
.014± ^l	1.745	.000	Grossularite	Sil.	..	.....	G.=3.5. Insol.	178
.014± ^m	1.745	.000	Almandite	Sil.	..	.....	G.=3.5. Insol.	180
.015± ⁿ	1.80±	.000	Spessartite	Sil.	..	.....	G.=4.25. Insol.	178
.015± ^a	1.815±	.000		Sil.	..	.....	G.=4.2. Insol.	178

Section 9. $N_F - N_G = .0155 \text{ to } .0195$

Niter									
<i>Copiapite</i>	.171	1.505			KNO ₃	—	7°	011 cleav.	Sol. H ₂ O
<i>Rhombochase</i>	.06±	1.54±			Sul.	+	60°±	001 cleav.	Yellow
<i>Nitratite</i>	.102	1.550 ^a			Sul.	+	Sm.	001 cleav.	Red
<i>Rinnite</i>	.248	1.585			NaNO ₃	—	0°	1011 cleav.	Sol. H ₂ O
<i>Salammoniac</i>	.001	1.589			Hal.	+	0°	Abn. int. colors	
<i>Datolite</i>	.000	1.642			NH ₄ Cl	—	.....	Poor cleav.	Sol. H ₂ O
<i>Willemite</i>	.045	1.653			Sil.	—	74°	No cleav.	Gel. HCl
<i>Trimerite</i>	.029	1.694			Sil.	+	0°	0001 cleav.	Gel. HCl
<i>Hedenbergite</i>	.011	1.720			Sil.	+	83°	001 cleav.	Sol. HCl
<i>EPIDOTE</i>	.019	1.737			Sil.	+	60°	110 cleav. at 87°	
<i>Libethenite</i>	.03±	1.74±			Sil.	—	80°±	001 cleav.	Golden
<i>Pyrope</i>	.087	1.745			Phos.	—	83°±	Poor cleav.	Green
<i>Grossularite</i>	.000	1.746			Sil.	..	.....	G. = 3.5.	Insol.
<i>Monazite</i>	.000	1.76±			Sil.	..	.....	G. = 3.5.	Insol.
<i>Spessartite</i>	.05±	1.79±			Phos.	+	12°±	001 cleav.	Yellow
<i>Smithsonite</i>	.000	1.811			Sil.	—	.....	G. = 4.2.	Insol.
<i>Caledonite</i>	.228	1.849			Carb.	—	0°	1011 cleav.	
	.091	1.866			Sul.	—	85°	001 cleav.	Blue-green

Section 10. $N_F - N_G = .0195 \text{ to } .0245$

<i>Metatorbernite</i>									
<i>Wocherite</i>	.002	1.624			Phos.	+	0°±	Abn. int. colors	
	.026	1.716			Sil.	—	75°±	010 cleav.	Yellow

^a From TL-Li = .0094.	^h From "blue" - "red" = .0139.	^h From TL-Li = .0105.	ⁱ From TL-red = .0071.
^b From TL-Li = .0097.	ⁱ From TL-Li = .0093.	^o From TL-Li = .0094.	^u From TL-Li = .0097.
^c From TL-Li = .0086.	^j From TL-Li = .0078.	^p From TL-Li = .0085.	^v From TL-Li = .0108.
^d From "violet" - "red" = .014.	^k From TL-C = .0085.	^q From TL-Li = .0081.	^w From "blue" - "red" = .018.
^e From TL-Li = .0085.	^l From TL-Li = .0083.	^r From TL-Li = .0092.	^x From Bowen's graph.
^f From F-C = .015 for N _p as measured by V. E. Barnes at the University of Wisconsin, 1929.	^m From TL-Li = .010.	^s From "blue" - "red" = .016.	^y From "blue" - "red" = .02
^g From TL-Li = .010.			

TABLE V.—DISPERSION OF MINERALS

TABLE V.—DISPERSION OF MINERALS—Continued

N _D , N _F or N _m		N _D —N _F	Mineral	Chem.	Sign	2V	Other Characters	Page
F—C	D							
Section 10. N _F —N _C = .0195 to .0245—Continued								
.022± ^a	1.742	.000	Garnet	Sil.	..	.....	Insol.	174
.02± ^b	1.755	.000	<i>Arsenolite</i>	As ₂ O ₃	..	.....	Oct., Mass.	43
.0204	1.786	.026	<i>Allacite</i>	Phos.	—	4°	X=green; Y, Z=yellow	155
.021± ^c	1.786	.038	<i>Tephroite</i>	Sil.	—	65°	Pleo. Gel. HCl	194
.02± ^d	1.807	.000	<i>Gahnite</i>	ZnAl ₂ O ₄	..	.....	Octahedral	63
.021 ^e	1.838	.000	<i>Uvarovite</i>	Sil.	..	.....	Insol.	180
.023± ^f	1.875	.242	Siderite	FeCO ₃	—	0°	1011 cleav. Efferv. HCl	76
.022± ^g	1.909	.083	Titanite	Sil.	+	26°	Wedge cryst. Extr. Disp.	204
.021	1.92	.016	<i>Scheelite</i>	CaWO ₄	+	0°	111 cleav.	97
.023	1.93±	.05±	Zircon	ZrSiO ₄	+	0°	Tet. prisms. G.=4.7	183
Section 11. N _F —N _C = .0245 to .0295								
.029	1.652	.017	<i>Mullite</i>	Sil.	+	50°±	010 cleav. Pink	201
.027± ^h	1.664	.150	<i>Strontianite</i>	SrCO ₃	—	11°	110 cleav. Efferv. HCl	81
.028±	1.75±	.04±	<i>Epidote</i>	Sil.	—	75°±	001 cleav. Golden	314
.027± ⁱ	1.76±	.000	Grossularite	Sil.	..	.....	Insol.	180
.027	1.812	.000	<i>Beckelite</i>	Sil.	..	.....	100 cleav. Yellow	420
.029	1.84±	.000	<i>Roméite</i>	Antim.	..	.....	111 cleav. Yellow	159
.026	1.883	.017	<i>Anglesite</i>	PbSO ₄	+	70°±	001, 010 cleav. G.=6.3	99
.025	2.42	.000	<i>Diamond</i>	C	..	.....	111 cleav. H.=10	13
Section 12. N _F —N _C = .0295 to .0495								
.03± ^j	1.75	.045	<i>Lorenzenite</i>	Sil.	+	39°	120 cleav. Rare	400
.035± ^k	1.799	.05	Acmite	Sil.	—	62°	110 cleav. at 87°	234

.04± ^k	1.89±	.000	Andradite	Sil.	.....	Insol.	180
.033± ^l	1.90±	.09±	Titanite	Sil.	33°±	Wedge cryst. Extr. Disp.	204
.04± ^m	1.97	.011	Powellite	CaMoO ₄	0°	111 cleav. Tet.	98
.049	1.99±	.096	Cassiterite	SnO ₂	0°	110 cleav. G.=7±	52
.049	2.06	.000	Chlorargyrite	AgCl	.....	H.=1.5. G.=5.5	30
.046	2.06	.012	Pyromorphite	Phos.	0°	Hex. Sol. HNO ₃	131
.035± ⁿ	2.074	.273	Cerussite	Carb.	9°	110 cleav. G.=6.5	80
.04± ^o	2.087	.000	Senarmontite	Sb ₂ O ₃	.....	Oct. Sol. HCl	43
.045± ^p	2.16 Li	.000	Manganosite	MnO	.....	100 cleav. Green	41

Section 13. $N_F - N_C = .0495 \text{ to } .0995$

.066	1.82	.09	Carphosiderite	Sul.	0°	0001 cleav. Sol. HCl	107
.057±	1.97	.683	Calomel	Hg ₂ Cl ₂	0°	100 cleav. Tet.	30
.053± ^q	2.00	.000	Pyrochlore	Colum.	.....	Oct. Brown±	163
.08	2.013	.016	Zincite	ZnO	0°	0001 cleav. Red±	41
.07± ^r	2.038	.287	Sulfur	S	69°	G.=2. Yellow±	14
.05	2.06	.000	Chlorargyrite	AgCl	.....	H.=1.5. G.=5.5	30
.08	2.25	.000	Bromyrite	AgBr	.....	H.=1.5. G.=6.0	30
.091	2.295	.010	Finnemanite	Arsen.	0°	1011 cleav. G.=7.2	159
.08± ^s	2.356	.022	Wurtzite	ZnS	0°	Fibrous. Pleo.	20
.09	2.368±	.000	Sphalerite	ZnS	.....	110 cleav. Sol. HCl	19
.09± ^t	2.41±	.08±	Stibioantimonite	Tant.	75°	100 cleav. G.=7	167
.073	2.654	.043	Moissanite	SiC	0°	H.=9.5. G.=3.2	17

- ^k From TI-Li=.0145.
^l From Na-Li=.007.
^m From TI-Li=.014.
ⁿ From "green"-"yellow"=.0126.
^o From TI-Li=.013.
^p From TI-Li=.0156.
^q From TI-Li=.015.
^r From Na-Li=.014.
^s From "green"-"red"=.03.
^t From TI-Li=.035.
^u From TI-Li=.042.
^v From Na-Li=.026.
^w From TI-Li=.059.

TABLE V.—DISPERSION OF MINERALS—Continued

N, N _o or N _m		N _D —N _p	Mineral	Chem.	Sign	2V	Other Characters	Page
F—C	D							
Section 14. N _F —N _C = .0995 to .195								
.125 ^a	2.21	.01	<i>Ioderylite</i>	AgI	+	0°	0001 cleav. G.=5.6	30
.12± ^a	2.30	.000	<i>Brunnerite</i>	Ox.	..	.....	Ps. Tet. G.=5±	69
.13± ^b	2.35	.000	<i>Marshite</i>	CuI	..	.....	110 cleav. G.=5.6	30
.13± ^c	2.39	.14±	<i>Goethite</i>	Ox.	—	Sm.	010 cleav. Extr. Disp.	47
.134	2.41±	.098	<i>Wulfenite</i>	PbMoO ₄	—	0°	111 cleav. G.=6.9	98
.12± ^a	2.481	.271	<i>Pyrophanite</i>	MnTiO ₃	—	0°	0221 cleav. Red±	67
.142	2.56	.073	<i>Octahedrite</i>	TiO ₂	—	0°	001 cleav. Pleo.	53
.13± ^c	2.59	.14±	<i>Brookite</i>	TiO ₂	+	Sm.	Poor cleav. Brown	59
.158± ^d	2.60±	.286	Rutile	TiO ₂	+	0°	Acic. G.=4.2	50
Section 15. N _F —N _C >.195								
.21± ^e	2.23	.000	<i>Bunsenite</i>	NiO	..	.....	Oct. Green	41
.23± ^f	2.47±	.000	<i>Sphalerite</i>	(Zn, Fe)S	..	.....	110 cleav. Brown	19
.23± ^g	2.51	.023	<i>Greenockite</i>	CdS	+	0°	G.=4.8. Yellow	21
.55± ^h	2.84	Str.	<i>Tenorite</i>	CuO	—	?	Nearly opaque	41
.4± ⁱ	2.91	36	<i>Cinnabar</i>	HgS	+	0°	1010 cleav. Red	21
.33± ^j	3.087	.295	<i>Proustite</i>	Ag ₃ AsS ₃	—	0°	1011 cleav. Scarlet	27
.34± ^k	3.176	.110	<i>Hutchinsonite</i>	Tl, As, S	—	38°	100 cleav. Scarlet	28
.5± ^l	3.22	.28	HEMATITE	Fe ₂ O ₃	—	0°	Red to opaque	44

^a From Na—Li=.04.^b From Tl—Li=.072.^c From Na—Li=.044.^d From Tl—Li=.105.^e From "blue"—"red"=.21.^f From Na—Li=.075.^g From "green"—"red"=.136.^h From "blue"—"red"=.55.ⁱ From 599μ—762μ=.149.^j From Na—Li=.109.^k From D—C=.113.^l From D—C=.178.

EXPLANATION OF PLATES

PLATE I.—The colored diagram shows the relation between interference colors of crystals, the thickness of the sections and the birefringence of the crystals. The interference colors begin with darkness at the left for zero birefringence and continue through gray, white, yellow and red to the end of the first order. The second order begins with blue and continues through green and yellow to end with the second red. The third order is similar to the second order, but the colors are somewhat paler. In the fourth order the colors are still paler, and the diagram does not go beyond the fourth order because the colors in higher orders are too pale to be of much use. The vertical coordinate on the diagram gives the thickness of the section, from zero to 0.06 millimeter. The birefringence ($N_o - N_p$) is given by the figures along the top and right side of the colored portion, and these should be used with the diagonal lines across the diagram. The interference color produced by a section of any crystal depends upon the birefringence ($N_o - N_p$) of the crystal, the thickness of the section, and the direction in which the section is cut with respect to the optic axis or optic axes of the crystal. In using the diagram to determine a mineral in a thin section it is desirable to use the following procedure:

1. Determine the thickness of the section (unless it can be safely assumed to be of standard thickness, namely 0.03 mm.) by finding the highest interference color given by some known mineral such as quartz or feldspar; if quartz, with $N_o - N_p = 0.009$, gives pure white as its highest interference color, it is easy to find from the diagram that the intersection of pure white with the diagonal line for $N_o - N_p = 0.009$ is at a point indicating a thickness (on the horizontal line) of about 0.03 mm.

2. Find the highest interference color given by the unknown mineral, taking care to note the order of the colors observed (see Part I, pages 112 and 116 to 119).

3. Find the point where this highest interference color intersects the line for the measured thickness; from this point follow the diag-

onal line to the top or right side, where the birefringence of the mineral will be found, as well as the names of important minerals having that birefringence.

In using the diagram it should be remembered that only rock-forming minerals and a few others are given along the border; when studying ores, etc., the diagram will give the birefringence. but will not always give the name of the mineral.

Furthermore, the diagram is based on the assumption that all minerals have the same birefringence for light of all wave-lengths; this is only approximately true for most minerals. Therefore, slight differences of tint are to be expected between the colors of the diagram and the colors observed. It is only in very rare cases that these differences are sufficient to interfere with the use of the diagram.

Many minerals vary in composition and therefore vary in birefringence; in general, minerals are entered on the diagram as many times as necessary to express all variations in their birefringence.

PLATE II.—In Plate II the most important minerals are arranged on the basis of their refringence, birefringence and optic sign. The horizontal coordinate is the refringence (N , N_o or N_m) with a change of scale at 1.85 and a range from 1.45 to 2.45. The vertical coordinate is birefringence ($N_g - N_p$) with zero birefringence in the middle of the diagram, birefringence of positive minerals from zero to 0.060 in the upper half and birefringence of negative minerals from zero to 0.060 in the lower half of the diagram.

Nearly all minerals vary in composition and therefore vary in refringence and birefringence, and, in some cases, in optic sign. All known variations in refringence and birefringence (and sign) are shown on the diagram, and this results in the condition that most minerals are represented not by points, nor even lines, but by areas. When data are sufficiently abundant and accurate the lines of the diagram are drawn as curves, as illustrated in the case of plagioclase (birefringence = $\pm 0.01 \pm$ and refringence = 1.53 to 1.58) and of scapolite (birefringence = $-0.02 \pm$ and refringence = $1.56 \pm$) but in most cases data are scanty and not highly accurate—then the lines are straight. In some cases—notably in the case of ordinary hornblende (birefringence = $-0.02 \pm$ and refringence = $1.65 \pm$)—available accurate data do not represent the limits of variation, and the area shown will be enlarged when accurate data are at hand.

When minerals vary in optic sign by passing through zero birefringence, the condition is easily shown by means of a line crossing

zero birefringence as illustrated by scapolite (birefringence = $-0.02 \pm$ and refringence = $1.56 \pm$) or by means of an area crossing zero birefringence, as illustrated by chlorite (birefringence = $+0.015$ to -0.01 and refringence = 1.55 to 1.67). When minerals vary in sign by means of having the optic angle ($2V$) pass through 90° , the condition is not so easily shown on the diagram, but it is indicated by the change of full lines to dash lines in the case of plagioclase (shown both in the positive and the negative fields at birefringence = $0.01 \pm$ and refringence = 1.53 to 1.58) or by a full line continued by an arrow with the appropriate sign; then the continuation of the line can be found in the field of opposite sign; this condition is illustrated by the case of olivine at birefringence = 0.036 and refringence = 1.65 to 1.68 in the positive field and at refringence = $1.68 +$ and birefringence = 0.037 in the negative field.

The diagram permits one to find very readily all the indices of refraction of any mineral. If the mineral is isotropic, its position along the middle line (zero birefringence) gives its only index, N . The name of every anisotropic mineral on the diagram is followed by a number which gives the value of the true optic angle ($2V$) in degrees. If a mineral is uniaxial the name is followed by 0° ; its position on the diagram gives the value of N_o and the optic sign; if the mineral is positive N_o is also N_p and N_g may be obtained by adding the birefringence to the value of N_p . If the mineral is negative N_o is also N_g and N_p may be obtained by subtracting the birefringence from the value of N_p . Finally, if the mineral is biaxial, its position on the diagram is determined by N_m and $N_g - N_p$, and the other indices (N_g and N_p) may be obtained readily from its optic sign, birefringence and optic angle by the use of the small diagram in the lower right hand corner of the main diagram. This small diagram has the true optic angle ($2V$) as the vertical coordinate, and, as the horizontal coordinate, it has $K = \frac{B_a}{N_g - N_p}$ and $K' = \frac{B_o}{N_g - N_p}$, in which B_a = the birefringence of the acute bisectrix section and B_o = the birefringence of the obtuse bisectrix section. For positive minerals, $K = \frac{N_m - N_p}{N_g - N_p}$ and $K' = \frac{N_g - N_m}{N_g - N_p}$ and, for positive minerals K is the (decimal) fraction of the birefringence ($N_g - N_p$) which must be added to N_m in order to obtain N_g and K is the (decimal) fraction of the birefringence which must be subtracted from N_m to obtain N_p ; for negative minerals K' is the

(decimal) fraction of the birefringence which must be subtracted from N_m in order to obtain N_p and K is the (decimal) fraction of the birefringence which must be added to N_m in order to obtain N_g . Accordingly, K' gives the decimal fraction of the birefringence to be added to or subtracted from N_m , *as suggested by the optic sign*, to obtain another index, and K gives the decimal fraction of the birefringence to be added to or subtracted from N_m , *contrary to the suggestion of the optic sign* to obtain the third index. For example, from the main diagram anhydrite is positive with $2V=42^\circ$, $N_m=1.576$ and $N_g-N_p=0.044$; from the small diagram for $2V=42^\circ$, $K'=0.87$ and $K=0.13$; accordingly, $N_g=1.576+0.044\times0.87=1.614$ and $N_p=1.576-0.044\times0.13=1.570$. These are the correct values of N_g and N_p .

In using this diagram to determine minerals it is desirable, first, to determine the optic sign, second, to measure the birefringence, and, third, to estimate the refringence. For the estimation of the refringence any section may be used if the birefringence of the mineral is weak, but a section showing the lowest interference color should be used if the birefringence of the mineral is not weak. Then, by making a small allowance for error in the measurement of the birefringence and a larger allowance for error in estimating the refringence, an area may be outlined on the diagram in which the unknown mineral will be found, if it is a rock-forming mineral. One reason why it is worth while to be able to obtain the other indices of refraction from the diagram is that they give the possible range of refringence which the mineral may show.

PLATE III.—The stereographic plot of Wulff is a device for plotting and measuring angles in a stereographic projection. It is printed on translucent paper so as to permit the reproduction from it of as many white prints as may be desired for use in the study of the optic properties of feldspars and in the study of any biaxial minerals by the methods of the universal stage.

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